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<td>14.11</td>
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<td>159</td>
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<td></td>
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<td>161</td>
</tr>
<tr>
<td></td>
<td><strong>List of key words</strong></td>
<td>162</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Signal word</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>

Table 1: Signal words in warning notices
1 Introduction

Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Warning of a danger point" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image" alt="Warning of dangerous electrical voltage" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image" alt="Warning of combustible substances" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image" alt="Warning of danger of tipping" /></td>
<td>Warning of danger of tipping</td>
</tr>
</tbody>
</table>

Table 2: Pictograms used 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:

<table>
<thead>
<tr>
<th>Typographic convention</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<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 mes-</td>
<td><em>Function monitoring</em> alarm trig-</td>
</tr>
<tr>
<td></td>
<td>sages, signals</td>
<td>gered</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.
2.4 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 voltage regulator serves to keep constant the output voltage of a transformer with an on-load tap-changer.

To do this, the voltage regulator compares the transformer's measured output voltage \( U_{\text{actual}} \) with a defined reference voltage \( U_{\text{desired}} \). The difference between \( U_{\text{actual}} \) and \( U_{\text{desired}} \) is the control deviation \( dU \).

If the control deviation is greater than the specified bandwidth (B%), the voltage regulator emits a switching pulse after a defined delay time \( T_1 \). The switching pulse triggers an on-load tap-changer tap change which corrects the transformer's output voltage.

The voltage regulator parameters can be optimally adjusted to the line voltage behavior to achieve a balanced control response with a small number of tap-change operations.

The following diagram shows an overview of voltage regulation.
The on-load tap-changer is on the high-voltage side and is activated by the motor-drive unit. The TAPCON® 260 measures voltage and current on the two transformer windings on the low-voltage side. The device is fitted with 2 measuring cards for this purpose. One of the two windings on the low-voltage side is regulated, the other is monitored (see connection diagram).

The TAPCON® 260 provides three ways of selecting the transformer winding to be regulated:

- The transformer winding with the higher current flow is regulated
- The TAPCON® 260 uses 1 digital signal to select the transformer winding to be regulated
- The TAPCON® 260 uses 2 digital signals to select the transformer winding to be regulated, see table below
### 3 Product description

<table>
<thead>
<tr>
<th>Input for transformer winding 1</th>
<th>Input for transformer winding 2</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>The transformer winding with the higher current flow is regulated.</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Transformer winding 1 is regulated.</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Transformer winding 2 is regulated.</td>
</tr>
</tbody>
</table>

Table 4: Selection of transformer winding to be regulated with two digital signals

The non-regulated transformer winding is monitored for overvoltage and undervoltage. In the event of overvoltage, the raise pulse and therefore the high-speed return are blocked on the non-regulated transformer winding. In the event of undervoltage, the lower pulse is likewise blocked on the non-regulated transformer winding.

Your individual specifications determine which of the 3 options is implemented. The selection is determined by an MR-specific device configuration and can only be undertaken by Maschinenfabrik Reinhausen GmbH.

### 3.3 Performance features

The TAPCON® is responsible for controlling tapped transformers.

Apart from control tasks, the TAPCON® 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 for freely selectable functions**

- **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**

- **Power-dependent desired value adjustment**

- **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
• Additional digital inputs and outputs which can be freely parameterized by the customer
• Parallel operation of up to 16 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 LOCAL and REMOTE keys is disabled.

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

Table 5: 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.

Figure 2: Front view

1 Operating panel with display and LEDs
2 Rack for optional expansions
3 19-inch plug-in housing (in accordance with DIN 41494 Part 5)
4 Name plate

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 Product description

Figure 4: Operating controls

- RAISE key: Sends control command for raise tap-change to the motor-drive unit in manual mode.
- LOWER key: Sends control command for lower tap-change to the motor-drive unit in manual mode.
- REMOTE key: Activate/deactivate "Remote" operating mode. When you deactivate this operating mode, the "Local" operating mode is automatically activated.
- MANUAL key: Activate "Manual" operating mode.
- AUTO key: Activate "Automatic" operating mode.
- PREV key: Change measured value display and switch to previous parameters.
- NEXT key: Change measured value display and switch to next parameters.
- ENTER key: Confirm selection and save modified parameters.
- ESC key: Escape current menu and select previous menu levels.
- MENU key: Select main menu.
- F1...F5 function keys: Select functions displayed on the screen.
3.5.3 Display elements

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating status LED, green</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Overcurrent blocking LED, red</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Undervoltage blocking LED, red</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>Overvoltage blocking LED, red</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Parallel operation active LED, green</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>NORMset active LED, green</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>LED 1, function can be freely assigned, yellow</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>LED 2, function can be freely assigned, yellow</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 5: Display elements
3 Product description

Display

Figure 6: Display

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Status line</td>
<td>7</td>
<td>Time bar for delay time T1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Measured voltage $U_{\text{actual}}$</td>
<td>8</td>
<td>Mark for desired voltage $U_{\text{desired}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Desired voltage currently used $U_{\text{ref1}}$, $U_{\text{ref2}}$, $U_{\text{ref3}}$</td>
<td>9</td>
<td>Mark for measured voltage $U_{\text{actual}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Other measured values (use $\rightarrow$ or $\leftarrow$ to switch between them)</td>
<td>10</td>
<td>Remaining delay time T1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tap position $n-1$; $n$; $n+1$</td>
<td>11</td>
<td>Voltage currently regulated $U_1/U_2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Bandwidth (upper and lower limit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other measured values

In auto mode and manual mode the measured value display 4 can be set using the $\rightarrow$ or $\leftarrow$ 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>Current1</td>
<td>Apparent current of winding 1</td>
</tr>
</tbody>
</table>
### Table 6: Measured value display

<table>
<thead>
<tr>
<th>Unit</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Apparent power of winding 1</td>
</tr>
<tr>
<td>P1</td>
<td>Active power of winding 1</td>
</tr>
<tr>
<td>Q1</td>
<td>Reactive power of winding 1</td>
</tr>
<tr>
<td>Phase1</td>
<td>Phase angle between U and I of winding 1</td>
</tr>
<tr>
<td>Cos1</td>
<td>Active factor cosine $\varphi$ (power factor) of winding 1</td>
</tr>
<tr>
<td>Current2</td>
<td>Apparent current of winding 2</td>
</tr>
<tr>
<td>S2</td>
<td>Apparent power of winding 2</td>
</tr>
<tr>
<td>P2</td>
<td>Active power of winding 2</td>
</tr>
<tr>
<td>Q1</td>
<td>Reactive power of winding 2</td>
</tr>
<tr>
<td>Phase2</td>
<td>Phase angle between U and I of winding 2</td>
</tr>
<tr>
<td>Cos2</td>
<td>Active factor cosine $\varphi$ (power factor) of winding 2</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.
3 Product description

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:

<table>
<thead>
<tr>
<th>Card</th>
<th>Default/option</th>
<th>Max. number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN</td>
<td>Option</td>
<td>1</td>
</tr>
<tr>
<td>AC</td>
<td>Option</td>
<td>1</td>
</tr>
<tr>
<td>AD8</td>
<td>Option</td>
<td>1</td>
</tr>
<tr>
<td>AD</td>
<td>Option</td>
<td>1, optional with extension module</td>
</tr>
<tr>
<td>CIC</td>
<td>Option</td>
<td>2</td>
</tr>
<tr>
<td>CPU</td>
<td>Standard</td>
<td>1</td>
</tr>
<tr>
<td>IO</td>
<td>Standard</td>
<td>1</td>
</tr>
<tr>
<td>MI</td>
<td>Standard</td>
<td>1</td>
</tr>
<tr>
<td>SU</td>
<td>Standard</td>
<td>1</td>
</tr>
<tr>
<td>UC</td>
<td>Standard</td>
<td>1 UC card in standard Up to 5 additional UC cards possible</td>
</tr>
</tbody>
</table>

Table 7: Assemblies

The functions of the assemblies are described in the following sections. You can find more information about the assemblies and a description of the interfaces in the Technical data [► 150] 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

Figure 9: SUM-P card
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.

**UC card**

The UC card contains 10 digital inputs and 10 digital potential-free outputs. The device can be equipped with several UC cards (UC1, UC2...).
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)

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).

![AD8 card](image)

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

![AN card](image)

Figure 17: AN card

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
3 Product description

- AC115: 115 V AC input voltage

⚠️ **CAUTION**

*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

![Figure 20: CPU card](image)

3.5.5.7 System networking

The device is equipped with the following assemblies:

**CIC card**

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

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RS232</td>
<td>6</td>
<td>TxD LED for transmit signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RS485</td>
<td>7</td>
<td>RxD LED for receive signal</td>
<td></td>
<td></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>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fiber-optic cable, optional</td>
<td>9</td>
<td>Clip for connecting cable shield</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Reset key</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SID card

The SID interface card is used to connect the device to the control station system (SCADA). The IEC 61850 protocol transfers the data using Ethernet.

Figure 22: SID card

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reset key</td>
<td>3</td>
<td>RS232 system interface</td>
</tr>
<tr>
<td>2</td>
<td>LED for operating status</td>
<td>4</td>
<td>RJ45 (Ethernet)</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 8: 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.
4 Packaging, transport and storage

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
- ½-19" mounting frame for wall mounting

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 [► 157].
2. Place device in 19" frame and screw down.

![Figure 23: 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 9: 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 10: 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 24: Recommended wiring

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

- 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 27: Securing the shielding

1 Securing the CAN bus cable’s shielding

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 ► 35.
► 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:

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 28: 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:

2. Press [F1] or [F5] to select the required language.
3. Press [Enter]

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 Format</th>
<th>Time Format</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:

   - Press [F4] Time
   - 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 [Enter]
   - The time is set.
Date

To set the date, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** 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 **F3**
   - 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 chapter.

#### Setting transformer data

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

1. Set primary transformer voltage.
2. Set secondary transformer voltage.
3. Set primary transformer current.
4. Select current-transformer connection.
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.
2. Set the bandwidth [► 68].
3. Set delay time T1 [► 68].
6 Commissioning

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 [► 82].
2. Set the line data for the ohmic voltage drop Ur [► 83].
3. Set the line data for the inductive voltage drop Ux [► 83].

Setting parallel operation (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 [► 93].
2. Assign the CAN bus address [► 93].
3. Set circulating reactive current sensitivity [► 94].
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) [► 97].

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 Commissioning

6.3.1 Checking control functions

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

✓ Supply voltage must be present.

1. Press \[ \text{ } \] to select manual mode.
2. Set transmission ratio for voltage transformer, current transformer and measuring arrangement.
3. Measure actual voltage and compare with the measured value displayed on the device’s main screen.
4. Press \[ \text{ } \] key several times to display the operating values for current, power and phase angle and compare them with values of the operating measuring instruments.
5. Control the on-load tap-changer manually with the \[ \text{ } \] or \[ \text{ } \] keys until the measured voltage \( V_{\text{actual}} \) reaches the desired voltage \( V_{\text{desired}} \) set in the next stage.
6. Set desired value 1 to the value you want.
7. Set bandwidth in relation to step voltage \[ \text{ } \]
8. Set delay time \( T_1 \) to 20 seconds \[ \text{ } \]
9. Set control response \( T_1 \) to linear \[ \text{ } \]
10. Press \[ \text{ } \] to raise the on-load tap-changer 1 step.
11. Press \[ \text{ } \] to select auto mode.
   \[ \rightarrow \] After 20 seconds, the device returns the on-load tap-changer to the original operating position.
12. Press \[ \text{ } \] to select manual mode.
13. Press \[ \text{ } \] to lower the on-load tap-changer 1 step.
14. Press \[ \text{ } \] to select auto mode.
   \[ \rightarrow \] After 20 seconds, the device returns the on-load tap-changer to the original operating position.
15. Press \[ \text{ } \] to select manual mode.
16. Set delay time \( T_2 \) to 10 seconds \[ \text{ } \]
17. Activate delay time \( T_2 \).
18. Press \[ \text{ } \] twice to raise the on-load tap-changer 2 steps.
19. Press \[ \text{ } \] to select auto mode.
   \[ \rightarrow \] After 20 seconds, the device lowers the on-load tap-changer one step and after another 10 seconds another step.
20. Press \[ \text{ } \] to select manual mode.
21. Set delay time T1 [► 68] and delay time T2 [► 70] to the desired value.

We recommend a temporary setting of 100 seconds for **delay time T1** when commissioning the transformer. Depending on the operating conditions, you can also specify the delay time following a longer observation period. In this regard, it is useful to register how the actual voltage progresses and the number of tap-change operations per day.

### 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 \[ auto \] to select manual mode.
2. Set undervoltage U < [%] to 85 % [► 73].
3. Set the absolute limit values parameter to Off [► 71].
4. Set the U< blocking parameter to On [► 74].
5. Set desired value 1 such that the measured voltage is below the undervoltage U< [%] limit value.

   - 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 \[ auto \] to select auto mode.

   - The device blocks and does not issue any control commands.

7. Press \[ auto \] 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 \[ auto \] to select manual mode.
2. Set overvoltage $U_{> \%}$ to 115 % [► 75].
3. Set the absolute limit values parameter to Off [► 71].
4. Set desired value 1 such that the measured voltage $U_{\text{actual}}$ is above the overvoltage $U_{> \%}$ limit value.

**Measured voltage = 100 V**
Desired value 1 = Set to 85 V (less than $100 \, V / 1.15 = 87 \, V$).

$\Rightarrow$ The Overvoltage $U_{> \%}$ LED will light up.
$\Rightarrow$ The Overvoltage message appears in the display and the relevant signaling relay is activated.

5. Press [AUTO] to select auto mode.
   $\Rightarrow$ The LOWER output relay emits a control command every 1.5 seconds.
7. Reset the operating values for desired value 1 and overvoltage $U_{> \%}$ to the desired operating values.
   $\Rightarrow$ The function test for overvoltage blocking is complete.

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

1. Press [ESC] to select manual mode.
2. Set desired value 2 to the value you want.
3. Apply voltage $L+$ to terminal desired value 2 (see connection diagram).
4. Press [ESC] until the main screen is displayed.
   $\Rightarrow$ Desired value 2 is shown on the main screen.
5. Set desired value 3 to the value you want.
6. Apply voltage $L+$ to terminal desired value 3 (see connection diagram).
7. Press [ESC] until the main screen is displayed.
   $\Rightarrow$ Desired value 3 is shown on the main screen.
   $\Rightarrow$ 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 $\geq 10 \%$ of the nominal transformer current is needed for the following function tests. Before the function test, ensure that all parameters for line drop compensation [► 82] and for Z compensation [► 84] are set to 0.

1. Press [ESC] to select manual mode.
2. Press [ESC] until the main screen is displayed.
3. If necessary, press ➔ until the control deviation \(dU\) is shown. 
   ⇒ The measured voltage must be within the bandwidth.
4. Set line drop compensation \(Ur\) parameter to 20.0 V [► 83].
   ⇒ The control deviation \(dU\) must be negative.
5. Set line drop compensation \(Ux\) parameter to -20.0 V [► 83].
6. Press ESC until the main screen is displayed.
7. If necessary, press ➔ until the control deviation \(dU\) is shown.
   ⇒ The control deviation \(dU\) 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 \(Ur\) and line drop compensation \(Ux\) 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 ESC until the main screen is displayed.
4. If necessary, press ➔ until the control deviation \(dU\) is shown.
   ⇒ The measured voltage must be within the bandwidth.
5. Set the Z compensation parameter to 15.0 V.
6. Press ESC until the main screen is displayed.
7. If necessary, press ➔ until the control deviation \(dU\) is shown.
   ⇒ The control deviation \(dU\) 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.
6 Commissioning

Also refer to
- Setting Z compensation [► 85]
- Setting the Z compensation limit value [► 85]

6.3.3 Checking parallel operation

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

Requirements

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

- 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\textsubscript{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 [AUTO] 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 [► 94] 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 [► 94] 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 [M] 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 \textbf{AUTO} to select auto mode.
\rightarrow The motor-drive unit automatically returns to the original operating position.

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

\begin{itemize}
  \item If one or all devices indicate \textit{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 \textit{Troubleshooting} [\textgreater 138].
  \item The function test for circulating reactive current blocking is complete.
\end{itemize}
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 General

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

7.2.1 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. Menu > F4 Configuration > F3 General > Press → until the desired parameter is displayed.

   ➞ Regulator ID.

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 (digit > 9) until another digit position appears.

4. If necessary, press F4 in order to highlight the 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 device ID is set.

### 7.2.2 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 MENU > F4 Configuration > F3 General > △ until the desired parameter is displayed.
   ⇒ Setting the baud rate.
2. Press F1 or F5 to select the required baud rate.
3. Press △
   ⇒ The baud rate is set.

### 7.2.3 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 [► 86].

To change the desired unit for the voltage display, proceed as follows:
1. Press **MENU** > F4 Configuration > F3 General > ⋯ until the desired parameter is displayed.
   ⇒ Display kV/V.
2. Press F1 or F5 to select kV or V units.
3. Press ←
   ⇒ The required unit is set for the voltage display.

### 7.2.4 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 **MENU** > F4 Configuration > F3 General > ⋯ until the desired parameter is displayed.
   ⇒ Display %/A
2. Press F1 or F5 to select % or A units.
3. Press ←
   ⇒ The required unit is set for the current display.

### 7.2.5 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.
Figure 35: Switching pulse time in normal mode

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set delay time T1 or T2</td>
</tr>
<tr>
<td>2</td>
<td>Set switching pulse time (for example 1.5 seconds)</td>
</tr>
</tbody>
</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 2, the next earliest switching pulse occurs in rapid return control mode 3 1.5 seconds after the previous switching pulse ended.
### 7. Functions and settings

**Figure 36: Switching pulse in rapid return control mode**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start of first raise switching pulse/lower switching pulse</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Set switching pulse time (for example 1.5 seconds)</td>
<td></td>
</tr>
</tbody>
</table>

To set the pulse duration, proceed as follows:

1. **Configuration** > **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.

### 7.2.6 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>Delay time T1 and delay time T2 are deactivated.</td>
</tr>
<tr>
<td></td>
<td>Raise switching pulse and lower switching pulse occur when value exceeds/falls below the band-width.</td>
</tr>
<tr>
<td>MPS triggered</td>
<td>The Motor protective switch was triggered 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 12: 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.

#### 7.2.7 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 13: Possible messages for output relays

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

1. Press Configuration > General > until the desired parameter is displayed.  
   ➞ IO1-X1:25/26 or IO1-X1:23/24.
2. Press F1 or F5 until the desired function appears in the display.
3. Press ➔.  
   ➞ The function is assigned.

7.2.8 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:
7 Functions and settings

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.

### 7.2.9 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.

---

### Table: Wiring for Motor Runtime Monitoring

<table>
<thead>
<tr>
<th>1</th>
<th>Motor running control input I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Motor protective switch triggered control input I/O (optional)</td>
</tr>
<tr>
<td>3</td>
<td>Motor protective switch output relay I/O (optional)</td>
</tr>
<tr>
<td>4</td>
<td>Motor-drive unit runtime exceeded output relay I/O (optional)</td>
</tr>
</tbody>
</table>

---

**Figure 40: Wiring for motor runtime monitoring**

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.

---

**Figure 40: Wiring for motor runtime monitoring**

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 \[ \rightarrow \]

\[ \rightarrow \] The motor runtime is set.

### 7.2.10 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>
</table>
| Standard | **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. |
| Swapped  | **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. |

Table 14: Device response

To select the tapping direction, proceed as follows:

1. Press \[ MENU \rightarrow F4 \rightarrow F3 \rightarrow \rightarrow \] until the desired parameter is displayed.

\[ \rightarrow \] Tapping direction turned.

2. Press \[ F1 \] or \[ F5 \] to select the required option.

3. Press \[ \rightarrow \]

\[ \rightarrow \] The tapping direction is selected.

### 7.3 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. Press \( \text{NORMset} \) or \( \text{NORMset activation.} \)
2. Press \( \text{On} \) or \( \text{Off} \) to activate NORMset by selecting \( \text{On} \) or to deactivate \( \text{NORMset} \) by selecting \( \text{Off} \).
3. Press \( \text{NORMset is activated/deactivated.} \)

**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. Press \( \text{F2} \) until the desired parameter is displayed.
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \text{The primary voltage is set.} \)

**Setting the secondary voltage**

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

To set the secondary voltage, proceed as follows:
7 Functions and settings

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 [F2]
   - 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 [F2]
   - The desired value is set.

### 7.4 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>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_{\text{actual}}$ is outside the bandwidth. Delay time $T_1$ starts.</td>
<td>$U_{\text{actual}}$ is within the bandwidth before delay time $T_1$ is complete.</td>
<td>$U_{\text{actual}}$ is outside the bandwidth. Delay time $T_1$ starts.</td>
<td>$U_{\text{actual}}$ is still outside the bandwidth when delay time $T_1$ is complete. Tap-change operation is initiated.</td>
</tr>
</tbody>
</table>

Behavior with delay times T1 and T2

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 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 to return to the tolerance bandwidth.

**Figure 42: Behavior of the regulation function with delay times T1 and T2**

1. + B %: Upper limit
2. $U_{\text{desired}}$: Desired value
3. - B %: Lower limit
4. Set delay times T1 and T2.
5. $U_{\text{actual}}$: Measured voltage
6. B%: Tolerance bandwidth
A. $U_{\text{actual}}$ is outside the bandwidth. Delay time T1 starts.
B. Delay time T1 complete. Tap change triggered.
C. Delay time T2 complete. Tap change triggered.

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

### 7.4.1 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.
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

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.

You have to set this parameter for both winding 1 and winding 2. Proceed as follows to set the desired value:

1. Press until the desired parameter is displayed.
   - Desired value (for winding 1)/Winding 2 desired value (for winding 2)
2. If necessary press to select the unit you want, V or kV.
3. Press to highlight the position.
   - The desired position is highlighted and the value can be changed.
4. Press to increase the value or to reduce it.
5. Press.
   - The desired value is set.

### 7.4.2 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.

### 7.4.3 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:
7 Functions and settings

1. **Menu** > F3 Parameter > F2 Control parameter > 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 delay time T1 is set.

### 7.4.4 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 (ΔV) 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 44: Diagram showing integral control response**

<table>
<thead>
<tr>
<th>ΔV/B</th>
<th>Control deviation &quot;ΔV&quot; as % of desired value as ratio to the set bandwidth &quot;B&quot; as % of desired value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&quot;Delay time T1&quot; parameter</td>
</tr>
</tbody>
</table>
To set the control response T1, proceed as follows:

1. **Menu > F3 Parameter > F2 Control parameter > Press** until the desired parameter is displayed.
2. Press **F1** or **F5** to set the response you want.
3. Press **<<**

⇒ The control response T1 is set.

### 7.4.5 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. **Menu > F3 Parameter > F2 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. **Menu > F3 Parameter > F2 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.
7.4.6 Selecting the winding to regulate

You can use this parameter to select the winding that is to be regulated. You can select the following options:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>The device uses the voltage of the winding with the highest apparent current for regulation.</td>
</tr>
<tr>
<td>Winding1</td>
<td>The device regulates the voltage of winding 1 for regulation.</td>
</tr>
<tr>
<td>Winding2</td>
<td>The device regulates the voltage of winding 2 for regulation.</td>
</tr>
</tbody>
</table>

Table 15: Selection of regulated winding

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

1. Press \( \text{Parameter} > \text{F3} \) Parameter > \( \text{F2} \) Control parameter > Press until the desired parameter is displayed. \( \Rightarrow \) Regulated winding selection.

2. Press \( \text{F1} \) or \( \text{F5} \) to select the option you want.

3. Press \( \downarrow \) \( \Rightarrow \) The winding to be regulated is selected.

7.5 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.

7.5.1 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 16: 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 **←**.
   - The absolute limit value is activated/deactivated.

### 7.5.2 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 $V_{\text{set}}$, 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$[\text{► 74}]$ 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$[\text{► 75}]$ (for example when the transformer is switched off), the Undervoltage message is also displayed. You can however suppress this message.
7 Functions and settings

Figure 45: Response to value falling below limit value

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ B %: Upper limit</td>
</tr>
<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 limit value for undervoltage $U_&lt;$</td>
</tr>
<tr>
<td>5</td>
<td>Limit value for suppressing alarms below 30 V</td>
</tr>
<tr>
<td>6</td>
<td>Set signaling delay time for limit value for undervoltage $U_&lt;$</td>
</tr>
<tr>
<td>7</td>
<td>$U_{\text{actual}}$: Measured voltage</td>
</tr>
<tr>
<td>A</td>
<td>Value falls below limit value</td>
</tr>
<tr>
<td>B</td>
<td>Undervoltage $U_&lt;$ message is displayed</td>
</tr>
<tr>
<td>C</td>
<td>Voltage falls below 30 V</td>
</tr>
<tr>
<td>D</td>
<td>Voltage exceeds 30 V again</td>
</tr>
<tr>
<td>E</td>
<td>Value exceeds limit value</td>
</tr>
</tbody>
</table>

**Setting undervoltage $V_<$ as %**

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 **Absolute limit values** and activate the **Off** selection.

To set the limit value for undervoltage $V_<$, proceed as follows:

1.  Set $U_{\text{under voltae %}}$ to 90%.
2.  Press **F3** Parameter > **F3** Limit values > Press **→** until the desired parameter is displayed.
3.  Press **F1** to increase the value or **F5** to reduce it.
4.  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 $F_3$ 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. $\uparrow$ Parameter $\rightarrow F_3$ Parameter $\rightarrow F_3$ Limit values $\rightarrow$ Press $\rightarrow$ until the desired parameter is displayed.
2. If necessary press $F_3$ to select the unit you want, "V" or "kV".
3. Press $F_1$ to increase the value or $F_5$ to reduce it.
4. Press $\leftarrow$.

$\Rightarrow$ 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. $\uparrow$ Parameter $\rightarrow F_3$ Parameter $\rightarrow F_3$ Limit values $\rightarrow$ Press $\rightarrow$ until the desired parameter is displayed.
2. Press $F_4$ to highlight the position.

$\Rightarrow$ The desired position is highlighted and the value can be changed.
3. Press $F_1$ to increase the time or $F_5$ to reduce it.
4. Press $\leftarrow$.

$\Rightarrow$ 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 17: Behavior

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

1. \[\text{Parameter} > \text{Limit values} > \text{Press} \rightarrow\] until the desired parameter is displayed.
   \(\Rightarrow\) V< blocking.

2. Press \(\text{F1}\) for On setting or \(\text{F5}\) for Off setting.

3. Press \(\downarrow\)
   \(\Rightarrow\) 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 Undervoltage message is also displayed when the measured value is less than 30 V.</td>
</tr>
<tr>
<td>Off</td>
<td>The Undervoltage message is no longer displayed when the measured value is less than 30 V.</td>
</tr>
</tbody>
</table>

Table 18: Response

To activate/deactivate the message, proceed as follows:

1. \[\text{Parameter} > \text{Limit values} > \text{Press} \rightarrow\] until the desired parameter is displayed.
   \(\Rightarrow\) V< also under 30 V.

2. Press \(\text{F1}\) for On setting or \(\text{F5}\) for Off setting.

3. Press \(\downarrow\)
   \(\Rightarrow\) The message is activated/deactivated.

7.5.3 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.
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 $T_1$. Once the set switching pulse time $5$ has passed, the tap position is lowered $C$ 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.

**Figure 46: Response to limit value being exceeded**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set limit value for overvoltage $U&gt;!$</td>
</tr>
<tr>
<td>2</td>
<td>$+B%$: Upper limit</td>
</tr>
<tr>
<td>3</td>
<td>$U_{\text{desired}}$: Desired value</td>
</tr>
<tr>
<td>4</td>
<td>$-B%$: Lower limit</td>
</tr>
<tr>
<td>5</td>
<td>Set switching pulse time</td>
</tr>
<tr>
<td>6</td>
<td>$U_{\text{actual}}$: Measured voltage</td>
</tr>
<tr>
<td>A</td>
<td>Value exceeds limit value</td>
</tr>
<tr>
<td>B</td>
<td>Value falls below limit value</td>
</tr>
<tr>
<td>C</td>
<td>High-speed return is started (lower tap-change)</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 Functions and settings

1. **Parameter > Limit values >** Press until the desired parameter is displayed.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **←**
   
   The limit value is set.

### Setting overvoltage \( V > \) 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 transformer 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 overvoltage limit \( V > \), proceed as follows:

1. **Parameter > Limit values >** 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.

#### 7.5.4 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. MENU > F3 Parameter > F3 Limit values > Press ➔ until the desired parameter is displayed.
2. If necessary press F3 to select the unit you want: % or A.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ➔
   ⇔ The limit value is set.

7.5.5 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. MENU > F3 Parameter > F3 Limit values > Press ➔ until the desired parameter is displayed.
2. Press F1 or F5 to select the option you want.
3. Press ➔
   ⇔ Function monitoring is activated/deactivated.

7.5.6 Switching interval monitoring

You can use this function to monitor the typical tap-change response of your transformer. To do this, you can set the permissible number of consecutive RAISE operations within a defined time period in auto mode.

If the maximum permissible number of tap-change operations is exceeded, the device blocks any more RAISE operations for a time that you can set. As an option, Maschinenfabrik Reinhausen can parameterize the device such that a message is output via a relay during the blocking time.
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Figure 47: Normal control response (left); abnormal control response (right)

<table>
<thead>
<tr>
<th>#</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Device blocking T1 Delay time</td>
</tr>
<tr>
<td>2</td>
<td>Defined time period for monitoring RAISE operations Bandwidth B%</td>
</tr>
</tbody>
</table>

### 7.5.6.1 Setting maximum number per time interval

You can use this parameter to define the maximum permissible number of consecutive RAISE operations.

The 0 setting deactivates the tap-change supervisory control function. There is no limit to the maximum number of consecutive RAISE operations.

To set the maximum number of permissible consecutive RAISE operations, proceed as follows:

1. Press **MENU** > **F3** Control parameter > **F3** Limit values > Press **→** until the desired parameter is displayed.
   - Max. steps in time window.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **←**
   - The maximum number of permissible consecutive RAISE operations is set.

### 7.5.6.2 Setting time window for monitoring RAISE operations

You can use this parameter to define the time interval for monitoring the number of consecutive RAISE operations.

To set the time interval (time slice), proceed as follows:
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7.5.6.3 Setting blocking time

You can use this parameter to define the blocking time after reaching the maximum permissible number of consecutive RAISE operations. Further RAISE commands are blocked during this blocking time.

To set the blocking time, proceed as follows:

1. **MENU > F3** Control parameter > F3 Limit values > Press ➔ until the desired parameter is displayed.
   - Block time max steps.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ➔
   - The blocking time is set.

7.5.6.4 Setting counting behavior

You can use this parameter to define the counting behavior. All RAISE operations within the defined time period are counted as standard, even if they are interrupted by a LOWER operation. Alternatively, you can stipulate that the counter is reset during a LOWER operation.

To set the counting behavior, proceed as follows:

1. **MENU > F3** Control parameter > F3 Limit values > Press ➔ until the desired parameter is displayed.
   - Lower -> reset raise cnt.
2. Press F1 or F5 to set the option you want.
3. Press ➔
   - The desired option is selected.

7.5.7 Permitted tap positions

You can use the parameters described below to restrict the permissible range of tap positions in auto mode. If you activate this function, the device does not switch to tap positions outside the set limits in auto mode.
In manual mode, for manual tap changes on the motor-drive unit or for remote tap changes via a SCADA system, monitoring of the step limits is not active. This may result in the set limits being exceeded.

When switching from manual to auto mode, the tap changer should be within the permitted tap positions.

### 7.5.7.1 Setting minimum permitted tap position

You can use this parameter to set the minimum permitted tap position. To do so, proceed as follows:

1. Press \[ \text{MENU} > \text{F3} \] Parameter \[ \rightarrow \text{F3} \] Limit values \[ \rightarrow \] until the desired parameter is displayed.
   - Tap min.
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 value or \[ \text{F5} \] to reduce it.
4. Press \[ \rightarrow \]
   - The minimum permitted tap position is set.

### 7.5.7.2 Setting the maximum permitted tap position

You can use this parameter to set the maximum permitted tap position. To do so, proceed as follows:

1. Press \[ \text{MENU} > \text{F3} \] Parameter \[ \rightarrow \text{F3} \] Limit values \[ \rightarrow \] until the desired parameter is displayed.
   - Tap max.
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 value or \[ \text{F5} \] to reduce it.
4. Press \[ \rightarrow \]
   - The maximum permitted tap position is set.

### 7.6 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
7.6.1 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.

**Figure 54: Equivalent circuit**

**Figure 55: Phasor diagram**

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:**

\[ U_r = I_n \cdot \frac{k_{CT}}{k_{VT}} \cdot r \cdot L \cdot K \text{ [V]} \]
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 \( \Omega/\text{km} \)
- \( U_x \): Inductive resistance load in \( \Omega/\text{km} \)
- \( I_N \): 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 \( \Omega/\text{km} \) per phase
- \( x \): Inductive resistance load in \( \Omega/\text{km} \) per phase
- \( L \): Length of line in km
- \( K \): Nominal current factor

### 7.6.1.1 Setting the ohmic voltage drop \( V_r \)

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 \( V_r \), proceed as follows:

1. \[ \text{Menu} > F3 \] Parameter \[ F4 \] Compensation.  
   \( \Rightarrow \) \( V_r \) line drop compensation.
2. Press \( F4 \) to highlight the position.  
   \( \Rightarrow \) 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 \( \leftrightarrow \)  
   \( \Rightarrow \) The ohmic voltage drop \( V_r \) is set.

### 7.6.1.2 Setting the inductive voltage drop \( V_x \)

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 $V_x$, proceed as follows:

1. Press $\text{F3}$ > $\text{Parameter}$ > $\text{F4}$ Compensation > Press $\rightarrow$ until the desired parameter is displayed.
   $\Rightarrow$ $V_x$ line drop compensation.

2. Press $\text{F4}$ to highlight the position.
   $\Rightarrow$ The desired 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 $\leftarrow$
   $\Rightarrow$ The inductive voltage drop $V_x$ is set.

### 7.6.2 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.

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:

$$\Delta U%$$

$\Delta U%$ max

$\Delta U%$

Figure 56: Z compensation
7 Functions and settings

\[ \Delta U = 100 \times \frac{U_{Tr} - U_{Load}}{U_{Load}} \times \frac{I_N \times k_{CT}}{I} \]

<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.

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

### 7.6.2.2 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. **Parameter > F3** Parameter > **F4** Compensation > Press \[→\] until the desired parameter is displayed.
   \[⇒\] Z comp. limit value.

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

3. Press \[←\]
   \[⇒\] The limit value is set.

### 7.7 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.

<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>-</td>
</tr>
<tr>
<td>Yes -</td>
<td>-</td>
</tr>
<tr>
<td>Yes Yes</td>
<td>Yes -</td>
</tr>
<tr>
<td>Yes Yes - Yes</td>
<td>Primary voltage [kV]</td>
</tr>
<tr>
<td>Yes Yes - Yes</td>
<td>Primary voltage [kV]</td>
</tr>
</tbody>
</table>

Table 19: Influence of transformer data on measured value display
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7.7.1 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.

The primary transformer voltage can be specified separately for winding 1 and winding 2.

Proceed as follows to set the primary transformer voltage:

1. \textbf{Menu > F4 Configuration > F2 Transformer data.}
   \begin{itemize}
   \item Primary voltage (for winding 1)/Primary voltage2 (for winding 2).
   \end{itemize}
2. Press \textbf{F3} to highlight the decimal place.
   \begin{itemize}
   \item The decimal place is defined and the value can be changed.
   \end{itemize}
3. Press \textbf{F4} to highlight the position.
   \begin{itemize}
   \item The desired position is highlighted and the value can be changed.
   \end{itemize}
4. Press \textbf{F1} to increase the value or \textbf{F5} to reduce it.
5. Press \textbf{↓}
   \begin{itemize}
   \item The primary transformer voltage is set.
   \end{itemize}

7.7.2 Setting the secondary transformer voltage

This parameter can be used to set the secondary transformer voltage in V.

The secondary transformer voltage can be specified separately for winding 1 and winding 2.

Proceed as follows to set the secondary transformer voltage:

1. \textbf{Menu > F4 Configuration > F2 Transformer data} > Press \textbf{↓} until the desired parameter is displayed.
   \begin{itemize}
   \item Secondary voltage (for winding 1)/Secondary voltage2 (for winding 2).
   \end{itemize}
2. Press \textbf{F4} to highlight the position.
   \begin{itemize}
   \item The desired position is highlighted and the value can be changed.
   \end{itemize}
3. Press \textbf{F1} to increase the value or \textbf{F5} to reduce it.
4. Press \textbf{↓}
   \begin{itemize}
   \item The secondary transformer voltage is set.
   \end{itemize}
7.7.3 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 20: Example of unit displayed: %/A

The primary transformer current can be specified separately for winding 1 and winding 2.

Proceed as follows to set the primary transformer current:

   - Primary current (for winding 1)/Primary current2 (for winding 2).
   - 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 primary transformer current is set.

7.7.4 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
The current-transformer connection can be specified separately for winding 1 and winding 2.

Proceed as follows to set the current-transformer connection:

1. Press \[ \text{F4} \] Configuration > \[ \text{F2} \] Transformer data > Press \[ \leftarrow \rightarrow \] until the desired parameter is displayed.
   - Current-transformer connection (for winding 1)/Current-transformer connection2 (for winding 2).
2. Press \[ \text{F1} \] or \[ \text{F5} \] to select the required connection terminal.
3. Press \[ \leftrightarrow \]
   - The current-transformer connection is set.

### 7.7.5 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 21: 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

Figure 57: Phase difference 0 1PH
• 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

![Diagram of Circuit B](image)

Figure 58: Phase difference 0 3PHN

• 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:

![Diagram of Circuit C](image)

Figure 59: 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.
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- The voltage drop on an outer conductor is determined by the current:
  \((I_{L1} + I_{L2})/\sqrt{3}\).

Circuit D

![Diagram of Circuit D with labels](image)

Figure 60: 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

![Diagram of Circuit E with labels](image)

Figure 61: 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

![Circuit Diagram](image)

Figure 62: 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. **Configuration > Transformer data > Press** until the desired parameter is displayed.
   - Transformer circuit.
2. Press **F1** or **F5** to select the required phase difference.
3. Press **→**
   - The phase difference is set.

7.8 Parallel operation

In the *Parallel operation* menu item, you can set the parameters needed for parallel transformer operation. Parallel transformer operation is used to increase the throughput capacity or short-circuit capacity in one place.

**Conditions for parallel operation**

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

- Identical rated voltages
- Transformer power ratio ($< 3 : 1$)
- Maximum deviation of short-circuit voltages ($U_{k}$) for transformers connected in parallel $< 10\%$
- Same number of switching groups
- The same current-transformer connection has to be used for all devices running in parallel
You can control up to 16 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 operation method**

The device supports parallel operation following the methods described below:

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

You must select the same parallel operation method (circulating reactive current minimization or tap synchronization) for all voltage regulators operating in parallel. Otherwise you cannot operate the devices in parallel.

The following sections describe how you can set the parameters. Ensure that you have set the following parameters when activating parallel operation:

- CAN bus address

### 7.8.1 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. Press \[ F4 \] Configuration > \[ F4 \] Parallel operation > Press until the desired parameter is displayed.
2. Press \[ F1 \] to increase the value or \[ F5 \] to reduce it.
3. Press \[ \] The CAN bus address is saved.

### 7.8.2 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.

### 7.8.2.1 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. **Configuration > F4** Parallel operation.
2. Press F1 or F5 until **circulating reactive current** appears in the display.
3. The parallel operation method is set.

When using the **circulating reactive current** parallel operation method, you have to set the parameters for the **circulating reactive current sensitivity** and **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. Configuration > Parallel operation > Press until the desired parameter is displayed.
   - Stability.

2. Press to increase the value or to reduce it.

3. If necessary, press to highlight the decimal place.
   - The decimal place is now highlighted and the value can be changed.

4. Press
   - 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 > Parallel operation > Press until the desired parameter is displayed.
   - Blocking.

2. Press to increase the value or to reduce it.

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

**7.8.2.2 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:
Option | Description
--- | ---
Master | The voltage regulator is designated as the master.
Follower | The voltage regulator is designated as the follower.
Sync.auto | Automatic assignment of master or follower. 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.

Table 22: 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 Enter.
   - The tap synchronization method is selected.

7.8.3 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 23: Settings for SKB parallel operation

To select the type of parallel operation control, proceed as follows:
7 Functions and settings

1. Press until the desired parameter is displayed.
   - SKB parallel operation.
2. Press or to set the option you want.
3. Press →
   - The type of parallel control is set.

7.8.4 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:

1. until the desired parameter is displayed.
   - Error message.
2. Press to increase the value or to reduce it.
3. Press ←
   - The delay time for the parallel operation error message is set.

7.8.5 Deactivating parallel operation

To deactivate parallel operation, proceed as follows:

1. Parallel operation method.
2. Press or to deactivate parallel operation with the Off selection.
3. Press ←
   - Parallel operation is deactivated.

7.9 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></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 24: Analog tap position capture

### 7.9.1 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 25: Parameter settings

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

1. **Configuration** > F4 Continue > F3 Analog inputs. ⇒ Input 1 lower 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 ←. ⇒ The lower limit value for the tap position is assigned.
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. MENU > F4 Configuration > F5 Continue > F3 Analog inputs > Press until the desired parameter is displayed.
   - Input 1 lower value.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵
   - The lower value for the tap position is assigned.

7.9.2 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 26: Parameter settings

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

1. MENU > F4 Configuration > F5 Continue > F3 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 ↵
7 Functions and settings

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. Press \( \text{Menu} \rightarrow \text{F4 Configuration} \rightarrow \text{F5 Continue} \rightarrow \text{F3 Analog inputs} \rightarrow \text{Press} \) until the desired parameter is displayed.
   \( \Rightarrow \) Input 1 upper value.
2. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
3. Press \( \rightarrow \).

7.10 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>I0xx/UCxx</td>
<td>There is a signal at control input I0xx/UCxx (e.g. I0:25)</td>
</tr>
<tr>
<td>SI:be1</td>
<td>SI:be1 (command) is received</td>
</tr>
<tr>
<td>SI:be2</td>
<td>SI:be2 (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>
</tbody>
</table>
7 Functions and settings

<table>
<thead>
<tr>
<th>Functions available</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<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 27: Functions available for LEDs

Assigning function

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

1. **Configuration > F4 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.

7.11 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 Functions and settings

7.11.1 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. \[\text{Menu} \rightarrow \text{F4} \rightarrow \text{Configuration} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F3} \rightarrow \text{Measuring transducer 1/2}.\]
   \[\Rightarrow \text{Output 1 measured value}.\]

2. Press \[\text{F1} \text{or} \text{F5} \rightarrow \text{until the desired option is displayed.}\]

3. Press \[\Rightarrow \text{The desired measured value is assigned.}\]

7.11.2 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 \[\text{Menu} \rightarrow \text{F4} \rightarrow \text{Configuration} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F3} \rightarrow \text{Measuring transducer 1/2} \rightarrow \text{Output 1 bottom}.\]
   \[\Rightarrow \text{Output 1 bottom}.\]

2. Press \[\text{F1} \text{or} \text{F5} \rightarrow \text{until the desired physical parameter is displayed.}\]

3. Press \[\Rightarrow \text{The desired physical parameter is assigned.}\]

7.11.3 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 \[\text{Menu} \rightarrow \text{F4} \rightarrow \text{Configuration} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F3} \rightarrow \text{Measuring transducer 1/2} \rightarrow \text{Output 1 top}.\]
   \[\Rightarrow \text{Output 1 top}.\]

2. Press \[\text{F1} \text{or} \text{F5} \rightarrow \text{until the desired physical parameter is displayed.}\]
7 Functions and settings

3. Press  
   ⇒ The desired physical parameter is assigned.

7.11.4 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. > Configuration > Continue > Continue > Measuring transducer 1 / 2 > Press until the desired parameter is displayed.
   ⇒ Output 1 lower value.

2. Press to increase the value or to reduce it.

3. Press  
   ⇒ The minimum absolute value is assigned.

7.11.5 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. > Configuration > Continue > Continue > Measuring transducer 1 / 2 > Press until the desired parameter is displayed.
   ⇒ Output 1 upper value.

2. Press to increase the value or to reduce it.

3. Press  
   ⇒ The minimum absolute value is assigned.

7.12 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 [► 106] 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 [► 107].

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 [► 126] 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.

### 7.12.1 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. Press `F4` → Configuration → `F5` → Continue → `F5` → Continue → `F3` → Memory.

   \( V < \) threshold.

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

3. Press `\( \)`.

   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. Press `F4` → Configuration → `F5` → Continue → `F5` → Continue → `F3` → Memory → Press `\( \) 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 `\( \)`

   The undervoltage threshold is set.

### 7.12.2 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. **Configuration > Continue > Continue > Memory > Press** until the desired parameter is displayed.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **←**.
   - 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. **Configuration > Continue > Continue > Memory > Press** until the desired parameter is displayed.
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 **←**.
   - The overvoltage threshold is set.

7.12.3 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. Configuration > F5 Continue > F5 Continue > F3 Memory > Press \(\rightarrow\) until the desired parameter is displayed.
   \(\Rightarrow\) Average value interval.

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

3. Press \(\leftarrow\)
   \(\Rightarrow\) The average value interval is set.

### 7.12.4 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 28: 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.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Saving at high resolution</td>
</tr>
<tr>
<td>2</td>
<td>Saving at low resolution</td>
</tr>
<tr>
<td>3</td>
<td>Run-in time/overrun time; duration: 10 seconds</td>
</tr>
<tr>
<td>A</td>
<td>Start of event's run-in time</td>
</tr>
<tr>
<td>B</td>
<td>Event occurs (voltage departs from bandwidth)</td>
</tr>
<tr>
<td>C</td>
<td>Event occurs (voltage returns to bandwidth)</td>
</tr>
<tr>
<td>D</td>
<td>End of event's overrun time</td>
</tr>
</tbody>
</table>

![Figure 74: Event duration (more than 5 minutes)](image)
Figure 75: Event duration (more than 5 minutes)

1. High-resolution recording
2. Low-resolution recording
3. Duration: 10 seconds
4. Duration of high-resolution recording: 5 minutes
5. Start of event's run-in time
6. End of event's 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 29: 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. \[\text{F4} \quad \text{Configuration} \quad \text{F5} \quad \text{Continue} \quad \text{F5} \quad \text{Continue} \quad \text{F3} \quad \text{Memory} \quad \text{Press} \quad \text{Event memory.} \]
2. Press \[\text{F1}\] or \[\text{F5}\] to set the event memory size you want.
3. Press \[\leftarrow\] The event memory size is set.

7.12.5 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.

7.12.5.1 Visual display of time plotter function

The time plotter is displayed as follows:
Symbols

Figure 76: Time plotter symbols

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Move time axis back</td>
<td>4</td>
<td>Select values to set</td>
</tr>
<tr>
<td>2</td>
<td>Move time axis forward</td>
<td>5</td>
<td>Decrease set values by one unit</td>
</tr>
<tr>
<td>3</td>
<td>Increase set values by one unit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Desired/actual voltage value display

Figure 77: Desired/actual value display

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set desired voltage value display</td>
<td>3</td>
<td>Actual voltage value display</td>
</tr>
<tr>
<td>2</td>
<td>Actual voltage value display</td>
<td>4</td>
<td>Set desired voltage value display</td>
</tr>
</tbody>
</table>
Overvoltage/undervoltage display

Figure 78: Overvoltage/undervoltage

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overvoltage bar/undervoltage bar</td>
<td>3</td>
<td>Upper voltage value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lower voltage value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.12.5.2 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 30: Duration of range displayed
To undertake settings, proceed as follows:

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

2. Press **F4** to highlight the setting box for reporting times.
   - The setting box is now highlighted and the value can be changed.

3. Press **F3** to move the display forwards one step or **F5** to move it back one step.
   - The time axis is set.

### 7.12.5.3 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 31: Voltage range between the horizontal grid lines**
To set the voltage range, proceed as follows:

1. Press \texttt{INFO} > \texttt{F5} \texttt{Info} > Press \texttt{<} until the desired display appears.  
   \(\Rightarrow\) Time plotter.
2. Press \texttt{F4} until the setting box for the voltage range is highlighted.  
   \(\Rightarrow\) The setting box is now highlighted and the value can be changed.
3. Press \texttt{F3} to advance one unit or \texttt{F5} to move back one unit.  
   \(\Rightarrow\) The voltage range is set.

### 7.12.5.4 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: \texttt{HH:MM:SS}
To move the sequence to a precise time, proceed as follows:

1. Press \textit{Menu} $\rightarrow$ F5 \textit{Info} $\rightarrow$ Press \textasciitilde until the desired display appears. $\Rightarrow$ Time plotter.

2. Press F4 until the setting box for the retrace time is highlighted. $\Rightarrow$ 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. $\Rightarrow$ The retrace time is set. The sequence for the specified time appears in the display.

\subsection*{7.12.5.5 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: \textbf{DD.MM.YY}
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 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.

### 7.13 Communication interface SiD

The following section describes how to configure the communication interface.

#### 7.13.1 Assigning a network mask

You can use this parameter to set the network mask.

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

To assign a network mask, proceed as follows:

1. Press MENU > F4 Configuration > F3 General > ⌈ until the desired parameter is displayed.
   ⇒ Network mask.

2. Press F4 in order 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 network mask is assigned.

#### 7.13.2 Assigning network address

You can use this parameter to assign a network address to the device.

To assign a network address, proceed as follows:
7 Functions and settings

1. Press \textbf{MENU} > F4 Configuration > F3 General > \textbf{...} until the desired parameter is displayed.
   \(\Rightarrow\) Network address.

2. Press \textbf{F4} in order to highlight the position.
   \(\Rightarrow\) The desired position is highlighted and the value can be changed.

3. Press \textbf{F1} to increase the value or \textbf{F5} to reduce it.

4. Press \textbf{...}
   \(\Rightarrow\) The network address is assigned.

7.13.3 Entering the time server address

This parameter lets you enter the IP address of a SNTP time server. If you are using a time server, the device uses the time of the time server as the system time.

\begin{itemize}
  \item Be sure to enter a valid time server address that is not 0.0.0.0, otherwise it will not be possible to connect to the device.
\end{itemize}

To enter the time server address of the SNTP server, proceed as follows:

1. Press \textbf{MENU} > F4 Configuration > F3 General > \textbf{...} until the desired parameter is displayed.
   \(\Rightarrow\) Time server address.

2. Press \textbf{F4} in order to highlight the position.
   \(\Rightarrow\) The desired position is highlighted and the value can be changed.

3. Press \textbf{F1} to increase the value or \textbf{F5} to reduce it.

4. Press \textbf{...}
   \(\Rightarrow\) The time server IP address is entered.

7.13.4 Entering gateway

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

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

To enter the gateway address, proceed as follows:
1. Press \text{Menu} > \text{F4} \text{Configuration} > \text{F3} \text{General} > \rightarrow until the desired parameter is displayed.
   \Rightarrow \text{Gateway}.

2. Press \text{F4} in order to highlight the position.
   \Rightarrow \text{The desired 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.
   \Rightarrow \text{The gateway address is entered.}

\section*{7.13.5 Entering IED name}

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

The IED name must start with a letter and may contain no more than 11 characters.

To enter the IED name, proceed as follows:

1. Press \text{Menu} > \text{F4} \text{Configuration} > \text{F3} \text{General} > \rightarrow until the desired parameter is displayed.
   \Rightarrow \text{IED name}.

2. Press \text{F4} in order to highlight the position.
   \Rightarrow \text{The desired 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.
   \Rightarrow \text{The IED name is entered.}

\section*{7.14 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.

\subsection*{7.14.1 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:

\begin{itemize}
  \item RS232
  \item Ethernet
\end{itemize}
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:

   - Comm. port CIC2.
2. Press F1 or F5 to set the option you want.
3. Press ↵
   - The communication port is selected.

### 7.14.2 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. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Continue > F3 Comm. interface 2.
   - Comm. port CIC2.
2. Press F1 or F5 to set the option you want.
3. Press ↵
   - The baud rate is selected.

### 7.14.3 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.

7.14.4 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.

7.14.5 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:
7 Functions and settings

   - Transmission delay CIC 2.
2. Press [F1] to increase the value or [F5] to reduce it.
3. Press [→]
   - The transmission delay time for the RS485 interface is set.

**7.15 Displaying information about device**

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

**7.15.1 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:

- Press [MENU] > [F5] Info
  - Info.

**7.15.2 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

7.15.3 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</td>
<td>LED 6...LED 9</td>
</tr>
<tr>
<td>←</td>
<td>All LEDs</td>
</tr>
</tbody>
</table>

Table 32: Arrangement of keys for the LED test

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. Press 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.

7.15.4 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

Figure 88: Signals

| 1 | Signaling status | 2 | Control inputs/output relays |

To query the status, proceed as follows:

► Press MENU > F5 Info > → until the desired measurement parameter is displayed.

⇒ INPUT/OUTPUT STATUS.

7.15.5 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.

Figure 89: UC card signals

| 1 | Signaling status | 2 | Control inputs |

To query the status, proceed as follows:

► Press MENU > F5 Info > → until the desired measurement parameter is displayed.

⇒ UC1 CARD STATUS/UC2 CARD STATUS.
7.15.6 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 \textit{\textbf{[MENU]}} > \textit{\textbf{F5}} Info > \textit{\textbf{\rightarrow}} until the desired measurement parameter is displayed.
   \Rightarrow Parameters.
2. Press \textit{\textbf{F3}} and \textit{\textbf{F4}} at the same time.
3. Press \textit{\textbf{\leftarrow}}
   \Rightarrow All parameters have been reset to the factory settings.

7.15.7 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:

\textit{\textbf{\uparrow}} Press \textit{\textbf{[MENU]}} > \textit{\textbf{F5}} Info > \textit{\textbf{\rightarrow}} until the desired measurement parameter is displayed.

\Rightarrow RTC.

7.15.8 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:

\textit{\textbf{\uparrow}} \textit{\textbf{[MENU]}} > \textit{\textbf{F5}} Info > \textit{\textbf{\rightarrow}} until the desired display appears.

\Rightarrow Parallel operation.

7.15.9 Displaying data on CAN bus

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

**Figure 90: CAN bus data**

<table>
<thead>
<tr>
<th></th>
<th>CAN bus address of device</th>
<th>4</th>
<th>Reactive current in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Voltage in V</td>
<td>5</td>
<td>Current tap position</td>
</tr>
<tr>
<td>3</td>
<td>Active current in %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 91: Other CAN bus data**

<table>
<thead>
<tr>
<th></th>
<th>Group input 1</th>
<th>5</th>
<th><strong>Follower</strong> tap synchronization (0 = deactivated; 1 = activated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Group input 2</td>
<td>6</td>
<td><strong>Auto</strong> tap synchronization (0 = deactivated; 1 = activated)</td>
</tr>
<tr>
<td>3</td>
<td>Circulating reactive current parallel operation (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>
<tr>
<td>4</td>
<td><strong>Master</strong> tap synchronization (0 = deactivated; 1 = activated)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To display the CAN bus data, proceed as follows:

1. Press **INFO** > [F5] 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.
7.15.10 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 **MENU** > **F5 Info** > **→** until the desired measurement parameter is displayed.

⇒ MEASURED VALUE MEMORY

7.15.11 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.

![Figure 92: Peak memory](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum measured voltage U1</td>
</tr>
<tr>
<td>2</td>
<td>Maximum on-load tap-changer tap position</td>
</tr>
<tr>
<td>3</td>
<td>Time (HH:MM:SS) and date (DD.MM.YY) of maximum measured voltage U1</td>
</tr>
<tr>
<td>4</td>
<td>Time (HH:MM:SS) and date (DD.MM.YY) of maximum recorded tap position</td>
</tr>
<tr>
<td>5</td>
<td>Time (HH:MM:SS) and date (DD.MM.YY) of minimum recorded tap position</td>
</tr>
<tr>
<td>6</td>
<td>Minimum on-load tap-changer tap position</td>
</tr>
<tr>
<td>7</td>
<td>Minimum measured voltage U1</td>
</tr>
</tbody>
</table>

To display the peak memory, proceed as follows:
7 Functions and settings

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

7.15.13 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:

\begin{itemize}
  \item Press \text{MENU} > F5 Info > \rightarrow until the desired measurement parameter is displayed.
  \Rightarrow \text{UPCOMING MESSAGES}
\end{itemize}
8 Control system protocol

8.1 Protocol specification

The device provides an extract of commands and messages from the interface protocol IEC 61850 for communication.

**Device-specific data points**
You can find the device-specific data points and presets in the device’s ICD file. You can request the following documents for the device or download from the device:

- MICS (Model Implementation Conformance Statement)
- PICS (Protocol Implementation Conformance Statement)
- PIXIT (Protocol Implementation eXtra Information for Testing)
- TICS (Technical Issues Conformance Statement)

Please note possible restrictions and comments regarding device specific data points and default settings listed in the documents above.

8.1.1 Downloading ICD file

You can download the ICD file via FTP from the device. You have to establish an ethernet connection between the device and your PC.

For a smooth download with Windows Vista/7/8 operating systems, use Windows Explorer.

Proceed as follows to download the ICD file:

1. Enter `ftp://gast@<IP address>` in your browser (in the example in the diagram below, the IP address is 192.168.0.1) and select the directory `home/gast`.
2. If necessary, confirm the password prompt without entering a password.

3. Use **Save as** to download the ICD file (in this example ATCC.ICD).

4. Other files, such as the Model Implementation Conformance Statement, are located in the **misc** folder and can also be downloaded using **Save as**.

### 8.2 Downloading ICD file

You can download the ICD file via FTP from the device. You have to establish an ethernet connection between the device and your PC.

For a smooth download with Windows Vista/7/8 operating systems, use Windows Explorer.

Proceed as follows to download the ICD file:

1. Enter `ftp://gast@<IP adress>` in your browser (in the example in the diagram below, the IP adress is 192.168.0.1) and select the directory **home/gast**.
2. If necessary, confirm the password prompt without entering a password.

![FTP directory /home/gast/ at 192.168.10.51](image)

Figure 94: Downloading the ICD file using an Internet browser

3. Use **Save as** to download the ICD file (in this example ATCC.ICD).
4. Other files, such as the Model Implementation Conformance Statement, are located in the **misc** folder and can also be downloaded using **Save as**.

### 8.3 Data points

You will find these abbreviations in the following tables.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>no / not available</td>
</tr>
<tr>
<td>Y</td>
<td>yes / available</td>
</tr>
<tr>
<td>M</td>
<td>mandatory</td>
</tr>
<tr>
<td>O</td>
<td>optional</td>
</tr>
<tr>
<td>C</td>
<td>conditional</td>
</tr>
</tbody>
</table>

#### 8.3.1 LPHD - Physical device

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPHD</td>
<td>-</td>
<td>Physical device information</td>
<td>M</td>
<td>-</td>
</tr>
</tbody>
</table>

**Data**

**Common logical node information**

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhyNam</td>
<td>DPL</td>
<td>Physical device name plate</td>
<td>M</td>
<td>-</td>
</tr>
</tbody>
</table>
8 Control system protocol

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhyHealth</td>
<td>INS</td>
<td>Physical device health</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Proxy</td>
<td>SPS</td>
<td>Indicates if this LN is a proxy</td>
<td>M</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 33: LPHD class (LPHD1)

8.3.2 LLN0 - Logical node

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLN0</td>
<td>-</td>
<td>Logical node zero name</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Data

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>ENC</td>
<td>Mode</td>
<td>M</td>
<td>Status only</td>
</tr>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>NamPlt</td>
<td>LPL</td>
<td>Name plate</td>
<td>M</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 34: LLNO class

8.3.3 ATCC1 - Automatic tap changer controller

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E/C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCC1</td>
<td>-</td>
<td>AVR</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Common logical node information

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>ENC</td>
<td>Mode</td>
<td>O</td>
<td>status-only</td>
</tr>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>O</td>
<td>1:=OK; 2:=function monitoring; 3:=no internal communication or parameter error</td>
</tr>
<tr>
<td>NamPlt</td>
<td>LPL</td>
<td>Name plate</td>
<td>O</td>
<td>-</td>
</tr>
</tbody>
</table>

Controls

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E/C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TapChg</td>
<td>BSC</td>
<td>Change tap position</td>
<td>C</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>ParOp</td>
<td>DPC</td>
<td>Parallel independent</td>
<td>M</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>LTCBlk</td>
<td>SPC</td>
<td>Block automatic control</td>
<td>O</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>CirCur</td>
<td>SPC</td>
<td>Circulating current (parallel control)</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>Master</td>
<td>SPC</td>
<td>Master mode (parallel control)</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>Attribute name</td>
<td>Attribute type</td>
<td>Explanation</td>
<td>M/O/E/C</td>
<td>Remarks</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>-------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Follower</td>
<td>SPC</td>
<td>Follower mode (parallel control)</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>SICmd1</td>
<td>SPC</td>
<td>Serial interface command 1</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>SICmd2</td>
<td>SPC</td>
<td>Serial interface command 2</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>SICmd3</td>
<td>SPC</td>
<td>Serial interface command 3</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>VoltLvl1</td>
<td>SPC</td>
<td>Voltage level 1</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>VoltLvl2</td>
<td>SPC</td>
<td>Voltage level 2</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
<tr>
<td>VoltLvl3</td>
<td>SPC</td>
<td>Voltage level 3</td>
<td>E</td>
<td>direct-with-normal-security</td>
</tr>
</tbody>
</table>

**Measured values**

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E/C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CtlV</td>
<td>MV</td>
<td>Control voltage</td>
<td>M</td>
<td>Unit: V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiplier: none</td>
</tr>
<tr>
<td>LodA</td>
<td>MV</td>
<td>Load current (transformer secondary current)</td>
<td>O</td>
<td>Unit: A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiplier: none</td>
</tr>
</tbody>
</table>

**Status information**

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E/C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loc</td>
<td>SPS</td>
<td>Local operation</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Auto</td>
<td>SPS</td>
<td>Automatic manual</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>OverV</td>
<td>SPS</td>
<td>Voltage high limit reached</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>UnderV</td>
<td>SPS</td>
<td>Voltage low limit reached</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>OverC</td>
<td>SPS</td>
<td>Current overload</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>MotDrv</td>
<td>SPS</td>
<td>Motor drive running</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>UInd1</td>
<td>SPS</td>
<td>User indication 1</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>UInd2</td>
<td>SPS</td>
<td>User indication 2</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>UInd3</td>
<td>SPS</td>
<td>User indication 3</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>UInd4</td>
<td>SPS</td>
<td>User indication 4</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>FuncMon</td>
<td>SPS</td>
<td>Function monitoring</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>ParErr</td>
<td>SPS</td>
<td>Parameter error</td>
<td>E</td>
<td>-</td>
</tr>
</tbody>
</table>

**Settings**

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E/C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BndCtr</td>
<td>ASG</td>
<td>Band center voltage (actual reference)</td>
<td>O</td>
<td>Unit: V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiplier: none</td>
</tr>
<tr>
<td>BndWid</td>
<td>ASG</td>
<td>Band width voltage (as percent of nominal voltage, FPF presumed)</td>
<td>O</td>
<td>Unit: none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiplier: c</td>
</tr>
<tr>
<td>CtlDITmms</td>
<td>ING</td>
<td>Control intentional time delay (FPF presumed, in seconds)</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>LDCR</td>
<td>ASG</td>
<td>Line drop voltage due to line resistance component (voltage)</td>
<td>O</td>
<td>Unit: V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiplier: none</td>
</tr>
</tbody>
</table>
### 8.3.4 GGiO1 - Generic process I/O

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGiO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Common logical node information</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mod</td>
<td>ENC</td>
<td>Mode</td>
<td>O</td>
<td>status-only</td>
</tr>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>O</td>
<td>1: OK; 3: no internal communication</td>
</tr>
<tr>
<td>NamPlt</td>
<td>LPL</td>
<td>Name plate</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measured values</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Status information</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ind1</td>
<td>SPS</td>
<td>IO-X1:31</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind2</td>
<td>SPS</td>
<td>IO-X1:33</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind3</td>
<td>SPS</td>
<td>IO-X1:16</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

Table 35: ATCC class (ATCC1)
## 8 Control system protocol

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ind4</td>
<td>SPS</td>
<td>IO-X1:17</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind5</td>
<td>SPS</td>
<td>IO-X1:14</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind6</td>
<td>SPS</td>
<td>IO-X1:13</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind7</td>
<td>SPS</td>
<td>IO-X1:11</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind8</td>
<td>SPS</td>
<td>IO-X1:12</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind9</td>
<td>SPS</td>
<td>IO-X1:29</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Ind10</td>
<td>SPS</td>
<td>IO-X1:28</td>
<td>O</td>
<td>-</td>
</tr>
</tbody>
</table>

**Settings**

| -              | -              | -            | -     | -       |

Table 36: GGIO class (GGIO1)

### 8.3.5 GGIO2 - Generic process I/O

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGIO2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Common logical node information**

<table>
<thead>
<tr>
<th>Mod</th>
<th>ENC</th>
<th>Mode</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>O</td>
<td>1: OK; 3: no internal communication</td>
</tr>
</tbody>
</table>

| NamPlt | LPL | Name plate | O | - |

**Controls**

| - | - | - | - | - |

**Measured values**

| - | - | - | - | - |

**Status information**

| Ind1 | SPS | UC1-X1:11 | O | - |
| Ind2 | SPS | UC1-X1:12 | O | - |
| Ind3 | SPS | UC1-X1:14 | O | - |
| Ind4 | SPS | UC1-X1:15 | O | - |
| Ind5 | SPS | UC1-X1:16 | O | - |
| Ind6 | SPS | UC1-X1:17 | O | - |
| Ind7 | SPS | UC1-X1:30 | O | - |
| Ind8 | SPS | UC1-X1:31 | O | - |
| Ind9 | SPS | UC1-X1:32 | O | - |
| Ind10 | SPS | UC1-X1:33 | O | - |

**Settings**

| - | - | - | - | - |

Table 37: GGIO class (GGIO2)
## 8.3.6 Ggio3 - Generic process I/O

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ggio3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Common logical node information

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>ENC</td>
<td>Mode</td>
<td>O</td>
<td>status-only</td>
</tr>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>O</td>
<td>1 = OK; 3 = no internal communication</td>
</tr>
</tbody>
</table>

| NamePlate | LPL | Name plate | O   |                          |

### Controls

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

### Measured values

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

### Status information

<table>
<thead>
<tr>
<th>Ind1</th>
<th>SPS</th>
<th>UC2 X1:11</th>
<th>O</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ind2</td>
<td>SPS</td>
<td>UC2 X1:12</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind3</td>
<td>SPS</td>
<td>UC2 X1:14</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind4</td>
<td>SPS</td>
<td>UC2 X1:15</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind5</td>
<td>SPS</td>
<td>UC2 X1:16</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind6</td>
<td>SPS</td>
<td>UC2 X1:17</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind7</td>
<td>SPS</td>
<td>UC2 X1:30</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind8</td>
<td>SPS</td>
<td>UC2 X1:31</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind9</td>
<td>SPS</td>
<td>UC2 X1:32</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Ind10</td>
<td>SPS</td>
<td>UC2 X1:33</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

### Settings

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

Table 38: Ggio class (Ggio3)

## 8.3.7 Ggio4 - Generic process I/O

<table>
<thead>
<tr>
<th>Attribute name</th>
<th>Attribute type</th>
<th>Explanation</th>
<th>M/O/E</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ggio4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Common logical node information

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>ENC</td>
<td>Mode</td>
<td>O</td>
<td>status-only</td>
</tr>
<tr>
<td>Beh</td>
<td>INS</td>
<td>Behavior</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>Health</td>
<td>O</td>
<td>1 = OK; 3 = no internal communication</td>
</tr>
</tbody>
</table>

| NamePlate | LPL | Name plate | O   |                          |

### Controls

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
### Attribute name | Attribute type | Explanation | M/O/E | Remarks
---|---|---|---|---
- | - | - | - | -

**Measured values**

- | - | - | - | -

**Status information**

| Ind1 | SPS | UC3 X1:11 | O | - |
| Ind2 | SPS | UC3 X1:12 | O | - |
| Ind3 | SPS | UC3 X1:14 | O | - |
| Ind4 | SPS | UC3 X1:15 | O | - |
| Ind5 | SPS | UC3 X1:16 | O | - |
| Ind6 | SPS | UC3 X1:17 | O | - |
| Ind7 | SPS | UC3 X1:30 | O | - |
| Ind8 | SPS | UC3 X1:31 | O | - |
| Ind9 | SPS | UC3 X1:32 | O | - |
| Ind10 | SPS | UC3 X1:33 | O | - |

**Settings**

- | - | - | - | -

*Table 39: GGIQ class (GGIQ4)*
9 Maintenance and care

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

This chapter describes how to eliminate simple operating faults.

10.1 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 40: General faults

10.2 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 &lt; or &gt;. Then activate operating mode Auto.</td>
</tr>
<tr>
<td>Device blocking</td>
<td>Undervoltage blocking active</td>
<td>Check parameters</td>
</tr>
<tr>
<td>• LED V&lt; 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>• LED I&gt; illuminated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth set too high</td>
<td></td>
<td>Determine recommended bandwidth [► 68] and set parameters.</td>
</tr>
</tbody>
</table>

Table 41: No regulation in AUTO mode
## 10.3 Man-machine interface

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Keys</strong></td>
<td>REMOTE operating mode active and LED in key illuminated.</td>
<td>Press ( \text{EMOR} ) to activate LOCAL mode.</td>
</tr>
<tr>
<td>▪ MANUAL/AUTO operating mode cannot be changed</td>
<td>Parameter error</td>
<td>Reset parameters to factory settings [( \text{124} )].</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>Contrast incorrectly set.</td>
<td>Set contrast [( \text{43} )].</td>
</tr>
<tr>
<td>▪ No display.</td>
<td>Voltage supply interrupted.</td>
<td>Check voltage supply.</td>
</tr>
<tr>
<td>▪ LEDs in keys and not illuminated.</td>
<td>Fuse faulty.</td>
<td>Contact Maschinenfabrik Reinhausen.</td>
</tr>
<tr>
<td><strong>LEDs</strong></td>
<td>Customized LED parameterization.</td>
<td>Check parameters.</td>
</tr>
<tr>
<td>▪ Freely configurable LED lights up</td>
<td>Input signal not constant.</td>
<td>Check input signal.</td>
</tr>
<tr>
<td><strong>LEDs</strong></td>
<td>Different baud rates set.</td>
<td>Check baud rate set on device and PC.</td>
</tr>
<tr>
<td>▪ LED flashing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **COM1** | Cannot be connected to PC using TAPCON®-trol. | | }

Table 42: Man-machine interface

## 10.4 Incorrect measured values

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measured voltage</strong></td>
<td>Connection has no contact in the plug terminal.</td>
<td>Check wiring and plug terminal.</td>
</tr>
<tr>
<td>▪ No measured value.</td>
<td>Insulation trapped</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wire not inserted far enough.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Circuit breaker tripped.</td>
<td>Check fuse.</td>
</tr>
<tr>
<td><strong>Measured voltage</strong></td>
<td>Voltage drop on measuring lead.</td>
<td>Check measured voltage at plug terminal MI:01/MI:02.</td>
</tr>
<tr>
<td>▪ Measured value too low.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measured voltage</strong></td>
<td>Possible sources of fault:</td>
<td>Check measured voltage at plug terminal MI:01/MI:02.</td>
</tr>
<tr>
<td>▪ Measured value fluctuates.</td>
<td>▪ Leads laid in parallel.</td>
<td>Increase distance from source of interference.</td>
</tr>
<tr>
<td></td>
<td>▪ Tap-change operations.</td>
<td>Install filter if necessary.</td>
</tr>
<tr>
<td><strong>Measured current</strong></td>
<td>Line to current transformer interrupted.</td>
<td>Check wiring.</td>
</tr>
<tr>
<td>▪ No measured value.</td>
<td>Short-circuiting jumper in current transformer not removed.</td>
<td>Remove short-circuiting jumper.</td>
</tr>
</tbody>
</table>
### 10.5 Parallel operation faults

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• LED not lit up.</td>
<td>CAN bus address of device set to &quot;0&quot;.</td>
<td>Set CAN bus address (anything but 0).</td>
</tr>
<tr>
<td>Problem with CAN bus.</td>
<td>Device incorrectly connected (plug twisted, offset).</td>
<td>Check connections.</td>
</tr>
<tr>
<td>• Device not listed.</td>
<td>Devices have the same CAN bus addresses.</td>
<td>Connect as shown in connection diagram.</td>
</tr>
</tbody>
</table>

Table 44: Parallel operation faults

### 10.6 Tap position capture incorrect

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step display incorrect.</td>
<td>Incorrect wiring.</td>
<td>Check wiring.</td>
</tr>
<tr>
<td>• Plus or minus sign incorrect</td>
<td></td>
<td>Connect as shown in connection diagram.</td>
</tr>
<tr>
<td></td>
<td>Minimum value of analog input signal not correctly parameterized.</td>
<td>Check parameters.</td>
</tr>
</tbody>
</table>

Table 43: Incorrect measured values
### 10.7 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?
11 Messages

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

11.1 Signal inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Inscription</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO-X1:28</td>
<td>MOTOR-DRIVE UNIT IN OPERATION</td>
<td>Motor-drive unit is in operation</td>
</tr>
<tr>
<td>IO-X1:29</td>
<td>MOTOR PROTECTIVE SWITCH OFF</td>
<td>Motor protective switch has triggered</td>
</tr>
<tr>
<td>IO-X1:31</td>
<td>CAN BE FREELY PARAMETERIZED</td>
<td>0:OFF</td>
</tr>
<tr>
<td>IO-X1:33</td>
<td></td>
<td>1:MASTER_FOLLOWER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2:LOCAL_REMOTE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3:REGULATOR_BLOCKING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4:LV_HIGHSPEED_TAP_CHANGES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5:MOTOR_PROTECTIVE_SWITCH_TRIGGERED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6:REMOTE</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>UC-X1:11</td>
<td>PARALLEL GROUP 1</td>
<td>Assign parallel operation group 1</td>
</tr>
<tr>
<td>UC-X1:12</td>
<td>PARALLEL GROUP 2</td>
<td>Assign parallel operation group 2</td>
</tr>
<tr>
<td></td>
<td>BCD1…BCD10</td>
<td>BCD tap input signal</td>
</tr>
</tbody>
</table>

Table 46: Signal inputs
## 11.2 Signal outputs

<table>
<thead>
<tr>
<th>Relay</th>
<th>Inscription</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<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>RAISE</td>
<td>Signal for raise switching pulse</td>
</tr>
<tr>
<td>IO-X1:06</td>
<td>LOWER</td>
<td>Signal for lower switching pulse</td>
</tr>
<tr>
<td>IO-X1:20</td>
<td>UNDERVOLTAGE OVERVOLTAGE OVERCURRENT</td>
<td>Signal for undervoltage, overvoltage, overcurrent message</td>
</tr>
<tr>
<td>UC-X1:02</td>
<td>PARALLEL FAULT</td>
<td>Signal for parallel operation error message</td>
</tr>
<tr>
<td>UC-X1:04</td>
<td>PARALLEL ON</td>
<td>Signal if parallel operation is active</td>
</tr>
<tr>
<td>UC-X1:06...10, UC-X1:19...27</td>
<td>TAP POSITION BCD1...BCD20, BCD+ , BCD-</td>
<td>BCD signal of tap position</td>
</tr>
</tbody>
</table>

Table 47: Signal outputs
## 11.3 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>Parallel operation error</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>Motor protection device</td>
<td>Event message appears if motor protective switch triggers.</td>
</tr>
<tr>
<td>Blocking</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>No OLTC position</td>
<td>Event message appears if no OLTC position is detected.</td>
</tr>
<tr>
<td>Tap-change detection error</td>
<td>Event message appears if an on-load tap-change operation has not been detected correctly.</td>
</tr>
</tbody>
</table>

Table 48: Event messages
12 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.
# 13 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...9999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Primary voltage2</td>
<td>0...9999 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>Secondary voltage2</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>Winding2 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>Winding2 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>Winding2 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>Winding2 desired value 3</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>Selection of regulated winding</td>
<td>Automatic; Winding1; Winding2</td>
<td>Auto</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>I&gt; Overcurrent2</td>
<td>50...210 %</td>
<td>110 %</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; Undervoltage2 (%)</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; Undervoltage2 (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; Overvoltage2 (%)</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>U&gt; Overvoltage2 (V)</td>
<td>34...160 V</td>
<td>110.0 V</td>
<td></td>
</tr>
<tr>
<td>Parameter &gt; Compensation</td>
<td>Setting range</td>
<td>Factory setting</td>
<td>Current setting</td>
</tr>
<tr>
<td>----------------------------------</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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Configuration &gt; Transformer data</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary voltage</td>
<td>0...9999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Primary voltage2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary current</td>
<td>0...9999 A</td>
<td>0 A</td>
<td></td>
</tr>
<tr>
<td>Primary current2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>57...125 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Secondary voltage2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current transformer connection</td>
<td>Unknown; 0.2 A; 1 A; 5 A</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Current-transformer connection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformer circuit</td>
<td>See [► 89]</td>
<td>0 1PH</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Configuration &gt; General</th>
<th></th>
<th></th>
<th></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 [► 59]</td>
<td>Desired value 3</td>
<td></td>
</tr>
<tr>
<td>IO1-X1:25/26</td>
<td>See [► 59]</td>
<td>Desired value 2</td>
<td></td>
</tr>
<tr>
<td>IO1-X1:31</td>
<td>See [► 58]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>IO1-X1:33</td>
<td>See [► 58]</td>
<td>Off</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 [► 44]</td>
<td>English</td>
<td></td>
</tr>
<tr>
<td>Tapping direction swapped</td>
<td>Standard/Swapped</td>
<td>Standard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Configuration &gt; Parallel operation</th>
<th></th>
<th></th>
<th></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>Parallel operation method</td>
<td>Off, circulating reactive current; master; follower; synch. auto</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Stability</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Configuration &gt; Analog inputs    |                  |                 |                 |</p>
<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>
<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></td>
</tr>
<tr>
<td>Input 2 lower limit</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td></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>
<tr>
<td>Configuration &gt; LED selection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED1</td>
<td>See [► 100]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>LED2</td>
<td>See [► 100]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>LED3 yellow</td>
<td>See [► 100]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>LED4 green</td>
<td>See [► 100]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>LED4 red</td>
<td>See [► 100]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Configuration &gt; Measuring transducer 1/2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output 1 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Output 1 upper value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 1 lower value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 1 upper</td>
<td>1 mA; 10 mA; 20 mA; 0</td>
<td>20 mA</td>
<td></td>
</tr>
<tr>
<td>Output 1 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
<td></td>
</tr>
<tr>
<td>Output 2 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Output 2 upper value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 2 lower value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 2 upper</td>
<td>1 mA; 10 mA; 20 mA; 0</td>
<td>20 mA</td>
<td></td>
</tr>
<tr>
<td>Output 2 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
<td></td>
</tr>
<tr>
<td>Configuration &gt; Measuring transducer 3/4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output 3 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Output 3 upper value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 3 lower value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 3 upper</td>
<td>1 mA; 10 mA; 20 mA; 10 V</td>
<td>20 mA</td>
<td></td>
</tr>
<tr>
<td>Output 3 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
<td></td>
</tr>
<tr>
<td>Output 4 measured value</td>
<td>See [► 102]</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Output 4 upper value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 4 lower value</td>
<td>-9999...9999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Output 4 upper</td>
<td>1 mA; 10 mA; 20 mA; 10 V</td>
<td>20 mA</td>
<td></td>
</tr>
<tr>
<td>Output 4 lower</td>
<td>See [► 102]</td>
<td>+4 mA</td>
<td></td>
</tr>
</tbody>
</table>

Configuration > Memory
### Parameter Overview

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event memory</td>
<td>256 k; 512 k; 1024 k; 2048 k</td>
<td>256 k</td>
<td></td>
</tr>
<tr>
<td>Average value interval</td>
<td>See [► 106]</td>
<td></td>
<td>1 s</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>
<tr>
<td>Configuration &gt; Communication interface CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm. port CIC1</td>
<td>RS232; RS485; Ethernet; OF</td>
<td>RS232</td>
<td></td>
</tr>
<tr>
<td>Baud rate comm. CIC1</td>
<td>9.6...57.6 kilobaud</td>
<td>9.6 kilobaud</td>
<td></td>
</tr>
<tr>
<td>Network address CIC1</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>TCP port CIC1</td>
<td>0...9999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiber-optic cable light On/Off CIC1</td>
<td>On; Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Local SCADA Address CIC1</td>
<td>0...9999</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SCADA Master Address CIC1</td>
<td>0...9999</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Unsolicited messages CIC1</td>
<td>On; Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Repeatedly unsolicited mes-</td>
<td>0...100</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>sages CIC1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appl. conf. timeout CIC1</td>
<td>1...60 s</td>
<td>5 s</td>
<td></td>
</tr>
<tr>
<td>Transmission delay CIC1</td>
<td>0...254</td>
<td>4 ms</td>
<td></td>
</tr>
</tbody>
</table>

Table 49: Overview of parameters
14 Technical data

14.1 Indicator elements

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

Table 50: Indicator elements

14.2 Power supply

<table>
<thead>
<tr>
<th>SUH-P</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible voltage range</td>
<td>88...264 V AC</td>
</tr>
<tr>
<td></td>
<td>88...353 V DC</td>
</tr>
<tr>
<td></td>
<td>$U_N$: 100...240 V AC</td>
</tr>
<tr>
<td></td>
<td>$U_N$: 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>
</tbody>
</table>
| Internal fuse            | 250 V; 3 A; 6.3 x 32 mm, "delayed-action" char-
                                            | acteristics                                     |

Table 51: Standard model

Figure 95: Internal fuses of SUH-P card

F1  Fuse

F2  Spare fuse
14 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 52: Special model

Figure 96: 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></td>
<td>1</td>
<td>L1 / +DC</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N / GND</td>
</tr>
</tbody>
</table>

Table 53: Terminal X1
14.3 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 measurement</strong></td>
<td>( U_{\text{N}}: 100 \text{ V AC} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range: ( 85...140 \text{ V AC} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rated frequency: ( 45...65 \text{ Hz} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrinsic consumption: (&lt; 1 \text{ VA} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measurement category IV in accordance with IEC 61010-2-30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring error: (&lt; 0.3 % \pm 40 \text{ ppm/°C} )</td>
<td></td>
</tr>
<tr>
<td><strong>Current measurement</strong></td>
<td>( I_{\text{N}}: 0.2 / 1 / 5 \text{ A} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range: ( 0.01...2.1 \cdot I_{\text{N}} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rated frequency: ( 45...65 \text{ Hz} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrinsic consumption: (&lt; 1 \text{ VA} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overload capacity: ( 2.1 \cdot I_{\text{N}} ) (continuously), ( 40 \times I_{\text{N}} / 1 \text{ s} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring error: (&lt; 0.5 % \pm 40 \text{ ppm/°C} )</td>
<td></td>
</tr>
<tr>
<td><strong>Phase angle</strong></td>
<td>Measuring accuracy: ( \pm 1° )</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency measurement</strong></td>
<td>( f_{\text{N}}: 50 / 60 \text{ Hz} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range: ( 45...65 \text{ Hz} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring accuracy: ( \pm 1 \text{ Hz} )</td>
<td></td>
</tr>
</tbody>
</table>

Table 54: Voltage measurement and current measurement

**Interfaces**

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Voltage transformer</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Voltage transformer</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Shared return conductor</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Current transformer with rated current of 5 A</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Current transformer with rated current of 1 A</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Current transformer with rated current of 0.2 A</td>
</tr>
</tbody>
</table>

Table 55: MI card terminal X1
<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage transformer L1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Voltage transformer L1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Return conductor of current transformer L1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Current transformer L1 (rated current 5 A)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Voltage transformer L2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Voltage transformer L2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Return conductor of current transformer L2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Current transformer L2 (rated current 5 A)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Voltage transformer L3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Voltage transformer L3</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Return conductor of current transformer L3</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Current transformer L3 (rated current 5 A)</td>
<td></td>
</tr>
</tbody>
</table>

Table 56: MI3-G card terminal X1

### 14.4 Digital inputs and outputs

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Quantity</th>
<th>IO</th>
<th>UC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical 0</td>
<td></td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Logical 1</td>
<td></td>
<td>0...25 V DC</td>
<td>40...250 V DC</td>
</tr>
<tr>
<td>Input current</td>
<td></td>
<td>Min. 1 mA</td>
<td></td>
</tr>
</tbody>
</table>

With pulsating DC voltage, the voltage minimum must always exceed 40 V.

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Number (number of change-over contacts in parentheses)</th>
<th>8 (5)</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact loadability</td>
<td>Min.: 12 V, 100 mA Max. AC: 250 V, 5 A Max. DC: See diagram</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 57: Digital inputs and outputs
14.5 Analog inputs and outputs

<table>
<thead>
<tr>
<th></th>
<th>AD</th>
<th>AD8</th>
<th>AN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channels</td>
<td>2 inputs</td>
<td>8 inputs</td>
<td>2 outputs or 4 outputs (AN + AN1)</td>
</tr>
<tr>
<td>Input signals</td>
<td>0...±20mA</td>
<td>0...±10mA</td>
<td>0...±10V</td>
</tr>
<tr>
<td>(depending on</td>
<td>0...±10mA</td>
<td>50...2000 ohms</td>
<td>-</td>
</tr>
<tr>
<td>configuration)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output signals</td>
<td>-</td>
<td>-</td>
<td>0...±20mA</td>
</tr>
<tr>
<td>(depending on</td>
<td></td>
<td></td>
<td>0...±10mA</td>
</tr>
<tr>
<td>configuration)</td>
<td></td>
<td></td>
<td>0...±1mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0...±10V</td>
</tr>
</tbody>
</table>

Table 58: Analog inputs and outputs (optional)

14.6 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>

Figure 97: Maximum contact loadability of outputs with direct current

1 Ohmic load
### 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 59: Control voltage supply

![Figure 98: Internal fuses of AC-115 card and AC-230 card](image)

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

Table 60: Terminal X1

<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>

Table 61: Terminal X2
14 Technical data

14.7 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 62: Terminal X9 (CAN bus)

*) Alternatively, you can fit the cable shield to the partition plate’s cable clip.

14.8 System networking

CIC card

<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) Polarity: A &gt; B by 200 mV corresponds to 1. A &lt; B by 200 mV corresponds to 0. Recommended terminating resistor 120 Ω.</td>
</tr>
<tr>
<td>RJ45 (optional)</td>
<td>Max. 100 m 10 MBit/s</td>
</tr>
<tr>
<td>Fiber-optic cable (optional)</td>
<td>F-ST (850 nm or 660 nm) F-SMA (850 nm or 660 nm)</td>
</tr>
</tbody>
</table>

Table 63: 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 64: Terminal X8 (RS232)
### Technical data

#### 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>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 65: 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>TxD+</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>TxD-</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>RxD+</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>RxD-</td>
</tr>
</tbody>
</table>

Table 66: Terminal X7 (RJ45)

#### SID card

<table>
<thead>
<tr>
<th>SID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJ45</td>
<td>Max. 100 m</td>
</tr>
<tr>
<td></td>
<td>Ethernet</td>
</tr>
<tr>
<td></td>
<td>100 MBit/s</td>
</tr>
</tbody>
</table>

Table 67: Technical data for SID card

<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>
</tr>
<tr>
<td></td>
<td>3</td>
<td>RxD+</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>RxD-</td>
</tr>
</tbody>
</table>

Table 68: RJ45 interface

#### 14.9 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 69: Dimensions and weight
Figure 99: Dimensions
14.10 Ambient conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-25°C...+70°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-30°C...+85°C</td>
</tr>
</tbody>
</table>

Table 70: Permissible ambient conditions

14.11 Tests

14.11.1 Electrical safety

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<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>
</tbody>
</table>

Table 71: Electrical safety

14.11.2 EMC tests

<table>
<thead>
<tr>
<th>Standard</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 72: EMC tests

14.11.3 Environmental durability tests

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>
### Table 73: Environmental durability tests

<table>
<thead>
<tr>
<th>Standard</th>
<th>Test Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60068-2-3</td>
<td>Constant moist heat</td>
</tr>
<tr>
<td></td>
<td>+ 40 °C / 93 % / 4 days, no dew</td>
</tr>
<tr>
<td>IEC 60068-2-30</td>
<td>Cyclic moist heat (12 + 12 hours)</td>
</tr>
<tr>
<td></td>
<td>+ 55 °C / 93 % / 6 cycles</td>
</tr>
</tbody>
</table>
### Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>DIN</td>
<td>Abbreviation for “Deutsches Institut für Normung”</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EN</td>
<td>Abbreviation for “European Norm”</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>
</tr>
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List of key words

<table>
<thead>
<tr>
<th>A</th>
<th>D</th>
<th>I</th>
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<tbody>
<tr>
<td>AC card</td>
<td>Date</td>
<td>ICD file</td>
</tr>
<tr>
<td>AD card</td>
<td>Delay time T1</td>
<td>128, 129</td>
</tr>
<tr>
<td>AD8 card</td>
<td>Delay time T2</td>
<td>128</td>
</tr>
<tr>
<td>AN card</td>
<td>Activating</td>
<td>70</td>
</tr>
<tr>
<td>Analog input</td>
<td>Desired value</td>
<td>70</td>
</tr>
<tr>
<td>Assemblies</td>
<td>Desired value</td>
<td>Input 1 lower limit</td>
</tr>
<tr>
<td>Assembly</td>
<td>Device ID</td>
<td>98</td>
</tr>
<tr>
<td>AC card</td>
<td>Display contrast</td>
<td>98</td>
</tr>
<tr>
<td>AD card</td>
<td>Display dimming</td>
<td>Input 1 lower limit</td>
</tr>
<tr>
<td>AD8 card</td>
<td>Display elements</td>
<td>Input 1 upper limit</td>
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<tr>
<td>AN card</td>
<td>LED</td>
<td>Input 1 upper limit</td>
</tr>
<tr>
<td>CIC card</td>
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<td>99</td>
</tr>
<tr>
<td>CPU card</td>
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<tr>
<td>IO card</td>
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<tr>
<td>MI</td>
<td></td>
<td>25</td>
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<tr>
<td>SID card</td>
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<td>24</td>
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<tr>
<td>SU card</td>
<td></td>
<td>24</td>
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<tr>
<td>UC card</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Average value interval</td>
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<td>Desired value</td>
</tr>
<tr>
<td>Average value memory</td>
<td></td>
<td>Desired value</td>
</tr>
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<th>B</th>
<th>E</th>
<th>L</th>
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<tr>
<td>Bandwidth</td>
<td>Electromagnetic compatibility</td>
<td>Language</td>
</tr>
<tr>
<td>Baud rate</td>
<td>Event memory</td>
<td>44</td>
</tr>
<tr>
<td>Block time max steps</td>
<td></td>
<td>124, 146</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>F</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable recommendation</td>
<td></td>
<td>Maximum number of tap-changes in time</td>
</tr>
<tr>
<td>CAN bus</td>
<td>Factory setting</td>
<td>79</td>
</tr>
<tr>
<td>Data</td>
<td>Fiber-optic cable</td>
<td>Measured value memory</td>
</tr>
<tr>
<td>CIC card</td>
<td>Information about laying</td>
<td>126</td>
</tr>
<tr>
<td>CIC card SCADA information</td>
<td></td>
<td>Measured values</td>
</tr>
<tr>
<td>Circulating reactive current</td>
<td>37</td>
<td>121</td>
</tr>
<tr>
<td>Blocking</td>
<td>Function monitoring</td>
<td>Measuring transducer</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Function test</td>
<td>Memory</td>
</tr>
<tr>
<td>COM1 setting</td>
<td>Additional functions</td>
<td>103</td>
</tr>
<tr>
<td>Communication port</td>
<td></td>
<td>MI</td>
</tr>
<tr>
<td>Compensation</td>
<td>Circulating reactive current</td>
<td>MI3-G</td>
</tr>
<tr>
<td>Z compensation</td>
<td>blocking</td>
<td>25</td>
</tr>
<tr>
<td>Connection</td>
<td>Circulating reactive current</td>
<td>Motor runtime</td>
</tr>
<tr>
<td>Contrast</td>
<td>sensitivity</td>
<td>61</td>
</tr>
<tr>
<td>Control parameter</td>
<td></td>
<td>Output relay</td>
</tr>
<tr>
<td>Desired value</td>
<td>Control functions</td>
<td>61</td>
</tr>
<tr>
<td>control parameters</td>
<td></td>
<td>Desired value</td>
</tr>
<tr>
<td>Control response T1</td>
<td></td>
<td>Desired value</td>
</tr>
<tr>
<td>CPU card</td>
<td>Desired value 2</td>
<td>Desired value</td>
</tr>
<tr>
<td></td>
<td>Desired value 3</td>
<td>Desired value</td>
</tr>
<tr>
<td></td>
<td>Line drop compensation</td>
<td>Desired value</td>
</tr>
<tr>
<td></td>
<td>Overvoltage U&gt;</td>
<td>Overvoltage V&gt;</td>
</tr>
<tr>
<td></td>
<td>Parallel operation</td>
<td>Relative</td>
</tr>
<tr>
<td></td>
<td>Undervoltage U&lt;</td>
<td>Undervoltage U&lt;</td>
</tr>
<tr>
<td></td>
<td>Z compensation</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Function tests</td>
<td>Inductive voltage drop</td>
</tr>
<tr>
<td></td>
<td>LDC</td>
<td>Ohmic voltage drop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower -&gt; reset raise cnt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G</th>
<th>H</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway</td>
<td>High-speed return</td>
<td></td>
</tr>
</tbody>
</table>
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- Operating controls 18
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- Limit value 85
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