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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, Germany
Tel.: (+49) 9 41/40 90-0
Fax: (+49) 9 41/40 90-7001
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 Subject to change without notice

The information contained in this technical file comprises the technical specifications approved at the time of printing. Significant modifications will be included in a new edition of the technical file.

The document number and version number of this technical file are shown in the footer.

1.3 Completeness

This technical file is incomplete without the supporting documentation.

1.4 Supporting documents

The following documents apply to this product:

• Operating instructions
• Connection diagrams

Also observe generally valid legislation, standards, guidelines and specifications on accident prevention and environmental protection in the respective country of use.
1.5 Safekeeping

This technical file and all supporting documents must be kept ready at hand and accessible for future use at all times.

1.6 Notation conventions

This section contains an overview of the symbols and textual emphasis used.

1.6.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.6.1.1 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 and source of danger

Consequences

► Action

► Action

1.6.1.2 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.

1.6.1.3 Signal words and pictograms

The following signal words are used:

<table>
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<th>Meaning</th>
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<tr>
<td>DANGER</td>
<td>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Indicates a hazardous situation which, if not avoided, could result in injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
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Table 1: Signal words in warning notices
1.6.2 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.

1.6.3 Typographic conventions

The following typographic conventions are used in this technical file:

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<th>Typographic convention</th>
<th>Purpose</th>
<th>Example</th>
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<td>UPPERCASE</td>
<td>Operating controls, switches</td>
<td>ON/OFF</td>
</tr>
<tr>
<td>[Brackets]</td>
<td>PC keyboard</td>
<td>[Ctrl] + [Alt]</td>
</tr>
<tr>
<td><strong>Bold</strong></td>
<td>Software operating controls</td>
<td>Press <strong>Continue</strong> button</td>
</tr>
<tr>
<td>…&gt;…&gt;…</td>
<td>Menu paths</td>
<td>Parameter &gt; Control parameter</td>
</tr>
<tr>
<td><em>Italics</em></td>
<td>System messages, error messages, signals</td>
<td><em>Function monitoring</em> alarm triggered</td>
</tr>
<tr>
<td>[► Number of pages]</td>
<td>Cross reference</td>
<td>[► 41].</td>
</tr>
</tbody>
</table>

Table 3: Typographic conventions
2 Safety

2.1 General safety information

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

▪ Read this technical file through carefully to familiarize yourself with the product.
▪ Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use

The product and associated equipment and special tools supplied with it comply with the relevant legislation, regulations and standards, particularly health and safety requirements, applicable at the time of delivery.

If used as intended and in compliance with the specified requirements and conditions in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any hazards to people, property or the environment. This applies throughout the product's entire life, from delivery through installation and operation to disassembly and disposal.

The operational quality assurance system ensures a consistently high quality standard, particularly in regard to the observance of health and safety requirements.

The following is considered appropriate use

▪ The product must be operated in accordance with this technical file and the agreed delivery conditions and technical data
▪ The equipment and special tools supplied must be used solely for the intended purpose and in accordance with the specifications of this technical file

2.3 Inappropriate use

Use is considered to be inappropriate if the product is used other than as described in the Appropriate use section. Please also note the following:

▪ Risk of explosion and fire from highly flammable or explosive gases, vapors, or dusts. Do not operate product in areas at risk of explosion.
▪ Unauthorized or inappropriate changes to the product may lead to personal injury, material damage, and operational faults. Only modify product following discussion with Maschinenfabrik Reinhausen GmbH.
2 Safety

2.4 Personnel qualification

The product is designed solely for use in electrical energy systems and facilities operated by appropriately trained staff. This staff comprises people who are familiar with the installation, assembly, commissioning and operation of such products.

2.5 Operator’s duty of care

To prevent accidents, disruptions 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:

▪ All warning and hazard notices are complied with.
▪ Personnel are instructed regularly in all relevant aspects of operational safety, the operating instructions and particularly the safety instructions contained therein.
▪ Regulations and operating instructions for safe working as well as the relevant instructions for staff procedures in the case of accidents and fires are kept on hand at all times and are displayed in the workplace where applicable.
▪ The product is only used when in a sound operational condition and safety equipment in particular is checked regularly for operational reliability.
▪ Only replacement parts, lubricants and auxiliary materials which are authorized by the manufacturer are used.
▪ The specified operating conditions and requirements of the installation location are complied with.
▪ All necessary devices and personal protective equipment for the specific activity are made available.
▪ The prescribed maintenance intervals and the relevant regulations are complied with.
▪ Installation, electrical connection and commissioning of the product may only be carried out by qualified and trained personnel in accordance with this technical file.
▪ The operator must ensure appropriate use of the product.
3 Product description

This chapter contains an overview of the design and function of the product.

3.1 Scope of delivery

The following items are included in the delivery:

- TAPCON® 260
- CD MR-Suite (contains the TAPCON®-trol program)
- Technical files
- Serial cable RS232
- USB adapter with installation CD (optional)

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.

3.2 Function description of the voltage regulation

The TAPCON® 260 serves to keep constant the output voltage of a bank of transformers with on-load tap-changers. The bank of transformers consists of 3 single-phase transformers, each with an on-load tap-changer and motor-drive unit.

The TAPCON® 260 compares the measured voltage of the bank of transformers \( U_{\text{actual}} \) with a defined reference voltage \( U_{\text{desired}} \). The difference between \( U_{\text{actual}} \) and \( U_{\text{desired}} \) is the control deviation \( dU \).

The TAPCON® 260 parameters can be optimally adjusted to the line voltage response to achieve a balanced control response with a small number of tap-change operations by the on-load tap-changer.

The following diagram shows an overview of voltage regulation.

![Diagram of voltage regulation](image)

Figure 1: Overview of voltage regulation of a bank of transformers
3.3 Performance features

The TAPCON® 260 is responsible for controlling tapped transformers in a bank of transformers.

Apart from control tasks, the TAPCON® 260 provides additional functions such as:

- Integrated protective functions:
  - Undervoltage blocking and overvoltage blocking
  - Overvoltage detection with high-speed return
- Compensation for voltage drops on the line (line drop compensation)
- Compensation for voltage fluctuations in the meshed grid (Z compensation)
- Digital inputs and outputs can be individually programmed on-site by the user
- Additional indicators using LEDs outside the display
- Display of all measured values such as voltage, current, active power, apparent power or reactive power, power factor (cos ϕ)
- Selection of 3 different desired values
- When ordering you can choose between tap position capture:
  - using analog signal 4…20 mA
  - using analog signal via resistor contact series
  - using digital signal via BCD code
- Parallel operation of up to 16 banks of transformers in 2 groups using the following methods:
  - Master/Follower
  - Circulating reactive current minimization

3.4 Operating modes

The device can be operated in the following operating modes:

Auto mode (AUTO)

In auto mode, the voltage is automatically controlled in accordance with the set parameters. You cannot change further device settings in auto mode. There is no active management by a higher level control system in this operating mode.

Manual mode (MANUAL)

In manual mode, there is no automatic control. The motor-drive unit can be controlled via the device’s operating panel. You can change the device settings.
Local mode (LOCAL)

There is no active management by a superordinate control system in this operating mode.

Remote mode (REMOTE)

In remote mode, you can perform commands using an external control level. In this case, manual operation of the AUTO, LOCAL, REMOTE, and buttons is disabled.

<table>
<thead>
<tr>
<th></th>
<th>AUTO</th>
<th>AUTO</th>
<th>SET</th>
<th>SET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOCAL</td>
<td>REMOTE</td>
<td>LOCAL</td>
<td>REMOTE</td>
</tr>
<tr>
<td>Automatic regulation</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tap-change operation using operating controls</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Tap-change operation using inputs</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Tap-change operation using SCADA*</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Value adjustment using SCADA*</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 4: Overview of operating modes

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

3.5 Hardware

The individual assemblies are fitted in a standardized 19-inch plug-in housing. The front panels of the assemblies are secured to the plug-in housing at the top and bottom. An IEC 60603-2 plug connector provides the electrical connection.

The assemblies are connected to one another via a data bus and direct current (DC) supply. This allows for an upgrade with additional plug-in modules and extension cards at a later date.
3 Product description

Figure 2: Front view

<table>
<thead>
<tr>
<th></th>
<th>Operating panel with display and LEDs</th>
<th>3</th>
<th>19-inch plug-in housing (in accordance with DIN 41494 Part 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating panel with display and LEDs</td>
<td>3</td>
<td>19-inch plug-in housing (in accordance with DIN 41494 Part 5)</td>
</tr>
<tr>
<td>2</td>
<td>Rack for optional expansions</td>
<td>4</td>
<td>Name plate</td>
</tr>
</tbody>
</table>

3.5.1 Name plate

The name plate is on the outside of the device:

Figure 3: Name plate

3.5.2 Operating controls

The device has 15 pushbuttons. The illustration below is an overview of all the device's operating controls.
3.5.3 Display elements

The device has a graphics display and 15 LEDs, which indicate the various operating statuses or events.
## 3 Product description

![Display elements](image)

**Figure 5: Display elements**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>LED Colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating status LED, green</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Overcurrent blocking LED, red</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Undervoltage blocking LED, red</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Overvoltage blocking LED, red</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Parallel operation active LED, green</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NORMset active LED, green</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Parallel operation fault LED, yellow</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Tap difference LED, yellow</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Motor protective switch LED, yellow</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Master LED, green/yellow/red</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Graphics display</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Auto mode active LED</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Manual mode active LED</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Remote operating mode active LED</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Lower tap-change active LED</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Raise tap-change active LED</td>
<td></td>
</tr>
</tbody>
</table>
3 Product description

Display

![Display Image](image)

**Figure 6: Display**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Status line</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Measured voltage $U_{\text{Act}}$</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Reference voltage $U_{\text{Ref}}$</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Other measured values (use [→] or [←] to switch between them)</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Current tap position ED1, ED2, ED3</td>
<td>10</td>
</tr>
</tbody>
</table>

Other measured values

In auto mode and manual mode the measured value display 4 can be set using the \[→\] or \[←\] keys. The following measured values can be displayed:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>dU</td>
<td>Control deviation</td>
</tr>
<tr>
<td>I</td>
<td>Current</td>
</tr>
<tr>
<td>S</td>
<td>Apparent power</td>
</tr>
<tr>
<td>P</td>
<td>Active power</td>
</tr>
<tr>
<td>Q</td>
<td>Reactive power</td>
</tr>
</tbody>
</table>
### Status line

Current messages and events are displayed in the status line. You can find more information about messages and events in the Messages chapter.

### 3.5.4 Serial interface

The parameters for the device can be set using a PC. The COM 1 (RS232) serial interface on the front panel is provided for this purpose. You can use the connection cable supplied to establish a connection to your PC via the RS232 or USB port (using the optional USB adapter).

TAPCON®-trol software is needed for parameterization via the serial interface. The software and the related operating instructions are contained on the CD provided.

![Device connection to a PC](image)

Figure 7: Device connection to a PC

### 3.5.5 Assemblies

Depending on configuration, the device may have various assemblies which perform the functions required. Depending on configuration, the device may be equipped with the following assemblies:
The functions of the assemblies are described in the following sections. You can find more information about the assemblies in the Technical data [► 148] section.

### 3.5.5.1 Power supply

The wide range power supply (SU card) supplies the device with power. Depending on configuration, the device is equipped with one of the following variants:

- **SUH-P**: Rated input voltage 100...240 V AC or 88...353 V DC (input voltage range 88...264 V AC, 88...353 V DC)
- **SUM-P**: Input voltage 36...72 V DC
- **SUL-P**: Input voltage 18...36 V DC

![Figure 8: SUH-P card](image-url)
3 Product description

3.5.5.2 Voltage measurement and current measurement

To measure voltage and current, the device can be equipped with the assembly MI or MI3-G:

- MI: 1-phase measurement of voltage and current
- MI3-G: 3-phase measurement of voltage and current

Only connect the MI card to one current transformer, otherwise the current measurement will not work.
3.5.5.3 **Digital inputs and outputs**

To record and output digital signals, the device may be equipped with the following assemblies:

- IO card
- UC card

**IO card**

The IO card contains 9 digital inputs and 8 digital potential-free outputs. 5 outputs take the form of change-over contacts.
3.5.5.4 Analog inputs and outputs

To record and output analog signals, the device may be equipped with the following assemblies:

- AD card
- AD8 card
- AN card

**AD card**

The analog input card has 1 input or with an extension card 2 inputs that can record the following analog signals:

- 0...±10 V
- 0...±10 mA
- 0...±20 mA
Resistance measurement (50...2 000 Ω)

Figure 15: AD card

Only use the R8/R12 and R42/R46 rotary potentiometers to calibrate the resistance measurement.

AD8 card

The analog input card has 8 inputs that can record the analog signals (4...20mA).

Figure 16: AD8 card

AN card

Depending on configuration, the AN card provides 2 analog outputs or with an extension module AN1 a total of 4 analog outputs. The following signal types are supported:

- 0...±20mA
- 0...±10mA
- 0...±1mA
- 0...±10V
3.5.5.5 **Control voltage supply**

An additional non-regulated control voltage of 60 V DC can be created with the AC card if your system does not have external DC voltage as the signal voltage for the device’s digital inputs. Depending on device configuration, one of the following two variants can be fitted:

- AC230: 230 V AC input voltage
- AC115: 115 V AC input voltage

**Risk of injury from increased output voltage**

Slight loading of the AC card may result in the output voltage increasing to up to 85 V DC.

► Only wire card when not energized.

The output performance of the AC card is limited. The generated DC voltage can be used only for the control inputs of the device.
3.5.5.6 Central processing unit

The CPU card is the device's central computing unit. All internal device functions and the application functions, such as processing measured values, are controlled and monitored by the CPU card.

The CPU card contains a flash memory (optional measured value memory) as a non-volatile data storage in which the operating data such as measured values or events are stored. An EEPROM for storing parameters and a real-time clock (RTC) for recording time are included on the CPU card.

The CPU card contains the following interfaces:
- RS232 system interface
- CAN bus

3.5.5.7 System networking

As an option, the device can be equipped with up to 2 CIC cards. The CIC cards are used to communicate using a control system protocol or TAPCON®-trol software (CIC2).
3 Product description

Figure 21: CIC card

<table>
<thead>
<tr>
<th>1</th>
<th>RS232</th>
<th>6</th>
<th>TxD LED for transmit signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>RS485</td>
<td>7</td>
<td>RxD LED for receive signal</td>
</tr>
<tr>
<td>3</td>
<td>RJ45 (Ethernet), optional</td>
<td>8</td>
<td>Clk LED for operating mode (flashes for 2 seconds)</td>
</tr>
<tr>
<td>4</td>
<td>Fiber-optic cable, optional</td>
<td>9</td>
<td>Clip for connecting cable shield</td>
</tr>
<tr>
<td>5</td>
<td>Reset key</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4 Packaging, transport and storage

4.1 Packaging

4.1.1 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.

4.1.2 Markings

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Protect against moisture" /></td>
<td>Protect against moisture</td>
</tr>
<tr>
<td><img src="image" alt="Top" /></td>
<td>Top</td>
</tr>
<tr>
<td><img src="image" alt="Fragile" /></td>
<td>Fragile</td>
</tr>
<tr>
<td><img src="image" alt="Attach lifting gear here" /></td>
<td>Attach lifting gear here</td>
</tr>
<tr>
<td><img src="image" alt="Center of mass" /></td>
<td>Center of mass</td>
</tr>
</tbody>
</table>

Table 7: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

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

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

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):
- Completeness based on the delivery slip
- External damage of any type.

The checks must take place after unloading when the crate or transport container can be accessed from all sides.
Visible damage  If external transport damage is detected on receipt of the shipment, proceed as follows:

- 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.

4.3 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.
5 Mounting

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

**WARNING**

Electric shock

Risk of fatal injury due to electrical voltage.

- De-energize the device and system peripherals and lock them to prevent them from being switched back on.
- Do so by short-circuiting the current transformer; do not idle the current transformer.

**NOTICE**

Electrostatic discharge

Damage to the device due to electrostatic discharge.

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

### 5.1 Preparation

The following tools are needed for mounting:

- Screwdriver for the fixing bolts (M6)
- Small screwdriver for connecting the signal lines and supply lines

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

### 5.2 Mounting device

Depending on your order, you can mount the device in one of the following variants:

- 19" frame (in accordance with DIN 41494 Part 5)
- 19" flush control panel frame

Below you will find a description of how to mount the device in a 19" frame. For control panel installation or wall mounting, note the technical files supplied.

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

1. Place cage nuts in the desired locations on the 19" frame, noting the device dimensions [► 155].
5 Mounting

2. Place device in 19" frame and screw down.

![Figure 22: Example of device mounting in a 19" frame](image)

5.3 Connecting device

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

**WARNING**

**Electric shock**
Risk of fatal injury due to connection mistakes

- 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, near the device’s power supply so that it is freely accessible. This will allow the device to be replaced with ease in the event of a defect.

5.3.1 Cable recommendation

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

Excessive line capacitance can prevent the relay contacts from breaking the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control lines on the function of the relay contacts.
<table>
<thead>
<tr>
<th>Cable</th>
<th>Card</th>
<th>Terminal</th>
<th>Cable type</th>
<th>Conductor cross-section</th>
<th>Max. length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>SU</td>
<td>X1:1/2</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Voltage measurement</td>
<td>MI/MI1</td>
<td>1/2</td>
<td>Shielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Current measurement</td>
<td>MI/MI1</td>
<td>5/6/9/10</td>
<td>Unshielded</td>
<td>4 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Relay*</td>
<td>IO</td>
<td>X1:1...10</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Relay*</td>
<td>UC</td>
<td>X1:1...10</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>IO</td>
<td>X1:11...17</td>
<td>Shielded</td>
<td>1.0 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>UC</td>
<td>X1:11...17</td>
<td>Shielded</td>
<td>1.0 mm²</td>
<td>-</td>
</tr>
<tr>
<td>CAN bus</td>
<td>CPU</td>
<td>1...5</td>
<td>Shielded</td>
<td>1.0 mm²</td>
<td>2000 m</td>
</tr>
</tbody>
</table>

Table 8: Recommendation for connection cable (standard connections)

*) Observe line capacitance, see note above.

<table>
<thead>
<tr>
<th>Cable</th>
<th>Card</th>
<th>Terminal</th>
<th>Cable type</th>
<th>Conductor cross-section</th>
<th>Max. length</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>AC</td>
<td>X1/2:1/2</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Analog inputs</td>
<td>AD8</td>
<td>X1:1...3</td>
<td>Shielded</td>
<td>1.5 mm²</td>
<td>400 m (&lt; 25 Ω/km)</td>
</tr>
<tr>
<td>Analog outputs</td>
<td>AN/AN1</td>
<td>X1</td>
<td>Shielded</td>
<td>1mm²</td>
<td>-</td>
</tr>
<tr>
<td>RS-232</td>
<td>CIC</td>
<td>X8</td>
<td>Shielded</td>
<td>0.25 mm²</td>
<td>25 m</td>
</tr>
<tr>
<td>RS-485</td>
<td>CIC</td>
<td>X9</td>
<td>Shielded</td>
<td>0.75 mm²</td>
<td>1000 m (&lt; 50 Ω/km)</td>
</tr>
<tr>
<td>Ethernet</td>
<td>SID</td>
<td>RJ45</td>
<td>shielded, CAT 7</td>
<td>-</td>
<td>100 m</td>
</tr>
<tr>
<td>Media converter</td>
<td>MC1</td>
<td>-</td>
<td>Optical fiber with MTRJ-ST duplex patch cable</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Media converter</td>
<td>MC2</td>
<td>-</td>
<td>Fiber-optic cable, connector type: F-ST; fiber type: multi mode/single mode; wavelength: 1310 nm</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 9: Recommendation for connection cable (optional connections)
5.3.2 Information about laying fiber-optic cable

To ensure the smooth transfer of data via the fiber-optic cable, you must ensure that mechanical loads are avoided when laying the fiber-optic cable and later on during operation.

Please note the following:
- Radii must not fall below the minimum permissible bend radii (do not bend fiber-optic cable).
- The fiber-optic cables must not be over-stretched or crushed. Observe the permissible load values.
- The fiber-optic cables must not be twisted.
- Be aware of sharp edges which could damage the fiber-optic cable’s coating when laying or could place mechanical loading on the coating later on.
- Provide a sufficient cable reserve near distributor cabinets for example. Lay the reserve such that the fiber-optic cable is neither bent nor twisted when tightened.

5.3.3 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.

5.3.3.1 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.

5.3.3.2 Wiring requirement of operating site

Note the following when wiring the operating site:
- The connection cables must be laid in metallic cable ducts with a ground connection.
- Do not route lines which cause interference (for example power lines) and lines susceptible to interference (for example signal lines) in the same cable duct.
- Maintain a gap of at least 100 mm between lines causing interference and those susceptible to interference.
Figure 23: Recommended wiring

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cable duct for lines causing interference</td>
</tr>
<tr>
<td>2</td>
<td>Interference-causing line (e.g. power line)</td>
</tr>
<tr>
<td>3</td>
<td>Cable duct for lines susceptible to interference</td>
</tr>
<tr>
<td>4</td>
<td>Line susceptible to interference (e.g. signal line)</td>
</tr>
</tbody>
</table>

- Short-circuit and ground reserve lines.
- The device must never be connected using multi-pin collective cables.
- Signal lines must be routed in a shielded cable.
- The individual conductors (outgoing conductors/return conductors) in the cable core must be twisted in pairs.
- The shield must be fully (360°) connected to the device or a nearby ground rail.

Using "pigtails" may limit the effectiveness of the shielding. Connect close-fitting shield to cover all areas.
5.3.3.3 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.
- The device must be grounded at the screw provided, the protective grounding connection, using a ground strap (cross-section min. 8 mm²).
5.3.3.4 Information about shielding the CAN bus

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

**NOTICE**

**Damage to the device**

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

► Connect the devices to a potential compensation rail to compensate for potential.

► If both devices have different potentials, only connect the CAN bus cable's shielding to one device.

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

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

1. Connect all devices to a potential compensation rail to compensate for the potential.
2. Connect CAN bus cable's shielding to all connected devices.
Variant 2: The connected devices have different potential

Note that the shielding is less effective with this variant.

If the devices to be connected have different potential, proceed as follows:
► Connect CAN bus cable's shielding to just one device.

Connecting shielding

Connect the CAN bus cable's shielding to the intended point on the CPU card using the cable clips provided:

![Figure 26: Securing the shielding](image)

5.3.4 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 [► 33].
► Connect the lines to be wired to the device to the system periphery as shown in the connection diagrams supplied.

5.3.5 Wiring device

To obtain a better overview when connecting cables, only use as many leads as necessary.
To wire the device, proceed as follows:
✓ Note the connection diagram.
✓ Use only the specified cables for wiring. Note the cable recommendation [► 33].
✓ Wire the lines to the system periphery [► 39].
1. Strip insulation from lines and leads.
2. Crimp stranded wires with wire end sleeves.
4. Fasten screws for the corresponding terminals using a screwdriver.
5. Plug connectors into the correct slots.

5.3.6 Checking functional reliability
To ensure that the device is wired correctly, check its functional reliability.

NOTICE
Damage to device and system periphery
An incorrectly connected device can lead to damages in the device and system periphery.
► Check the entire configuration before commissioning.
► Prior to commissioning, be sure to check the actual voltage and operating voltage.

Check the following:
▪ Once you have connected the device to the grid, the screen displays the MR logo and then the operating screen.
▪ The green Operating display LED top left on the device's front panel lights up.

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

- Check the entire configuration before commissioning.
- Prior to commissioning, be sure to check the actual voltage and operating voltage.

We recommend using a device for industrial instrumentation to record the actual transformer voltage value in order to evaluate how the device is functioning.

### 6.1 Setting the display contrast

You can adjust the contrast in the display with the help of an adjustment screw on the front of the device. To adjust the contrast, proceed as follows:

- Use a screwdriver to turn the adjustment screw on the front until the contrast is adjusted to the desired setting.

![Figure 27: Setting the display contrast](image)

### 6.2 Setting parameters

To commission the device, you must set the following parameters. For more detailed information about the parameters, refer to the respective sections.
6.2.1 Setting the language

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

<table>
<thead>
<tr>
<th>Language</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Italian</td>
</tr>
<tr>
<td>German</td>
<td>Portuguese</td>
</tr>
<tr>
<td>French</td>
<td>Russian</td>
</tr>
<tr>
<td>Spanish</td>
<td></td>
</tr>
</tbody>
</table>

To set the language, proceed as follows:

1. MENU > F4 Configuration > F3 General. ➔ Language
2. Press F1 or F5 to select the required language.
3. Press ➔ The language is set.

6.2.2 Setting date and time

You must set the system date and system time on the device. You must set the date and time in the following formats:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD.MM.YY</td>
<td>HH:MM:SS</td>
</tr>
</tbody>
</table>

The time does not switch from daylight saving time to standard time and back automatically. You have to change the time manually.

Time

To set the time, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F4 Memory > Press ➔ until the desired display appears.
   ➔ Time
2. Press F4 to highlight a digit.
   ➔ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ➔ The time is set.
Date

To set the date, proceed as follows:

1. Configuration > F4 Continue > F4 Memory > Press until the desired display appears.
   ⇒ Date
2. Press F4 to highlight a digit.
   ⇒ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press .
   ⇒ The date is set.

6.2.3 Setting further parameters

Set further parameters to commission the device. More detailed information about each of the parameters can be found in the Functions and settings [► 54] chapter.

Setting transformer data

Set the transformer data and phase difference of the current transformer and voltage transformer:

1. Set primary transformer voltage [► 87].
2. Set secondary transformer voltage [► 87].
3. Set primary transformer current [► 88].
4. Select current-transformer connection [► 89].
5. Select transformer circuit [► 89].

Setting NORMset

If you want to commission voltage regulation quickly, you can activate NORMset mode. If you want to set the parameters yourself, continue with the sections below.

► Activate NORMset and set the relevant parameters [► 63].

Setting control parameters

Set the following control parameters:

1. Set desired value 1 [► 67].
2. Set the bandwidth [► 68].
3. Set delay time T1 [► 68].
4. Switch all motor-drive units into the same tap position [► 54].
Setting line drop compensation (optional)

If you need line drop compensation, you must set all important parameters for this:
1. Select the LDC compensation method [► 77].
2. Set the line data for the ohmic voltage drop Ur [► 79].
3. Set the line data for the inductive voltage drop Ux [► 79].

Setting parallel operation on several banks of transformers (optional)

If you need parallel operation, you must set all important parameters for this:
1. Set the parallel operation method to the circulating reactive current method [► 94].
2. Assign the CAN bus address [► 93].
3. Set circulating reactive current sensitivity [► 95].
4. Set circulating reactive current blocking [► 95].

Setting control system protocol (optional)

If you need a control system protocol, you must set all important parameters for this. More detailed information about this can be found in the control system protocol description.

Setting tap position capture via analog input (optional)

If you want to capture the tap position via the analog input, you must set the parameters required for this:
► Capture tap positions via analog input (input 1 or input 2) [► 98].

All parameters relevant to commissioning are entered. Continue with the function tests.

6.3 Function tests

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

- You must ensure that the REMOTE mode is disabled before you can control the on-load tap-changer manually in manual mode.
- You can only activate the on-load tap-changer manually in manual mode using the [ ] and [ ] keys.
- During the function test, you must set the most important parameters. Details on the parameters listed can be found in the Functions and settings [► 54] chapter.
6.3.1 Checking control functions

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

- Supply voltage must be present.
- All motor-drive units must be in the same tap position.

1. Press to select manual mode.
2. Set transmission ratio for voltage transformer, current transformer and measuring set-up.
3. Measure actual voltage and compare with the measured value displayed on the device's main screen.
4. Press key several times to display the operating values for current, power and phase angle and compare them with values of service instruments.
5. Control all on-load tap-changers manually with the or keys and the "ED all" selection until the measured voltage (U_actual) reaches the desired voltage (U_desired) set in the next stage.
6. Set desired value 1 to the value you want [► 67].
7. Set bandwidth depending on step voltage [► 68].
8. Set delay time T1 to 20 seconds [► 68].
9. Set control response T1 to linear [► 69].
10. Press and select the "ED all" option to raise the on-load tap-changer 1 step.
11. Press to select auto mode.
   → After 20 seconds, the device returns the on-load tap-changer to the original operating position.
12. Press to select manual mode.
13. Press and select the "ED all" option to lower the on-load tap-changer 1 step.
14. Press to select auto mode.
   → After 20 seconds, the device returns the on-load tap-changer to the original operating position.
15. Press to select manual mode.
16. Set delay time T2 to 10 seconds [► 70].
17. Activate delay time T2.
18. Press twice and select the "ED all" option to raise the on-load tap-changer 2 steps.
19. Press \textcolor{red}{\textbf{Auto}} to select auto mode.
   → After 20 seconds, the device lowers the on-load tap-changer one step and after another 10 seconds another step.

20. Press \textcolor{red}{\textbf{Manual}} to select manual mode.

21. Set delay time $T_1$ [⇒ 68] and delay time $T_2$ [⇒ 70] to the desired value.

We recommend a temporary setting of 100 seconds for delay time $T_1$ when commissioning the transformer. Depending on the operating conditions, you can also specify the delay time following a longer observation period. In this regard, it is useful to register how the actual voltage progresses and the number of tap-change operations per day.

6.3.2 Checking additional functions

This section describes how you can check the following additional functions:

- Undervoltage blocking
- Overvoltage blocking
- Activation of desired values 2 and 3
- Line drop compensation
- Z compensation

Proceed as follows:

Checking undervoltage blocking $U<$

1. Press \textcolor{red}{\textbf{Manual}} to select manual mode.
2. Set undervoltage $U < \%$ to 85 $\%$ [⇒ 72].
3. Set the absolute limit values parameter to Off [⇒ 71].
4. Set the $U<$ blocking parameter to On [⇒ 73].
5. Set desired value 1 such that the measured voltage is below the undervoltage $U<$ $\%$ limit value [⇒ 67].

Measured voltage = 100 V
Desired value 1 = Set to 120 V (greater than 100 V/0.85 = 117 V).

→ The Undervoltage $U<$ LED will light up.
→ After around 10 seconds the Undervoltage message appears in the display and the relevant signaling relay is activated.

6. Press \textcolor{red}{\textbf{Auto}} to select auto mode.
   → The device blocks and does not issue any control commands.

7. Press \textcolor{red}{\textbf{Manual}} to select manual mode.
8. Reset the operating values for **desired value 1** and **undervoltage U< [%]** to the desired operating values.
   ⊳ The function test for undervoltage blocking is complete.

**Checking overvoltage blocking U>**

1. Press ⚙ to select manual mode.
2. Set overvoltage U> [%] to 115 % [► 74].
3. Set the absolute limit values parameter to Off [► 71].
4. Set desired value 1 such that the measured voltage Uactual is above the overvoltage U> [%] limit value [► 67].
   
   Measured voltage = 100 V
   Desired value 1 = Set to 85 V (less than 100 V/1.15 = 87 V).

   ⊳ The **Overvoltage U>** LED will light up.
   ⊳ The **Overvoltage** message appears in the display and the relevant signaling relay is activated.

5. Press AUTO to select auto mode.
   ⊳ The LOWER output relay emits a control command every 1.5 seconds.

6. Press ⚙ to select manual mode.
7. Reset the operating values for **desired value 1** and **overvoltage U> [%]** to the desired operating values.
   ⊳ The function test for overvoltage blocking is complete.

**Checking desired value 2 and desired value 3**

1. Press ⚙ to select manual mode.
2. Set **desired value 2** to the value you want. [► 67]
3. Apply voltage L+ to terminal **desired value 2** (see connection diagram).
4. Press ESC until the main screen is displayed.
   ⊳ **Desired value 2** is shown on the main screen.
5. Set desired value 3 to the value you want [► 67].
6. Apply voltage L+ to terminal **desired value 3** (see connection diagram).
7. Press ESC until the main screen is displayed.
   ⊳ **Desired value 3** is shown on the main screen.
   ⊳ The function test for **desired value 2** and **desired value 3** is complete.
Checking line drop compensation

If you want to use line drop compensation, you need to run this function test. A load current of ≥ 10 % of the nominal transformer current is needed for the following function tests. Before the function test, ensure that all parameters for line drop compensation [► 77] and for Z compensation [► 80] are set to 0.

1. Press to select manual mode.
2. Press until the main screen is displayed.
3. If necessary, press until the control deviation $d_U$ is shown.
   - The measured voltage must be within the bandwidth.
4. Set line drop compensation $U_r$ parameter to 20.0 V [► 79].
   - The control deviation $d_U$ must be negative.
5. Set line drop compensation $U_x$ parameter to -20.0 V [► 79].
6. Press until the main screen is displayed.
7. If necessary, press until the control deviation $d_U$ is shown.
   - The control deviation $d_U$ must be positive.

If the control deviation appears in the opposite direction, change the polarity of the current transformer.

8. Set the line drop compensation $U_r$ and line drop compensation $U_x$ parameters to the desired operating values.
   - The function test for line drop compensation is complete.

Checking Z compensation

If you want to use Z compensation, you need to run this function test. A load current of ≥ 10 % of the nominal transformer current is needed for the following function test.

1. Press to select manual mode.
2. Set all parameters for line drop compensation and Z compensation to 0.
3. Press until the main screen is displayed.
4. If necessary, press until the control deviation $d_U$ is shown.
   - The measured voltage must be within the bandwidth.
5. Set the Z compensation parameter to 15.0 V.
6. Press until the main screen is displayed.
7. If necessary, press until the control deviation $d_U$ is shown.
   - The control deviation $d_U$ must be negative.
If the control deviation appears in the opposite direction, change the polarity of the current transformer.

8. Set the **Z compensation** and **Z compensation limit value** parameters to the desired operating values.
   - The function test for Z compensation is complete.

**Also refer to**
- Setting Z compensation [▶ 81]
- Setting the Z compensation limit value [▶ 81]

### 6.3.3 Checking parallel operation of several banks of transformers

This section describes how you can run the function test for parallel operation of several banks of transformers.

**Requirements**

To obtain perfect functioning in parallel operation, the voltage regulator must be commissioned in simplex mode. Make sure that the conditions below have been fulfilled.

- All motor-drive units of the banks of transformers (ED1...ED3) are in the same tap position.
- All devices are set to the same operating parameters for **desired value**, **circulating reactive current sensitivity** and **delay time T1**.
- The circulating reactive current sensitivity on all devices must be set to 0 %.
- The **circulating reactive current blocking** parameter must be set to 20 %.
- You must undertake all settings in manual mode.
- Each device needs an individual address on the CAN bus.

#### 6.3.3.1 Checking circulating reactive current sensitivity

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

1. Adjust both transformers in simplex mode to the same actual voltage by means of the on-load tap-changer.
   - When both devices are in a state of equilibrium, then the value of the control deviation dV [%] is smaller than the set bandwidth. You can see this in the main screen if the mark for the measured voltage $U_{\text{actual}}$ is within the bandwidth.

2. Connect the transformers in parallel and enable the parallel control.
   - The two devices must still be in a state of equilibrium.
   - The **Parallel operation** LED on the front panel is illuminated.
3. On one of the two transformers, raise the tap position of the on-load tap-changer by one setting; on the second transformer, lower the tap position of the on-load tap-changer by one setting.
   ⇒ The two devices must still be in a state of equilibrium.

4. Adjust the **circulating reactive current sensitivity** until the result displayed exceeds the set value for the bandwidth by approx. 0.2 % to 0.3 %.
   ⇒ The value for the result changes in the help text in the last line of the display.

5. Set the value given in the previous step for all devices in parallel operation.

6. Press to select auto mode for both devices.
   ⇒ The devices return the on-load tap-changer units to the original tap positions.
   ⇒ The function test for circulating reactive current sensitivity is complete.

If the earlier tap positions are not reached, increase the value of the circulating reactive current sensitivity [► 95] parameter.

If one of the two on-load tap-changer units switches one or more tap positions higher and the other switches the same amount lower, you need to reduce the value of the circulating reactive current sensitivity [► 95] parameter.

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

### 6.3.3.2 Checking circulating reactive current blocking

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

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

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

3. Set the **parallel operation method** parameter to **circulating reactive current**.
4. The circulating reactive current blocking parameter should be reduced [95] from the set value of 20 % in steps of 1 % until the Parallel operation error: circulating reactive current limit exceeded is displayed.
   - The Parallel operation LED lights up when the circulating reactive current blocking limit is reached.
   - Any further regulation is blocked.

5. After the set delay time for the parallel operation error message (time can be adjusted [97]), the signaling relay UC-X1:1/UC-X1:2 (default setting) is activated.

6. Increase the circulating reactive current blocking parameter again until the message Parallel operation error: circulating reactive current limit exceeded disappears.

7. Press to select auto mode.
   - The motor-drive unit automatically returns to the original operating position.

8. Set the value determined for the circulating reactive current blocking on the devices in parallel operation as well.

   If one or all devices indicate Parallel operation error: circulating reactive current limit exceeded although the control inputs are correctly connected for all the devices, then all the devices block. This could be due to various causes. Further information is given in the chapter Troubleshooting [135].

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

### 6.3.3.3 Checking tap synchronization method

This section describes how to run the function test for tap synchronization (master/follower). If instances arise where a follower switches in the opposite direction to the master step change, then the setting for the tapping direction [63] parameter on the follower must be changed from Default to Swapped.

**NOTICE**

Damage resulting from formation of circulating reactive current

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

- Check transformer type plate.
- Set device parameters in accordance with transformer configuration.

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

1. Assign the master function to one device.
2. Assign the follower function to the other devices.
3. Compare the tap position displays 3 of devices 1 2. All devices must display the same tap position, if not switch them into the same one.

![Diagram comparing tap positions](image)

Figure 30: Comparing tap positions

<table>
<thead>
<tr>
<th></th>
<th>Master</th>
<th></th>
<th>Tap position display</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

To perform the function test, proceed as follows:

1. Press on the follower to select manual mode.
2. If necessary, set the follower tapping direction [► 63].
3. Press on the master to select manual mode.
4. Press or on the master to manually change the tap position.
5. Press on the follower to select auto mode.
   - The follower follows the master’s control command.
6. Press on the master to select auto mode.
7. Press on the follower to select manual mode.
8. Press or on the follower to manually change the tap position.
   - After expiry of the set delay time for parallel operation errors [► 97], the Tap difference to follower error message is displayed in the main screen on the master.
9. Press several times on the follower to manually increase the tap position by the number of permitted steps (maximum permitted tap difference) and then one more step.

⇒ After expiry of the set delay time for parallel operation errors, the following error messages are displayed on the master: *Parallel operation error: tap difference to follower*

⇒ After expiry of the set delay time for parallel operation errors, the following error messages are displayed on the follower: *Parallel operation error: permitted tap difference to master exceeded.*

10. Press *Auto* on the follower to select auto mode.

⇒ There is no response. All devices remain blocked.

11. Press in the master and follower to select manual mode.

12. Press or on the master and follower to manually set the desired step.

Because in parallel operation the tap positions of the transformers which are running in parallel are compared following the *Automatic tap synchronization* method, it is absolutely essential that these transformers have the same position designation and that the *Raise* and *Lower* signals produce the same voltage change in all transformers.

⇒ The function tests for the tap synchronization method are complete.

Installation and commissioning of the device is complete.
7 Functions and settings

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

7.1 Key lock

The device is equipped with a key lock to prevent unintentional operation. You can only set or change the parameters when the key lock is deactivated in manual mode.

Activating key lock

To activate the key lock, proceed as follows:

► Press Esc and F5 at the same time.

⇒ A confirmation appears in the display for a brief period. The key lock is activated. Parameters can no longer be entered.

Deactivating key lock

To deactivate the key lock, proceed as follows:

► Press Esc and F5 at the same time.

⇒ The key lock is deactivated. Parameters can be entered.

7.2 Carrying out tap-change operation manually

In manual mode [► 15] you can manually carry out an on-load tap-changer tap-change operation. To do this, you can choose whether you want to switch 1 motor-drive unit individually (ED 1...ED 3) or all 3 motor-drive units at the same time (ED all).

By switching the motor-drive units individually, you can compare the tap positions of the on-load tap-changers in the 3 transformers. If the tap positions are different, the tap difference LED lights up.

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

1. If necessary, press Esc to activate manual mode.
2. Press and hold down or .

⇒ The "Syn. Control up/down" display appears.
3. Press F2, F5 as required to select the option you want.

⇒ The tap-change operation is carried out.

7.3 General

You can undertake general settings on the device in the General menu item.
7 Functions and settings

7.3.1 Setting device ID

You can use the device ID parameter to assign a 4-digit ID to the device. This ID is used to uniquely identify the device in the TAPCON®-trol software.

To set the device ID, proceed as follows:

1. Press \( \text{Menu} > \text{F4} \) Configuration > \( \text{F3} \) General > Press \( \cdot \) until the desired parameter is displayed.
   \( \Rightarrow \) Regulator ID.

2. Press \( \text{F1} \) to change the first digit.
   \( \Rightarrow \) If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.

3. Press \( \text{F1} \) (digit > 9) until another digit position appears.

4. If necessary, press \( \text{F4} \) in order to highlight the digit position.
   \( \Rightarrow \) The required digit is highlighted and can be changed.

5. Press \( \text{F1} \) or \( \text{F5} \) to change the digit.

6. Repeat steps 3 to 5 until all required digits have been entered.

7. Press \( \cdot \)
   \( \Rightarrow \) The device ID is set.

7.3.2 Setting the baud rate

You can use this parameter to set the COM1 interface's baud rate. You can select the following options:

- 9.6 kilobaud
- 19.2 kilobaud
- 38.4 kilobaud
- 57.6 kilobaud

To set the baud rate, proceed as follows:

1. Press \( \text{Menu} > \text{F4} \) Configuration > \( \text{F3} \) General > \( \cdot \) until the desired parameter is displayed.
   \( \Rightarrow \) Setting the baud rate.

2. Press \( \text{F1} \) or \( \text{F5} \) to select the required baud rate.

3. Press \( \cdot \)
   \( \Rightarrow \) The baud rate is set.
7.3.3 Setting the voltage display kV/V

This parameter sets how the measured voltage is displayed and used. You can select the following options:

- **V**: The secondary voltage of the system's voltage transformer is displayed in V and is the reference value for the control parameters.
- **kV**: The primary voltage of the system's voltage transformer is displayed in kV and is the reference value for the control parameters.

The voltage transformer's primary voltage is calculated by the device. For correct functions, you must set the transformer data \(\Rightarrow 86\).

To change the desired unit for the voltage display, proceed as follows:

1. Press \(\text{MENU} \rightarrow F4 \text{ Configuration} \rightarrow F3 \text{ General} \rightarrow \rightarrow\) until the desired parameter is displayed.
   \(\Rightarrow\) Display kV/V.
2. Press \(F1\) or \(F5\) to select kV or V units.
3. Press \(\rightarrow\)
   \(\Rightarrow\) The required unit is set for the voltage display.

7.3.4 Setting current display unit

In this display, you can set the unit for the limit values displayed for overcurrent and undercurrent as a percentage ("%") or absolute value ("A").

It is only possible to change from % to A if all the transformer data have previously been entered.

To set the desired unit for the current display, proceed as follows:

1. Press \(\text{MENU} \rightarrow F4 \text{ Configuration} \rightarrow F3 \text{ General} \rightarrow \rightarrow\) until the desired parameter is displayed.
   \(\Rightarrow\) Display %/A
2. Press \(F1\) or \(F5\) to select % or A units.
3. Press \(\rightarrow\)
   \(\Rightarrow\) The required unit is set for the current display.

7.3.5 Setting the switching pulse time

You can use this parameter to set the duration of the switching pulse for the motor-drive unit.
If you set the switching pulse time to 0 s, the motor-drive unit is activated with a continuous signal. The signal then remains active for as long as the or keys are pressed.

**Switching pulse in normal mode**

If you set the switching pulse time to 1.5 seconds for example, after the set delay time T1 or delay time T2 there will be a switching pulse of 1.5 seconds.

The waiting time between 2 consecutive switching pulses corresponds to the set delay time T1 or delay time T2.

![Diagram showing switching pulse time in normal mode](image)

Figure 35: Switching pulse time in normal mode

<table>
<thead>
<tr>
<th></th>
<th>Set delay time T1 or T2</th>
<th>2</th>
<th>Set switching pulse time (for example 1.5 seconds)</th>
</tr>
</thead>
</table>

If the motor-drive unit does not start with the factory setting (1.5 seconds), you need to extend the raise switching pulse time / lower switching pulse time.

**Switching pulse for rapid return control**

If you set the raise switching pulse time or lower switching pulse time to 1.5 seconds, for example, the next earliest switching pulse occurs in rapid return control mode 1.5 seconds after the previous switching pulse ended.
To set the pulse duration, proceed as follows:

1. **Menu > F4** Configuration > **F3** General > Press ➔ until the desired parameter is displayed.
   ➔ R/L pulse duration.

2. Press **F1** or **F5** to select the pulse duration you want.

3. Press ➔
   ➔ The R/L pulse duration is now set.

### 7.3.6 Configuring control inputs IO1-X1:33/31

Depending on your device configuration, the following parameters can be used by MR for special functions. In this case, these parameters are pre-assigned. You may not be able to view or freely assign these parameters.

You can use this parameter to assign functions to the freely configurable control inputs. You can assign the following functions:
### 7 Functions and settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>No function selected</td>
</tr>
<tr>
<td>Master/Follower</td>
<td>Master mode is activated when a signal is present.</td>
</tr>
<tr>
<td></td>
<td>Follower mode is activated when no signal is present.</td>
</tr>
<tr>
<td>Local/Remote</td>
<td><em>Local</em> operating mode is activated if the signal is present.</td>
</tr>
<tr>
<td></td>
<td><em>Remote</em> operating mode is activated if the signal is not present.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Automatic regulation is blocked.</td>
</tr>
<tr>
<td>LV S tap change</td>
<td><strong>Delay time T1</strong> and <strong>delay time T2</strong> are deactivated.</td>
</tr>
<tr>
<td></td>
<td>Raise switching pulse and lower switching pulse occur when value exceeds/falls below the bandwidth.</td>
</tr>
<tr>
<td>MPS triggered</td>
<td>The <em>Motor protective switch was triggered</em> message is assigned to the control input.</td>
</tr>
<tr>
<td>Remote/Local</td>
<td><em>Remote</em> operating mode is activated if the signal is present.</td>
</tr>
<tr>
<td></td>
<td><em>Local</em> operating mode is activated if the signal is not present.</td>
</tr>
</tbody>
</table>

Table 11: Possible functions for control inputs

If you set both control inputs to *Local/Remote* and there is a signal (1) at one input, but no signal (0) at the other control input, you can prevent the device from being operated. This means that the *Manual/Auto* and *Raise/lower* functions are not possible with either the keys on the front panel or the inputs for remote messages or serial interface.

To assign functions to the control inputs, proceed as follows:

1. Press **Menu** > **F4** Configuration > **F3** General > until the desired parameter is displayed.
   - IO1-X1:33 or IO1-X1:31.
2. Press **F1** or **F5** until the desired function appears in the display.
3. Press **←**
   - The function is assigned.

### 7.3.7 Configuring output relays IO1-X1:25/26 and IO1-X1:23/24

Depending on your device configuration, the following parameters can be used by MR for special functions. In this case, these parameters are pre-assigned. You may not be able to view or freely assign these parameters.
You can use this parameter to assign the freely configurable output relay messages which are to be issued. You can assign the following messages:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>No function selected</td>
</tr>
<tr>
<td>Master/Follower</td>
<td>Assign Master/Follower message.</td>
</tr>
<tr>
<td>Local/Remote</td>
<td>Assign Local/Remote message.</td>
</tr>
<tr>
<td>Undervoltage</td>
<td>Assign Undervoltage blocking message.</td>
</tr>
<tr>
<td>Overvoltage blocking</td>
<td>Assign Overvoltage blocking message.</td>
</tr>
<tr>
<td>Desired value 2</td>
<td>Assign Desired value 2 message.</td>
</tr>
<tr>
<td>Desired value 3</td>
<td>Assign Desired value 3 message.</td>
</tr>
<tr>
<td>MD operating time I&gt;</td>
<td>Pulse message triggered. Assign Motor runtime exceeded message.</td>
</tr>
<tr>
<td>MD operating time D&gt;</td>
<td>Continuous signal is active. Assign Motor runtime exceeded message.</td>
</tr>
<tr>
<td>Bandwidth &lt;</td>
<td>Assign Value fallen below bandwidth message.</td>
</tr>
<tr>
<td>Bandwidth &gt;</td>
<td>Assign Bandwidth exceeded message.</td>
</tr>
</tbody>
</table>

Table 12: Possible messages for output relays

To assign functions to the output relays, proceed as follows:

1. Press \( \text{F4} \) Configuration > \( \text{F3} \) General until the desired parameter is displayed.
   \( \Rightarrow \) IO1-X1:25/26 or IO1-X1:23/24.
2. Press \( \text{F1} \) or \( \text{F5} \) until the desired function appears in the display.
3. Press \( \text{F1} \) or \( \text{F5} \) until the desired function is assigned.

### 7.3.8 Dimming display

You can use this parameter to activate or deactivate automatic display dimming. You can select the following options:

- **On**: The display is automatically dimmed if no key is pressed for 15 minutes. The display returns to full brightness by pressing any key.
- **Off**: Automatic display dimming is deactivated.

Activating this function extends the display's service life.

To activate/deactivate automatic display dimming, proceed as follows:
1. Press **MENU** > **F4** Configuration > **F3** General > → until the desired parameter is displayed.
   - Display off.

2. Press **F1** or **F5** to activate/deactivate automatic dimming.

3. Press ←
   - Automatic dimming is set.

### 7.3.9 Setting motor runtime monitoring

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

**Behavior**

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

1. *Motor runtime monitoring* message is issued
2. Continuous signal via output relay *Motor-drive unit runtime exceeded* (optional)
3. Pulse signal via *Trigger motor protective switch* output relay (optional)

**Parameterizing control input**

To use runtime monitoring, you need to correctly wire the corresponding control input and parameterize to *Motor running*. The motor runtime must also be set.

**Wiring control input/output relay**

If you want to monitor the motor runtime, the device and motor-drive unit must be connected and parameterized as shown below.
If you want to use the output relay, the feedback from the motor-drive unit **Motor protective switch triggered** must also be wired to a control input and parameterized. This message resets the **Motor runtime exceeded** output relay when the motor protective switch is switched back on and activates the **Motor protective switch triggered** message.

If the runtime monitoring is set to 0.0 seconds this equates to it being switched off.

To set the motor runtime, proceed as follows:

1. **Menu > F4** Configuration > **F3** General > Press ··· until the desired parameter is displayed.
   - Motor runtime.

2. Press **F4** to highlight the position.
   - The desired position is highlighted and the value can be changed.

3. Press **F1** to increase the value or **F5** to reduce it.
4. Press →

⇒ The motor runtime is set.

7.3.10 Swapping tapping direction

Depending on your configuration, with this parameter, you can set how the device behaves in the event of a raise or lower tap change. This parameter is taken into account in the parallel operation method "tap synchronization" as follower and when checking the permitted tap position.

You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Signal at Raise relay: Device switches up one step to increase the voltage. Signal at Lower relay: Device switches down one step to decrease the voltage.</td>
</tr>
<tr>
<td>Swapped</td>
<td>Signal at Raise relay: Device switches down one step to increase the voltage. Signal at Lower relay: Device switches up one step to decrease the voltage.</td>
</tr>
</tbody>
</table>

Table 13: Device response

To select the tapping direction, proceed as follows:

1. Press MENU > F4 Configuration > F3 General > → until the desired parameter is displayed.

⇒ Tapping direction turned.

2. Press F1 or F5 to select the required option.

3. Press →

⇒ The tapping direction is selected.

7.4 NORMset

NORMset mode is used for quickly starting voltage regulation. In NORMset mode, the bandwidth and delay time parameters are automatically adapted to the requirements of the grid.

To start NORMset mode, you must set the following parameters:

- Normset activation
- Desired value 1
- Primary voltage
- Secondary voltage
Line drop compensation cannot be performed in NORMset mode.

Set the following parameters to operate the device in NORMset mode.

**Activating/deactivating NORMset**

You can use this parameter to activate NORMset mode.

A manual tap-change operation is required to activate NORMset. This is how the voltage regulator determines the bandwidth required.

If the transformer is switched off, another manual tap-change operation is required.

To activate/deactivate NORMset mode, proceed as follows:

1. **MENU > F2 NORMset**
   - NORMset activation.
2. Press **F1** or **F5** to activate NORMset by selecting On or to deactivate NORMset by selecting Off.
3. Press **Δ**.
   - NORMset is activated/deactivated.

**Setting the primary voltage**

With this parameter, you can set the voltage transformer's primary voltage.

To set the primary voltage, proceed as follows:

1. **MENU > F2 NORMset > Press ** until the desired parameter is displayed.
   - Primary voltage.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **Δ**.
   - The primary voltage is set.

**Setting the secondary voltage**

With this parameter, you can set the voltage transformer's secondary voltage.

To set the secondary voltage, proceed as follows:
1. **MENU** > **F2** NORMset > Press ➔ until the desired parameter is displayed.
   ⇐ Secondary voltage.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press ➔ The secondary voltage is set.

### Setting desired value 1

With this parameter, you can set the desired value for automatic voltage regulation. You can enter the desired value in V or in kV. If you enter the desired value in V, the value relates to the voltage transformer's secondary voltage. If you set the desired value in kV, the value relates to the voltage transformer's primary voltage.

Settings in kV are only possible if you have previously entered the parameters for primary and secondary voltage.

To set the desired value, proceed as follows:

1. **MENU** > **F2** NORMset > Press ➔ until the desired parameter is displayed.
   ⇐ Desired value 1.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press ➔ The desired value is set.

### 7.5 Control parameters

All of the required for the regulation function are described in this section. For voltage regulation, you can set the following parameters:

- Desired values 1…3
- Bandwidth
- Delay time T1
- Control response T1
- Delay time T2

For voltage regulation, you can set delay time T1 and also delay time T2. The following sections describe how the regulation function responds in both cases:
Behavior only with delay time T1

If the measured voltage $U_{\text{actual}}$ is within the set bandwidth, no control commands are issued to the motor-drive unit for the tap-change operation. Control commands will also not be issued to the motor-drive unit if the measured voltage returns to the tolerance bandwidth within the set delay time $T_1$. However, if the measured voltage deviates from the set bandwidth for a long period, a tap-change command occurs after expiration of the set delay time $T_1$. The on-load tap-changer carries out a tap-change in a raise or lower direction to return to the tolerance bandwidth.

![Figure 41: Behavior of the regulation function with delay time T1](image)

<table>
<thead>
<tr>
<th>1</th>
<th>$+ B%$: Upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>$U_{\text{desired}}$: Desired value</td>
</tr>
<tr>
<td>3</td>
<td>$- B%$: Lower limit</td>
</tr>
<tr>
<td>4</td>
<td>Set delay time $T_1$</td>
</tr>
<tr>
<td>5</td>
<td>$U_{\text{actual}}$: Measured voltage</td>
</tr>
<tr>
<td>6</td>
<td>$B%$: Tolerance bandwidth</td>
</tr>
</tbody>
</table>

- **A** $U_{\text{actual}}$ is outside the bandwidth. Delay time $T_1$ starts.
- **B** $U_{\text{actual}}$ is within the bandwidth before delay time $T_1$ is complete.
- **C** $U_{\text{actual}}$ is outside the bandwidth. Delay time $T_1$ starts.
- **D** $U_{\text{actual}}$ is still outside the bandwidth when delay time $T_1$ is complete. Tap-change operation is initiated.

Behavior with delay times $T_1$ and $T_2$

Delay time $T_2$ can be used to correct major control deviations more quickly. Ensure that you set a lower value in the "Delay time T2" parameter than in the "Delay time T1" parameter.
If the measured voltage $U_{\text{actual}}$ deviates from the set bandwidth for a long period $A$, a control impulse is output to the motor-drive unit after the set delay time $T_1$. If the measured voltage $U_{\text{actual}}$ is still outside the bandwidth, delay time $T_2$ starts once delay time $T_1$ is complete. Once delay time $T_2$ is complete, a control impulse is again output to the motor-drive unit for the tap change $C$ to return to the tolerance bandwidth.

![Figure 42: Behavior of the regulation function with delay times T1 and T2](image)

1. + B %: Upper limit
2. $U_{\text{desired}}$: Desired value
3. - B %: Lower limit
4. $U_{\text{actual}}$: Measured voltage
5. $B\%$: Tolerance bandwidth
6. Delay time $T_1$ complete. Tap change triggered.

The following sections describe how to set the relevant control parameters.

### 7.5.1 Setting desired value 1...3

You can use this parameter to set up to 3 desired voltage values $U_{\text{Ref}}$. The desired voltage value is specified as a fixed value. The desired value 1 is the default desired value. Desired values 2 and 3 are activated if there is a continuous signal at factory-preset control inputs IO-X1:31 or IO-X1:33 provided you have programmed these previously. If there is a signal at several control inputs at the same time, desired value 2 is activated.
7 Functions and settings

Options for setting the desired values

The device provides the following ways of changing the desired voltage value during operation:

- Using the control parameters menu item via the operating screen
- Using binary inputs
- Using control system protocols if a communication card is ready for operation

Reference of kV and V for voltage transformer

Desired values set in kV refer to the primary voltage of the voltage transformer. Desired values set in V refer to the secondary voltage of the voltage transformer. The transformer data must be entered correctly for this display.

To set the desired value, proceed as follows:

1. Press \( \text{Parameter} > \text{Control parameter} > \text{Press} \) until the desired parameter is displayed.
2. If you have already entered the transformer data, press \( \text{F3} \) to select the unit you want: "V" or "kV".
3. Press \( \text{F4} \) to highlight the position.
   - The desired position is highlighted and the value can be changed.
4. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
5. Press \( \text{F5} \) to save the value.

7.5.2 Bandwidth

You can use this parameter to set the maximum permissible deviation in measured voltage \( U_{\text{Act}} \). The deviation relates to the activated desired value. The following sections describe how you determine and set the bandwidth required.

7.5.3 Setting delay time T1

Use this parameter to set delay time T1. This function delays the issuing of a tap-change command for a defined period. This prevents unnecessary tap-change operations if the tolerance bandwidth is exited.

To set the delay time T1, proceed as follows:

1. Press \( \text{Parameter} > \text{Control parameter} > \text{Press} \) until the desired parameter is displayed.
2. Press \( \text{F4} \) to highlight the position.
   - The desired position is highlighted and the value can be changed.
3. Press \( \text{F1} \) to increase the time or \( \text{F5} \) to reduce it.
4. Press \( \rightarrow \)
\( \Rightarrow \) The delay time \( T1 \) is set.

### 7.5.4 Setting control response \( T1 \)

The control response \( T1 \) can be set to linear or integral.

**Linear control response \( T1 \)**
With linear control response, the device responds with a constant delay time regardless of the control deviation.

**Integral control response \( T1 \)**
With integral control response, the device responds with a variable delay time depending on the control deviation. The greater the control deviation \( (\Delta V) \) in relation to the set bandwidth \( (B) \), the shorter the delay time. The delay time can therefore be reduced down to 1 second. This means that the device responds faster to large voltage changes in the grid. Regulation accuracy improves as a result but the frequency of tap-changes increases too.

![Diagram showing integral control response](image)

Figure 43: Diagram showing integral control response

<table>
<thead>
<tr>
<th>( \Delta V/B )</th>
<th>Control deviation ( \Delta V ) as % of desired value as ratio to the set bandwidth ( B ) as % of desired value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“Delay time ( T1 )” parameter</td>
</tr>
</tbody>
</table>

To set the control response \( T1 \), proceed as follows:

1. Press \( \text{MENU} \rightarrow \text{F3} \) Parameter \( \rightarrow \text{F2} \) Control parameter \( \rightarrow \) Press \( \rightarrow \) until the desired parameter is displayed.
2. Press \( \text{F1} \) or \( \text{F5} \) to set the response you want.
3. Press \( \rightarrow \)
\( \Rightarrow \) The control response \( T1 \) is set.
7.5.5 Setting delay time T2

With this parameter, you can set delay time T2. Delay time T2 is used to compensate for large control deviations faster.

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

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

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

To set the delay time T2, proceed as follows:

1. Parameter > Control parameter > Press until the desired parameter is displayed. ⇒ Delay time T2.
2. Press F1 to increase the time or F5 to reduce it.
3. Press . ⇒ The delay time T2 is set.

Activating/deactivating delay time T2

To activate/deactivate delay time T2, proceed as follows:

1. Parameter > Control parameter > Press until the desired parameter is displayed. ⇒ T2 activation.
2. Press F5 or F1 to activate/deactivate T2.
3. Press . ⇒ The delay time T2 is activated/deactivated.

7.6 Limit values

In the Limit values menu item, you can set all the parameters needed for limit value monitoring as relative or absolute values. You can set three limit values:

▪ Undervoltage V<
▪ Overvoltage V>
▪ Overcurrent I>
Limit value monitoring is used to reduce damage to the system periphery. The following sections describe how you can set the parameters.

**7.6.1 Activating/deactivating absolute or relative limit values**

You can use this parameter to select either the set relative or absolute limit values. The following settings are possible:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>The device uses the relative limit values [%] you have entered</td>
</tr>
<tr>
<td>On</td>
<td>The device uses the absolute limit values [V] you have entered</td>
</tr>
</tbody>
</table>

Table 14: Selection between relative and absolute value

To activate/deactivate the absolute limit values, proceed as follows:

1. **Menu** > **F3** Parameter > **F3** Limit values.
   - Absolute limit values.
2. Press **F1** for On setting or **F5** for Off setting.
3. Press **Enter**
   - The absolute limit value is activated/deactivated.

**7.6.2 Setting undervoltage monitoring V<**

You can use these parameters to set the limit values for an undervoltage. Undervoltage monitoring prevents tap-change operations if there is a power cut.

**Behavior**

If the measured voltage \( U_{\text{actual}} \) falls below the set limit value \( L \), the red LED \( U< \) lights up. The switching pulses to the motor-drive unit are blocked at the same time provided you have activated the blocking undervoltage \( U< \) parameter. Once the set signaling delay time \( \rightarrow 73 \) has passed, the signaling relay activates. The **Undervoltage U<** message appears in the display. The message is reset as soon as the measured voltage \( U_{\text{actual}} \) again exceeds the limit value for undervoltage \( E \). If the measured voltage \( U_{\text{actual}} \) falls below 30 V \( C \) (for example when the transformer is switched off), the **Undervoltage** message is also displayed. You can however suppress \( \rightarrow 74 \) this message.
7 Functions and settings

Figure 44: Response to value falling below limit value

1. \( + B \% \): Upper limit
2. \( U_{\text{desired}} \): Desired value
3. \( - B \% \): Lower limit
4. Set limit value for undervoltage \( U< \)
5. Limit value for suppressing alarms below 30 V
6. Set signaling delay time for limit value for undervoltage \( U< \)
7. \( U_{\text{actual}} \): Measured voltage

<table>
<thead>
<tr>
<th>Setting undervoltage ( V&lt; ) as ( % )</th>
</tr>
</thead>
<tbody>
<tr>
<td>You can use this parameter to set the limit value as a relative value (%). This limit value refers to the desired value you have set. If you want to use the set relative value as the limit value, go to <strong>Absolute limit values</strong> and activate the Off selection.</td>
</tr>
</tbody>
</table>

To set the limit value for undervoltage \( V< \), proceed as follows:

1. **MENU** > F3 Parameter > F3 Limit values > Press \( \rightarrow \) until the desired parameter is displayed.
2. Press F1 to increase the value or F5 to reduce it.
3. Press \( \leftrightarrow \).

\( \Rightarrow \) The limit value is set.
Setting undervoltage V< in V/kV

You can use this parameter to set the limit value as an absolute value in V or kV units. If you use the F3 key to change the display to kV, this value relates to the primary transformer voltage. If you change the display to V, this relates to the secondary voltage.

If you want to use the set absolute values as the limit value, go to Absolute limit values and activate the On selection.

To set the absolute limit value for undervoltage V<, proceed as follows:
1. Press until the desired parameter is displayed.
2. If necessary press F3 to select the unit you want, "V" or "kV".
3. Press F1 to increase the value or F5 to reduce it.
4. Press The limit value is set.

Setting signaling delay time for undervoltage V<

You can use this parameter to set the delay time after which the Undervoltage relay is to activate and the event message appear on the display. This can be used to prevent messages from being issued when the value briefly falls below the limit value. The undervoltage LED always lights up immediately regardless.

To set the delay time for this message, proceed as follows:
1. Press until the desired parameter is displayed.
2. Press F4 to highlight the position. The desired position is highlighted and the value can be changed.
3. Press F1 to increase the time or F5 to reduce it.
4. Press The signaling delay time for undervoltage V< is set.

Activating/deactivating undervoltage blocking

You can use this parameter to set how the device behaves if the voltage falls below the undervoltage limit. You can select the following options:
### 7 Functions and settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Automatic regulation is blocked.</td>
</tr>
<tr>
<td>Off</td>
<td>Automatic regulation remains active.</td>
</tr>
</tbody>
</table>

Table 15: Behavior

To activate/deactivate the undervoltage blocking, proceed as follows:

1. **MENU** > **F3** Parameter > **F3** Limit values > Press ➔ until the desired parameter is displayed. ➔ V< blocking.
2. Press **F1** for On setting or **F5** for Off setting.
3. Press ➔. ➔ Undervoltage blocking is activated/deactivated.

### Activating/deactivating message for voltages below 30 V

You can use this parameter to set whether the *Undervoltage* message is to be suppressed at a measured value of less than 30 V. This setting is used to ensure that no event message appears when the transformer is switched off. You can select the following options:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>The <em>Undervoltage</em> message is also displayed when the measured value is less than 30 V.</td>
</tr>
<tr>
<td>Off</td>
<td>The <em>Undervoltage</em> message is no longer displayed when the measured value is less than 30 V.</td>
</tr>
</tbody>
</table>

Table 16: Response

To activate/deactivate the message, proceed as follows:

1. **MENU** > **F3** Parameter > **F3** Limit values > Press ➔ until the desired parameter is displayed. ➔ V< also under 30 V.
2. Press **F1** for On setting or **F5** for Off setting.
3. Press ➔. ➔ The message is activated/deactivated.

### 7.6.3 Setting overvoltage monitoring V>

You can use these parameters to set the limit values for overvoltage monitoring. This overvoltage monitoring triggers tap-change operations to return to the desired operating status. If the operating status can no longer be corrected, a message is triggered by the *Function monitoring* relay.
**Response to high-speed return**

If the measured voltage \( U_{\text{actual}} \) exceeds the set limit value 1, the red LED \( U> \) and associated signaling relay activate. The *Overvoltage \( U> \)* message appears in the display. At the same time, the high-speed return function is activated without delay time \( T1 \). Once the set switching pulse time 5 has passed, the tap position is lowered 6 by activating the motor-drive unit until the measured voltage \( U_{\text{actual}} \) again falls below the limit value 6. The *Overvoltage \( U> \)* message is reset.

![Diagram](image)

Figure 45: Response to limit value being exceeded

<table>
<thead>
<tr>
<th></th>
<th>Set limit value for overvoltage ( U&gt; )</th>
<th>6 ( U_{\text{actual}} ): Measured voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>+ B %: Upper limit</td>
<td>A Value exceeds limit value</td>
</tr>
<tr>
<td>3</td>
<td>( U_{\text{desired}} ): Desired value</td>
<td>B Value falls below limit value</td>
</tr>
<tr>
<td>4</td>
<td>- B %: Lower limit</td>
<td>C High-speed return is started (lower tap-change)</td>
</tr>
<tr>
<td>5</td>
<td>Set switching pulse time</td>
<td></td>
</tr>
</tbody>
</table>

The following sections describe how you can set the parameters for the overvoltage monitoring \( V> \) limit value.

**Set overvoltage \( V< \) as %**

The limit value is entered as a relative value (%) of the set desired value. To set the limit value, proceed as follows:
7.6.4 Setting overcurrent monitoring I>

You can use this parameter to set the limit value for overcurrent to prevent tap-change operations in the event of excess load currents.

If the measured current exceeds the set limit value, the red LED I> and associated signaling relay activate. The Overcurrent blocking message appears in the display. The device’s output pulses are blocked at the same time.

You have to enter the limit value as a relative value (%) of the current transformer’s set nominal current. You can use the F3 key to change the input from a percentage % to absolute values in amps A. The percentage value relates to the nominal current. To change the input, the transformer data [► 86] must be set.

To set the limit value I> overcurrent for overcurrent blocking, proceed as follows:

1. Press F3 until the desired parameter is displayed.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ➔.
4. The limit value is set.
7 Functions and settings

1. **Parameter > Limit values > Press until the desired parameter is displayed.**
2. If necessary press to select the unit you want: % or A.
3. Press to increase the value or to reduce it.
4. Press  
   ⇒ The limit value is set.

**7.6.5 Activating/deactivating function monitoring**

If the measured value leaves the current bandwidth (desired value +/- bandwidth) for more than 15 minutes without a tap-change operation taking place, the function monitoring relay is activated. This results in a message on the display which is only reset when the measured value returns to within the current bandwidth.

If the measured voltage is below 30 V, then the measured value is outside the bandwidth and the relevant relay is also activated after 15 minutes. You can deactivate this function if you want to avoid a function monitoring message when the transformer is switched off:

1. **Parameter > Limit values > Press until the desired parameter is displayed.**
2. Press or to select the option you want.
3. Press  
   ⇒ Function monitoring is activated/deactivated.

**7.7 Compensation**

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

- R&X compensation (line drop compensation)
- Z compensation

**7.7.1 R&X compensation**

R&X compensation (LDC) requires exact cable data. Line voltage drops can be compensated very accurately using LDC.

To set R&X compensation correctly, you need to calculate the ohmic and inductive voltage drop in V with reference to the secondary side of the voltage transformer. You also need to correctly set the transformer circuit used.
You can calculate the ohmic and inductive voltage drop using the following formulas. This voltage drop calculation relates to the relativized voltage on the secondary side of the voltage transformer.

**Formula for calculating the ohmic voltage drop:**

\[ U_r = I_N \cdot \frac{k_{CT}}{k_{VT}} \cdot r \cdot L \cdot K \ [V] \]

**Formula for calculating the inductive voltage drop:**

\[ U_x = I_N \cdot \frac{k_{CT}}{k_{VT}} \cdot x \cdot L \cdot K \ [V] \]

- \( U_r \) Ohmic resistance load in \( \Omega/km \)
- \( U_x \) Inductive resistance load in \( \Omega/km \)
- \( I_N \) Nominal current (amps) of selected current-transformer connection on device: 0.2 A; 1 A; 5 A
- \( k_{CT} \) Current transformer ratio
- \( k_{VT} \) Voltage transformer ratio
- \( r \) Ohmic resistance load in \( \Omega/km \) per phase
7 Functions and settings

<table>
<thead>
<tr>
<th>x</th>
<th>Inductive resistance load in Ω/km per phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Length of line in km</td>
</tr>
<tr>
<td>K</td>
<td>Nominal current factor</td>
</tr>
</tbody>
</table>

### 7.7.1.1 Setting the ohmic voltage drop Vr

You can use this parameter to set the ohmic voltage drop (ohmic resistance load).

If you do not want to use line drop compensation, you have to set the value 0.0 V.

To set the ohmic voltage drop Vr, proceed as follows:

1. Press [Parameter] > [Compensation] > [Vr line drop compensation].
3. Press [F1] to increase the value or [F5] to reduce it.
4. Press [ ] to The ohmic voltage drop Vr is set.

### 7.7.1.2 Setting the inductive voltage drop Vx

You can use this parameter to set the inductive voltage drop (inductive resistance load). The compensation effect can be rotated by 180° in the display using a plus or minus sign.

If you do not want to use line drop compensation, you have to set the value 0.0 V.

To set the inductive voltage drop Vx, proceed as follows:

1. Press [Parameter] > [Compensation] > [Vx line drop compensation].
3. Press [F1] to increase the value or [F5] to reduce it.
4. Press \( \rightarrow \).

\[ \Rightarrow \] The inductive voltage drop \( V_x \) is set.

### 7.7.2 Z compensation

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

**Figure 48: Z compensation**

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

\[
\Delta U = 100 \cdot \frac{U_{tr} - U_{load}}{U_{load}} \cdot \frac{I_N \cdot k_{CT}}{I}
\]

<table>
<thead>
<tr>
<th>( \Delta U )</th>
<th>Voltage increase</th>
<th>( I )</th>
<th>Load current in A</th>
</tr>
</thead>
<tbody>
<tr>
<td>( U_{tr} )</td>
<td>Transformer voltage with current ( I )</td>
<td>( I_N )</td>
<td>Nominal current of current-transformer connection in A (0.2 A; 1 A; 5 A )</td>
</tr>
<tr>
<td>( U_{load} )</td>
<td>Voltage on line end with current ( I ) and on-load tap-changer in same operating position</td>
<td>( k_{CT} )</td>
<td>Current transformer ratio</td>
</tr>
</tbody>
</table>

Sample calculation: \( U_{tr} = 100.1 \, V \), \( U_{load} = 100.0 \, V \), \( I_N = 5 \, A \), \( k_{CT} = 200 \, A/5 \, A \), \( I = 100 \, A \)

Produces a voltage increase \( \Delta U \) of 0.2%

The following sections describe how you can set the parameters you need for Z compensation.
7 Functions and settings

7.7.2.1 Setting Z compensation

This parameter sets the voltage increase \( \Delta V \) previously calculated.

If you do not want to use Z compensation, you have to set the value 0.0 %.

To set the Z compensation, proceed as follows:

1. \( \text{Menu} \rightarrow \text{F3 Parameter} \rightarrow \text{F4 Compensation} \rightarrow \text{Press } \rightarrow \text{until the desired parameter is displayed.} \)
   \( \Rightarrow \text{Z compensation.} \)
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \rightarrow \)
   \( \Rightarrow \) The Z compensation is set.

7.7.2.2 Setting the Z compensation limit value

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

If you do not want to use a limit value, you have to set the value 0.0 %.

To set the limit value, proceed as follows:

1. \( \text{Menu} \rightarrow \text{F3 Parameter} \rightarrow \text{F4 Compensation} \rightarrow \text{Press } \rightarrow \text{until the desired parameter is displayed.} \)
   \( \Rightarrow \text{Z comp. limit value.} \)
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \rightarrow \)
   \( \Rightarrow \) The limit value is set.

7.8 Cross-monitoring

You can use cross-monitoring to set reciprocal monitoring of 2 devices for compliance with the set voltage limit values. At least 2 devices with different CAN bus addresses are needed for cross-monitoring.
No measured value or measurement card error

For the check, the measured voltage of the device 1 is transmitted to the device 2 via a second separate measurement input and vice versa. The calculated measured voltage is compared with the original measured values via the CAN bus. If the measured values deviate, the Measured value error message is issued.

Checking the limit values

When checking the limit values, one device transmits a measured voltage to the other via the second separate measurement input. You can set the following limit values for this measured value:

- Separate desired value [► 82]
- Undervoltage limit value [► 83]
- Overvoltage limit value [► 84]

As soon as one of the set limit values is exceeded, once the set delay time for the error message [► 85] has lapsed, the Measured value error message is output. If wired accordingly, relay contacts can block the raise/lower pulse to the motor-drive unit. Regulation of individual devices is not affected by limit value monitoring.

The following sections describe how you set the relevant parameters for the monitoring device.

Also refer to

- Setting delay time for error message [► 85]
- Setting desired value for regulator 2 [► 82]
- Setting undervoltage limit value V< for regulator 2 [► 83]
- Setting overvoltage limit value V> for regulator 2 [► 84]

7.8.1 Setting desired value for regulator 2

You can use this parameter to set the desired value for the device to be monitored.

You can use the F3 key to change the display to the following units:
### 7.8.2 Setting undervoltage limit value $V<$ for regulator 2

You can use this parameter to set the undervoltage limit value $V<$ of the device to be monitored. You can set the undervoltage limit value $V<$ as an absolute value ($V$ or $kV$).

#### Setting absolute value

You can use the $F_3$ key to change the display to the following units:

<table>
<thead>
<tr>
<th>Volts (V)</th>
<th>Kilovolts (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This value relates to the secondary voltage of the system's voltage transformer.</td>
<td>This value relates to the primary voltage of the system's voltage transformer.</td>
</tr>
</tbody>
</table>

Table 18: Units available

If you want to change the display from $V$ to $kV$, you have to set the transformer data of the device to be monitored.

To set the undervoltage limit value of the voltage regulator to be monitored, proceed as follows:

1. Press $F_3$ to enter cross-monitoring.
2. Press $F_5$ to select the desired value of the device to be monitored.
3. Press $F_1$ to increase the value or $F_5$ to reduce it.
4. The desired value of the device to be monitored is set.

---

Volts (V) | Kilovolts (kV) |
-----------|----------------|
This value relates to the secondary voltage of the system's voltage transformer. | This value relates to the primary voltage of the system's voltage transformer.

Table 17: Units available

If you want to change the display from $V$ to $kV$, you have to set the transformer data of the device to be monitored.

To enter the desired value of the device to be monitored, proceed as follows:

1. $\text{Parameter > F}_3$ Cross-monitoring.
2. Press $F_1$ to increase the value or $F_5$ to reduce it.
3. The desired value of the device to be monitored is set.
   ⇒ V< regulator 2.
2. Press F1 to increase the value or F5 to reduce it.
3. Press →
   ⇒ The undervoltage limit value is set as an absolute value.

Setting relative value
To set the undervoltage limit value of the voltage regulator to be monitored, proceed as follows:
   ⇒ V< regulator 2.
2. Press F1 to increase the value or F5 to reduce it.
3. Press →
   ⇒ The undervoltage limit value is set as a relative value.

7.8.3 Setting overvoltage limit value V> for regulator 2
You can use this parameter to set the overvoltage limit value V> of the device to be monitored. You can set the undervoltage limit value V< as an absolute value (V or kV).

Setting absolute value
You can use the F3 key to change the display to the following units:

<table>
<thead>
<tr>
<th>Volts (V)</th>
<th>Kilovolts (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This value relates to the secondary voltage of the system's voltage transformer.</td>
<td>This value relates to the primary voltage of the system's voltage transformer.</td>
</tr>
</tbody>
</table>

Table 19: Units available

If you want to change the display from V to kV, you have to set the transformer data of the device to be monitored.

To set the overvoltage limit value of the voltage regulator to be monitored, proceed as follows:
7 Functions and settings

   ⇒ V> regulator 2
2. Press [F1] to increase the value or [F5] to reduce it.
3. Press [↓]
   ⇒ The overvoltage limit value is set as an absolute value.

Setting relative value

To set the overvoltage limit value of the voltage regulator to be monitored, proceed as follows:

   ⇒ V< regulator 2.
2. Press [F1] to increase the value or [F5] to reduce it.
3. Press [↓]
   ⇒ The overvoltage limit value is set as a relative value.

7.8.4 Setting delay time for error message

You can use this parameter to set the delay time for the cross-monitoring error message. If an error is recorded by a monitoring device, the error message is only displayed after the delay time.

To set the error message delay time, proceed as follows:

   ⇒ Error message.
2. Press [F1] to increase the value or [F5] to reduce it.
3. Press [↓]
   ⇒ The delay time is set.

7.8.5 Setting transformer for regulator 2

You use these parameters to set the transformer data of the device to be monitored.

Setting the primary transformer voltage

The primary transformer voltage is set in kV.

To set the primary transformer voltage of voltage regulator 2, proceed as follows:
1. **Parameter > Cross-monitoring > Press until the desired parameter is displayed.**
   - P.T. prim. voltage reg. 2.
2. Press **F3** to highlight the decimal place.
   - The decimal place is defined and the value can be changed.
3. Press **F1** to increase the value or **F5** to reduce it.
4. Press **†**.
   - The primary transformer voltage is set.

### Setting the secondary transformer voltage

The secondary transformer voltage is set in V.

To set the secondary transformer voltage of voltage regulator 2, proceed as follows:

1. **Parameter > Cross-monitoring > Press until the desired parameter is displayed.**
   - P.T. sec. voltage reg. 2.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **†**.
   - The secondary transformer voltage is set.

### 7.9 Transformer data

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

The following parameters are available for this purpose:

- Primary voltage
- Secondary voltage
- Primary current
- Secondary current (current transformer connection)
- Transformer circuit

The measured values displayed for the device are influenced by the settings for the above parameters. Note the table below.
7 Functions and settings

<table>
<thead>
<tr>
<th>Parameter set</th>
<th>Measured value display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary voltage</td>
<td>Secondary voltage</td>
</tr>
<tr>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 20: Influence of transformer data on measured value display

7.9.1 Setting the primary transformer voltage

This parameter can be used to set the primary transformer voltage in kV. When you are setting the primary transformer voltage, the device shows the primary voltage rather than the secondary voltage in the main screen and you can also set the control parameters in kV.

If a setting of 0 kV is chosen, no primary transformer voltage is displayed.

To set the primary transformer voltage, proceed as follows:

1. Press \( \text{F4} \) Configuration > \( \text{F2} \) Transformer data. 
2. Press \( \text{F3} \) to highlight the decimal place. 
3. Press \( \text{F4} \) to highlight the position. 
4. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it. 
5. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.

The primary transformer voltage is set.

7.9.2 Setting the secondary transformer voltage

This parameter can be used to set the secondary transformer voltage in V.
To set the secondary transformer voltage, proceed as follows:

1. MENU > F4 Configuration > F2 Transformer data > Press \( \rightarrow \) until the desired parameter is displayed.
   \( \Rightarrow \) Secondary voltage.

2. Press \( \rightarrow \) to highlight the position.
   \( \Rightarrow \) The desired position is highlighted and the value can be changed.

3. Press \( \uparrow \) to increase the value or \( \downarrow \) to reduce it.

4. Press \( \rightarrow \)
   \( \Rightarrow \) The secondary transformer voltage is set.

7.9.3 Setting primary transformer current

This parameter can be used to set the primary transformer current.

- When you are setting the primary transformer current, the measured value is displayed in the main screen.
- If you set a value of 0, no measured value is displayed in the main screen.

<table>
<thead>
<tr>
<th>Setting parameter</th>
<th>Current feed</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary current</td>
<td>Secondary current</td>
<td>Power connection</td>
</tr>
<tr>
<td>No parameterization</td>
<td>Unknown</td>
<td>1 A</td>
</tr>
<tr>
<td>No parameterization</td>
<td>1 A</td>
<td>1 A</td>
</tr>
<tr>
<td>50 A</td>
<td>Unknown</td>
<td>1 A</td>
</tr>
<tr>
<td>50 A</td>
<td>1 A</td>
<td>1 A</td>
</tr>
</tbody>
</table>

Table 21: Example of unit displayed: %/A

To set the primary transformer current, proceed as follows:

1. MENU > F4 Configuration > F2 Transformer data > Press \( \rightarrow \) until the desired parameter is displayed.
   \( \Rightarrow \) Primary current.

2. Press \( \rightarrow \) to highlight the position.
   \( \Rightarrow \) The desired position is highlighted and the value can be changed.
7 Functions and settings

3. Press \[F1\] to increase the value or \[F5\] to reduce it.
4. Press \[\leftarrow\] \\
   The primary transformer current is set.

7.9.4 Setting the current transformer connection

This parameter can be used to set the current transformer connection. This setting is needed for the device to display the correct secondary current in the info screen.

If you select the "Unknown" option, the percentage of current (with reference to the current transformer connection used) is displayed in the info screen.

- 0.2 A
- 1 A
- 5 A

To set the current transformer connection, proceed as follows:
1. \[\text{Configuration} \rightarrow \text{Transformer data} \rightarrow \text{Press} \leftarrow \text{until the desired parameter is displayed.} \]
   The current transformer connection.
2. Press \[F1\] or \[F5\] to select the required connection terminal.
3. Press \[\leftarrow\] \\
   The current transformer connection is set.

7.9.5 Setting the phase difference for the current transformer/voltage transformer

You can use this parameter to set the phase difference of the current transformer and voltage transformer. You can set the common transformer circuits as follows:

<table>
<thead>
<tr>
<th>Tap-change operation</th>
<th>Setting</th>
<th>Measurement method</th>
<th>Phase difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0 1PH</td>
<td>1 phase</td>
<td>0°</td>
</tr>
<tr>
<td>B</td>
<td>0 3PHN</td>
<td>3 phase</td>
<td>0°</td>
</tr>
<tr>
<td>C</td>
<td>0 3PH</td>
<td>3 phase</td>
<td>0°</td>
</tr>
<tr>
<td>D</td>
<td>90 3PH</td>
<td>3 phase</td>
<td>90°</td>
</tr>
<tr>
<td>E</td>
<td>30 3PH</td>
<td>3 phase</td>
<td>30°</td>
</tr>
<tr>
<td>F</td>
<td>-30 3PH</td>
<td>3 phase</td>
<td>-30°</td>
</tr>
</tbody>
</table>

Table 22: Set values for transformer circuit

Note the following sample circuits to select the correct transformer circuit.
Circuit A: 1-phase measurement in 1-phase grid

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

Circuit B: 1-phase measurement in 3-phase grid

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

Figure 52: Phase difference 0 3PH

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

Circuit D

Figure 53: Phase difference 90 3PH

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT is looped into the outer conductor L3.
- The current $I_{L3}$ is ahead of voltage $U_{L1} - V_{L2}$ by 90°.
- The voltage drop on an outer conductor is determined by the current $I_{L3}$. 
Circuit E

Figure 54: Phase difference 30 3PH

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

Circuit F

Figure 55: Phase difference -30 3PH

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

To set the phase difference for the transformer circuit, proceed as follows:
1. Press \textit{Menu} > \textbf{F4} Configuration > \textbf{F2} Transformer data > Press \textit{→} until the desired parameter is displayed.
   \(\Rightarrow\) Transformer circuit.

2. Press \textbf{F1} or \textbf{F5} to select the required phase difference.

3. Press \textit{←}
   \(\Rightarrow\) The phase difference is set.

\section*{7.10 Parallel operation of several banks of transformers}

In the \textit{Parallel operation} menu item, you can set the parameters needed for parallel operation of banks of transformers. Parallel operation of banks of transformers is used to increase the throughput capacity or short-circuit capacity in one place.

\subsection*{Conditions for parallel operation}

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

- Identical rated voltage
- Transformer power ratio (< 3 : 1)
- Maximum deviation of short-circuit voltages \((U_k)\) for transformers connected in parallel < 10 %
- Same number of switching groups

You can control up to 16 banks of transformers connected in parallel in one or 2 groups without detecting the system topology. Information is swapped between the voltage regulators operating in parallel using the CAN bus. Parallel operation is activated using one of 2 status inputs or the control system.

Parallel control can take one of two forms:

- Parallel operation following the "Circulating reactive current minimization" principle
- Parallel operation following the "Tap synchronization" (master/follower) principle

The following sections describe how you can set the parameters.

\subsection*{7.10.1 Assigning CAN bus address}

You can use this parameter to assign a CAN bus address to the device. So that all devices can communicate using the CAN bus, each device requires a unique identifier. Addresses can be set from 1 to 16. If the value is set to 0, then no communication takes place.

To enter the CAN bus address, proceed as follows:
1. Menu > F4 Configuration > F4 Parallel operation > Press \[\rightarrow\] until the desired parameter is displayed.
   ⇒ CAN address.
2. Press F1 to increase the value or F5 to reduce it.
3. Press \[\downarrow\]
   ⇒ The CAN bus address is saved.

7.10.2 Selecting parallel operation method

You can use this parameter to select a parallel operation method. Two different methods can be assigned to the device.

- Circulating reactive current minimization
- Tap synchronization (master/follower)

You must select the same parallel operation method for all voltage regulators operating in parallel.

The following sections describe how you can set the parameters for a parallel operation method.

7.10.2.1 Setting circulating reactive current method

When the **circulating reactive current** parallel operation method is selected, then parallel operation is carried out using the circulating reactive current minimization method. The circulating reactive current is calculated from the transformer currents and their phase angles. A voltage proportional to the circulating reactive current is added to the independently operating voltage regulators as a correction for the measurement voltage. This voltage correction can be reduced or increased using the circulating reactive current sensitivity setting.

The circulating reactive current method is suited to transformers connected in parallel with a similar nominal output and short-circuit voltage \( V_K \) and to vector groups with the same and different step voltages. This does not require any information about the tap position.

To set the **circulating reactive current** parallel operation method, proceed as follows:
1. Press \( \text{F1} \) or \( \text{F5} \) until \textit{circulating reactive current} appears in the display.

2. Press \( \text{F3} \). \( \Rightarrow \) The parallel operation method is set.

When using the \textit{circulating reactive current} parallel operation method, you have to set the parameters for the \textit{circulating reactive current sensitivity} and \textit{circulating reactive current blocking}.

**Setting circulating reactive current sensitivity**

The circulating reactive current sensitivity is a measure of its effect on the behavior of the voltage regulator. At a setting of 0 % no effect is present. With circulating reactive current relating to the rated current of the current transformer, if you set the value to 10 % for example, this would cause the voltage in the voltage regulator to be corrected by 10 %. This correction to the voltage can be increased or decreased with this setting to attain the optimum value.

As soon as you change the circulating reactive current sensitivity value, the value for the result changes in the help text in the display.

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

1. Press \( \text{F4} \) Configuration > \( \text{F4} \) Parallel operation until the desired parameter is displayed.

2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.

3. If necessary, press \( \text{F3} \) to highlight the decimal place.

4. Press \( \text{F3} \). \( \Rightarrow \) The circulating reactive current sensitivity is set.

**Setting circulating reactive current blocking**

You can use this parameter to set the limit value for the maximum permissible circulating reactive current. If, during parallel operation, the circulating reactive current exceeds the set limit value, then the following event is activated:

- Problem with parallel operation

All devices operating in parallel are blocked. Depending on the set delay time for the parallel operation error message, the signaling relay Problem with parallel operation is activated.
To set the blocking limit for the maximum permitted circulating reactive current, proceed as follows:

1. **Configuration > F4** 
   - **Parallel operation** > Press → until the desired parameter is displayed.
   - **Blocking.**

2. Press **F1** to increase the value or **F5** to reduce it.

3. Press **←**
   - The blocking limit for the maximum permitted circulating reactive current is set.

### 7.10.2.2 Setting tap synchronization

With the tap synchronization method, you need to designate one voltage regulator as the master and all others as followers. The master handles voltage regulation and transmits its latest tap positions to all followers via the CAN bus. The followers compare the tap position received with their own tap position. If the set permissible tap difference between the tap position received and their own position is exceeded, the followers switch to the tap position received from the master. This ensures that the transformers operating in parallel are always in the same tap position.

For the tap synchronization method, you can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>The voltage regulator is designated as the master.</td>
</tr>
<tr>
<td>Follower</td>
<td>The voltage regulator is designated as the follower.</td>
</tr>
<tr>
<td>Sync.auto</td>
<td>Automatic assignment of master or follower.</td>
</tr>
<tr>
<td></td>
<td>If no master is detected, the voltage regulator with the lowest CAN bus address is automatically designated as the master. All other voltage regulators are designated as followers.</td>
</tr>
</tbody>
</table>

Table 23: Tap synchronization method

In parallel operation, an individual CAN bus address must be assigned to each voltage regulator. Up to 16 CAN participants are supported.

Proceed as follows to set the tap synchronization method:

1. **Configuration > F4** 
   - **Parallel operation.**
   - **Parallel operation method.**

2. Press **F1** or **F5** to select the option you want.

3. Press **←**
   - The tap synchronization method is selected.
7.10.3 Selecting parallel operation control

As an option, the device can be fitted with a plug-in card for parallel operation with an existing parallel operation control unit when extending existing systems. You can connect the following parallel operation control units:

- SKB 30E
- VC 100E-PM/PC

The settings required for parallel control must be undertaken in accordance with the relevant valid operating instructions of the parallel operation control unit.

If you do not have a parallel control unit, in the SKB parallel operation display you must select the Off selection. The possible selections are described in more detail in the table below.

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Parallel operation control with existing parallel control unit</td>
</tr>
<tr>
<td>Off</td>
<td>Parallel operation control via CAN bus</td>
</tr>
</tbody>
</table>

Table 24: Settings for SKB parallel operation

To select the type of parallel operation control, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press until the desired parameter is displayed.
2. Press F1 or F5 to set the option you want.
3. Press Config. The type of parallel control is set.

7.10.4 Setting delay time for parallel operation error messages

You can use this parameter to set the delay time for a parallel operation error message so that brief fault messages are not received if the motor-drive units involved in the parallel operation have different runtimes. Once the set delay time has elapsed, the event is issued at the output relay. Automatic regulation is blocked and the on-load tap-changers can only be adjusted in manual mode.

To set the delay time for the parallel operation error message, proceed as follows:
7.10.5 Deactivating parallel operation

To deactivate parallel operation, proceed as follows:

1. **Menu** > **F4** Configuration > **F4** Parallel operation.  
   ⇒ Parallel operation method.
2. Press **F1** or **F5** to deactivate parallel operation with the **Off** selection.
3. Press **←**
   ⇒ Parallel operation is deactivated.

7.11 Analog tap position capture (optional)

For the analog tap position capture, you must assign the lowest tap position to the analog input for the minimum measured value and the highest tap position for the maximum measured value.

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

The analog input card is used to record the tap position of an analog signal transmitter. Depending on device configuration, you can capture the following signals:

<table>
<thead>
<tr>
<th>Resistor contact series</th>
<th>AD card</th>
<th>AD8 card</th>
</tr>
</thead>
<tbody>
<tr>
<td>50…2,000 ohms</td>
<td>50…2,000 ohms</td>
<td>not possible</td>
</tr>
<tr>
<td>Injected current</td>
<td>0/4…20 mA</td>
<td>0/4…20 mA</td>
</tr>
</tbody>
</table>

Table 25: Analog tap position capture

7.11.1 Setting lower limit value

You can use these parameters to set the lower limit value for the tap position. To do this, you must set the lower value of the signal range and the linked lowest tap position.

You can undertake the settings for each input on the analog input card.
For example: To capture a tap position range of 1...19 via input 1 as 4...20 mA, you must set 20 % for the "Input 1 lower limit" parameter and 1.0 for the "Input 1 lower value" parameter.

### Setting lower limit value of input signal

To configure the analog input, you must state the lower limit value of the input signal. Use the following settings depending on your analog signal:

<table>
<thead>
<tr>
<th>Analog signal</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injected current: 0...20 mA</td>
<td>0 % (= 0 mA)</td>
</tr>
<tr>
<td>Injected current: 4...20 mA</td>
<td>20 % (= 4 mA)</td>
</tr>
<tr>
<td>Resistor contact series</td>
<td>always 20 %</td>
</tr>
</tbody>
</table>

Table 26: Parameter settings

To set the lower limit value of the input, proceed as follows:

1. Configuration > Continue > Analog inputs > Input 1 lower limit.
2. Press F4 to highlight the position.
3. Press F1 to increase the value or F5 to reduce it.
4. Press Enter.

### Setting lower value of input signal

To configure the analog input, an absolute value must be assigned to the lower value of the applied signal.

To set the lower value for the input, proceed as follows:

1. Configuration > Continue > Analog inputs > Press until the desired parameter is displayed.
2. Press F1 to increase the value or F5 to reduce it.
3. Press Enter.

### Setting upper limit value

You can use parameters to set the upper value for the tap position. To do this, you must set the upper value of the signal range and linked highest tap position.
You can undertake the settings for each input on the analog input card.

For example: To capture a tap position range of 1...19 via input 1 as 4...20 mA, you must set 100 % for the "Input 1 upper limit" parameter and 19.0 for the "Input 1 upper value" parameter.

### Setting upper limit value of input signal

To configure the analog input, you must state the upper limit value for the input signal. Use the following settings depending on your analog signal:

<table>
<thead>
<tr>
<th>Analog signal</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injected current: 0/4...20 mA</td>
<td>100 % (= 20 mA)</td>
</tr>
<tr>
<td>Resistor contact series</td>
<td>always 100 %</td>
</tr>
</tbody>
</table>

Table 27: Parameter settings

To set the upper limit value for the input, proceed as follows:

1. **Configuration > Continue > Analog inputs > Press** until the desired parameter is displayed.
   - Input 1 upper limit.

2. Press **F4** to highlight the position.
   - The desired position is highlighted and the value can be changed.

3. Press **F1** to increase the value or **F5** to reduce it.

4. Press **

### Setting upper value of input signal

To configure the analog input, an absolute value must be assigned to the upper value of the applied signal.

To set the upper value for the input, proceed as follows:

1. **Configuration > Continue > Analog inputs > Press** until the desired parameter is displayed.
   - Input 1 upper value.

2. Press **F1** to increase the value or **F5** to reduce it.

3. Press **

### 7.12 LED selection

You can use this parameter to assign functions to the 4 free LEDs which light up when an event occurs. You can use labeling strips to label them.
Depending on your device configuration, the following parameters can be used by MR for special functions. In this case, these parameters are pre-assigned. You may not be able to view or freely assign these parameters.

**Functions available for LEDs**

An overview of all possible functions which you can assign to the LEDs is provided in the table below.

<table>
<thead>
<tr>
<th>Functions available</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>LED deactivated</td>
</tr>
<tr>
<td>IOxx/UCxx</td>
<td>There is a signal at control input IOxx/UCxx (e.g. IO:25)</td>
</tr>
<tr>
<td>SI: bef1</td>
<td>SI: bef1 (command) is received</td>
</tr>
<tr>
<td>SI: bef2</td>
<td>SI: bef2 (command) is received</td>
</tr>
<tr>
<td>Undervoltage</td>
<td>Undervoltage present</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>Overvoltage present</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>Overcurrent present</td>
</tr>
<tr>
<td>Par. error</td>
<td>Parallel operation error present</td>
</tr>
<tr>
<td>Motor protection</td>
<td>Motor protective switch triggered</td>
</tr>
<tr>
<td>Blocking</td>
<td>Regulation is blocked</td>
</tr>
<tr>
<td>Circulating reactive current</td>
<td>Parallel operation selected using circulating reactive current method</td>
</tr>
<tr>
<td>Master</td>
<td>Device in parallel operation activated as master</td>
</tr>
<tr>
<td>Follower</td>
<td>Device in parallel operation activated as follower</td>
</tr>
<tr>
<td>Automatic</td>
<td>Auto mode activated</td>
</tr>
<tr>
<td>Bandwidth &lt;</td>
<td>Value is below bandwidth</td>
</tr>
<tr>
<td>Bandwidth &gt;</td>
<td>Value is above bandwidth</td>
</tr>
<tr>
<td>Power-dep.des.</td>
<td>Power-dependent desired value adjustment activated</td>
</tr>
</tbody>
</table>

Table 28: Functions available for LEDs

**Assigning function**

To assign a function to an LED, proceed as follows:

1. **[F4]** Configuration > **[F5]** Continue > **[F4]** LED selection > Press until the desired parameter is displayed.
2. Press **[F1]** or **[F5]** to select the option you want.
3. Press **[←]** The function is assigned.
7.13 **Measuring transducer function**

Depending on the configuration and version of the measuring transducer module 2 or 4, the transducer module can be used to obtain measured values as analog values in the following ranges:

- ± 20 mA
- ± 10 mA
- ± 10 V (only AN2 card)
- ± 1 mA

The following values are available:

- V1
- V2 (optional via a second measurement input)
- I1
- Active current
- Reactive current
- Active power
- Reactive power
- Apparent power
- Tap position
- Desired value

If the analog outputs have not been set as you want them in the factory, the section below describes how you can adjust the measuring transducer.

7.13.1 **Linking measured value with output**

In this display you can assign a measured value to be transferred to the measuring transducer output.

In order to assign a measured value to the measuring transducer output, proceed as follows (example using measuring transducer 1/2; "output 1 measured value"):

1. Press \[\text{Menu} \rightarrow F4\] Configuration \[\rightarrow F5\] Continue \[\rightarrow F5\] Continue \[\rightarrow F3\] Measuring transducer 1/2.  
   - Output 1 measured value.
2. Press \[F1\] or \[F5\] until the desired option is displayed.
3. Press \[\rightarrow\] .  
   - The desired measured value is assigned.

7.13.2 **Assigning minimum physical parameter**

In this display you can assign a minimum physical parameter to the measuring transducer output.
To assign the lower physical parameter to the measuring transducer, proceed as follows:

1. Press \( \text{MEN\textsc{i}} \) > \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F3} \) Measuring transducer 1 / 2 > \( \text{F} \) until the desired parameter is displayed.

   ⇒ Output 1 bottom.

2. Press \( \text{F1} \) or \( \text{F5} \) until the desired physical parameter is displayed.

3. Press \( \text{F} \)

   ⇒ The desired physical parameter is assigned.

### 7.13.3 Assigning maximum physical parameter

In this display you can assign a maximum physical parameter to the measuring transducer output.

To assign the upper physical parameter to the measuring transducer, proceed as follows:

1. Press \( \text{MEN\textsc{i}} \) > \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F3} \) Measuring transducer 1 / 2 > \( \text{F} \) until the desired parameter is displayed.

   ⇒ Output 1 top.

2. Press \( \text{F1} \) or \( \text{F5} \) until the desired physical parameter is displayed.

3. Press \( \text{F} \)

   ⇒ The desired physical parameter is assigned.

### 7.13.4 Assigning minimum absolute value

In this display you can assign a minimum limit value to the measuring transducer output as an absolute value.

To assign the minimum absolute value, proceed as follows:

1. \( \text{MEN\textsc{i}} \) > \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F3} \) Measuring transducer 1 / 2 > \( \text{F} \) until the desired parameter is displayed.

   ⇒ Output 1 lower value.

2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.

3. Press \( \text{F} \)

   ⇒ The minimum absolute value is assigned.
7.13.5 Assigning maximum absolute value

In this display you can assign a maximum limit value to the measuring transducer output as an absolute value.

To assign the maximum absolute value, proceed as follows:

1. Press \[ \text{MENU} \] > \[ F4 \] Configuration > \[ F5 \] Continue > \[ F5 \] Continue > \[ F3 \] Measuring transducer 1/2 > Press \[ \Rightarrow \] until the desired parameter is displayed.
   ⇒ Output 1 upper value.

2. Press \[ F1 \] to increase the value or \[ F5 \] to reduce it.

3. Press \[ \leftarrow \].
   ⇒ The minimum absolute value is assigned.

7.14 Memory (optional)

With this you can undertake measured value memory settings. This configures the event memory and recorder function. The device has a memory capacity of 8 MB. The memory is split into 2 areas:

**Average value memory**

In the average value memory, all measured and calculated values are averaged and saved using the average value intervals you set. You can set [► 107] the average value intervals in stages between 1 and 40 seconds.

**Event memory**

Data is always saved to the event memory at the highest resolution without first being averaged. You can also determine how much memory space is to be made available exclusively for the event memory [► 108].

**Triggering event**

The data recorder can trigger an event depending on the undervoltage and/or overvoltage limit value that you can set. The data recorded here are stored in the measured value memory’s event memory.

**Chronological sequence**

To allow instances where values exceed or fall below the limit values to be better evaluated, the chronological sequence for the measured and calculated values also includes the last 10 seconds before values actually exceed or fall below the limit value. Each event is saved for a maximum of 5 minutes.

When an event is active, only the chronological sequence of the measured and calculated values is stored in the event memory.
As soon as there is no more free space in the event memory, the oldest values are overwritten by the new values measured. You can access information about the current event memory content via the Info [► 132] menu.

**Data recorder**

The data-recorder module can be used to save the data listed below and display and evaluate it either on the display or using the TAPCON®-trol visualization software on a PC.

The following values are displayed:

- **Measured values**
  - On-load tap-changer position
  - Voltage
  - Active current
  - Reactive current

- **Calculated values**
  - Active power
  - Reactive power
  - Apparent power
  - Output factor

Calculation of the values stated depends on the measured values captured and the parameters set, for example:

- Current measuring circuit
- Primary current
- Voltage transformer data from primary and secondary sides

A correct calculation can only be undertaken if you have correctly entered the configuration data in full.

### 7.14.1 Setting undervoltage threshold

You can use these parameters to set the undervoltage threshold as a relative or absolute value. If the voltage falls below the set undervoltage threshold, high-resolution measured values are saved for as long as this situation prevails.
Relative value

To set the undervoltage threshold, proceed as follows:

1. **F4** Configuration > **F5** Continue > **F5** Continue > **F3** Memory.
   - \( V < \) threshold.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press \( \leftarrow \).
   - The undervoltage threshold is set.

Absolute value

Entries can be made either in V or kV. If you enter the absolute value in V, it relates to the secondary transformer voltage. If you enter the absolute value in kV, it relates to the primary voltage.

To set the undervoltage threshold, proceed as follows:

1. **F4** Configuration > **F5** Continue > **F5** Continue > **F3** Memory > Press \( \leftarrow \) until the desired parameter is displayed.
   - \( V < \) memory.
2. If necessary press **F3** to select the unit you want, V or kV.
3. If V is selected, press **F4** to highlight the decimal place.
   - The decimal place is now highlighted and the value can be changed.
4. Press **F1** to increase the value or **F5** to reduce it.
5. Press \( \leftarrow \).
   - The undervoltage threshold is set.

7.14.2 Setting overvoltage threshold

You can use these parameters to set the overvoltage threshold as a relative or absolute value. If the voltage exceeds the set overvoltage threshold, high-resolution measured values are saved for as long as this situation prevails.
Relative value

To set the overvoltage threshold, proceed as follows:

1. Press \( \text{F4 Configuration} \rightarrow \text{F5 Continue} \rightarrow \text{F5 Continue} \rightarrow \text{F3 Memory} \rightarrow \text{V} > \text{threshold} \).
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \text{F5} \).
   \[ \text{The overvoltage threshold is set.} \]

Absolute value

Entries can be made either in V or kV. If you enter the absolute value in V, it relates to the secondary transformer voltage. If you enter the absolute value in kV, it relates to the primary voltage.

To set the overvoltage threshold, proceed as follows:

1. Press \( \text{F4 Configuration} \rightarrow \text{F5 Continue} \rightarrow \text{F5 Continue} \rightarrow \text{F3 Memory} \rightarrow \text{V memory} \).
2. If necessary press \( \text{F3} \) to select the unit you want, V or kV.
3. If V is selected, press \( \text{F4} \) to highlight the decimal place.
   \[ \text{The decimal place is now highlighted and the value can be changed.} \]
4. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
5. Press \( \text{F5} \).
   \[ \text{The overvoltage threshold is set.} \]

7.14.3 Setting time difference of average value interval

You can use this parameter to set the long-term memory for the device. The memory is split into the average value memory and event memory. Depending on the setting, intervals of 1; 2; 4; 10; 20 or 40 seconds are saved in the average value memory.

When you set the average value interval, the complete memory is cleared once the change is confirmed.
To set the average value interval, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F3** Memory > Press ↳ until the desired parameter is displayed. ⇒ Average value interval.

2. Press **F1** to increase the time or **F5** to reduce it.

3. Press ↳

⇒ The average value interval is set.

### 7.14.4 Setting event memory size

You can use this parameter to configure the event memory size. The event memory stores instances of values exceeding or falling below the preset threshold values (V> and V<). It stores this information in high resolution. The maximum number of events depends on the size of the event memory:

<table>
<thead>
<tr>
<th>Event memory size</th>
<th>256 kB</th>
<th>512 kB</th>
<th>1024 kB</th>
<th>2048 kB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum number of events</td>
<td>20</td>
<td>40</td>
<td>80</td>
<td>160</td>
</tr>
</tbody>
</table>

Table 29: Event memory size

#### Event lasting less than 5 minutes

If the event lasts less than 5 minutes, it is recorded in high resolution 1. The high-resolution data are first recorded 10 seconds A before the event B. If the voltage has returned to the bandwidth C, the event is still recorded until the overrun time of 10 seconds D has passed.

At a low resolution 2 the entire process is saved.
Event lasting more than 5 minutes

The high-resolution data are first recorded 10 seconds before the event. If the event is still active after 5 minutes, the data continues to be saved at a low resolution. If the voltage returns to the bandwidth, this is considered a new event. The high-resolution recording of new data commences at the start of the 10-second run-in time and ends after the 10-second overrun time.
The table below shows the memory time. Depending on the average value interval and the size of the event memory, it is a maximum of 401 days.

<table>
<thead>
<tr>
<th>Average value interval</th>
<th>Size of event memory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>256 kB</td>
</tr>
<tr>
<td>1 s</td>
<td>10 d</td>
</tr>
<tr>
<td>2 s</td>
<td>20 d</td>
</tr>
<tr>
<td>4 s</td>
<td>40 d</td>
</tr>
<tr>
<td>10 s</td>
<td>100 d</td>
</tr>
<tr>
<td>20 s</td>
<td>201 d</td>
</tr>
<tr>
<td>40 s</td>
<td>401 d</td>
</tr>
</tbody>
</table>

Table 30: Memory time of measured value memory
When you set the event memory size, the complete memory is cleared as soon as you confirm the change.

To set the event memory size, proceed as follows:

1. Configuration > F4 Configuration > F5 Continue > F5 Continue > F3 Memory > Press until the desired parameter is displayed.

2. Press F1 or F5 to set the event memory size you want.

3. Press — The event memory size is set.

### 7.14.5 Time plotter

The **Info** menu item is where you'll find the time plotter function. The actual voltage and desired value you have set is displayed here. The units of voltage per unit are defined automatically and you can change them at any time.

You can undertake the following settings in the time plotter function:

- Division of time axis
- Voltage range
- Retrace time
- Retrace date

The following sections describe how you can access the time plotter.

#### 7.14.5.1 Visual display of time plotter function

The time plotter is displayed as follows:
Symbols

Figure 69: Time plotter symbols

1 Move time axis back
2 Move time axis forward
3 Increase set values by one unit
4 Select values to set
5 Decrease set values by one unit

Desired/actual voltage value display

Figure 70: Desired/actual value

1 Set desired voltage value display
2 Actual voltage value display
3 Actual voltage value display
4 Set desired voltage value display
7.14.5.2 Moving time axis

You can set the reporting times in the setting box in the time plotter. Refer to the table for the time axis division and the resulting duration of the range shown.

<table>
<thead>
<tr>
<th>Steps which can be set (grid width)</th>
<th>15 s</th>
<th>30 s</th>
<th>1 min</th>
<th>2.5 min</th>
<th>5 min</th>
<th>10 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displayed range (in full display)</td>
<td>3.5 min</td>
<td>7 min</td>
<td>14 min</td>
<td>35 min</td>
<td>70 min</td>
<td>140 min</td>
</tr>
</tbody>
</table>

Table 31: Duration of range displayed
To undertake settings, proceed as follows:

1. Press > Info > Press  until the desired display appears.
   ⇨ Time plotter.

2. Press  to highlight the setting box for reporting times.
   ⇨ The setting box is now highlighted and the value can be changed.

3. Press  to move the display forwards one step or  to move it back one step.
   ⇨ The time axis is set.

7.14.5.3 Setting voltage range

In this display the voltage range is shown in the area between the horizontal grid lines. You can restrict the area between the horizontal grid lines in the corresponding setting box. Depending on the display setting, you can display the voltage range to be displayed in V or kV. The voltage range to be displayed is divided as follows:

<table>
<thead>
<tr>
<th>Division</th>
<th>0.5 V</th>
<th>1 V</th>
<th>2 V</th>
<th>5 V</th>
<th>10 V</th>
<th>15 V</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1 kV</td>
<td>0.2 kV</td>
<td>0.5 kV</td>
<td>1 kV</td>
<td>2 kV</td>
<td>5 kV</td>
<td>10 kV</td>
<td>20 kV</td>
</tr>
</tbody>
</table>

Table 32: Voltage range between the horizontal grid lines
To set the voltage range, proceed as follows:

1. \( \text{MENU} \rightarrow \text{F5} \) Info > Press \( \rightarrow \) until the desired display appears.
   - Time plotter.

2. Press \( \text{F4} \) until the setting box for the voltage range is highlighted.
   - The setting box is now highlighted and the value can be changed.

3. Press \( \text{F3} \) to advance one unit or \( \text{F5} \) to move back one unit.
   - The voltage range is set.

7.14.5.4 Setting retrace time

This function allows you to move the sequence to a precise time in order to trace how voltage has behaved in the past.

Any time between the present time and the oldest time in the memory can be set. The time is entered in the following format: \text{HH:MM:SS}
To move the sequence to a precise time, proceed as follows:

1. **MENU** > **F5** Info > **Press** ← until the desired display appears.
   - Time plotter.

2. Press **F4** until the setting box for the retrace time is highlighted.
   - The setting box is now highlighted and the value can be changed.

3. Press **F3** to advance the time or **F5** to move it back.
   - The retrace time is set. The sequence for the specified time appears in the display.

### 7.14.5.5 Setting retrace date

This function allows you to display the sequences of measured values for a time or date you have selected in order to trace how voltage has behaved in the past.

Any date between the present date and the oldest time in the memory can be set. The date is entered in the following format: **DD.MM.YY**
To move the sequence to a precise time, proceed as follows:

1. **INFO > F5** until the desired display appears.
   - Time plotter.

2. Press **F4** until the setting box for the retrace date is highlighted.
   - The setting box is now highlighted and the value can be changed.

3. Press **F3** to advance the date by one digit or **F5** to move it back one digit.
   - The retrace date is set. The sequence for the specified day appears in the display.

### 7.15 Communication interface CIC1 (optional)

The following section describes how to configure the communication interface.

#### 7.15.1 Selecting the communication port

You can use this parameter to select the communication port used for the CIC card. You can select the following options:

- RS232
- RS485
- Ethernet (optional)
- Fiber-optic cable (optional)

You can only select one communication port. All remaining ports remain disabled. It is not possible to use several communication ports at the same time.

This display is only provided for the following interface protocols:

- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

To select the communication port, proceed as follows:
7.15.2 Selecting communication baud rate

You can use this parameter to set the desired baud rate for the communication interface. You can select the following options:

- 9.6 kilobaud
- 19.2 kilobaud
- 38.4 kilobaud
- 57.6 kilobaud

The baud rate of 57.6 kilobaud is only active for communication interfaces RS232, RS485 and fiber-optic cable. A baud rate of 57.6 kilobaud cannot be used for Ethernet.

This display is only provided for the following interface protocols:

- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

To set the communication interface baud rate, proceed as follows:

1. Press \textbf{MENU} > F4 Configuration > F5 Continue > F5 Continue > F4 Comm. interface 1.
2. Press F1 or F5 to set the option you want.
3. Press \textbf{←}

The baud rate is selected.

7.15.3 Assigning network address

You can use this parameter to assign a network address (IPv4) to the device. If you want to connect the device by means of Ethernet, you need to set a valid network address.
This display is only provided for the following interface protocols:

- DNP3
- MODBUS ASCII/RTU

To assign the network address, proceed as follows:

1. Press \( \text{MEN} \rightarrow \text{F4} \) Configuration \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F4} \) Comm. interface 1 > Press until the desired parameter is displayed.
   - Network address CIC1.
2. Press \( \text{F4} \) to highlight the position.
   - The position is highlighted and the value can be changed.
3. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
4. Press \( \rightarrow \)
   - The network address is assigned.

### 7.15.4 Assigning the TCP port

You can use this parameter to assign a TCP port to the device. If you want to connect the device by means of Ethernet, you need to set a valid TCP port.

This display is only provided for the following interface protocols:

- DNP3
- MODBUS ASCII/RTU

To assign the TCP port, proceed as follows:

1. Press \( \text{MEN} \rightarrow \text{F4} \) Configuration \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F4} \) Comm. interface 1 > Press until the desired parameter is displayed.
   - TCP Port CIC1.
2. Press \( \text{F4} \) to highlight the position.
   - The position is highlighted and the value can be changed.
3. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
4. Press \( \rightarrow \)
   - The TCP port is assigned.

### 7.15.5 Setting fiber-optic cable transmission behavior

You can use this parameter to set the device’s transmission behavior, when you connect the device via optical fiber (OF). This determines whether or not the transmit LED lights up when the signal (logical 1) is active.
This display is only provided for the following interface protocols:

- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

To set the fiber-optic cable transmission behavior, proceed as follows:

1. **ON**
   - Light on
   - Light off

2. Press **Logical 1** to set the option you want.

3. Press **Logical 0** to set the option you want.

   - The fiber-optic cable transmission behavior is set.

### 7.15.6 Selecting MODBUS type

You can use this parameter to select the Modbus type. The following Modbus types are available:

- Modbus ASCII
- Modbus RTU

This display is only provided for the following interface protocol:

- MODBUS ASCII/RTU

To select the Modbus types, proceed as follows:

1. **Modbus-RTU**

   - Modbus ASCII or Modbus RTU

2. Press **Logical 1** to set the option you want.

3. Press **Logical 0** to set the option you want.

   - The Modbus type is set.
7.15.7 Setting local SCADA address

You can use this parameter to assign a SCADA address to the device. You have to define this parameter if the device is to communicate via the control system protocol.

This display is only provided for the following interface protocols:

- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

To set the SCADA address, proceed as follows:

1. Configuration > Continue > Continue > Comm. interface 1 > Press until the desired parameter is displayed. → Local SCADA Address CIC1.
2. Press F1 to change the first digit.

If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7:

3. Press F1 until another digit position appears.
4. Press F4 to highlight a digit position. → The required digit is highlighted and can be changed.
5. Press F1 or F5 to change the digit.
6. Repeat steps 3 to 5 until all required digits have been entered.
7. Press → The SCADA address is set.

7.15.8 Setting SCADA master address

You can use this parameter to set the SCADA address for the master station. When the device is restarted, the device data is sent to this master station without prompting.

This display is only provided for the following interface protocol:

- DNP3

To set the SCADA master address, proceed as follows:
1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F4** Comm. Interface 1 > Press ↪ until the desired display appears.

   \(\Rightarrow\) SCADA Master Address CIC1.

2. Press **F1** to change the first digit.

   If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.

3. Press **F1** until another digit position appears.

4. Press **F4** to highlight a digit position.
   \(\Rightarrow\) The required digit is highlighted and can be changed.

5. Press **F1** or **F5** to change the digit.

6. Repeat steps 3 to 5 until all required digits have been entered.

7. Press **F1**
   \(\Rightarrow\) The SCADA master address is set.

---

### 7.15.9 Enabling unsolicited messages

When using the control system protocol DNP3, you can release the unsolicited data transmission through the device with this parameter. Data is transferred when a corresponding event occurs.

This display is only provided for the following interface protocol:

- **DNP3**

The voltage regulator must be restarted after changing this setting.

To enable unsolicited messages, proceed as follows:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F4** Comm. interface 1 > Press ↪ until the desired parameter is displayed.

   \(\Rightarrow\) Unsolicited messages CIC1.

2. Press **F1** or **F5** to set the option you want.

3. Press **F1**

   \(\Rightarrow\) Unsolicited messages are enabled/blockedException.
7.15.10 Setting number of attempts to transmit unsolicited messages

This parameter is used to set the maximum number of attempts to transmit unsolicited messages.

If the device receives no release for data transmission through the Master (for example, in case of transmission errors), then the data transmission is repeated in accordance with the set maximum number of send attempts.

This display is only provided for the following interface protocol:
- DNP3

The voltage regulator must be restarted after changing this setting.

To set the maximum number of attempts to transmit unsolicited messages, proceed as follows:

1. Matching > F4 Configuration > F5 Continue > F5 Continue > F4
   Comm. interface 1 > Press until the desired parameter is displayed.
   ⇒ Repeat unsolicited messages CIC1.
2. Press F1 to increase the value or F5 to reduce it.
3. Press Enter
   ⇒ The maximum number of attempts to transmit unsolicited messages is set.

7.15.11 Timeout for application confirm responses

You can use this parameter to define the permissible time which the device waits for the following feedback from the master device:
- Application confirmation response
- Confirmation of unsolicited message

If the permissible time is exceeded, another transmission request is sent to the master device. The number of requests sent is dependent on the set number of attempts to transmit unsolicited messages [► 123].

This display is only provided for the following interface protocol:
- DNP3

To set the timeout for application confirm responses, proceed as follows:
1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F4**
   Comm. interface 1 > Press ➔ until the desired parameter is displayed.
   ⇒ Appl. timeout confirm. CIC1

2. Press **F1** to increase the value or **F5** to reduce it.

3. Press ➔
   ⇒ The timeout for application confirm responses is set.

### 7.15.12 Setting the transmission delay time for the RS485 interface

You can use this parameter to set a send delay for the interface, for example, to compensate for the reaction time of an external RS485/RS232 transformer when changing between transmitting and receiving operation.

This display is only provided for the following interface protocols:

- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

To set the transmission delay time for the RS485 interface, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F4**
   Comm. interface 1 > Press ➔ until the desired parameter is displayed.
   ⇒ Transmission delay CIC1.

2. Press **F1** to increase the value or **F5** to reduce it.

3. Press ➔
   ⇒ The transmission delay time for the RS485 interface is set.

### 7.16 Communication interface CIC2 (optional)

Communication interface CIC2 is optional and is only used for communication with the TAPCON®-trol software. The following section describes how to configure the communication interface.

#### 7.16.1 Selecting the communication port

You can use this parameter to select the communication port used for the CIC card. You can select the following options:

- RS232
- Ethernet
7 Functions and settings

- Fiber-optic cable

You can only select one communication port. All remaining ports remain disabled. It is not possible to use several communication ports at the same time.

To select the communication port, proceed as follows:

1. \[\text{Menu} > F4 \text{ Configuration} > F5 \text{ Continue} > F5 \text{ Continue} > F5 \text{ Continue} > F3 \text{ Comm. interface 2}\]

2. Press F1 or F5 to set the option you want.

3. Press Enter

The communication port is selected.

### 7.16.2 Selecting communication baud rate

You can use this parameter to set the desired baud rate for the communication interface. You can select the following options:

- 9.6 kilobaud
- 19.2 kilobaud
- 38.4 kilobaud
- 57.6 kilobaud

The baud rate of 57.6 kilobaud is only active for communication interfaces RS232, RS485 and fiber-optic cable.

A baud rate of 57.6 kilobaud cannot be used for Ethernet.

To set the communication interface baud rate, proceed as follows:

1. \[\text{Menu} > F4 \text{ Configuration} > F5 \text{ Continue} > F5 \text{ Continue} > F5 \text{ Continue} > F3 \text{ Comm. interface 2} > \text{Press} \rightarrow \text{until the desired parameter is displayed}\]

2. Press F1 or F5 to set the option you want.

3. Press Enter

The baud rate is selected.

### 7.16.3 Assigning network address

You can use this parameter to assign a network address (IPv4) to the device. If you want to connect the device by means of Ethernet, you need to set a valid network address.
To assign the network address, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Continue > **F3** Comm. interface 2 > Press until the desired parameter is displayed.
   - Network address CIC2.
2. Press **F4** to highlight the desired position.
   - The position is highlighted and the value can be changed.
3. Press **F1** to increase the value or **F5** to reduce it.
4. Press **←**.
   - The network address is assigned.

### 7.16.4 Assigning the TCP port

You can use this parameter to assign a TCP port to the device. If you want to connect the device by means of Ethernet, you need to set a valid TCP port.

To assign the TCP port, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Continue > **F3** Comm. interface 2 > Press until the desired parameter is displayed.
   - TCP Port CIC2.
2. Press **F4** to highlight the position.
   - The position is highlighted and the value can be changed.
3. Press **F1** to increase the value or **F5** to reduce it.
4. Press **←**.
   - The TCP port is assigned.

### 7.16.5 Setting the transmission delay time for the RS485 interface

You can use this parameter to set a send delay for the interface, for example, to compensate for the reaction time of an external RS485/RS232 transformer when changing between transmitting and receiving operation.

To set the transmission delay time for the RS485 interface, proceed as follows:
1. \( \text{MENU} \rightarrow \text{F4} \) Configuration \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F5} \) Continue \( \rightarrow \text{F3} \) Comm. interface 2 \( \rightarrow \) Press \( \rightarrow \) until the desired parameter is displayed.
   \( \Rightarrow \) Transmission delay CIC 2.
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \leftarrow \)
   \( \Rightarrow \) The transmission delay time for the RS485 interface is set.

### 7.17 Displaying information about device

The next section describes how you can display information about the device.

#### 7.17.1 Displaying the info screen

Information about the device can be viewed here.

The following information is displayed:
- Device model
- Firmware version number
- Serial number
- RAM
- Additional cards

To display the info screen, proceed as follows:

\[ \text{MENU} \rightarrow \text{F5} \text{Info} \]

\( \Rightarrow \) Info.

#### 7.17.2 Displaying measured values

The current measured values are shown in this display. The following measured values can be displayed:

To display the measured values, proceed as follows:
7 Functions and settings

7.17.3 Carrying out LED test

You can check whether the LEDs are functioning properly. To do this, press the relevant function key to illuminate an LED:

<table>
<thead>
<tr>
<th>Key</th>
<th>LED no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F5</td>
<td>LED 1...LED 5</td>
</tr>
<tr>
<td>F1 + F5, F4 + F5</td>
<td>LED 6...LED 9</td>
</tr>
<tr>
<td>←</td>
<td>All LEDs</td>
</tr>
</tbody>
</table>

This function will only test the functional reliability of the respective LED. The function of the device linked to the LED is not tested.

To carry out the LED test, proceed as follows:

1. **MENU** > F5 Info > Press until the desired measurement parameter is displayed. ⇒ LED test.
2. To carry out the function test, press any F key for the LED you want to test.

7.17.4 Displaying input/output status

The status of the respective optocoupler inputs is shown in the **INPUT / OUTPUT-STATUS** display. As soon as a continuous signal is present at the input, it is shown in the display with a 1. 0 indicates no signal at the input.
7 Functions and settings

To query the status, proceed as follows:

► Press \( \text{INFO} \rightarrow F5 \text{ Info } \rightarrow \) until the desired measurement parameter is displayed.

\( \Rightarrow \) INPUT/OUTPUT STATUS.

7.17.5 Displaying UC card status

The status of the respective optocoupler inputs is shown in this display. As soon as a continuous signal is present at the input, it is shown in the display with a 1. 0 indicates no signal at the input.

To query the status, proceed as follows:

► Press \( \text{MENU} \rightarrow F5 \text{ Info } \rightarrow \) until the desired display appears.

\( \Rightarrow \) UC1 CARD STATUS/UC2 CARD STATUS/UC3 CARD STATUS.
7.17.6 Resetting parameters

With this display you can reset your settings to the factory settings. It also shows whether all parameters are saved correctly.

Resetting the parameters to the factory settings permanently deletes your settings.

To reset all the set parameters, proceed as follows:

1. Press $\text{MENU} > \text{F5} \text{ Info} > \rightarrow$ until the desired measurement parameter is displayed.
2. Press $\text{F3}$ and $\text{F4}$ at the same time.
3. Press $\leftarrow$.

$\Rightarrow$ All parameters have been reset to the factory settings.

7.17.7 Displaying real-time clock

An operations counter is started when the device is first switched on. This continues to run even if the device is switched off. Each of the operations counter's times is overwritten with that of the PC to visualize the measured values.

To display the real-time clock, proceed as follows:

$\Rightarrow$ Press $\text{MENU} > \text{F5} \text{ Info} > \rightarrow$ until the desired measurement parameter is displayed.

$\Rightarrow$ RTC.

7.17.8 Displaying parallel operation

This display indicates the regulator number (CAN bus address) for parallel operation and the number of voltage regulators which are currently operating in parallel.

To display the parallel operation data, proceed as follows:

$\Rightarrow$ Press $\text{MENU} > \text{F5} \text{ Info} > \rightarrow$ until the desired display appears.

$\Rightarrow$ Parallel operation.

7.17.9 Displaying data on CAN bus

The CAN bus data of the connected devices is shown in this display.
## 7 Functions and settings

### Figure 95: CAN bus data

<table>
<thead>
<tr>
<th></th>
<th>CAN bus address of device</th>
<th></th>
<th>Reactive current in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage in V</td>
<td>2</td>
<td>Current tap position</td>
</tr>
<tr>
<td>3</td>
<td>Active current in %</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 96: Other CAN bus data

<table>
<thead>
<tr>
<th></th>
<th>Group input 1</th>
<th></th>
<th>Follower tap synchronization (0 = deactivated; 1 = activated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Group input 2</td>
<td>5</td>
<td>Auto tap synchronization (0 = deactivated; 1 = activated)</td>
</tr>
<tr>
<td>2</td>
<td>Circulating reactive current parallel operation (0 = deactivated; 1 = activated)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Master tap synchronization (0 = deactivated; 1 = activated)</td>
<td>7</td>
<td>Device blocks group because parallel operation is experiencing a fault (0 = is not blocked; 1 = is blocked)</td>
</tr>
</tbody>
</table>

To display the CAN bus data, proceed as follows:

1. Press `MEN > F5` Info > until the desired measurement parameter is displayed.
   - DATA ON CAN BUS.
2. Press and hold `F1` to display more data.
   - The additional information is displayed until you release the key.
7.17.10 Displaying measured value memory

As an option, the device can be equipped with a long-term memory module. You can display information about the memory in this window.

To display the measured value memory, proceed as follows:

► Press \text{MENU} \rightarrow \text{F5 Info} \rightarrow \rightarrow until the desired measurement parameter is displayed.

\Rightarrow \text{MEASURED VALUE MEMORY}

7.17.11 Displaying peak memory

This display shows the minimum and maximum voltage measured since the last reset and the minimum and maximum on-load tap-changer tap positions. All values recorded are stored with a time and date.

The minimum and maximum values continue to be stored in an internal fixed value memory even in the event of power failure.

\begin{center}
\begin{tabular}{|l|l|}
\hline
1 & Maximum measured voltage U1 \tab 5 & Time (HH:MM:SS) and date (DD.MM.YY) of minimum recorded tap position \\
2 & Maximum on-load tap-changer tap position \tab 6 & Time (HH:MM:SS) and date (DD.MM.YY) of minimum measured voltage U1 \\
3 & Time (HH:MM:SS) and date (DD.MM.YY) of maximum measured voltage U1 \tab 7 & Minimum on-load tap-changer tap position \\
4 & Time (HH:MM:SS) and date (DD.MM.YY) of maximum recorded tap position \tab 8 & Minimum measured voltage U1 \\
\hline
\end{tabular}
\end{center}

To display the peak memory, proceed as follows:
7.17.12 Displaying CIC card SCADA information

The following information on the SCADA connection is displayed in this CIC card SCADA information display:

- Protocol
- Data format
- BOOT version

If necessary, you can also reset the Ethernet connection.

To display the SCADA information on the CIC card, proceed as follows:

1. Press \texttt{MENU} > \texttt{F5 Info} > \textless{} until the desired measurement parameter is displayed.
2. The CIC1 card SCADA information/CIC2 card SCADA information is displayed.
3. If necessary, you can reset the Ethernet connection.
4. Press \texttt{F3} and \texttt{F4} at the same time to reset the Ethernet connection.

7.17.13 Displaying upcoming messages

This display shows upcoming messages, such as:

- Undervoltage
- Overvoltage
- Fault in parallel operation
- etc.

To display the upcoming messages, proceed as follows:

1. Press \texttt{MENU} > \texttt{F5 Info} > \textless{} until the desired measurement parameter is displayed.
2. \texttt{UPCOMING MESSAGES}
8 Maintenance and care

You can clean the device’s housing with a dry cloth.
9 Fault elimination

This chapter describes how to eliminate simple operating faults.

9.1 General faults

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No function</td>
<td>No power supply</td>
<td>Check the power supply</td>
</tr>
<tr>
<td>• Operating status LED does not illuminate</td>
<td>Fuse tripped</td>
<td>Contact Maschinenfabrik Reinhausen GmbH</td>
</tr>
<tr>
<td>Relays chatter</td>
<td>Supply voltage too low</td>
<td>Check the supply voltage</td>
</tr>
<tr>
<td></td>
<td>High EMC load</td>
<td>Use shielded cables or external filters</td>
</tr>
<tr>
<td></td>
<td>Poor grounding</td>
<td>Check the functional ground</td>
</tr>
</tbody>
</table>

Table 35: General faults

9.2 No regulation in AUTO mode

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device control commands have no effect.</td>
<td>LOCAL/REMOTE switch in motor-drive unit switched to LOCAL.</td>
<td>Check operating mode and switch to REMOTE if necessary.</td>
</tr>
<tr>
<td>• RAISE/LOWER LEDs light up periodically</td>
<td>No connection</td>
<td>Check wiring as per connection diagram.</td>
</tr>
<tr>
<td>Device blocking</td>
<td>Negative power flow</td>
<td>Check current transformer polarity.</td>
</tr>
<tr>
<td></td>
<td>Control inputs have duplicate parameterization.</td>
<td>Check parameterization of control inputs. A function may only be assigned to one control input.</td>
</tr>
<tr>
<td></td>
<td>A control input is parameterized with blocking and a signal is present at this control input.</td>
<td>Check parameterization and status of control input under Info (Input/Output Status). If necessary, change parameterization or deactivate signal source.</td>
</tr>
<tr>
<td></td>
<td>NORMset is active, but has not been started up correctly</td>
<td>Activate operating mode and perform a manual tap-change operation using keys or . Then activate operating mode .</td>
</tr>
<tr>
<td>Device blocking</td>
<td>Undervoltage blocking active</td>
<td>Check parameters</td>
</tr>
<tr>
<td>• U&lt; LED illuminated</td>
<td>Overvoltage blocking active</td>
<td>Check parameters</td>
</tr>
<tr>
<td>Device blocking</td>
<td>Overcurrent blocking active</td>
<td>Check parameters</td>
</tr>
<tr>
<td>• I&gt; LED illuminated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 9 Fault elimination

#### Characteristics/detail | Cause | Remedy
--- | --- | ---
Device blocking  
- Tap difference LED illuminated | Tap positions of motor-drive units ED1, ED2 and ED3 not the same | Activate operating mode and perform a manual tap-change operation using keys \( \text{up} \) or \( \text{down} \) until the tap position of motor-drive units ED1, ED2 and ED3 have been compared.

Bandwidth set too high | - | Determine recommended bandwidth [► 68] and set parameters.

Table 36: No regulation in AUTO mode

#### 9.3 Man-machine interface

#### Characteristics/detail | Cause | Remedy
--- | --- | ---
Keys  
- MANUAL/AUTO operating mode cannot be changed | REMOTE operating mode active and LED in key \( \text{REMOTE} \) illuminated. | Press \( \text{REMOTE} \) to activate LOCAL mode.

Keys  
- LEDs in keys and not illuminated. | Parameter error | Reset parameters to factory settings [► 130].

Display  
- No display. | Contrast incorrectly set.  
Voltage supply interrupted.  
Fuse faulty. | Set contrast [► 41].  
Check voltage supply.  
Contact Maschinenfabrik Reinhausen.

LEDs  
- Freely configurable LED lights up | Customized LED parameterization. | Check parameters.

LEDs  
- LED flashing | Input signal not constant. | Check input signal.

COM1  
- Cannot be connected to PC using TAPCON®-trol. | Different baud rates set. | Check baud rate set on device and PC.

Table 37: Man-machine interface

#### 9.4 Incorrect measured values

#### Characteristics/detail | Cause | Remedy
--- | --- | ---
Measured voltage  
- No measured value. | Connection has no contact in the plug terminal.  
Insulation trapped  
Wire not inserted far enough.  
Circuit breaker tripped. | Check wiring and plug terminal.  
Check fuse.
<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured voltage</td>
<td>Measured value too low.</td>
<td>Voltage drop on measuring lead.</td>
</tr>
<tr>
<td>Measured voltage</td>
<td>Measured value fluctuates.</td>
<td>Possible sources of fault: Leads laid in parallel. Tap-change operations.</td>
</tr>
<tr>
<td>Measured current</td>
<td>No measured value.</td>
<td>Line to current transformer interrupted.</td>
</tr>
</tbody>
</table>

Table 38: Incorrect measured values

9.5 Parallel operation faults

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel operation cannot be activated. LED not lit up.</td>
<td>&quot;Parallel operation method&quot; parameter deactivated. CAN bus address of device set to &quot;0&quot;.</td>
<td>Set parallel operation method parameters. Set CAN bus address (anything but 0).</td>
</tr>
</tbody>
</table>
### 9.6 Tap position capture incorrect

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| Step display incorrect. | Incorrect wiring. | Check wiring.  
| Plus or minus sign incorrect | | Connect as shown in connection diagram. |
| | Minimum value of analog input signal not correctly parameterized. | Check parameters.  
| Step display incorrect. | Interference. | Shield the line.  
| Display fluctuates. | | Increase distance from source of interference.  
| | | Lay interference lines separately.  
| | | Route signal in separate lines (filter, shielded lines). |
| No step display. | No measurement signal. | Connect signal as shown in connection diagram.  
| "." is displayed. | No L- for digital input. | Check wiring.  
| | | Review status screen.  
| | | Connect as shown in connection diagram. |
| No step display. | Bit combination (code) impermissible. | Check wiring.  
| "?" is displayed. | "Motor running" signal present. | Review status screen.  
| | | Review status screen. |

Table 40: Tap position capture

### 9.7 Other faults

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

- Serial number

This can be found:

- Outer right side when viewed from the front

- Info screen (MENU > F5 Info)
Please provide answers to the following questions:

- Has a firmware update been carried out?
- 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?
10 Messages

This chapter contains an overview of the device’s messages.

10.1 Signal inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Inscription</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC1/2/3-X1:12</td>
<td>MOTOR-DRIVE UNIT IN OPERATION</td>
<td>Motor-drive unit is in operation</td>
</tr>
<tr>
<td>UC1/2/3-X1:11</td>
<td>MOTOR PROTECTIVE SWITCH OFF</td>
<td>Motor protective switch has triggered</td>
</tr>
<tr>
<td>IO-X1:31</td>
<td>See connection diagram</td>
<td>-</td>
</tr>
<tr>
<td>IO-X1:33</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>IO-X1:12</td>
<td>AUTO</td>
<td>Activate AUTO mode</td>
</tr>
<tr>
<td>IO-X1:11</td>
<td>MANUAL</td>
<td>Activate MANUAL mode</td>
</tr>
<tr>
<td>IO-X1:13</td>
<td>RAISE</td>
<td>Raise tap position</td>
</tr>
<tr>
<td>IO-X1:14</td>
<td>LOWER</td>
<td>Lower tap position</td>
</tr>
<tr>
<td>UC1/2/3-X1:14</td>
<td>BCD1...BCD10</td>
<td>BCD tap input signal</td>
</tr>
<tr>
<td>IO-X1:15</td>
<td>PARALLEL GROUP 1, or: See connection diagram</td>
<td>Assign parallel operation group 1</td>
</tr>
<tr>
<td>IO-X1:16</td>
<td>PARALLEL GROUP 2, or: See connection diagram</td>
<td>Assign parallel operation group 2</td>
</tr>
<tr>
<td>IO-X1:17</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Table 41: Signal inputs

10.2 Signal outputs

<table>
<thead>
<tr>
<th>Relay</th>
<th>Inscription</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO-X1:23</td>
<td>See connection diagram</td>
<td>-</td>
</tr>
<tr>
<td>IO-X1:25</td>
<td>See connection diagram</td>
<td>-</td>
</tr>
<tr>
<td>IO-X1:21</td>
<td>FUNCTION MONITORING</td>
<td>Signal for Function monitoring message</td>
</tr>
<tr>
<td>IO-X1:10</td>
<td>AUTO</td>
<td>Signal if auto mode is active</td>
</tr>
<tr>
<td>IO-X1:09</td>
<td>MANUAL</td>
<td>Signal if manual mode is active</td>
</tr>
<tr>
<td>IO-X1:04</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IO-X1:06</td>
<td>TAP DIFFERENCE</td>
<td>Signal if tap position difference of ED1, ED2, ED3 is greater than or equal to 1</td>
</tr>
</tbody>
</table>
## 10 Messages

<table>
<thead>
<tr>
<th>Relay</th>
<th>Inscription</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO-X1:20</td>
<td>UNDERVOLTAGE OVERVOLTAGE OVERCURRENT</td>
<td>Signal for <em>undervoltage, overvoltage, overcurrent</em> message</td>
</tr>
<tr>
<td>IO-X1:23</td>
<td>PARALLEL FAULT, or: See connection diagram</td>
<td>Signal for <em>parallel operation error message</em></td>
</tr>
<tr>
<td>IO-X1:25</td>
<td>PARALLEL ON, or: See connection diagram</td>
<td>Signal if parallel operation is active</td>
</tr>
<tr>
<td>UC-X1:06...10, UC-X1:19...23</td>
<td>TAP POSITION BCD1…BCD20</td>
<td>BCD signal of tap position</td>
</tr>
<tr>
<td>IO-X1:2/3</td>
<td>STATUS</td>
<td>Operating relay</td>
</tr>
<tr>
<td>UC1/2/3-X1:02</td>
<td>ED1/2/3 LOWER</td>
<td>Lower tap position of motor-drive unit ED1/2/3</td>
</tr>
<tr>
<td>UC1/2/3-X1:04</td>
<td>ED1/2/3 RAISE</td>
<td>Raise tap position of motor-drive unit ED1/2/3</td>
</tr>
</tbody>
</table>

Table 42: Signal outputs

### 10.3 Event messages

<table>
<thead>
<tr>
<th>Event message</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undervoltage</td>
<td>Event message appears if value falls below undervoltage limit value.</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>Event message appears if value exceeds overvoltage limit value.</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>Event message appears if value exceeds overcurrent limit value.</td>
</tr>
<tr>
<td>Event message</td>
<td>Cause</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Parallel operation error</strong></td>
<td>Event message appears with the following causes:</td>
</tr>
<tr>
<td></td>
<td>▪ Tap synchronization method</td>
</tr>
<tr>
<td></td>
<td>    Tap position not the same</td>
</tr>
<tr>
<td></td>
<td>      No master or more than one master set</td>
</tr>
<tr>
<td></td>
<td>    Invalid tap position</td>
</tr>
<tr>
<td></td>
<td>    Incorrect parallel operation method selected for a device</td>
</tr>
<tr>
<td></td>
<td>▪ Circulating reactive current minimization method</td>
</tr>
<tr>
<td></td>
<td>    Circulating reactive current limit exceeded</td>
</tr>
<tr>
<td></td>
<td>    Incorrect parallel operation method selected for a device</td>
</tr>
<tr>
<td></td>
<td>    Only one device in active parallel operation group</td>
</tr>
<tr>
<td><strong>Motor protection device</strong></td>
<td>Event message appears if motor protective switch triggers.</td>
</tr>
<tr>
<td><strong>Blocking</strong></td>
<td>Event message appears if the &quot;Blocking&quot; function is selected for the customer input and there is a signal at the customer input</td>
</tr>
<tr>
<td><strong>No OLTC position</strong></td>
<td>Event message appears if no OLTC position is detected.</td>
</tr>
<tr>
<td><strong>Tap-change detection error</strong></td>
<td>Event message appears if an on-load tap-change operation has not been detected correctly.</td>
</tr>
</tbody>
</table>

Table 43: Event messages
11 Disposal

The device was produced in accordance with European Community Directive 2011/65/EC (RoHS) and must be disposed of accordingly. If the device is not operated within the European Union, the national disposal requirements applicable in the country of use should be observed.
12 Overview of parameters

This section contains an overview of the relevant menus and parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter &gt; Normset</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normset activation</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Primary voltage</td>
<td>0...9.999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>57...125 V</td>
<td>100 V</td>
<td></td>
</tr>
<tr>
<td>Desired value 1</td>
<td>49...140 V</td>
<td>100 V</td>
<td></td>
</tr>
<tr>
<td><strong>Parameter &gt; Control parameter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.5...9 %</td>
<td>1.00 %</td>
<td></td>
</tr>
<tr>
<td>Desired value 1</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Desired value 2</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Desired value 3</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Desired value at 0 active power</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>T1 control response</td>
<td>T1 linear/T1 integral</td>
<td>T1 linear</td>
<td></td>
</tr>
<tr>
<td>T1 delay time</td>
<td>0...600 s</td>
<td>40 s</td>
<td></td>
</tr>
<tr>
<td>T2 activation</td>
<td>T2 on/T2 off</td>
<td>T2 off</td>
<td></td>
</tr>
<tr>
<td>T2 delay time</td>
<td>1...60 s</td>
<td>10.0 s</td>
<td></td>
</tr>
<tr>
<td><strong>Parameter &gt; Limit values</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fct. Monitoring</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Absolute limit values</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>I&gt; Overcurrent</td>
<td>50...210 %</td>
<td>110 %</td>
<td></td>
</tr>
<tr>
<td>Tap max.</td>
<td>-128...128</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Tap min.</td>
<td>-128...128</td>
<td>-128</td>
<td></td>
</tr>
<tr>
<td>U&lt; blocking</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>U&lt; Undervoltage (%)</td>
<td>60...100 %</td>
<td>90 %</td>
<td></td>
</tr>
<tr>
<td>U&lt; Undervoltage (V)</td>
<td>34...160 V</td>
<td>90.0 V</td>
<td></td>
</tr>
<tr>
<td>U&lt; Delay</td>
<td>0...20 s</td>
<td>10.0 s</td>
<td></td>
</tr>
<tr>
<td>U&lt; also under 30 V</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>U&gt; Overvoltage (%)</td>
<td>100...140 %</td>
<td>110.0 %</td>
<td></td>
</tr>
<tr>
<td>U&gt; Overvoltage (V)</td>
<td>34...160 V</td>
<td>110.0 V</td>
<td></td>
</tr>
<tr>
<td><strong>Parameter &gt; Compensation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ur line drop comp.</td>
<td>-25...25 V</td>
<td>0.0 V</td>
<td></td>
</tr>
<tr>
<td>Ux line drop comp.</td>
<td>-25...25 V</td>
<td>0.0 V</td>
<td></td>
</tr>
<tr>
<td>Z comp. limit value</td>
<td>0...15 %</td>
<td>0.0 %</td>
<td></td>
</tr>
<tr>
<td>Z compensation</td>
<td>0...15 %</td>
<td>0.0 %</td>
<td></td>
</tr>
<tr>
<td><strong>Parameter &gt; Cross-monitoring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error message</td>
<td>0...10 s</td>
<td>10 s</td>
<td></td>
</tr>
<tr>
<td>U prim. regulator 2</td>
<td>0...9.999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>U sec. regulator 2</td>
<td>57...125 V</td>
<td>100.0 V</td>
<td></td>
</tr>
</tbody>
</table>
## 12 Overview of parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>U&lt; regulator 2</td>
<td>34...160 V</td>
<td>60.0 V</td>
<td></td>
</tr>
<tr>
<td>U&lt; regulator 2</td>
<td>60...100 %</td>
<td>60 %</td>
<td></td>
</tr>
<tr>
<td>U&gt; regulator 2</td>
<td>34...160 V</td>
<td>140.0 V</td>
<td></td>
</tr>
<tr>
<td>U&gt; regulator 2</td>
<td>100...140 %</td>
<td>140 %</td>
<td></td>
</tr>
<tr>
<td>U ref for regulator 2</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > Transformer data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary voltage</td>
<td>0...9,999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Primary current</td>
<td>0...9,999 A</td>
<td>0 A</td>
<td></td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>57...125 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Current transformer connection</td>
<td>Unknown; 0.2 A; 1 A; 5 A</td>
<td></td>
<td>Unknown</td>
</tr>
<tr>
<td>Transformer circuit</td>
<td>See [► 89]</td>
<td>0 1PH</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > General

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display %/ A</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Display dark</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Display kV / V</td>
<td>kV/V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>COM1 setting</td>
<td>9.6 kilobaud; 19.2 kilobaud; 38.4 kilobaud; 57.6 kilobaud</td>
<td>57.6 kilobaud</td>
<td></td>
</tr>
<tr>
<td>R/L pulse duration</td>
<td>0...10 s</td>
<td>1.5 s</td>
<td></td>
</tr>
<tr>
<td>IO1-X1:23/24</td>
<td>See</td>
<td></td>
<td>see connection diagram</td>
</tr>
<tr>
<td>IO1-X1:25/26</td>
<td>See</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO1-X1:31</td>
<td>See</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO1-X1:33</td>
<td>See</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor runtime</td>
<td>0...30 s</td>
<td>0.0 s</td>
<td></td>
</tr>
<tr>
<td>Regulator ID</td>
<td>-</td>
<td>0000</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>See [► 42]</td>
<td>English</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > Parallel operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocking</td>
<td>0.5...20 %</td>
<td>20.0 %</td>
<td></td>
</tr>
<tr>
<td>CAN address</td>
<td>0...16</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Error message</td>
<td>1...99 s</td>
<td>10 s</td>
<td></td>
</tr>
<tr>
<td>ParErrorIfAlone</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Parallel operation method</td>
<td>Off, circulating reactive current; master; follower; synch. auto</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>SKB parallel operation</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Stability</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td></td>
</tr>
<tr>
<td>Tapping direction</td>
<td>Swapped</td>
<td>Standard</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > Analog inputs (optional)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input 1 upper limit</td>
<td>0...100 %</td>
<td>100.0 %</td>
<td></td>
</tr>
<tr>
<td>Input 1 lower limit</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td></td>
</tr>
</tbody>
</table>
## 12 Overview of parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input 1 upper value</td>
<td>-999.9...999.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Input 1 lower value</td>
<td>-999.9...999.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Input 2 upper limit</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Input 2 lower limit</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Input 2 upper value</td>
<td>-999.9...999.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Input 2 lower value</td>
<td>-999.9...999.9</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > LED selection

<table>
<thead>
<tr>
<th>LED 1</th>
<th>See [► 100]</th>
<th>See connection diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED 2</td>
<td>See [► 100]</td>
<td></td>
</tr>
<tr>
<td>LED 3 yellow</td>
<td>See [► 100]</td>
<td></td>
</tr>
<tr>
<td>LED 4 green</td>
<td>See [► 100]</td>
<td></td>
</tr>
<tr>
<td>LED 4 red</td>
<td>See [► 100]</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration > Measuring transducer 1/2 (optional)

<table>
<thead>
<tr>
<th>Output 1 measured value</th>
<th>See [► 102]</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 1 upper value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 1 lower value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 1 upper</td>
<td>1 mA; 10 mA; 20 mA; N/A</td>
<td>20 mA</td>
</tr>
<tr>
<td>Output 1 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
</tr>
<tr>
<td>Output 2 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
</tr>
<tr>
<td>Output 2 upper value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 2 lower value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 2 upper</td>
<td>1 mA; 10 mA; 20 mA; N/A</td>
<td>20 mA</td>
</tr>
<tr>
<td>Output 2 low</td>
<td>See [► 102]</td>
<td>+4 mA</td>
</tr>
</tbody>
</table>

### Configuration > Measuring transducer 3/4 (optional)

<table>
<thead>
<tr>
<th>Output 3 measured value</th>
<th>See [► 102]</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 3 upper value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 3 lower value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 3 upper</td>
<td>1 mA; 10 mA; 20 mA; 10 V</td>
<td>20 mA</td>
</tr>
<tr>
<td>Output 3 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
</tr>
<tr>
<td>Output 4 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
</tr>
<tr>
<td>Output 4 upper value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 4 lower value</td>
<td>-9,999...9,999</td>
<td>0</td>
</tr>
<tr>
<td>Output 4 upper</td>
<td>1 mA; 10 mA; 20 mA; 10 V</td>
<td>20 mA</td>
</tr>
<tr>
<td>Output 4 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
</tr>
</tbody>
</table>

### Configuration > Memory

| Event memory | 256 k; 512 k; 1024 k, 2048 k | 256 k |
### Table 44: Overview of parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average value interval</td>
<td>See [► 107]</td>
<td>1 s</td>
<td></td>
</tr>
<tr>
<td>U&lt; threshold</td>
<td>60...100 %</td>
<td>90 %</td>
<td></td>
</tr>
<tr>
<td>U&lt; memory</td>
<td>34...160 V</td>
<td>90.0 V</td>
<td></td>
</tr>
<tr>
<td>U&gt; threshold</td>
<td>100...140 %</td>
<td>110 %</td>
<td></td>
</tr>
<tr>
<td>U&gt; memory</td>
<td>34...160 V</td>
<td>110.0 V</td>
<td></td>
</tr>
</tbody>
</table>

**Configuration > Comm. port CIC1 (optional)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm. port CIC1</td>
<td>see protocol specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baud rate comm. CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network address CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCP port CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiber-optic cable light On/Off CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modbus ASCII/RTU CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local SCADA Address CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCADA Master Address CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrequested messages CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatedly unrequested messages CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appl. conf. timeout CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission delay CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Configuration > Comm. port CIC2 (optional)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm. port CIC2</td>
<td>RS232, Ethernet, FO</td>
<td>RS232</td>
<td></td>
</tr>
<tr>
<td>Baud rate comm. CIC2</td>
<td>9.6...57.6 kilobaud</td>
<td>9.6 kilobaud</td>
<td></td>
</tr>
<tr>
<td>Network address CIC2</td>
<td>0.0.0.0...255255255255</td>
<td>0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>TCP port CIC2</td>
<td>0...9,999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission delay CIC2</td>
<td>0...254 ms</td>
<td>5 ms</td>
<td></td>
</tr>
</tbody>
</table>
13 Technical data

13.1 Indicator elements

<table>
<thead>
<tr>
<th>Indicator elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display</td>
<td>LCD, monochrome, graphics-capable 128 x 128 pixels</td>
</tr>
<tr>
<td>LEDs</td>
<td>15 LEDs for operation display and messages</td>
</tr>
</tbody>
</table>

Table 45: Indicator elements

13.2 Power supply

<table>
<thead>
<tr>
<th>Power supply</th>
<th>SUH-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible voltage range</td>
<td>88...264 V AC 88...353 V DC</td>
</tr>
<tr>
<td></td>
<td>$U_{N}$: 100...240 V AC $U_{N}$: 88...353 V DC</td>
</tr>
<tr>
<td>Permissible frequency range</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Input current</td>
<td>Max. 1 A</td>
</tr>
<tr>
<td>Power consumption</td>
<td>35 VA</td>
</tr>
<tr>
<td>Internal fuse</td>
<td>250 V; 3 A; 6.3 x 32 mm, &quot;delayed-action&quot; characteristics</td>
</tr>
</tbody>
</table>

Table 46: Standard model

![Figure 98: Internal fuses of SUH-P card](image)

F1 Fuse F2 Spare fuse
13 Technical data

<table>
<thead>
<tr>
<th></th>
<th>SUL-P</th>
<th>SUM-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible voltage range</td>
<td>18...36 V DC</td>
<td>36...72 V DC</td>
</tr>
<tr>
<td>Input current</td>
<td>Max. 2.3 A</td>
<td>Max. 1 A</td>
</tr>
<tr>
<td>Internal fuse</td>
<td>250 V; 3 A; 6.3 x 32 mm, &quot;fast-acting&quot; characteristics</td>
<td></td>
</tr>
</tbody>
</table>

Table 47: Special model

Figure 99: Internal fuse of SUM-P card and SUL-P card

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>1</td>
<td>L1 / +DC</td>
</tr>
<tr>
<td>F1</td>
<td>2</td>
<td>N / GND</td>
</tr>
</tbody>
</table>

Table 48: Terminal X1
13.3 Voltage measurement and current measurement

<table>
<thead>
<tr>
<th></th>
<th>MI</th>
<th>MI3-G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td>1 phase</td>
<td>3 phase</td>
</tr>
<tr>
<td><strong>Voltage measure-</strong></td>
<td><strong>U_N</strong>: 100 V AC</td>
<td><strong>I_N</strong>: 0.2 / 1 / 5 A</td>
</tr>
<tr>
<td><strong>MI</strong></td>
<td><strong>Measuring range</strong>: 85...140 V AC</td>
<td><strong>Measuring range</strong>: 0.01...2.1 · I_N</td>
</tr>
<tr>
<td></td>
<td><strong>Rated frequency</strong>: 45...65 Hz</td>
<td><strong>Rated frequency</strong>: 45...65 Hz</td>
</tr>
<tr>
<td></td>
<td><strong>Intrinsic consumption</strong>: &lt; 1 VA</td>
<td><strong>Intrinsic consumption</strong>: &lt; 1 VA</td>
</tr>
<tr>
<td></td>
<td><strong>Measurement category IV in accordance with IEC 61010-2-30</strong></td>
<td><strong>Overload capacity</strong>: 2.1 · I_N (continuously), 40 × I_N / 1 s</td>
</tr>
<tr>
<td></td>
<td><strong>Measuring error</strong>: &lt; 0.3 % ± 40 ppm/°C</td>
<td><strong>Measuring error</strong>: &lt; 0.5 % ± 40 ppm/°C</td>
</tr>
<tr>
<td><strong>Current measure-</strong></td>
<td><strong>I_N</strong>: 0.2 / 1 / 5 A</td>
<td><strong>f_N</strong>: 50 / 60 Hz</td>
</tr>
<tr>
<td><strong>MI</strong></td>
<td><strong>Measuring range</strong>: 0.01...2.1 · I_N</td>
<td><strong>Measuring range</strong>: 45...65 Hz</td>
</tr>
<tr>
<td></td>
<td><strong>Rated frequency</strong>: 45...65 Hz</td>
<td><strong>Measuring accuracy</strong>: ± 1 Hz</td>
</tr>
<tr>
<td></td>
<td><strong>Intrinsic consumption</strong>: &lt; 1 VA</td>
<td><strong>Measuring accuracy</strong>: ± 1 Hz</td>
</tr>
<tr>
<td></td>
<td><strong>Overload capacity</strong>: 2.1 · I_N (continuously), 40 × I_N / 1 s</td>
<td><strong>Measuring error</strong>: &lt; 0.5 % ± 40 ppm/°C</td>
</tr>
<tr>
<td><strong>Phase angle</strong></td>
<td><strong>Measuring accuracy</strong>: ± 1°</td>
<td></td>
</tr>
<tr>
<td><strong>MI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency measure-</strong></td>
<td><strong>f_N</strong>: 50 / 60 Hz</td>
<td></td>
</tr>
<tr>
<td><strong>MI</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 49: Voltage measurement and current measurement

**Interfaces**

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage transformer</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Voltage transformer</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Shared return conductor</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Current transformer with rated current of 5 A</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Current transformer with rated current of 1 A</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Current transformer with rated current of 0.2 A</td>
<td></td>
</tr>
</tbody>
</table>

Table 50: MI card terminal X1
### Interface Pin Description

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Voltage transformer L1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Voltage transformer L1</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Return conductor of current transformer L1</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Current transformer L1 (rated current 5 A)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Voltage transformer L2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Voltage transformer L2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Return conductor of current transformer L2</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Current transformer L2 (rated current 5 A)</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Voltage transformer L3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Voltage transformer L3</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Return conductor of current transformer L3</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Current transformer L3 (rated current 5 A)</td>
</tr>
</tbody>
</table>

Table 51: MI3-G card terminal X1

### 13.4 Digital inputs and outputs

<table>
<thead>
<tr>
<th></th>
<th>IO</th>
<th>UC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Logical 0</td>
<td>0...25 V DC</td>
<td></td>
</tr>
<tr>
<td>Logical 1</td>
<td>40...250 V DC</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>With pulsating DC voltage, the voltage minimum must always exceed 40 V.</td>
</tr>
<tr>
<td>Input current</td>
<td>Min. 1 mA</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>8 (5)</td>
<td>10</td>
</tr>
<tr>
<td>Number (number of change-over contacts in parentheses)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact loadability</td>
<td>Min.: 12 V, 100 mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. AC: 250 V, 5 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. DC: See diagram</td>
<td></td>
</tr>
</tbody>
</table>

Table 52: Digital inputs and outputs
13 Technical data

Figure 100: Maximum contact loadability of outputs with direct current

| 1 Ohmic load |

13.5 Analog inputs and outputs

<table>
<thead>
<tr>
<th>Channels</th>
<th>AD</th>
<th>AD8</th>
<th>AN</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inputs</td>
<td>8 inputs</td>
<td>2 outputs or 4 outputs (AN + AN1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input signals (depending on configuration)</th>
<th>AD</th>
<th>AD8</th>
<th>AN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0...±20mA</td>
<td>0...±10mA</td>
<td>4...20 mA</td>
<td>-</td>
</tr>
<tr>
<td>0...±10V</td>
<td>50...2000 ohms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output signals (depending on configuration)</th>
<th>AD</th>
<th>AD8</th>
<th>AN</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>0...±20mA</td>
<td>0...±10mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0...±1mA</td>
<td>0...±10V</td>
</tr>
</tbody>
</table>

Table 53: Analog inputs and outputs (optional)

13.6 Control voltage supply (optional)

<table>
<thead>
<tr>
<th></th>
<th>AC-115</th>
<th>AC-230</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>115 V AC, 50/60 Hz</td>
<td>230 V AC, 50/60 Hz</td>
</tr>
<tr>
<td>Output</td>
<td>60 V DC</td>
<td>max. 0.2 A</td>
</tr>
</tbody>
</table>
13 Technical data

<table>
<thead>
<tr>
<th></th>
<th>AC-115</th>
<th>AC-230</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>0.16 A</td>
<td>0.08 A</td>
</tr>
<tr>
<td>Internal fuse</td>
<td>250 V; 3 A; 6.3 x 32 mm, &quot;fast-acting&quot; characteristics</td>
<td></td>
</tr>
</tbody>
</table>

Table 54: Control voltage supply

![Internal fuses of AC-115 card and AC-230 card](image)

Table 55: Terminal X1

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>L1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 56: Terminal X2

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>+DC</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-DC</td>
</tr>
</tbody>
</table>
13.7 Central processing unit

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>GND_ISO</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>CAN_L</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SHLD*</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>CAN_H</td>
</tr>
</tbody>
</table>

Table 57: Terminal X9 (CAN bus)

*) Alternatively, you can fit the cable shield to the partition plate's cable clip.

13.8 System networking

<table>
<thead>
<tr>
<th>Interface</th>
<th>CIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>9-pin SUB-D connector</td>
</tr>
<tr>
<td>RS485</td>
<td>3-pin socket from Phoenix Contact (MC1.5/3 GF 3.5)</td>
</tr>
<tr>
<td></td>
<td>Polarity:</td>
</tr>
<tr>
<td></td>
<td>A &gt; B by 200 mV corresponds to 1.</td>
</tr>
<tr>
<td></td>
<td>A &lt; B by 200 mV corresponds to 0.</td>
</tr>
<tr>
<td></td>
<td>Recommended terminating resistor 120 Ω.</td>
</tr>
<tr>
<td>RJ45 (optional)</td>
<td>Max. 100 m</td>
</tr>
<tr>
<td></td>
<td>10 MBit/s</td>
</tr>
<tr>
<td>Fiber-optic cable (optional)</td>
<td>F-ST (850 nm or 660 nm)</td>
</tr>
<tr>
<td></td>
<td>F-SMA (850 nm or 660 nm)</td>
</tr>
</tbody>
</table>

Table 58: Technical data for CIC card

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>TXD</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>RXD</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>GND</td>
</tr>
</tbody>
</table>

Table 59: Terminal X8 (RS232)
Table 60: Terminal X9 (RS485)

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>GND (100 Ω ground resistance)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>B (inverted)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>A (non-inverted)</td>
</tr>
</tbody>
</table>

Table 61: Terminal X7 (RJ45)

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>TxD+</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>TxD-</td>
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<tr>
<td></td>
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<td>RxD+</td>
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<td></td>
<td>6</td>
<td>RxD-</td>
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13.9 Dimensions and weight

<table>
<thead>
<tr>
<th>Housing (W x H x D)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19-inch plug-in housing in accordance with DIN 41494 Part 5</td>
</tr>
<tr>
<td></td>
<td>483 x 133 x 178 mm (19 x 5.2 x 7 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>5.0 kg (11 lb)</td>
</tr>
</tbody>
</table>

Table 62: Dimensions and weight
Figure 102: Dimensions
13 Technical data

13.10 Ambient conditions

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Operating temper-</strong></td>
<td><strong>-25°C...+70°C</strong></td>
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<tr>
<td><strong>ature</strong></td>
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</tr>
<tr>
<td><strong>Storage temper-</strong></td>
<td><strong>-30°C...+85°C</strong></td>
</tr>
<tr>
<td><strong>ature</strong></td>
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</tr>
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Table 63: Permissible ambient conditions

13.11 Tests

13.11.1 Electrical safety

<table>
<thead>
<tr>
<th>Standard/Label</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>EN 61010-1</td>
<td>Safety requirements for electrical measurement and control and regulation equipment and laboratory instruments</td>
</tr>
<tr>
<td>IEC 61131-2</td>
<td>Dielectric test with operating frequency 2.5 kV / 1 min</td>
</tr>
<tr>
<td>IEC 60255</td>
<td>Dielectric test with impulse voltage 5 kV, 1.2/50 μs</td>
</tr>
<tr>
<td>IEC 60 644-1</td>
<td>Level of contamination 2, overvoltage category III</td>
</tr>
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</table>

Table 64: Electrical safety

13.11.2 EMC tests

<table>
<thead>
<tr>
<th>Standard/Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61000-4-2</td>
<td>Electrostatic discharges (ESD) 6 kV/8 kV</td>
</tr>
<tr>
<td>IEC 61000-4-3</td>
<td>Electromagnetic fields (HF) 20 V/m 80...3000 MHz</td>
</tr>
<tr>
<td>IEC 61000-4-4</td>
<td>Fast transients (burst) 2 kV</td>
</tr>
<tr>
<td>IEC 61000-4-5</td>
<td>Surge transient immunity 4 kV/2 kV/1 kV</td>
</tr>
<tr>
<td>IEC 61000-4-6</td>
<td>HF interference immunity (lines) 10 V, 150 kHz...80 MHz</td>
</tr>
<tr>
<td>IEC 61000-4-8</td>
<td>Power frequency magnetic field immunity 30 A/m, 50 Hz, continuous</td>
</tr>
<tr>
<td>IEC 61000-4-11</td>
<td>Voltage dips, short interruptions and voltage variations immunity tests</td>
</tr>
<tr>
<td>IEC 61000-4-29</td>
<td>Voltage dips, short interruptions and voltage variations on DC input power port immunity tests</td>
</tr>
<tr>
<td>IEC 61000-6-2</td>
<td>Immunity requirements for industrial environments</td>
</tr>
<tr>
<td>IEC 61000-6-4</td>
<td>Emission standard for industrial environments</td>
</tr>
<tr>
<td>DIN EN 55011, DIN EN 55022</td>
<td>Emission &quot;RFI&quot;</td>
</tr>
</tbody>
</table>

Table 65: EMC tests

13.11.3 Environmental durability tests

<table>
<thead>
<tr>
<th>Standard/Label</th>
<th>Description</th>
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<tbody>
<tr>
<td>DIN EN 60529</td>
<td>Degree of protection IP20</td>
</tr>
<tr>
<td>IEC 60068-2-1</td>
<td>Dry cold - 25 °C / 96 hours</td>
</tr>
<tr>
<td>IEC 60068-2-2</td>
<td>Dry heat + 70 °C/ 96 hours</td>
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</tbody>
</table>

Maschinenfabrik Reinhausen 2014
<table>
<thead>
<tr>
<th>Standard</th>
<th>Test Description</th>
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<tbody>
<tr>
<td>IEC 60068-2-3</td>
<td>Constant moist heat&lt;br&gt; + 40 °C / 93 % / 4 days, no dew</td>
</tr>
<tr>
<td>IEC 60068-2-30</td>
<td>Cyclic moist heat (12 + 12 hours)&lt;br&gt; + 55 °C / 93 % / 6 cycles</td>
</tr>
</tbody>
</table>

Table 66: Environmental durability tests
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>DIN</td>
<td>Abbreviation for &quot;Deutsches Institut für Normung&quot;</td>
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<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
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<tr>
<td>EN</td>
<td>Abbreviation for &quot;European Norm&quot;</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>LDC</td>
<td>Line drop compensation</td>
</tr>
<tr>
<td>MR</td>
<td>Abbreviation for &quot;Maschinenfabrik Reinhausen GmbH&quot;</td>
</tr>
<tr>
<td>OF</td>
<td>Abbreviation for fiber-optic cable</td>
</tr>
<tr>
<td>R/L</td>
<td>Raise/lower</td>
</tr>
<tr>
<td>RTC</td>
<td>Abbreviation for &quot;Real Time Clock&quot;</td>
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<tr>
<td>A</td>
<td>B</td>
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<td>AC card</td>
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<td>AD card</td>
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<tr>
<td>AN card</td>
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<tr>
<td>Analog input</td>
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<tr>
<td>Application timeout confirmation</td>
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<tr>
<td>response</td>
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<td>Assemblies</td>
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<tr>
<td>Assembly</td>
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<td>AC card</td>
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<td>MI</td>
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**Note:** The table above lists key words related to various technical specifications and parameters, such as card types, input/output status, communication interfaces, and diagnostic features. Each entry represents a specific technical term or parameter, along with its associated page number or context within the document. For example, the AC card is mentioned on page 27, while the function test is described on pages 44, 48, and 75. This list serves as a reference for users to quickly locate relevant information within the manual.
<table>
<thead>
<tr>
<th>L</th>
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<td>Language</td>
<td>Parallel operation 93, 130</td>
<td>tap position capture</td>
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<td>LED selection</td>
<td>CAN bus 93</td>
<td>Analog 98</td>
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<td>Circulating reactive current 94</td>
<td>Tapping direction swapped 63</td>
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<td>Parallel operation error message 97</td>
<td>TCP port 119, 126</td>
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<td>Overvoltage V&gt; 74</td>
<td>Throughput capacity 93</td>
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<td>Time 42</td>
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<td>Undervoltage U&lt;</td>
<td>Parallel operation control 97</td>
<td>Time axis 113</td>
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<td>Time plotter 111</td>
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<td>Retrace date 116</td>
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<td>Peak memory 79</td>
<td>Retrace time 115</td>
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<td>Phase difference 89</td>
<td>Time axis 113</td>
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<td>Primary voltage 64</td>
<td>Visual display 111</td>
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<td>Primary current 88</td>
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<td>Relative 71</td>
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<td>Cross-monitoring 85</td>
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<td>Current transformer connection 89</td>
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<td>Transformer circuit 89</td>
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<td>R&amp;X compensation 77</td>
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<td>Raise/Lower pulse duration 56</td>
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<td>Measuring transducer</td>
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<td>Regulator ID 55</td>
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<td>Memory 104</td>
<td>Repeat unsolicited messages 123</td>
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<td>MI 23</td>
<td>Reset parameters 130</td>
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<td>MI3-G 23</td>
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<td>RTC 130</td>
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<td>Output relay 61</td>
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<td>SCADA address Device 121</td>
<td>V des. regulator 2 82</td>
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<tr>
<td>NORMset 64</td>
<td>Master 121</td>
<td>V&lt; also below 30 V 74</td>
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<td>Operating controls 17</td>
<td>Secondary voltage 64</td>
<td>V&lt; blocking 73</td>
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<td>Operating mode</td>
<td>Send delay time RS485 124, 126</td>
<td>V&lt; delay 73</td>
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<td>SU card 93</td>
<td>V&lt; regulator 2 83</td>
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<td>Local mode 16</td>
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<td>V&lt; threshold 105</td>
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<td>Manual mode 15</td>
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<td>V&gt; regulator 2 84</td>
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<td>Remote mode 16</td>
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<td>V&gt; threshold 106</td>
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<td>Voltage display kV/V 56</td>
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<td>Overview of parameters 144</td>
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<td>NORMset 64</td>
<td>Undervoltage blocking</td>
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<td>Absolute 73</td>
<td>V des. regulator 2 82</td>
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<td>Relative 72</td>
<td>V&lt; also below 30 V 74</td>
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<td>Undervoltage threshold 105</td>
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<td>Local mode 16</td>
<td>Unsolicited messages 122</td>
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<td>Manual mode 15</td>
<td>Upcoming messages 133</td>
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<td>Remote mode 16</td>
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<td>V&lt; blocking 73</td>
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<td>V&lt; regulator 2 83</td>
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<td>V&gt; threshold 106</td>
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<td>Voltage display kV/V 56</td>
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### List of key words

#### Z

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<td>Z compensation</td>
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<tr>
<td>Activate</td>
<td>81</td>
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<td>Limit value</td>
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MR worldwide

Australia
Reinhausen Australia Pty. Ltd.
17/20-22 St Albans Road
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Fax: +61 2 9502 2224
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E-Mail: lass@iran-transfo.com

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Fax: +39 02 69434766
E-Mail: sales@it.reinhausen.com

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21st floor, Standard Chartered Bank Bldg.,
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Phone: +82 2 767 4909
Fax: +82 2 736 0049
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Fax: +1 731 784 7682
E-Mail: sales@reinhausen.com

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Dubai Airport Freezone, Building Phase 6
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Phone: +971 4 2368 451
Fax: +971 4 2368 225
Email: service@ae.reinhausen.com