Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>8</td>
</tr>
<tr>
<td>1.1</td>
<td>Manufacturer</td>
<td>8</td>
</tr>
<tr>
<td>1.2</td>
<td>Subject to change without notice</td>
<td>8</td>
</tr>
<tr>
<td>1.3</td>
<td>Completeness</td>
<td>8</td>
</tr>
<tr>
<td>1.4</td>
<td>Safekeeping</td>
<td>8</td>
</tr>
<tr>
<td>1.5</td>
<td>Notation conventions</td>
<td>8</td>
</tr>
<tr>
<td>1.5.1</td>
<td>Hazard communication system</td>
<td>9</td>
</tr>
<tr>
<td>1.5.2</td>
<td>Information system</td>
<td>10</td>
</tr>
<tr>
<td>1.5.3</td>
<td>Instruction system</td>
<td>10</td>
</tr>
<tr>
<td>1.5.4</td>
<td>Typographic conventions</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Safety</td>
<td>12</td>
</tr>
<tr>
<td>2.1</td>
<td>General safety information</td>
<td>12</td>
</tr>
<tr>
<td>2.2</td>
<td>Appropriate use</td>
<td>12</td>
</tr>
<tr>
<td>2.3</td>
<td>Inappropriate use</td>
<td>12</td>
</tr>
<tr>
<td>2.4</td>
<td>Personnel qualification</td>
<td>12</td>
</tr>
<tr>
<td>2.5</td>
<td>Operator's duty of care</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Product description</td>
<td>14</td>
</tr>
<tr>
<td>3.1</td>
<td>Scope of delivery</td>
<td>14</td>
</tr>
<tr>
<td>3.2</td>
<td>Function description</td>
<td>14</td>
</tr>
<tr>
<td>3.3</td>
<td>Performance features</td>
<td>14</td>
</tr>
<tr>
<td>3.4</td>
<td>Variants</td>
<td>16</td>
</tr>
<tr>
<td>3.5</td>
<td>Hardware</td>
<td>18</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Power supply</td>
<td>18</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Voltage measurement and current measurement</td>
<td>19</td>
</tr>
<tr>
<td>3.5.3</td>
<td>Digital inputs and outputs</td>
<td>19</td>
</tr>
<tr>
<td>3.5.4</td>
<td>Analog inputs and outputs</td>
<td>20</td>
</tr>
<tr>
<td>3.5.5</td>
<td>Central processing unit</td>
<td>20</td>
</tr>
<tr>
<td>3.6</td>
<td>Main screen</td>
<td>21</td>
</tr>
<tr>
<td>3.7</td>
<td>Operating concept</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>Mounting</td>
<td>27</td>
</tr>
<tr>
<td>4.1</td>
<td>Preparation</td>
<td>27</td>
</tr>
<tr>
<td>4.2</td>
<td>Connecting the device</td>
<td>27</td>
</tr>
</tbody>
</table>
5 Commissioning.................................................................................................................................................. 41
   5.1 Setting the parameters.................................................................................................................................. 41
       5.1.1 Setting the language................................................................................................................................ 41
       5.1.2 Setting date and time.......................................................................................................................... 41
   5.2 Commissioning wizard.................................................................................................................................. 42

6 Operation........................................................................................................................................................... 44
   6.1 General.......................................................................................................................................................... 44
       6.1.1 Activating/deactivating automatic launch of commissioning wizard........................................................ 45
       6.1.2 Setting measured value display........................................................................................................... 45
       6.1.3 Transformer name.................................................................................................................................... 45
       6.1.4 Visualization......................................................................................................................................... 45
   6.2 Control (optional)......................................................................................................................................... 49
       6.2.1 Setting the desired value...................................................................................................................... 49
       6.2.2 Bandwidth............................................................................................................................................. 63
       6.2.3 Delay time T1.......................................................................................................................................... 64
       6.2.4 Delay time T2.......................................................................................................................................... 66
   6.3 Transformer data.......................................................................................................................................... 68
       6.3.1 Setting the primary transformer voltage............................................................................................... 68
       6.3.2 Setting the secondary transformer voltage........................................................................................... 68
       6.3.3 Setting primary transformer current.................................................................................................... 69
       6.3.4 Setting the secondary transformer current............................................................................................ 69
       6.3.5 Setting circuit for current transformer/voltage transformer and phase angle correction........................ 69
   6.4 Measurement................................................................................................................................................. 76
       6.4.1 Setting UI measuring channels............................................................................................................. 76
       6.4.2 Control variable...................................................................................................................................... 77
       6.4.3 Regulation mode..................................................................................................................................... 77
   6.5 Control of the motor-drive unit (optional).................................................................................................. 77
       6.5.1 Setting the switching pulse for controlling the motor-drive unit........................................................... 78
## Table of contents

6.1.2  Setting motor runtime monitoring........................................................................................................ 79
6.1.3  Setting the switching direction................................................................................................................ 79
6.6  Parallel operation......................................................................................................................................... 80
6.6.1  Selecting parallel operation method......................................................................................................... 80
6.6.2  Assigning a CAN bus address.................................................................................................................. 83
6.6.3  Setting behavior if no communication present....................................................................................... 84
6.6.4  Setting delay time for parallel operation error messages...................................................................... 84
6.6.5  TAPCON® 2xx retrofit............................................................................................................................. 84
6.7  Limit values................................................................................................................................................ 85
6.7.1  Voltage monitoring.................................................................................................................................... 88
6.7.2  Current monitoring..................................................................................................................................... 89
6.7.3  Power monitoring....................................................................................................................................... 90
6.7.4  Bandwidth monitoring.............................................................................................................................. 90
6.7.5  Temperature monitoring.......................................................................................................................... 92
6.7.6  Tx statistics monitoring........................................................................................................................... 93
6.7.7  DGA monitoring....................................................................................................................................... 94
6.7.8  Tap position monitoring.......................................................................................................................... 95
6.8  Hot-spot calculation (optional).................................................................................................................. 95
6.9  Setting calculation of transformer's loss of life (optional)...................................................................... 96
6.10  Cooling system control (optional)........................................................................................................... 97
6.10.1  Configuring cooling stages..................................................................................................................... 98
6.10.2  Configuring load-dependent mode......................................................................................................... 101
6.10.3  Configuring periodic mode.................................................................................................................... 102
6.10.4  Configuring alternating mode................................................................................................................ 103
6.10.5  Displaying status of cooling stages......................................................................................................... 104
6.11  Displaying protective device status (optional)........................................................................................ 105
6.12  Displaying tap-change operation statistics (optional)............................................................................ 106
6.13  DGA measured value trend........................................................................................................................ 107
6.14  Displaying temperature curve (optional)................................................................................................ 108
6.15  Changing tap position designation (optional)........................................................................................ 109
6.16  Displaying information about contact wear (only OILTAP®).................................................................... 110
6.17  Configuring analog inputs and outputs (optional)..................................................................................... 110
6.18  Configuring digital inputs and outputs..................................................................................................... 112
6.19  Name plate (optional).............................................................................................................................. 114
6.19.1  Enter the name plate data..................................................................................................................... 114
6.19.2  Displaying the name plate...................................................................................................................... 115
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.20</td>
<td>Maintenance (optional)</td>
<td>115</td>
</tr>
<tr>
<td>6.20.1</td>
<td>Setting operator interval for OLTC maintenance</td>
<td>116</td>
</tr>
<tr>
<td>6.20.2</td>
<td>Setting operator interval for transformer maintenance</td>
<td>118</td>
</tr>
<tr>
<td>6.20.3</td>
<td>Undertaking and confirming maintenance</td>
<td>118</td>
</tr>
<tr>
<td>6.20.4</td>
<td>Displaying maintenance overview</td>
<td>119</td>
</tr>
<tr>
<td>6.21</td>
<td>Event management</td>
<td>120</td>
</tr>
<tr>
<td>6.21.1</td>
<td>Displaying and acknowledging events</td>
<td>120</td>
</tr>
<tr>
<td>6.21.2</td>
<td>Configuring events</td>
<td>121</td>
</tr>
<tr>
<td>6.21.3</td>
<td>Displaying event memory</td>
<td>122</td>
</tr>
<tr>
<td>6.22</td>
<td>Measured values</td>
<td>124</td>
</tr>
<tr>
<td>6.22.1</td>
<td>Displaying current measured values</td>
<td>124</td>
</tr>
<tr>
<td>6.22.2</td>
<td>Displaying measured value recorder (optional)</td>
<td>125</td>
</tr>
<tr>
<td>6.23</td>
<td>SCADA</td>
<td>128</td>
</tr>
<tr>
<td>6.23.1</td>
<td>Configuring IEC 61850 (optional)</td>
<td>129</td>
</tr>
<tr>
<td>6.23.2</td>
<td>Configuring IEC 60870-5-101 (optional)</td>
<td>131</td>
</tr>
<tr>
<td>6.23.3</td>
<td>Configuring IEC 60870-5-103 (optional)</td>
<td>136</td>
</tr>
<tr>
<td>6.23.4</td>
<td>Configuring IEC 60870-5-104 (optional)</td>
<td>138</td>
</tr>
<tr>
<td>6.23.5</td>
<td>Configuring Modbus (optional)</td>
<td>141</td>
</tr>
<tr>
<td>6.23.6</td>
<td>Configuring DNP3 (optional)</td>
<td>144</td>
</tr>
<tr>
<td>6.24</td>
<td>Time synchronization</td>
<td>148</td>
</tr>
<tr>
<td>6.24.1</td>
<td>Activating time synchronization using SNTP</td>
<td>148</td>
</tr>
<tr>
<td>6.24.2</td>
<td>Entering the time server address</td>
<td>149</td>
</tr>
<tr>
<td>6.24.3</td>
<td>Setting the time zone</td>
<td>150</td>
</tr>
<tr>
<td>6.24.4</td>
<td>Setting synchronization interval</td>
<td>150</td>
</tr>
<tr>
<td>6.24.5</td>
<td>Reference time</td>
<td>150</td>
</tr>
<tr>
<td>6.25</td>
<td>User administration</td>
<td>151</td>
</tr>
<tr>
<td>6.25.1</td>
<td>User roles</td>
<td>151</td>
</tr>
<tr>
<td>6.25.2</td>
<td>Changing password</td>
<td>152</td>
</tr>
<tr>
<td>6.25.3</td>
<td>Creating, editing and deleting users</td>
<td>153</td>
</tr>
<tr>
<td>6.25.4</td>
<td>Setting access rights to parameters and events</td>
<td>155</td>
</tr>
<tr>
<td>6.26</td>
<td>Information about device</td>
<td>156</td>
</tr>
<tr>
<td>6.26.1</td>
<td>Hardware</td>
<td>156</td>
</tr>
<tr>
<td>6.26.2</td>
<td>Software</td>
<td>157</td>
</tr>
<tr>
<td>6.26.3</td>
<td>Parallel operation</td>
<td>157</td>
</tr>
<tr>
<td>6.27</td>
<td>Import/export manager</td>
<td>158</td>
</tr>
<tr>
<td>6.27.1</td>
<td>Exporting data</td>
<td>158</td>
</tr>
</tbody>
</table>
Table of contents

6.27.2 Importing data (software version 3.44 and later) ................................................................. 159
6.28 Linking signals and events ........................................................................................................ 160
6.28.1 Linking functions .................................................................................................................. 161
6.28.2 Linking digital outputs and control system messages ........................................................... 162
6.29 Motor Current Index (MCI) .................................................................................................... 165
6.29.1 Setting MCI monitoring ........................................................................................................ 166
6.29.2 Displaying the MCI .............................................................................................................. 167

7 Fault elimination ......................................................................................................................... 170
7.1 General faults .......................................................................................................................... 170
7.2 Human-machine interface ........................................................................................................ 170
7.3 Other faults .............................................................................................................................. 170

8 Disposal ..................................................................................................................................... 172

9 Technical data .......................................................................................................................... 173
9.1 Voltage supply .......................................................................................................................... 173
9.2 Voltage measurement and current measurement ................................................................. 173
9.3 Digital inputs and outputs ....................................................................................................... 174
9.4 Analog inputs and outputs ....................................................................................................... 176
9.5 Central processing unit ............................................................................................................ 177
9.6 Ambient conditions ................................................................................................................. 179
9.7 Standards and directives ......................................................................................................... 179

Glossary ......................................................................................................................................... 182

List of key words .......................................................................................................................... 184
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

Falkensteinaße 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 Safekeeping

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

1.5 Notation conventions

This section contains an overview of the symbols and textual emphasis used.
1.5.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.5.1.1 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

1.5.1.2 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.

1.5.1.3 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

Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warning of a danger point</td>
</tr>
</tbody>
</table>
1.5.2 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.

1.5.3 Instruction system

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

Single-step instructions

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

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

Multi-step instructions

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

Aim of action
✓ Requirements (optional).
1 Introduction

1. Step 1.
   ⇒ Result of step (optional).
2. Step 2.
   ⇒ Result of step (optional).
   ⇒ Result of action (optional).

1.5.4 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>Bold</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>Italics</td>
<td>System messages, error messages,</td>
<td><strong>Function monitoring</strong> alarm</td>
</tr>
<tr>
<td></td>
<td>signals</td>
<td>triggered</td>
</tr>
<tr>
<td>[► Number of pages].</td>
<td>Cross reference</td>
<td>[► 41].</td>
</tr>
</tbody>
</table>

Table 3: Typographic conventions
2 Safety

2.1 General safety information

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

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

2.2 Appropriate use

If used as intended and in compliance with the requirements and conditions specified 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:
- ISM® Monitoring
- Technical files

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

The device is used to record the measured values and status data of a power transformer and an on-load tap-changer and to make them available using a web-based visualization. In addition to this, the parameters can be changed via the visualization. You can set the required parameters for a regulation function depending on device configuration. The device can be incorporated into a control system (SCADA).

3.3 Performance features

Depending on your order, the device is equipped with the following optional function packages:
- Basic monitoring
  - Voltage, current, frequency
3 Product description

- Active power, reactive power, apparent power, power factor
- Temperature monitoring (ambient temperature, temperature of top-oil, temperature of bottom oil (optional), calculation of hot-spot temperature in accordance with IEC 60076-7 or IEEE C57.91)
- Optional: Transformer oil level
- Loss-of-life and relative aging rate
- Status of the motor-drive unit (motor protective switch, motor is running)
- Tap position display
- Optional: Status of protective devices (Buchholz relay, protective relay, pressure relief device)
  - On-load tap-changer monitoring
    - Contact wear calculation (only for OILTAP® V, M, R, RM, MS, G)
    - Maintenance interval calculation
    - Oil carbonization (only for OILTAP® V, M, R)
    - Monitoring of OLTC temperature (optional)
    - Tap-change statistics of on-load tap-changer
    - Optional: on-load tap-changer oil level
    - Optional: oil filter unit
    - Status of the motor-drive unit (motor protective switch, motor is running)
  - Automatic voltage regulation AVR basic
    - Measurement of voltage and current
    - 1 desired value
    - Voltage regulation with linear delay time $T_1$
    - Status of the motor-drive unit (motor protective switch, motor is running)
  - Automatic voltage regulation AVR pro
    - Measurement of voltage and current
    - Desired value in accordance with order (1, 3 or 5 desired values, TDSC, analog desired value specification, gradual desired value specification, desired value using BCD)
    - Automatic voltage regulation with linear or integral delay time $T_1$ and with delay time $T_2$
    - Parallel operation
    - Line drop compensation
    - Status of the motor-drive unit (motor protective switch, motor is running)
    - Bandwidth monitoring
    - Function monitoring
    - Limit value monitoring (voltage, current, power, phase angle)
3 Product description

- Cooling system control
  - 2, 4 or 6 cooling stages, can be individually parameterized
  - Load-dependent mode (for early activation of cooling stages)
  - Periodic mode (for regular activation of cooling stages)
  - Alternating mode (for equal loading of similar cooling stages)
- Cooling stage monitoring (2, 4 or 6 cooling stages)
- DGA
  - Up to 10 gases via analog input
  - Relative moisture in oil via analog input

3.4 Variants

The device is available in the following variants:
- ED-S without display
- ED-S with display
- ED-L without display
- ED-L with display

The ISM assemblies are installed in the motor-drive unit as follows (figures show swing frame (inside), with cover plate (swing frame closed), without cover plate (swing frame open)):

Figure 2: ED-S without display
3 Product description

Figure 3: ED-S with display

Figure 4: ED-L without display
3.5 Hardware

3.5.1 Power supply

The PULS DIMENSION QS3.241 assembly is used for the device’s power supply.

Figure 5: ED-L with display

Figure 6: QS3.241 assembly
3.5.2 Voltage measurement and current measurement

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

![Figure 7: UI 3 assembly](image)

3.5.3 Digital inputs and outputs

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

![Figure 8: DIO 28-15 assembly](image)
3.5.4 Analog inputs and outputs

The AIO 2 and AIO 4 assemblies provide analog inputs and outputs:

- AIO 2: 2 channels
- AIO 4: 4 channels

In accordance with the device configuration, the AIO assembly supports one of the following signal types:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Current</td>
</tr>
<tr>
<td>0...10 V</td>
<td>0...20 mA</td>
</tr>
<tr>
<td></td>
<td>4...20 mA</td>
</tr>
</tbody>
</table>

Resistance measurement (such as PT100, resistor contact series)

Table 4: Signal types supported by the AIO assembly

3.5.5 Central processing unit

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

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

The web-based visualization is split into various areas.

Figure 11: Main screen

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Display area</td>
</tr>
<tr>
<td>2</td>
<td>Secondary navigation</td>
</tr>
<tr>
<td>3</td>
<td>Primary navigation</td>
</tr>
<tr>
<td>4</td>
<td>Status bar</td>
</tr>
</tbody>
</table>
Main screen

The most important measured values of the transformer are displayed on the main screen. The individual status displays of the transformer shown can be selected directly when accessing via the web browser. They are used to link to the corresponding menu items. If you are operating the device via the front panel, you are only able to call up the elements via the Information menu.

Figure 12: Transformer data

<table>
<thead>
<tr>
<th></th>
<th>Temperature of top-oil</th>
<th>Hot-spot temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Load current and load voltage of phases L1, L2, L3</td>
<td></td>
</tr>
</tbody>
</table>
3.7 Operating concept

You can operate the device using the controls on the front panel or using the web-based ISM™ Intuitive Control Interface visualization via a PC. The scope of function and structure of both options is virtually identical. Any differences are highlighted in these operating instructions.
User rights and user roles

The device is fitted with a rights system and a roles system. The display and access rights to device settings or events can therefore be controlled at user level.

You can configure the rights system and roles system to meet your requirements. You will find more information about user rights and user roles in the User administration [► 151] section.

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

Login/logout

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

If you want to operate the device via the controls and visualization at the same time, you have to log in on the device and via the visualization.

Proceed as follows to log in as user:
1. Press the LOGIN button in the status line.
2. Enter your user name and password and select the Ok button.
   → Logged-in user appears in status line.

Proceed as follows to log out as user:
► Press the LOGOUT button in the status line.

Navigation

If you are operating the device using the controls on the front panel, you can use the rotary knob to navigate through the entire menu. The currently selected menu has a blue border. To open the highlighted menu, you must press the ENTER key. Pressing the BACK key takes you back to the previous menu level.

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

Example
To navigate to the "Date" parameter, proceed as follows:
1. Go to Settings.
2. Select Time.
3. Select Date.

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

Depending on the parameter, you can undertake the settings in various ways.

Selecting list  To select a list entry, proceed as follows:

1. Use rotary knob to navigate to list and press the ENTER key.

![Figure 15: Selecting entry from list](image)

2. Use rotary knob to highlight entry from list and press the ENTER key.
3. Press the Accept button to save the modified parameter.

Entering value  To enter a value, proceed as follows:

1. Use rotary knob to select the field for the value and press the ENTER key.
   - If operating via the front panel, the numerical keypad appears.
2. Enter the value you want and confirm with √.
3. Press the **Accept** button to save the modified parameter.

**Entering text**

To enter text, proceed as follows:

1. Use rotary knob to select the text box and press the **ENTER** key.
   ⇨ If operating via the front panel, the keyboard appears.

   ![Figure 17: Entering text](image_url)

2. Enter the text you want and confirm with √.
3. Press the **Accept** button to save the modified parameter.
4 Mounting

This chapter describes how to correctly install 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.

4.1 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.

4.2 Connecting the 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 using the grounding screw on the housing.

4.2.1 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 cables on the function of the relay contacts.

If you want to route Ethernet connections starting from a control cabinet or building, we recommend the use of fiber-optic cables (in accordance with the recommendation from IEC 61850-90-4).

### Table 5: Recommendation for connection cable

<table>
<thead>
<tr>
<th>Cable</th>
<th>Assembly</th>
<th>Cable type</th>
<th>Conductor cross-section</th>
<th>Max. length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>OT1205</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Voltage measurement</td>
<td>UI 1, UI 1-1, UI 3</td>
<td>Shielded</td>
<td>2.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Current measurement</td>
<td>UI 1, UI 1-1, UI 3</td>
<td>Unshielded</td>
<td>4 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>DIO 28-15, DIO 42-20</td>
<td>Shielded</td>
<td>1.5 mm², 400 m (&lt;25 Ω/km)</td>
<td></td>
</tr>
<tr>
<td>Signal outputs*</td>
<td>DIO 28-15, DIO 42-20</td>
<td>Shielded</td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>AIO 2, AIO 4</td>
<td>Shielded</td>
<td>1 mm², 400 m (&lt;25 Ω/km)</td>
<td></td>
</tr>
<tr>
<td>Signal outputs*</td>
<td>AIO 2, AIO 4</td>
<td>Shielded</td>
<td>1 mm²</td>
<td>-</td>
</tr>
<tr>
<td>RS232, RS485 SUB-D CAN bus</td>
<td>CPU I</td>
<td>Shielded</td>
<td>0.25 mm², 25 m</td>
<td></td>
</tr>
<tr>
<td>Ethernet RJ45</td>
<td>CPU I</td>
<td>Shielded</td>
<td>0.75 mm², 2,000 m (total CAN bus)</td>
<td></td>
</tr>
<tr>
<td>Ethernet FO</td>
<td>MC 2-2, SW 3-3</td>
<td>Duplex LC</td>
<td>Multimode, OM3, 1,310 nm</td>
<td>2,000 m</td>
</tr>
</tbody>
</table>

*) Observe line capacitance, see note above.

### 4.2.2 Information about connecting serial interfaces RS232 and RS485

#### NOTICE

**Damage to the device**

Using the wrong data cable may damage the device.

- Only use data cables which comply with the description below.
RS232 (D-SUB 9-pole)

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

Figure 18: RS232 data cable (9-pole)
RS485 (D-SUB 9-pole)

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

Figure 19: RS485 data cable
Combined interface RS232/RS485 (D-SUB 9-pole)

To connect the device via a combined RS232/RS485 interface (COM2), use a data cable with the following structure:

![Data cables for combined interface RS232/RS485](image)

**D-SUB 9-pole plug connection**

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

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

![Example of a soldered shielding on a plug housing](image)
4.2.3 Information about connecting analog sensors

**NOTICE**

**Damage to the device**

Incorrectly connected and configured analog inputs/outputs may result in damage to the device and sensor.

- Follow information about connecting analog sensors [► 32].
- Configure analog inputs and outputs according to the connected sensors [► 110].

The AIO 2 and AIO 4 assemblies have a separate plug connector for each channel (input or output). The connectors are assigned as follows:

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>11 16 I OUT (+): Current output +</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>12 17 I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>13 18 I/U IN (-): Voltage input -, current input -</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>14 19 I/U OUT (-): Voltage output -, current output -</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>15 20 not used</td>
</tr>
</tbody>
</table>

Table 6: Analog inputs and outputs

You can connect the following types of analog sensors:
- 4...20 mA
- PT100/PT1000 (2-wire, 3-wire, 4-wire)
4...20 mA sensor

You must connect a 4...20 mA sensor to the pins 2 and 3. You must also connect the supplied bridge to the pins 3, 4, and 5.

PT100/PT1000 sensor

Depending on type, you must connect a PT100 sensor or PT1000 sensor as follows:

- 2-wire: Pin 1 and 4
- 3-wire: Pin 1, 3, and 4
- 4-wire: Pin 1, 2, 3, and 4
4.2.4 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.

4.2.4.1 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.

4.2.4.2 Wiring requirement of operating site

Note the following when wiring the operating site:

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

Figure 25: Recommended wiring

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

- Short-circuit and ground reserve lines.
4 Mounting

- Never connect the device with a collective line containing numerous wires.
- To transmit signals, use shielded lines with individual conductors (outgoing conductor/return conductor) twisted in pairs.
- Connect full surface of shielding (360º) to device or to a nearby grounding bar.

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

![Recommended connection of the shielding](image)

**Figure 26: Recommended connection of the shielding**

<table>
<thead>
<tr>
<th>1</th>
<th>Connection of the shielding using a “pigtail”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Shielding connection covering all areas</td>
</tr>
</tbody>
</table>

### 4.2.4.3 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.

4.2.4.4 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 shielding for the CAN bus cable to the 9-pin D-sub connector:

![Diagram of CAN bus cable shielding to 9-pin D-sub connector](image)

Figure 27: Connection of CAN bus cable shielding to the 9-pin D-sub connector

4.2.4.5 Information about screening the cables for analog signals
In order to correctly record the analog signals, you must place the cable screening in the motor-drive unit on the grounding bar. The cable shielding should be removed as late as possible before connecting to keep the section with unshielded cables as short as possible. The shielding must be connected with shielding clips.

![Examples of supporting screening on ground bar](image)

Figure 28: Examples of supporting screening on ground bar (on left: Direct connection to AIO assembly, on right: Connection using line-up terminal)

4.2.5 Connecting cables to the system periphery
To obtain a better overview when connecting cables, only use as many leads as necessary.
To connect cables to the system periphery, proceed as follows:

- Use only the specified cables for wiring. Note the cable recommendation.

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

4.2.6 Wiring device

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

Proceed as follows to wire the device:

- Note the connection diagram.
- Use only the specified cables for wiring. Note the cable recommendation.
- Wire the lines to the system periphery [► 37].

1. Strip insulation from lines and leads.
2. Crimp stranded wires with wire end sleeves.

Figure 29: Example: Connector for voltage measurement
4. Insert the plug into the associated slot and lock or screw the plug in place.

4.2.7 Mounting terminating resistor of CAN bus

If you want to operate the device in parallel operation, you need to mount a 120 Ω terminating resistor at both ends of the CAN bus. Use the plug connector with terminating resistor provided as an option.

4.2.8 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 damage to the device and system periphery.
► Check the entire configuration before commissioning.

Check the following:
• The RUN LED on the CPU I assembly lights up.

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

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

NOTICE

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

► Check the entire configuration before commissioning.

5.1 Setting the parameters

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

5.1.1 Setting the language

You can use this parameter to set the display language for the device. The device comes with a maximum of 4 languages. 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>Chinese*</td>
</tr>
<tr>
<td>Korean*</td>
<td></td>
</tr>
</tbody>
</table>

*) Language is available as an option

To set the language, proceed as follows:

1. Press the **Language** button on the status bar.

Figure 32: Setting the language

2. Select the language you want from the list field.
3. Press the **Accept** button to save the modified parameter.
   
   The "Restart device" dialog appears.
4. Restart the device to apply the changed language setting.

5.1.2 Setting date and time

You can set the date and time in the following ways:

- Setting manually
- Time synchronization via control system (SCADA)
- Time synchronization via SNTP time server
If you are using a control system, the device automatically synchronizes the date and time with the control system. If you want to use an SNTP time server, you must set the required parameters. Observe the information provided in the Time synchronization section.

If you would like to set the date and time manually, you have to enter the values in the following formats:

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

Table 7: Formats

The time does not switch from daylight saving time to standard time and back automatically.

Proceed as follows to set the date and time manually:

1. Go to **Settings > Time**.

![Figure 33: Setting date and time](image)

2. Enter date and time.
3. Press the **Accept** button to save the modified parameter.

### 5.2 Commissioning wizard

If you want the device to help when setting the relevant parameters, you can use the commissioning wizard TILA (TAPCON® Interactive Launch Assist). The commissioning wizard provides a choice of parameters you can configure in order.

A detailed description of each of the parameters can be found in the Functions and settings chapter.
To call up the commissioning wizard, you will need the necessary access rights.

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

To set the parameters with the help of the commissioning wizard, proceed as follows:
1. Log in as user with the access rights required.
2. Go to Settings > Commissioning wizard.
3. Press the Next button to launch the commissioning wizard.
4. Follow the on-screen instructions.

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

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

6.1 General

You can set general parameters in this menu item:

General settings
- Display language for the device
  - Can also be set via the status bar [► 41]
- Activate/deactivate launching the commissioning wizard after the device is restarted
- Measured value display
- Transformer name
- Remote behavior

Settings for web-based visualization
- IP address
- Subnet mask
- Gateway address
- SSL encryption

Figure 35: General
6.1.1 Activating/deactivating automatic launch of commissioning wizard

You can use this parameter to set whether the commissioning wizard [► 42] TILA (TAPCON® Interactive Launch Assist) is to launch automatically when the device is restarted.

1. Go to Settings > Parameters > General > Commissioning wizard.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

6.1.2 Setting measured value display

This parameter lets you set whether the displayed measured values and control parameters are to refer to the primary side or secondary side.

To set the measurement transformer display, proceed as follows:

1. Go to Settings > Parameters > General > Measured value display.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

6.1.3 Transformer name

You can use this parameter to enter a transformer name for identification purposes.

1. Go to Settings > Parameters > General > Transformer name.
2. Enter transformer name.
3. Press the Accept button to save the modified parameter.

6.1.4 Visualization

The device is equipped with a web-based visualization. This allows you to configure the device with a PC and to display measured values.

Interfaces

A connection to the visualization can be established using 2 interfaces:

- Front interface ETH1.1 (for local access)
- Optional: ETH2.2 interface on the CPU I module (for access by means of the remote display, control center etc.)

System requirements

To access the web-based visualization, you need a PC with an HTML5-capable browser. The display is optimized for the following browsers:

- Microsoft® Internet Explorer 10 or higher
- Google Chrome™
To establish a connection with the visualization, please note the following sections.

### 6.1.4.1 Configuring visualization

You can use the following parameters to configure the interface for the visualization. The following parameters are available:

- IP address
- Subnet mask
- Gateway address
- SSL encryption

**IP address, subnet mask and gateway address**

You can use these parameters to undertake the network configuration for the visualization. These settings apply to access via the ETH2.2 interface on the CPU module.

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

1. Go to **Settings > Parameters > General > IP address, Subnet mask or Gateway**.
2. Enter the desired value.
3. Press the **Accept** button to save the modified parameter.

**Activating SSL encryption**

You can use this parameter to set whether access to the visualization should take place via an SSL-encrypted connection.

To activate SSL encryption, proceed as follows:

1. Go to **Settings > Parameters > General > SSL encryption**.
2. Select the desired option.
3. Press the **Accept** button to save the modified parameter.

### 6.1.4.2 Establishing connection to visualization

A connection to the visualization can be established using 2 interfaces:

- Front interface ETH1.1 (for local access)
- Optional: ETH2.2 interface on the CPU I module (for access by means of the remote display, control center etc.)
Establishing connection via front interface

The device is equipped with a DHCP server for connection via the front interface. To establish a connection via the front interface, proceed as follows:

1. Connect PC and device via front interface using Ethernet cable (RJ45 plug).

![Figure 36: Establishing connection via the front interface](image)

2. Activate automatic assignment of the IP address via DHCP on the PC.

3. Enter the visualization’s IP address http://192.168.165.1, or if SSL encryption is active enter https://192.168.165.1, on the PC in the browser.

△ The visualization is accessed.
Establishing connection via the ETH2.2 interface on the CPU I module on the back

To connect via the interface on the back, proceed as follows:

1. Connect PC and device via ETH2.2 interface on back using Ethernet cable (RJ45 plug).

2. Go to **Communication** on the device to display the device's IP address.

3. Assign the PC an unique IP address in the same subnet as the device (e.g. 192.0.1.100).
4. Enter the visualization’s IP address (e.g. http://192.0.1.230, if SSL encryption is active enter https://192.0.1.230) on the PC in the browser.

⇒ The visualization is accessed.

6.2 Control (optional)

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

6.2.1 Setting the desired value

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

6.2.1.1 Desired value 1

To set the desired value, proceed as follows:

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

6.2.1.2 Desired value 1...3

You can set 3 different desired values. The device always uses one of the set desired values for control. You can define the desired value used for control by means of the “Select desired value” parameter or with the digital inputs.
The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior parameter accordingly.

### Setting the desired value
To set the desired value, proceed as follows:
1. Go to Settings > Parameters > Control > Desired value.
2. Enter desired value.
3. Press the Accept button to save the modified parameter.

### Selecting a desired value
You can use this parameter to select the desired value used for control.
To select the desired value, proceed as follows:
1. Go to Settings > Parameters > Control > Select desired value.
2. Select the desired value you want in the list.
3. Press the Accept button to save the modified parameter.

#### 6.2.1.3 Desired value 1...5
You can set 5 different desired values. The device always uses one of the set desired values for control. You can define the desired value used for control by means of the "Select desired value" parameter or with the digital inputs.

The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior parameter accordingly.

### Setting the desired value
To set the desired value, proceed as follows:
1. Go to Settings > Parameters > Control > Desired value.
2. Enter desired value.
3. Press the Accept button to save the modified parameter.

### Selecting a desired value
You can use this parameter to select the desired value used for control.
To select the desired value, proceed as follows:
1. Go to Settings > Parameters > Control > Select desired value.
2. Select the desired value you want in the list.
3. Press the **Accept** button to save the modified parameter.

### 6.2.1.4 Analog setting of the desired value

With the analog setting of the desired value, the desired value for the automatic voltage regulation can be variably adapted using an analog signal (e.g. 4...20 mA).

![Figure 40: Analog setting of the desired value](image)

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

<table>
<thead>
<tr>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mA</td>
<td>4 mA</td>
</tr>
</tbody>
</table>

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

#### Setting desired value 1

To set the desired value, proceed as follows:

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

#### Setting max. desired value setting

With this parameter, you can set the desired value that corresponds to the maximum level of the analog signal level (e.g. 20 mA for 4...20 mA signal).

1. Go to **Settings > Parameters > Control > Setting max. desired value**.
2. Enter desired value.
3. Press the **Accept** button to save the modified parameter.
Setting min. desired value setting

With this parameter, you can set the desired value that corresponds to the minimum level of the analog signal (e.g. 4 mA for 4...20 mA signal).

1. Go to Settings > Parameters > Control > Setting min. desired value.
2. Enter desired value.
3. Press the Accept button to save the modified parameter.

6.2.1.5 Step-by-step setting of the desired value

For the step-by-step setting of the desired value, you can increase or decrease the desired value for the automatic voltage regulation by an adjustable step width using digital inputs or control system commands.

For each "Increase desired value" or "Decrease desired value" command, the active desired value is increased or decreased by the set step width. It is not possible to set desired values outside of the permitted setting range (49...140 V).

The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior parameter accordingly.

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

Setting desired value 1

To set the desired value, proceed as follows:

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

Setting desired value step width

To set the desired value step width, proceed as follows:

1. Go to Settings > Parameters > Control > Desired value step width.
2. Enter desired value step width.
3. Press the Accept button to save the modified parameter.

6.2.1.6 Active power-dependent adjustment of desired voltage value

The TAPCON® Dynamic Setpoint Control (TDSC) function is used to adapt the desired voltage value depending on the measured active power. This allows you to compensate for a voltage drop during increased load or an increase in voltage due to a decentralized feed-in.
Depending on whether positive or negative active power is measured, the desired value calculation is based on 2 linear equations (see example in diagram below).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
<th>Settings (see diagram below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U_{max}: Maximum desired value</td>
<td>Maximum set desired value is activated when P_{max} is exceeded.</td>
<td>103.0 V</td>
</tr>
<tr>
<td>U_{min}: Minimum desired value</td>
<td>Minimum set desired value is activated when value falls below P_{min}.</td>
<td>99.0 V</td>
</tr>
<tr>
<td>U_0: Desired value at 0 active power</td>
<td>Set desired value is activated when measured active power is 0 MW.</td>
<td>100.00 V</td>
</tr>
<tr>
<td>P_{max}: Active power at max. desired value</td>
<td>Set maximum active power value above which the power-dependent desired value is to attain the maximum value U_{max}.</td>
<td>20.0 MW</td>
</tr>
<tr>
<td>P_{min}: Active power at min. desired value</td>
<td>Set minimum active power value below which the power-dependent desired value is to attain the minimum value U_{min}.</td>
<td>-20.0 MW</td>
</tr>
</tbody>
</table>

Table 8: Parameters to be set for active power-dependent adjustment of desired voltage value

![Diagram](image-url)

Figure 41: Active power-dependent adjustment of desired voltage value

<table>
<thead>
<tr>
<th>U_{ref}</th>
<th>Desired value</th>
<th>U_{min}</th>
<th>Minimum desired value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_{meas}</td>
<td>Measured active power</td>
<td>U_{max}</td>
<td>Maximum desired value</td>
</tr>
<tr>
<td>P_{min}</td>
<td>Active power at minimum desired value</td>
<td>U_0</td>
<td>Set desired value when measured active power = 0</td>
</tr>
<tr>
<td>P_{max}</td>
<td>Active power at maximum desired value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Response to active power $P_{\text{max}}$ being exceeded

If the measured active power $P_{\text{meas}}$ exceeds the set parameter $P_{\text{max}}$, the value $U_{\text{max}}$ is adopted as the desired value.

$$U_{\text{ref}} = U_{\text{max}}$$

Response to value falling below active power $P_{\text{min}}$

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

$$U_{\text{ref}} = U_{\text{min}}$$

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

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

$$U_{\text{ref}} = U_{0}$$

Linear dependency with negative active power:

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

$$U_{\text{ref}} = \left( \frac{U_{0} - U_{\text{min}}}{0 - P_{\text{min}}} \right) \cdot P_{\text{meas}} + U_{0}$$

Linear dependency with positive active power:

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

$$U_{\text{ref}} = \left( \frac{U_{\text{max}} - U_{0}}{P_{\text{max}} - 0} \right) \cdot P_{\text{meas}} + U_{0}$$

To activate the active power-dependent adjustment of the desired voltage value, you need to set the following parameters:
Activating TDSC

The TDSC function is only active when the device can calculate the active power (correct current measurement and voltage measurement) and the required parameters are set. If this isn't done, the voltage is regulated to the set desired value [► 49]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs TDSC on and TDSC off (optional)
- Control system command (optional)

If you activate TDSC, the line drop compensation (R&X compensation or Z compensation) function is deactivated.

To activate/deactivate TDSC using parameters, proceed as follows:
1. Go to Settings > Parameters > Control > Activate TDSC.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

TDSC Umax/Umin

You can use these parameters to set the maximum and minimum desired value. The maximum or minimum desired value is activated when the measured active power reaches the set minimum or maximum active power.
1. Go to Settings > Parameters > Control > TDSC Umax/Umin.
2. Enter maximum/minimum desired value.
3. Press the Accept button to save the modified parameter.

TDSC U0

You can use this parameter to set the desired value which is to be used when the measured active power is 0.
1. Go to Settings > Parameter > Control > TDSC U0.
2. Enter desired value at active power 0.
3. Press the Accept button to save the modified parameter.

TDSC Pmax/Pmin

You can use these parameters to set the maximum and minimum active power value at which the maximum and minimum active power-dependent desired value is to be used for regulation.
1. Go to Settings > Parameters > Control > TDSC Pmax/Pmin.
2. Enter active power for maximum/minimum desired value.
3. Press the Accept button to save the modified parameter.
6.2.1.7 Active power-dependent adjustment of desired voltage value with 3 different desired values

The TAPCON® Dynamic Setpoint Control (TDSC) function is used to adapt the desired voltage value depending on the measured active power. This allows you to compensate for a voltage drop during increased load or an increase in voltage due to a decentralized feed-in.

The device provides you with 3 different sets of parameters for this purpose. Depending on the selection of the desired value 1, 2 or 3, the device uses the parameter set 1, 2 or 3 for TDSC.

Depending on whether positive or negative active power is measured, the desired value calculation is based on 2 linear equations (see example in diagram below).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
<th>Settings (see diagram below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U\textsubscript{max}</td>
<td>Maximum desired value</td>
<td>Maximum set desired value is activated when P\textsubscript{max} is exceeded.</td>
</tr>
<tr>
<td>U\textsubscript{min}</td>
<td>Minimum desired value</td>
<td>Minimum set desired value is activated when value falls below P\textsubscript{min}.</td>
</tr>
<tr>
<td>U\textsubscript{0}</td>
<td>Desired value at 0 active power</td>
<td>Set desired value is activated when measured active power is 0 MW.</td>
</tr>
<tr>
<td>P\textsubscript{max}</td>
<td>Active power at max. desired value</td>
<td>Set maximum active power value above which the power-dependent desired value is to attain the maximum value U\textsubscript{max}.</td>
</tr>
<tr>
<td>P\textsubscript{min}</td>
<td>Active power at min. desired value</td>
<td>Set minimum active power value below which the power-dependent desired value is to attain the minimum value U\textsubscript{min}.</td>
</tr>
</tbody>
</table>

Table 9: Parameters to be set for active power-dependent adjustment of desired voltage value
Figure 42: Active power-dependent adjustment of desired voltage value

<table>
<thead>
<tr>
<th>$U_{\text{ref}}$</th>
<th>Desired value</th>
<th>$U_{\text{min}}$</th>
<th>Minimum desired value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{\text{meas}}$</td>
<td>Measured active power</td>
<td>$U_{\text{max}}$</td>
<td>Maximum desired value</td>
</tr>
<tr>
<td>$P_{\text{min}}$</td>
<td>Active power at minimum desired value</td>
<td>$U_0$</td>
<td>Set desired value when measured active power = 0</td>
</tr>
<tr>
<td>$P_{\text{max}}$</td>
<td>Active power at maximum desired value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Response to active power $P_{\text{max}}$ being exceeded

If the measured active power $P_{\text{meas}}$ exceeds the set parameter $P_{\text{max}}$, the value $U_{\text{max}}$ is adopted as the desired value.

$$U_{\text{ref}} = U_{\text{max}}$$

Response to value falling below active power $P_{\text{min}}$

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

$$U_{\text{ref}} = U_{\text{min}}$$

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

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

$$U_{\text{ref}} = U_0$$

Linear dependency with negative active power:

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

$$U_{\text{ref}} = \left( \frac{U_0 - U_{\text{min}}}{0 - P_{\text{min}}} \right) \cdot P_{\text{meas}} + U_0$$

Linear dependency with positive active power:

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

$$U_{\text{ref}} = \left( \frac{U_{\text{max}} - U_0}{P_{\text{max}} - 0} \right) \cdot P_{\text{meas}} + U_0$$

To activate the active power-dependent adjustment of the desired voltage value, you need to set the following parameters:
Activating TDSC

The TDSC function is only active when the device can calculate the active power (correct current measurement and voltage measurement) and the required parameters are set. If this isn't done, the voltage is regulated to the set desired value 1/2/3 [► 49]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs TDSC on and TDSC off (optional)
- Control system command (optional)

If you activate TDSC, the line drop compensation (R&X compensation or Z compensation) function is deactivated.

To activate/deactivate TDSC using parameters, proceed as follows:
1. Go to Settings > Parameters > Control > Activate TDSC.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

TDSC 1/2/3 Umax/Umin

You can use these parameters to set the maximum and minimum desired value. The maximum or minimum desired value is activated when the measured active power reaches the set minimum or maximum active power.

1. Go to Settings > Parameters > Control > TDSC Umax/Umin.
2. Enter maximum/minimum desired value.
3. Press the Accept button to save the modified parameter.

TDSC 1/2/3 U0

You can use this parameter to set the desired value which is to be used when the measured active power is 0.

1. Go to Settings > Parameter > Control > TDSC U0.
2. Enter desired value at active power 0.
3. Press the Accept button to save the modified parameter.

TDSC 1/2/3 Pmax/Pmin

You can use these parameters to set the maximum and minimum active power value at which the maximum and minimum active power-dependent desired value is to be used for regulation.

1. Go to Settings > Parameters > Control > TDSC Pmax/Pmin.
2. Enter active power for maximum/minimum desired value.
3. Press the Accept button to save the modified parameter.
6.2.1.8 Desired value setting via BCD

With the desired value setting via BCD, you can variably adjust the desired value for the automatic voltage regulation via digital inputs by means of BCD coding.

Depending on variant, desired value setting via BCD is always active or you can activate it by creating a signal at the BCD desired value input.

The following outputs are available to you as an option:

- *Desired value setting faulty*: The device issues a signal if the BCD code for the desired value setting is invalid.
- *Desired value active*: The device issues a signal if desired value setting via BCD is active.

The permissible setting range is 49...140 V. The specified value is written to the parameter desired value 1. If the BCD coding is invalid or desired value setting via BCD is deactivated, the device uses the value set in parameter desired value 1.

<table>
<thead>
<tr>
<th>Desired value</th>
<th>BCD input</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 80 40 20 10 8 4 2 1</td>
</tr>
<tr>
<td>49 V</td>
<td>0 0 1 0 0 1 0 0 1</td>
</tr>
<tr>
<td>50 V</td>
<td>0 0 1 0 1 0 0 0 0</td>
</tr>
<tr>
<td>51 V</td>
<td>0 0 1 0 1 0 0 0 1</td>
</tr>
<tr>
<td>52 V</td>
<td>0 0 1 0 1 0 0 1 0</td>
</tr>
<tr>
<td>53 V</td>
<td>0 0 1 0 1 0 0 1 1</td>
</tr>
<tr>
<td>54 V</td>
<td>0 0 1 0 1 0 1 0 0</td>
</tr>
<tr>
<td>55 V</td>
<td>0 0 1 0 1 0 1 0 1</td>
</tr>
<tr>
<td>56 V</td>
<td>0 0 1 0 1 0 1 1 0</td>
</tr>
<tr>
<td>57 V</td>
<td>0 0 1 0 1 0 1 1 1</td>
</tr>
<tr>
<td>58 V</td>
<td>0 0 1 0 1 1 0 0 0</td>
</tr>
<tr>
<td>59 V</td>
<td>0 0 1 0 1 1 0 0 1</td>
</tr>
<tr>
<td>60 V</td>
<td>0 0 1 0 1 1 0 0 0</td>
</tr>
<tr>
<td>61 V</td>
<td>0 0 1 1 0 0 0 0 1</td>
</tr>
<tr>
<td>62 V</td>
<td>0 0 1 1 0 0 0 1 0</td>
</tr>
<tr>
<td>63 V</td>
<td>0 0 1 1 0 0 0 1 1</td>
</tr>
<tr>
<td>64 V</td>
<td>0 0 1 1 0 0 1 0 0</td>
</tr>
<tr>
<td>65 V</td>
<td>0 0 1 1 0 0 1 0 1</td>
</tr>
<tr>
<td>66 V</td>
<td>0 0 1 1 0 0 1 1 0</td>
</tr>
<tr>
<td>67 V</td>
<td>0 0 1 1 0 0 1 1 1</td>
</tr>
<tr>
<td>68 V</td>
<td>0 0 1 1 0 1 0 0 0</td>
</tr>
<tr>
<td>69 V</td>
<td>0 0 1 1 0 1 0 0 1</td>
</tr>
<tr>
<td>70 V</td>
<td>0 0 1 1 1 0 0 0 0</td>
</tr>
<tr>
<td>71 V</td>
<td>0 0 1 1 1 0 0 0 1</td>
</tr>
<tr>
<td>Desired value</td>
<td>BCD input</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>72 V</td>
<td>0</td>
</tr>
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<td>73 V</td>
<td>0</td>
</tr>
<tr>
<td>74 V</td>
<td>0</td>
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<tr>
<td>75 V</td>
<td>0</td>
</tr>
<tr>
<td>76 V</td>
<td>0</td>
</tr>
<tr>
<td>77 V</td>
<td>0</td>
</tr>
<tr>
<td>78 V</td>
<td>0</td>
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<tr>
<td>79 V</td>
<td>0</td>
</tr>
<tr>
<td>80 V</td>
<td>0</td>
</tr>
<tr>
<td>81 V</td>
<td>0</td>
</tr>
<tr>
<td>82 V</td>
<td>0</td>
</tr>
<tr>
<td>83 V</td>
<td>0</td>
</tr>
<tr>
<td>84 V</td>
<td>0</td>
</tr>
<tr>
<td>85 V</td>
<td>0</td>
</tr>
<tr>
<td>86 V</td>
<td>0</td>
</tr>
<tr>
<td>87 V</td>
<td>0</td>
</tr>
<tr>
<td>88 V</td>
<td>0</td>
</tr>
<tr>
<td>89 V</td>
<td>0</td>
</tr>
<tr>
<td>90 V</td>
<td>0</td>
</tr>
<tr>
<td>91 V</td>
<td>0</td>
</tr>
<tr>
<td>92 V</td>
<td>0</td>
</tr>
<tr>
<td>93 V</td>
<td>0</td>
</tr>
<tr>
<td>94 V</td>
<td>0</td>
</tr>
<tr>
<td>95 V</td>
<td>0</td>
</tr>
<tr>
<td>96 V</td>
<td>0</td>
</tr>
<tr>
<td>97 V</td>
<td>0</td>
</tr>
<tr>
<td>98 V</td>
<td>0</td>
</tr>
<tr>
<td>99 V</td>
<td>0</td>
</tr>
<tr>
<td>100 V</td>
<td>1</td>
</tr>
<tr>
<td>101 V</td>
<td>1</td>
</tr>
<tr>
<td>102 V</td>
<td>1</td>
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<tr>
<td>103 V</td>
<td>1</td>
</tr>
<tr>
<td>104 V</td>
<td>1</td>
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<tr>
<td>105 V</td>
<td>1</td>
</tr>
<tr>
<td>106 V</td>
<td>1</td>
</tr>
<tr>
<td>107 V</td>
<td>1</td>
</tr>
<tr>
<td>108 V</td>
<td>1</td>
</tr>
<tr>
<td>109 V</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 10: BCD-coded desired value

<table>
<thead>
<tr>
<th>Desired value</th>
<th>BCD input</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 V</td>
<td>1 0 0 0 0 1 0 0 0 0</td>
</tr>
<tr>
<td>111 V</td>
<td>1 0 0 0 0 1 0 0 0 1</td>
</tr>
<tr>
<td>112 V</td>
<td>1 0 0 0 0 1 0 0 1 0</td>
</tr>
<tr>
<td>113 V</td>
<td>1 0 0 0 0 1 0 0 1 1</td>
</tr>
<tr>
<td>114 V</td>
<td>1 0 0 0 0 1 0 1 0 0</td>
</tr>
<tr>
<td>115 V</td>
<td>1 0 0 0 0 1 0 1 0 1</td>
</tr>
<tr>
<td>116 V</td>
<td>1 0 0 0 0 1 0 1 1 0</td>
</tr>
<tr>
<td>117 V</td>
<td>1 0 0 0 0 1 0 1 1 1</td>
</tr>
<tr>
<td>118 V</td>
<td>1 0 0 0 0 1 1 0 0 0</td>
</tr>
<tr>
<td>119 V</td>
<td>1 0 0 0 0 1 1 0 0 1</td>
</tr>
<tr>
<td>120 V</td>
<td>1 0 0 0 1 0 0 0 0 0</td>
</tr>
<tr>
<td>121 V</td>
<td>1 0 0 0 1 0 0 0 0 1</td>
</tr>
<tr>
<td>122 V</td>
<td>1 0 0 0 1 0 0 0 1 0</td>
</tr>
<tr>
<td>123 V</td>
<td>1 0 0 0 1 0 0 0 1 1</td>
</tr>
<tr>
<td>124 V</td>
<td>1 0 0 0 1 0 0 1 0 0</td>
</tr>
<tr>
<td>125 V</td>
<td>1 0 0 0 1 0 0 1 0 1</td>
</tr>
<tr>
<td>126 V</td>
<td>1 0 0 0 1 0 0 1 1 0</td>
</tr>
<tr>
<td>127 V</td>
<td>1 0 0 0 1 0 0 1 1 1</td>
</tr>
<tr>
<td>128 V</td>
<td>1 0 0 0 1 0 1 0 0 0</td>
</tr>
<tr>
<td>129 V</td>
<td>1 0 0 0 1 0 1 0 0 1</td>
</tr>
<tr>
<td>130 V</td>
<td>1 0 0 0 1 1 0 0 0 0</td>
</tr>
<tr>
<td>131 V</td>
<td>1 0 0 0 1 1 0 0 0 1</td>
</tr>
<tr>
<td>132 V</td>
<td>1 0 0 0 1 1 0 0 1 0</td>
</tr>
<tr>
<td>133 V</td>
<td>1 0 0 0 1 1 0 0 1 1</td>
</tr>
<tr>
<td>134 V</td>
<td>1 0 0 0 1 1 0 1 0 0</td>
</tr>
<tr>
<td>135 V</td>
<td>1 0 0 0 1 1 0 1 0 1</td>
</tr>
<tr>
<td>136 V</td>
<td>1 0 0 0 1 1 0 1 1 0</td>
</tr>
<tr>
<td>137 V</td>
<td>1 0 0 0 1 1 0 1 1 1</td>
</tr>
<tr>
<td>138 V</td>
<td>1 0 0 0 1 1 1 0 0 0</td>
</tr>
<tr>
<td>139 V</td>
<td>1 0 0 0 1 1 1 0 0 1</td>
</tr>
<tr>
<td>140 V</td>
<td>1 0 0 1 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

**Setting desired value 1**

To set the desired value, proceed as follows:

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

You can use this parameter to set the maximum permissible deviation in measured voltage $U_{\text{actual}}$ from the desired value $U_{\text{desired}}$. The following section describes how you determine and set the bandwidth.

Determining bandwidth

In order to set the correct value, the transformer’s step voltage and nominal voltage must be known. Note that a large bandwidth will result in a large control deviation.

The bandwidth must always be greater than the following value:

$$[\pm B\%] \geq 0.6 \cdot \frac{U_{n-1} - U_n}{U_{\text{nom}}} \cdot 100\%$$

Figure 43: Calculation of minimum bandwidth

| $U_{n-1}$  | Step voltage of tap position n-1 |
| $U_n$     | Step voltage of tap position n   |
| $U_{\text{nom}}$ | Nominal voltage               |

The following transformer values are used to determine the minimum bandwidth:

Nominal voltage $U_{\text{nom}} = 11,000$ V
Step voltage in tap position 4 $U_{\text{step}4} = 11,275$ V
Step voltage in tap position 5 $U_{\text{step}5} = 11,000$ V

$$[\pm B\%] \geq 0.6 \cdot \frac{U_{\text{step}4} - U_{\text{step}5}}{U_{\text{nom}}} \cdot 100\%$$

$$[\pm B\%] \geq 0.6 \cdot \frac{11275 V - 11000 V}{11000 V} \cdot 100\%$$

$$[\pm B\%] \geq 1.5\%$$

Setting the bandwidth

To set the bandwidth, proceed as follows:

1. Go to Settings > Parameters > Control > Bandwidth.
2. Enter bandwidth.
3. Press the Accept button to save the modified parameter.
6.2.3 Delay time T1

Delay time T1 delays the issuing of a tap-change command for a defined period. This prevents unnecessary tap-change operations if the tolerance bandwidth is exited briefly.

Behavior only with delay time T1

If the measured voltage $U_{\text{actual}}$ is within the set bandwidth $B\%$, 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 $B\%$ within the set delay time T1. However, if the measured voltage deviates from the set bandwidth for a long period $\text{C}$, a tap-change command $\text{D}$ occurs after expiration of the set delay time T1. The on-load tap-changer carries out a tap-change in a raise or lower direction to return to the tolerance bandwidth.

Figure 44: Behavior of the regulation function with delay time T1

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ B %: Upper limit</td>
<td>4</td>
<td>Set delay time T1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$U_{\text{desired}}$: Desired value</td>
<td>5</td>
<td>$U_{\text{actual}}$: Measured voltage</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>- B %: Lower limit</td>
<td>6</td>
<td>$B%$: Tolerance bandwidth</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>$U_{\text{actual}}$ is outside the bandwidth. Delay time T1 starts.</td>
<td>B</td>
<td>$U_{\text{actual}}$ is within the bandwidth before delay time T1 is complete.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>$U_{\text{actual}}$ is outside the bandwidth. Delay time T1 starts.</td>
<td>D</td>
<td>$U_{\text{actual}}$ is still outside the bandwidth when delay time T1 is complete. Tap-change operation is initiated.</td>
<td></td>
</tr>
</tbody>
</table>
Setting delay time T1

To set the delay time T1, proceed as follows:
1. Go to **Settings > Parameters > Control > Delay time T1.**
2. Enter delay time T1.
3. Press the **Accept** button to save the modified parameter.

Selecting time response T1

You can use this parameter to set the time response for delay time T1. You can select the following options:
- Linear time response
- Integral time response

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

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

![Diagram for integral time response](image)

**Figure 45: Diagram for integral time response**

<table>
<thead>
<tr>
<th>ΔU/B</th>
<th>Control deviation &quot;ΔU&quot; as % of desired value in relation 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 time response T1, proceed as follows:
1. Go to **Settings > Parameters > Control > Time response T1.**
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

### 6.2.4 Delay time T2

You can use this parameter to set the delay time T2. Delay time T2 is used to compensate for large control deviations faster.

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

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

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

### Behavior with delay times T1 and T2

Delay time T2 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 $U_{actual}$ deviates from the set bandwidth for a long period, a control impulse is output to the motor-drive unit after the set delay time T1. If the measured voltage $U_{actual}$ is still outside the bandwidth,
delay time T2 starts once delay time T1 is complete. Once delay time T2 is complete, a control impulse is again output to the motor-drive unit for the tap change to return to the tolerance bandwidth.

Figure 46: Behavior of the regulation function with delay times T1 and T2

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ B %: Upper limit</td>
<td>4</td>
<td>Set delay times T1 and T2.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>U\text{desired}: Desired value</td>
<td>5</td>
<td>U\text{actual}: Measured voltage</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>- B %: Lower limit</td>
<td>6</td>
<td>B%: Tolerance bandwidth</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>U\text{actual} is outside the bandwidth. Delay time T1 starts.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Delay time T1 complete. Tap change triggered.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Delay time T2 complete. Tap change triggered.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Setting delay time T2

To set the delay time T2 proceed as follows:
1. Go to Settings > Parameters > Control > Delay time T2.
2. Set delay time T2.
3. Press the Accept button to save the modified parameter.

Activating delay time T2

To activate delay time T2, proceed as follows:
1. Go to Settings > Parameters > Control > Activate delay T2.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.
6.3 Transformer data

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

![Figure 47: Setting transformer data (example)](image)

### 6.3.1 Setting the primary transformer voltage

With this parameter, you can set the primary voltage of the voltage transformer in kV.

To set the primary transformer voltage, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Primary transformer voltage**.
2. Enter the primary transformer voltage.
3. Press the **Accept** button to save the modified parameter.

### 6.3.2 Setting the secondary transformer voltage

With this parameter, you can set the secondary voltage of the voltage transformer in V.

To set the secondary transformer voltage, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Secondary transformer voltage**.
2. Enter the secondary transformer voltage.
3. Press the **Accept** button to save the modified parameter.
6.3.3 Setting primary transformer current

With this parameter, you can set the primary current of the current transformer.

To set the primary transformer current, proceed as follows:
1. Go to Settings > Parameters > Transformer data > Primary transformer current.
2. Enter the primary transformer current.
3. Press the Accept button to save the modified parameter.

6.3.4 Setting the secondary transformer current

With this parameter, you can set the secondary current of the current transformer. You can select the following options:
- 0.2 A
- 1 A
- 5 A

To set the secondary transformer current, proceed as follows:
1. Go to Settings > Parameters > Transformer data > Secondary transformer current.
2. Select the secondary transformer current.
3. Press the Accept button to save the modified parameter.

6.3.5 Setting circuit for current transformer/voltage transformer and phase angle correction

To configure the circuit for the current transformer and voltage transformer, you must set the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measuring module</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UI 1</td>
</tr>
<tr>
<td>Voltage-transformer circuit</td>
<td>Yes</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>Yes</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>Yes</td>
</tr>
<tr>
<td>UI measuring channels</td>
<td>No</td>
</tr>
<tr>
<td>Measurement mode</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 11: Setting configuration of current transformer and voltage transformer

Note the following examples of common transformer circuits:
Circuit A: 1-phase measurement in 1-phase grid

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>1 Ph phase voltage</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>1 Ph phase current</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>0°</td>
</tr>
</tbody>
</table>

Table 12: Circuit A: 1-phase measurement in 1-phase grid

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

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

If you use this circuit, set the device as follows:
### Circuit B: 1-phase measurement in 3-phase grid

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>3 Ph differential voltage</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>3 Ph total current</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>0°</td>
</tr>
</tbody>
</table>

Table 13: Circuit B: 1-phase measurement in 3-phase grid

### Circuit C:

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>3 Ph differential voltage</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>3 Ph total current</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>0°</td>
</tr>
</tbody>
</table>

Table 14: Circuit C
Circuit D

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>3 Ph differential voltage</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>3 Ph phase current</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>90°</td>
</tr>
</tbody>
</table>

Table 15: Circuit D

Circuit E

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

If you use this circuit, set the device as follows:
Parameter | Option
--- | ---
Voltage-transformer circuit | 3 Ph differential voltage
Current-transformer circuit | 3 Ph phase current
Phase angle correction | 30°

Table 16: Circuit E

**Circuit F**

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>3 Ph differential voltage</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>3 Ph phase current</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>-30°</td>
</tr>
</tbody>
</table>

Table 17: Circuit F
Circuit G

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>-</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>-</td>
</tr>
<tr>
<td>Phase angle correction</td>
<td>-</td>
</tr>
<tr>
<td>UI measuring channels</td>
<td>3-phase measurement (channels 1, 2, 3)</td>
</tr>
<tr>
<td>Measurement mode</td>
<td>Phase-phase</td>
</tr>
</tbody>
</table>

Table 18: Circuit G

Circuit H

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage-transformer circuit</td>
<td>-</td>
</tr>
<tr>
<td>Current-transformer circuit</td>
<td>-</td>
</tr>
</tbody>
</table>
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase angle correction</td>
<td>-</td>
</tr>
<tr>
<td>UI measuring channels</td>
<td>3-phase measurement (channels 1, 2, 3)</td>
</tr>
<tr>
<td>Measurement mode</td>
<td>Phase-neutral</td>
</tr>
</tbody>
</table>

Table 19: Circuit H

### Setting voltage-transformer circuit

You can use this parameter to set your voltage transformer's circuit. You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ph phase voltage</td>
<td>Measurement in 1-phase grid between the conductor and neutral conductor.</td>
</tr>
<tr>
<td>3 Ph differential voltage</td>
<td>Measurement in 3-phase grid between 2 conductors</td>
</tr>
<tr>
<td>3 Ph phase voltage</td>
<td>Measurement in 3-phase grid between conductor and neutral conductor</td>
</tr>
</tbody>
</table>

Table 20: Voltage-transformer circuit

To set the voltage-transformer circuit, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Voltage-transformer circuit**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

### Setting current-transformer circuit

You can use this parameter to set the circuit for your current transformer. You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ph phase current</td>
<td>Measurement of phase current in 1-phase grid.</td>
</tr>
<tr>
<td>3 Ph total current</td>
<td>Measurement of differential current in 3-phase grid.</td>
</tr>
<tr>
<td>3 Ph phase current</td>
<td>Measurement of phase current in 3-phase grid.</td>
</tr>
</tbody>
</table>

Table 21: Current-transformer circuit

To set the current-transformer circuit, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Current-transformer circuit**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

**Setting phase angle correction**

You can use this parameter to set the phase angle correction for your transformer circuit. To do so, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Phase angle correction**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

**Setting measurement mode**

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can use this parameter to set whether you have connected the voltage transformer between 2 phases or between a phase and neutral.

To set the measuring mode, proceed as follows:

1. Go to **Settings > Parameters > Transformer data > Measuring mode**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

**Setting UI measuring channels**

See Setting UI measuring channels [► 76].

### 6.4 Measurement

#### 6.4.1 Setting UI measuring channels

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can use this parameter to set whether you use a 1-phase measurement (channel 1) or a 3-phase measurement (channels 1, 2, 3).

To set the UI measuring channels, proceed as follows:

1. Go to **Settings > Parameters > Measurement > UI measuring channels**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.
6.4.2 Control variable

If you are measuring the voltage and current with the 3-phase UI 3 measuring module and using the "single-phase" regulation mode, this parameter can be used to select the phase used for voltage regulation. You can select the following options:

- L1/N or L1/L2
- L2/N or L2/L3
- L3/N or L3/L1

To set the control variable, proceed as follows:
1. Go to Settings > Parameters > Measurement > Control variable.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

6.4.3 Regulation mode

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can use this parameter to set whether you want 1-phase voltage regulation or voltage regulation to the average value of the 3 phases. You can select the following options:

- Single-phase: Voltage is automatically regulated to one selected phase. Limit value monitoring, line drop compensation, and parallel operation also take place on the selected phase using the circulating reactive current minimization method.
- Average value regulation: Voltage is automatically regulated to the average of the 3 phases. Limit value monitoring, line drop compensation, and parallel operation also take place using the circulating reactive current minimization method to the average of the 3 phases.

If you activate the average value regulation option, automatic voltage regulation is blocked should the voltage or current measurement of one of the 3 phases fail.

To set the regulation mode, proceed as follows:
1. Go to Settings > Parameters > Measurement > Regulation mode.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

6.5 Control of the motor-drive unit (optional)

You can use the following parameters to configure control of the motor-drive unit. You can set the following:

- Switching pulse
- Motor runtime
- Switching direction
6.5.1 Setting the switching pulse for controlling the motor-drive unit

You can use the switching pulse time and switching pulse pause parameters to adapt the switching pulse of the device to the requirements of the motor-drive unit's controller.

Setting the switching pulse time

You can use the switching pulse time parameter to set the maximum duration of the switching pulse. It resets after the switching pulse time has elapsed or if the device receives the Motor running signal beforehand or the tap position is changed.

To set the switching pulse time, proceed as follows:
1. Go to Settings > Parameters > Motor control > Switching pulse time.
2. Enter switching pulse time.
3. Press the Accept button to save the modified parameter.

Setting the switching pulse pause

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

To set the switching pulse pause, proceed as follows:
1. Go to Settings > Parameters > Motor control > Switching pulse pause.
2. Enter switching pulse pause.
3. Press the Accept button to save the modified parameter.
6.5.2 Setting motor runtime monitoring

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

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

1. *Motor runtime exceeded event.*
2. Pulse signal via *Trigger motor protective switch output relay*

Note that motor-drive units with cycle settings or motor-drive units without stepped switching behavior will run for longer under certain circumstances. Set a longer motor runtime for such units.

The following parameters are available to configure the motor runtime monitoring:
- Motor runtime
- Motor runtime monitoring

**Motor runtime**
You can use this parameter to set the motor runtime. Proceed as follows:

1. Go to *Settings > Parameters > Motor control > Motor runtime monitoring.*
2. Enter motor runtime.
3. Press the *Accept* button to save the modified parameter.

**Motor runtime monitoring**
You can use this parameter to activate or deactivate motor runtime monitoring. Proceed as follows:

1. Go to *Settings > Parameters > Motor control > Motor runtime monitoring.*
2. Select the option you want.
3. Press the *Accept* button to save the modified parameter.

6.5.3 Setting the switching direction

You can use this parameter to set the switching direction. This lets you adjust the behavior of the device based on how your on-load tap-changer and motor-drive unit are configured. You can select the following options:
<table>
<thead>
<tr>
<th>Setting</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>The device issues a signal via the Raise output to increase the voltage. The device issues a signal via the Lower output to reduce the voltage.</td>
</tr>
<tr>
<td>Swapped</td>
<td>The device issues a signal via the Lower output to increase the voltage. The device issues a signal via the Raise output to reduce the voltage.</td>
</tr>
</tbody>
</table>

Table 22: Behavior

To set the switching direction, proceed as follows:
1. Go to Settings > Parameters > Motor control > Switching direction.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

### 6.6 Parallel operation

Parallel transformer operation is used to increase the throughput capacity or short-circuit capacity at one location. The device provides you with specific functions for regulating transformers.

#### Conditions for parallel 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
- For parallel operation with CAN communication: Current transformers with the same rated values must be used for all devices operating in parallel

#### 6.6.1 Selecting parallel operation method

You can use this parameter to select a parallel operation method. The following methods can be assigned to the device:
- Circulating reactive current minimization
- Tap synchronization (master/follower/auto)
- Power factor

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 for a parallel operation method.

### 6.6.1.1 Circulating reactive current minimization

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 regulating device as a correction for the measurement voltage. You can use the circulating reactive current sensitivity parameter to decrease or increase this voltage correction.

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

Note that the following prerequisites must be met for the "circulating reactive current minimization" parallel operation method:

- You have to use current transformers with the same rated values for all transformers in parallel operation.
- If you wish to operate in parallel operation with existing devices, you have to activate the Retrofit TAPCON® 2xx [► 84] parameter.

To select the circulating reactive current minimization parallel operation method, proceed as follows:

1. Go to **Settings > Parameters > Parallel operation > Parallel operation method**.
2. Select the **Circulating reactive current** option.
3. Press the **Accept** button to save the modified parameter.

To configure the circulating reactive current minimization parallel operation method, you have to also set the following parameters:

- Circulating reactive current sensitivity
- Circul. reactive current blocking limit

#### Setting circulating reactive current sensitivity

You can use this parameter to set the influence of circulating reactive current on how the control deviation is calculated. The higher the set value, the greater the calculated control deviation as a result of circulating reactive current.

To determine the ideal circulating reactive current sensitivity, note the relevant section in the Commissioning chapter.

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

1. Go to **Settings > Parameters > Parallel operation > Circulating reactive current sensitivity**.
2. Enter the circulating reactive current sensitivity.

3. Press the **Accept** button to save the modified parameter.

### Setting the circulating reactive current blocking limit

You can use this parameter to set the limit value for the maximum permissible circulating reactive current. This value relates to the rated current of the current transformer. If, during parallel operation, the circulating reactive current exceeds the set limit value, the device triggers the *Circulating reactive current blocking limit exceeded* event. All devices operating in the parallel operation group are blocked.

To set the circulating reactive current blocking limit, proceed as follows:

1. Go to **Settings > Parameters > Parallel operation > Circulating reactive current blocking limit**.
2. Enter the circulating reactive current blocking limit.
3. Press the **Accept** button to save the modified parameter.

### 6.6.1.2 Setting tap synchronization

With the **Tap synchronization** parallel operation method, you need to designate one device as the master and all other devices as followers. The master handles voltage regulation and transmits its current tap positions to all followers via the CAN bus. The followers compare the tap position received with their own tap position. If the tap position is not the same, the followers switch to the tap position received from the master. This ensures that the transformers operating in parallel are always in the same tap position.

If there is a tap difference between the master and follower, the master refrains from issuing any control commands to the motor-drive unit until all of the followers have reached the same tap position. If the tap difference persists for longer than the set delay time for parallel operation error messages, the master triggers the *Step difference to follower* event.

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

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>The device is designated as the master.</td>
</tr>
<tr>
<td>Follower</td>
<td>The device is designated as the follower.</td>
</tr>
<tr>
<td>Auto. tap synchronization</td>
<td>Automatic assignment of master or follower. If no master is detected, the device with the lowest CAN bus address is automatically designated as the master. All other devices are designated as followers.</td>
</tr>
</tbody>
</table>

Table 23: Tap synchronization method

To select the tap synchronization parallel operation method, proceed as follows:

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

To configure the tap synchronization parallel operation method, you also have to set the following parameters:

- Master/follower current blocking
- Maximum tap difference

### Master/follower current blocking

You can use this parameter to activate the circulating reactive current blocking limit for the tap synchronization parallel operation method. The device thereby calculates and monitors the circulating reactive current in the same manner as for the circulating reactive current minimization parallel operation method. The Circulating reactive current blocking [► 81] parameter is used to set the limit value.

To activate circulating reactive current blocking for the tap synchronization parallel operation method, proceed as follows:

1. Go to **Settings > Parameters > Parallel operation > Master/follower current blocking**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

### Maximum tap difference

You can use this parameter to set the maximum permissible tap difference between followers and master on the follower.

If the tap difference is greater than the set maximum tap difference to the master, the follower immediately blocks. The follower therefore no longer attempts to reach the master's tap position. After the set delay time for parallel operation error messages has elapsed, the follower issues the *Permitted tap difference to master exceeded* message.

To set the maximum permissible tap difference, proceed as follows:

1. Go to **Settings > Parameters > Parallel operation > Maximum tap difference**.
2. Enter the maximum tap difference.
3. Press the **Accept** button to save the modified parameter.

### Assigning a 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. If the value is set to 0, then no communication takes place.

1. Go to **Settings > Parameters > Parallel operation > CAN bus address**.
2. Enter CAN bus address.
3. Press the **Accept** button to save the modified parameter.
6.6.3 Setting behavior if no communication present

You can use this parameter to set how the voltage regulator behaves if communication via the CAN bus is not possible.

The setting for this parameter is only effective if you have selected the Error option for the Error if no communication present parameter.

You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent regulation</td>
<td>The device switches from parallel operation to normal automatic voltage regulation</td>
</tr>
<tr>
<td>Auto blocking</td>
<td>Automatic voltage regulation is blocked.</td>
</tr>
<tr>
<td>cosφ interpolation</td>
<td>Continuation of parallel operation with interpolated values (only possible with circulating reactive current parallel operation method)</td>
</tr>
<tr>
<td>Power factor</td>
<td>Circulating reactive current minimization without CAN bus communication parallel operation method</td>
</tr>
</tbody>
</table>

Table 24: Behavior if no communication present

To set the behavior, proceed as follows:

1. Go to Settings > Parameters > Parallel operation > Behavior if no communication present.
2. Select the desired option.
3. Press the Accept button to save the modified parameter.

6.6.4 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.

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

1. Go to Settings > Parameters > Parallel operation > Delay time for the parallel operation error message.
2. Enter the delay time.
3. Press the Accept button to save the modified parameter.

6.6.5 TAPCON® 2xx retrofit

The TAPCON® 2xx retrofit function allows you to operate the device in parallel operation with existing devices. If you activate this parameter, you have to reverse the prefix of the "Phase angle correction" parameter for the transformer data (from - to + or from + to -).
Parallel operation with the following existing devices is supported:

- TAPCON® 230 pro/expert
- TAPCON® 240
- TAPCON® 250
- TAPCON® 260
- TRAFOGUARD® with "Voltage regulation" options package

If you wish to operate several devices in parallel operation with existing devices, you have to activate the TAPCON® 2xx retrofit function on each device.

To activate the TAPCON® 2xx retrofit function, proceed as follows:

- Reverse prefix of phase angle correction.
- 1. Go to **Settings > Parameters > TAPCON® 2xx retrofit > TAPCON® 2xx retrofit**.
- 2. Select the option you want.
- 3. Press the **Accept** button to save the modified parameter.

### 6.7 Limit values

For various measured values, you can define limit values which are monitored by the device. Depending on the measured value, you can define different numbers of limit values. The following measured values can be monitored:

<table>
<thead>
<tr>
<th></th>
<th>2nd lower limit</th>
<th>1st lower limit</th>
<th>1st upper limit</th>
<th>2nd upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>U&lt;&lt;</td>
<td>U&lt;</td>
<td>U&gt;</td>
<td>U&gt;&gt;</td>
</tr>
<tr>
<td>Current</td>
<td>-</td>
<td>I&lt;</td>
<td>I&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Apparent power</td>
<td>S&lt;&lt;</td>
<td>S&lt;</td>
<td>S&gt;</td>
<td>S&gt;&gt;</td>
</tr>
<tr>
<td>Active power</td>
<td>P&lt;&lt;</td>
<td>P&lt;</td>
<td>P&gt;</td>
<td>P&gt;&gt;</td>
</tr>
<tr>
<td>Reactive power</td>
<td>Q&lt;&lt;</td>
<td>Q&lt;</td>
<td>Q&gt;</td>
<td>Q&gt;&gt;</td>
</tr>
<tr>
<td>Power factor</td>
<td>cos phi&lt;&lt;</td>
<td>cos phi&lt;</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 25: Limit values

The "lower" limit values are monitored to determine whether the measured value reaches or falls below the limit value. The "upper" limit values are monitored to determine whether the measured value reaches or exceeds the limit value.

If you are measuring voltage and current in 3 phases, you can also monitor the following limit values:

- Difference in voltage between the 3 phases: $\Delta U_{3ph}$
- Phase symmetry between the 3 phases: $\Delta \phi_{3ph}$

Various parameters for configuring limit value monitoring are provided for each limit value.

The parameters available and ways in which they can be selected may vary depending on the limit value.
Figure 50: Schematic diagram of limit value monitoring (taking example of "Upper limit value")

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Limit value</td>
</tr>
<tr>
<td>2</td>
<td>Hysteresis</td>
</tr>
<tr>
<td>3</td>
<td>Measured value</td>
</tr>
<tr>
<td>4</td>
<td>Delay time</td>
</tr>
<tr>
<td>A</td>
<td>Duration of set &quot;behavior&quot;</td>
</tr>
</tbody>
</table>

### Relative/absolute limit value

You can use this parameter to set whether the device is to use the "Absolute limit value" or "Relative limit value".

#### Absolute limit value

You can use this parameter to set the limit value as a fixed absolute value. Unlike the relative value, this limit is not dependent on a reference value.

#### Relative limit value

You can use this parameter to set the limit value relative to a reference value.

### Hysteresis limit value

You can use this parameter to set the hysteresis. For "Upper limit value", the hysteresis is deducted from the limit value and for "Lower limit value", it is added to the limit value. When a limit value is violated, the set device behavior is only reset once the measured value has exceeded the hysteresis. The purpose of the hysteresis is to allow the device to ignore small fluctuations around the limit value.
Delay time limit value

You can use this parameter to set the delay time. If a limit value is violated, the device only undertakes the set behavior once the delay time has elapsed. The purpose of the delay time is to allow the device to ignore brief limit value violations.

Behavior limit value

You can use this parameter to define how the device behaves when a limit value is violated. The options available may vary depending on the limit value. The following options are available:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>The limit value is not monitored.</td>
</tr>
<tr>
<td>High-speed return</td>
<td>The device continues to perform tap-change operations in the required direction until the limit value is no longer violated. The device ignores the set delay time T1 of automatic voltage regulation.</td>
</tr>
<tr>
<td>Auto blocking</td>
<td>The device blocks automatic voltage regulation.</td>
</tr>
<tr>
<td>Auto/manual blocking</td>
<td>The device blocks automatic voltage regulation and manual tap-change operations.</td>
</tr>
<tr>
<td>Auto-blocking for lower step</td>
<td>The device blocks tap-change operations to a lower tap position.</td>
</tr>
<tr>
<td>Auto-blocking for raise step</td>
<td>The device blocks tap-change operations to a higher tap position.</td>
</tr>
<tr>
<td>Auto/manual blocking for lower step</td>
<td>The device blocks automatic voltage regulation and manual tap-change operations to a lower tap position.</td>
</tr>
<tr>
<td>Auto/manual blocking for raise step</td>
<td>The device blocks automatic voltage regulation and manual tap-change operations to a higher tap position.</td>
</tr>
<tr>
<td>Switch to Manual</td>
<td>The device switches to manual mode.</td>
</tr>
<tr>
<td>Target tap position</td>
<td>The device automatically switches to the set target tap position.</td>
</tr>
</tbody>
</table>

Table 26: Device behavior

6.7.1 Voltage monitoring

To monitor the transformer's current output voltage, you can set 4 limit values:
- Undervoltage U<<
- Undervoltage U<
- Overvoltage U>
- Overvoltage U>>
You can set the following parameters for each limit value: A detailed description of the limit value concept and parameters can be found in the Limit values section.

- Relative/absolute limit value
- Limit value [V]: Absolute limit value
- Limit value [%]: Limit value relative to desired voltage value
- Hysteresis limit value
- Delay time limit value
- Behavior limit value

To set the voltage monitoring, proceed as follows:
1. Go to Settings > Parameters > Voltage monitoring.
2. Select the parameter you want.
3. Set parameter.
4. Press the Accept button to save the modified parameter.

6.7.2 Current monitoring

For monitoring of the transformer's current load current, you can set 4 limit values:

- \( I_{\ll} \)
- \( I_{\ll} \)
- \( I_{\gg} \)
- \( I_{\gg} \)

You can set the following parameters for each limit value. A detailed description of the limit value concept and parameters can be found in the Limit values [89] section.

- Relative/absolute limit value
- Limit value [A] or [kA]: Absolute limit value
- Limit value [%]: Limit value relative to rated current of current transformer
- Hysteresis limit value
- Delay time limit value
- Behavior limit value

To set the current monitoring, proceed as follows:
1. Go to Settings > Parameters > Current monitoring.
2. Select the parameter you want.
3. Set parameter.
4. Press the Accept button to save the modified parameter.
6.7.3 Power monitoring

For monitoring of the transformer's current power, you can set the following limit values:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>S&lt;&lt;</th>
<th>S&lt;</th>
<th>S&gt;</th>
<th>S&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active power</td>
<td>P&lt;&lt;</td>
<td>P&lt;</td>
<td>P&gt;</td>
<td>P&gt;&gt;</td>
</tr>
<tr>
<td>Reactive power</td>
<td>Q&lt;&lt;</td>
<td>Q&lt;</td>
<td>Q&gt;</td>
<td>Q&gt;&gt;</td>
</tr>
<tr>
<td>Power factor</td>
<td>cos phi&lt;&lt;</td>
<td>cos phi&lt;</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 27: Limit values for power monitoring

You can set the following parameters for each limit value. A detailed description of the limit value concept and parameters can be found in the Limit values section.

- Limit value: Absolute limit value
- Hysteresis limit value
- Delay time limit value

**Behavior** If the limit value is exceeded, the device issues a message.

To set the power monitoring, proceed as follows:

1. Go to **Settings > Parameters > Power monitoring**.
2. Select the parameter you want.
3. Set parameter.
4. Press the **Accept** button to save the modified parameter.

6.7.4 Bandwidth monitoring

The following limit values are monitored by the bandwidth monitoring. The set bandwidth [► 63] is used for this purpose.

- Upper bandwidth
- Lower bandwidth

You can set the following parameters for each limit value: A detailed description of the limit value concept and parameters can be found in the Limit values [► 89] section.

- Hysteresis limit value: Input a percentage with reference to the desired voltage value.
- Delay time limit value

**Behavior** If the limit value is exceeded, the device issues the **Upper bandwidth limit value/Lower bandwidth limit value** message.

The "Function monitoring" function is used to detect long periods when values exceed or fall below the bandwidth. Long periods when values exceed or fall below the bandwidth indicate a problem with the device function because the device is not able to correct the control deviation.
Behavior

If the value falls below or exceeds the set bandwidth, the Function monitoring event is displayed after the set delay time for function monitoring has elapsed. The event is automatically acknowledged as soon as the measured value returns to within the set bandwidth.

The following parameters are available for setting function monitoring:

- Function monitoring
- Hysteresis
- Delay time

Figure 51: Setting function monitoring

Activating function monitoring

You can use this parameter to activate function monitoring. You can select the following options:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Function monitoring is deactivated.</td>
</tr>
<tr>
<td>Only Auto</td>
<td>Function monitoring is only active in AVR AUTO operating mode.</td>
</tr>
<tr>
<td>Auto and Manual</td>
<td>Function monitoring is active in AVR AUTO and AVR MANUAL operating mode</td>
</tr>
</tbody>
</table>

Table 28: Activate function monitoring

To activate function monitoring, proceed as follows:

1. Go to Settings > Parameters > Bandwidth monitoring > Function monitoring.
2. Select the option you want from the list box.
3. Press the Accept button to save the modified parameter.
Setting the hysteresis

To set the hysteresis, proceed as follows:
1. Go to Settings > Parameters > Bandwidth monitoring > Hysteresis.
2. Enter hysteresis.
3. Press the Accept button to save the modified parameter.

Setting the delay time

To set the delay time, proceed as follows:
1. Go to Settings > Parameters > Bandwidth monitoring > Delay time.
2. Enter delay time.
3. Press the Accept button to save the modified parameter.

Also refer to
- Current monitoring [► 89]
- Bandwidth [► 63]

6.7.5 Temperature monitoring

You can set different limit values for every measured/calculated temperature. If the measured temperature is greater than limit value > or >>, the device triggers an event message. If the measured temperature is less than limit value < or <<, the device triggers an event message.

![Temperature monitoring](image)

Figure 52: Temperature monitoring

To set the temperature monitoring, proceed as follows:
1. Go to Settings > Parameters > Temperature monitoring.
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the Accept button to save the modified parameter.
6 Operation

6.7.6 Tx statistics monitoring

You can set 2 limit values for the calculated aging rate of the transformer:

- Relative aging rate
- Aging rate

If the calculated aging rate is greater than the limit value, the device triggers an event.

Figure 53: Tx statistics monitoring

To set the limit values, proceed as follows:

1. Go to Settings > Parameters > Tx statistics monitoring.
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the Accept button to save the modified parameter.
Displaying transformer statistics

To display the transformer statistics, proceed as follows:

► Go to **Information > Statistics**.

![Figure 54: Transformer statistics](image)

### 6.7.7 DGA monitoring

For the DGA monitoring "DGA", you can set 2 limit values each for moisture content and gas content of the oil. The measured values are recorded via the AIO assembly. You need to configure [► 110] this assembly for this purpose. You can display the current measured values by going to "Information" under "DGA" [► 107].

Depending on the device configuration, you can monitor up to 11 DGA signals:

<table>
<thead>
<tr>
<th>Gas</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2O</td>
<td>H2O&gt;</td>
<td>%</td>
</tr>
<tr>
<td>H2</td>
<td>H2&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>N2</td>
<td>N2&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>CO</td>
<td>CO&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>CO2</td>
<td>CO2&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>CH4</td>
<td>CH4&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>C2H2</td>
<td>C2H2&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>C2H4</td>
<td>C2H4&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>C2H6</td>
<td>C2H6&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>O2</td>
<td>O2&gt;</td>
<td>ppm</td>
</tr>
<tr>
<td>TDCG</td>
<td>TDCG&gt;</td>
<td>ppm</td>
</tr>
</tbody>
</table>

Table 29: Possible choice of gases
To set the DGA monitoring, proceed as follows:
1. Go to **Settings > Parameters > DGA monitoring**.
2. Select the parameter you want.
3. Set parameter.
4. Press the **Accept** button to save the modified parameter.

### 6.7.8 Tap position monitoring

You can set 2 limit values for tap position monitoring:
- Pos<
- Pos>

You can set the following parameters for each limit value. A detailed description of the limit value concept and parameters can be found in the Limit values [► 95] section.
- Lower/upper tap position
- Behavior limit value
- Delay time (optional)

To set tap position monitoring, proceed as follows:
1. Go to **Settings > Parameters > Tap position monitoring**.
2. Select the parameter you want.
3. Set parameter.
4. Press the **Accept** button to save the modified parameter.

### 6.8 Hot-spot calculation (optional)

You can set the parameters for the hot-spot calculation in the Hot-spot menu.

![Figure 55: Hot-spot calculation](image)
If you are using a cooling system, you also need to enter the following parameters for each cooling stage.

You can set the following parameters:

- Calculation method
  - IEC 60076-7
  - IEEE Std C57.91
- Hot-spot factor (only with IEC 60076-7 calculation method)
- Gradient (only with IEC 60076-7 calculation method)
- Winding exponent (only with IEC 60076-7 calculation method)
- Oil time constant (only with IEC 60076-7 calculation method)
- k21 (only with IEC 60076-7 calculation method)
- k22 (only with IEC 60076-7 calculation method)
- Gradient (only with IEEE Std C57.91 calculation method)
- Exponent (only with IEEE Std C57.91 calculation method)
- Rated current of transformer (with IEC 60076-7 and IEEE Std C57.91 calculation methods)
- Winding time constant (with IEC 60076-7 and IEEE Std C57.91 calculation methods)

Note the relevant standard for more information about the parameters.

To set the parameters for the hot-spot calculation, proceed as follows:

1. Go to **Settings > Parameters > Hot-spot**.
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the **Accept** button to save the modified parameter.

### 6.9 Setting calculation of transformer’s loss of life (optional)

In order to calculate the transformer’s aging rate, you need to set the following parameters:

- Insulating paper
- Transformer age
- Anticipated service life
Insulating paper (only with IEC 60076-7 calculation method)

You can use this parameter to set whether the transformer is equipped with thermally stabilized insulation paper or not. This parameter is used to calculate the relative aging rate and is only relevant if you calculate the hot-spot temperature in accordance with IEC 60076-7.

Transformer age

You can use this parameter to set the current age of the transformer in years. This parameter is used to calculate the aging rate.

Anticipated service life

You can use this parameter to set the anticipated service life of the transformer in years. This parameter is used to calculate the aging rate.

To set the parameters for calculating the aging rate, proceed as follows:

1. Go to Settings > Parameters > Rel. aging rate.
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the Accept button to save the modified parameter.

6.10 Cooling system control (optional)

You can use the cooling system control function package to control and/or monitor up to 6 cooling stages depending on device configuration. You can set parameters for the following cooling stages:

<table>
<thead>
<tr>
<th>Cooling stage</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0</td>
<td>Operation without cooling stage</td>
</tr>
<tr>
<td>S1</td>
<td>Operation with cooling stage 1</td>
</tr>
</tbody>
</table>
### Configuring cooling stages

To control the cooling system you have to set the following parameters for every cooling stage:

- Operating duration
- Number of starts
- Activate cooling stage
- Switch on input variable
- Switch off input variable
- Switching point
- Hysteresis
- Switch-on delay
- Alternating mode
- Periodic mode
- Active if error

### Operating duration

The device records the operating duration of the cooling stage. You can use this parameter to reset the operating duration of the relevant cooling stage if you have replaced fans or pumps on the cooling system, for example.
To edit the operating duration, proceed as follows:
1. Go to Settings > Parameters > Cooling stage X > Operating duration.
2. Enter the value you want.
3. Press the Accept button to save the modified parameter.

Number of starts

The device records the number of starts of the cooling stage. You can use this parameter to reset the number of starts of the relevant cooling stage if you have replaced fans or pumps on the cooling system, for example.

To edit the number of starts, proceed as follows:
1. Go to Settings > Parameters > Cooling stage X > Number of starts.
2. Enter the value you want.
3. Press the Accept button to save the modified parameter.

Activating cooling stage

You can use this parameter to activate or deactivate the cooling stage.

To activate/deactivate the cooling stage, proceed as follows:
1. Go to Settings > Parameters > Cooling stage X > Activate.
2. Select the option you want from the list box.
3. Press the Accept button to save the modified parameter.

Switch on input variable

You can use this parameter to set which measured temperature value is to be used to switch on the cooling stage. You can select the following options:
- Upper oil temperature
- Hot-spot temperature
- Ambient temperature
- Lower oil temperature
- OLTC oil temperature
- Generic temperature

To select the input variable for switching on the cooling stages, proceed as follows:
1. Go to Settings > Parameters > Cooling stage X > Switch on input variable.
2. Select the option you want from the list box.
3. Press the Accept button to save the modified parameter.
Switch off input variable

You can use this parameter to set which measured temperature value is to be used to switch off the cooling stage. You can select the following options:

- Upper oil temperature
- Hot-spot temperature
- Ambient temperature
- Lower oil temperature
- OLTC oil temperature
- Generic temperature

To select the input variable for switching off the cooling stages, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Switch off input variable**.
2. Select the option you want from the list box.
3. Press the **Accept** button to save the modified parameter.

Switching point

You can use this parameter to set the temperature at which the cooling stage is to be switched on or off. If the temperature exceeds the switching point, the cooling stage is switched on. If the temperature is less than the switching point minus the optional hysteresis, the cooling stage is switched off.

To set the switching point, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Switching point**.
2. Enter the value you want.
3. Press the **Accept** button to save the modified parameter.

Hysteresis

You can use this parameter to set a hysteresis below the switching point. The cooling stage is only switched off if the temperature is less than the switching point minus the hysteresis.

To set the hysteresis, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Hysteresis**.
2. Enter the value you want.
3. Press the **Accept** button to save the modified parameter.

Switch-on delay

You can use this parameter to set the switch-on delay for the cooling stage. The cooling stage is only switched on if the measured temperature is greater than the switching point for longer than the set switch-on delay.
To set the switch-on delay, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Switch-on delay**.
2. Enter the value you want.
3. Press the **Accept** button to save the modified parameter.

**Alternating mode**

You can use this parameter to activate alternating mode [► 103] for the cooling stage.

To activate alternating mode, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Alternating mode**.
2. Select the option you want from the list box.
3. Press the **Accept** button to save the modified parameter.

**Periodic mode**

You can use this parameter to activate periodic mode [► 102] for the cooling stage.

To activate periodic mode, proceed as follows:
1. Go to **Settings > Parameters > Cooling stage X > Periodic mode**.
2. Select the option you want from the list box.
3. Press the **Accept** button to save the modified parameter.

### 6.10.2 Configuring load-dependent mode

In load-dependent mode all cooling stages are activated if the load current of the transformer is greater than the set switching point. You can set the switching point as a percentage in relation to the transformer rated current. Once the switch-on delay has elapsed, the cooling stages are activated. To limit the switch-on current of the cooling stages, they are activated one after another with a delay time of 60 seconds.

The following parameters are available to configure the load-dependent mode:

- Activate load-dependent mode
- Switching point: Switch-on threshold as percentage, in relation to rated current of transformer.
- Switch-on delay: Delay time for switching on the first cooling stage.
- Overrun: Period for which the cooling stages remain switched on if the transformer load current is again less than the set switching point.
To configure the load-dependent mode, proceed as follows:

To use this function, you need to activate the corresponding cooling stage [► 98].

1. Go to **Settings > Parameters > General cooling**.
2. Select the parameter you want.
3. Select the option you want from the list box or enter the desired value.
4. Press the **Accept** button to save the modified parameter.

### 6.10.3 Configuring periodic mode

Periodic mode is used to prevent the bearings of the cooling stages from seizing up as a result of long idle periods. To do this, the cooling stages are operated for a certain period at regular intervals regardless of the measured temperature. You can activate/deactivate periodic mode individually for every cooling stage (Configuring cooling stages [► 98]).

The following parameters are available to configure periodic mode:

- **Activate periodic mode**
- **Switch-on delay**: Period after which the cooling stages are to be switched on for the first time.
- **Switch-on duration**: Period for which the cooling stages are to be switched on.
- **Interval**: Period after which the cooling stages are to be switched on again.
To configure periodic mode, proceed as follows:

1. Go to Settings > Parameters > General cooling.
2. Select the parameter you want.
3. Select the option you want from the list box or enter the desired value.
4. Press the Accept button to save the modified parameter.

### Configuring alternating mode

If the transformer is equipped with several similar cooling stages, you can run the stages in alternating mode. In alternating mode, each of the cooling stages is run in turn to evenly distribute the load of the cooling stages. You can activate/deactivate alternating mode individually for every cooling stage (Configuring cooling stages [► 98]).

Only use alternating mode for similar cooling stages.

Example: If you activate alternating mode for 2 cooling stages and set a change interval of 1,000 h, then cooling stage 1 is switched off after 500 h and cooling stage 2 is switched on. After 500 h cooling stage 2 is switched off and cooling stage 1 is switched on etc.

The following parameters are available to configure alternating mode:

- Activate alternating mode
- Change interval: Period after which the cooling stage is to be changed.
6 Operation

To configure alternating mode, proceed as follows:

1. Go to **Settings > Parameters > General cooling**.
2. Select the parameter you want.
3. Select the option you want from the list box or enter the desired value.
4. Press the **Accept** button to save the modified parameter.

### 6.10.5 Displaying status of cooling stages

You can display the status of the cooling stages. The following information is available to you for every cooling stage:

- **Status**
  - Gray: Cooling stage inactive
  - Blue: Cooling stage active
  - Yellow, red: Event message
- **Number of starts**
- **Operating time**
- **Parameter set**
  - Delay time
  - Hysteresis
  - Switch-on threshold
To display the status of the cooling stages, proceed as follows:

► Go to Information > Cooling stages.

### 6.11 Displaying protective device status (optional)

The overview display shows you the current status of the connected protective devices.

Note that the inputs for recording the protective device status are "High-active". If the protective device is tripped, there must be a signal.

To call up the overview display of the status of the protective devices, proceed as follows:

► Go to Information > Protective devices.
6.12 Displaying tap-change operation statistics (optional)

In the tap-change operation statistics, you can display how often the on-load tap-changer has been switched to a particular tap position and how long it has remained in a particular tap position.

The top diagram shows how often the on-load tap-changer was switched into a particular tap position and how long it spent there. The bottom diagram shows the time spent in the tap positions over the last 10 days.

To display the tap-change operation statistics, proceed as follows:

► Go to Information > Tap-change operation statistics.
6.13 DGA measured value trend

You can display the time pattern of the DGA measurements measured over the last 10 days.

► Go to Information > DGA.

Figure 64: DGA measured value trend

Relative moisture in oil

You can also display the time pattern of the moisture in oil over the last 10 days. To do so, proceed as follows:

► Go to Information > DGA > DGA (relative).

Figure 65: DGA measured value trend relative

You can also display the DGA measured value trend over a time period you define. You will find more information in the “Measured value recorder” [► 125] section.
6.14 Displaying temperature curve (optional)

You can display the time pattern of the temperatures measured over the last 10 days. To do so, proceed as follows:

► Go to **Information > Temperature curve**.

![Temperature curve](image1)

**Figure 66: Temperature curve**

**Generic temperatures**

If using additional temperature sensors (generic temperature 1...8), you can display the temperature curve for these temperatures over the last 10 days. To do so, proceed as follows:

► Go to **Information > Gener. temperatures**.

![Generic temperatures](image2)

**Figure 67: Generic temperatures**
6.15 Changing tap position designation (optional)

This function allows you to edit the designation of the tap position. The designations are displayed on the main screen when each of the tap positions is active and are used for the control system.

To edit the designations of the respective tap positions, proceed as follows:

1. Go to Settings > Tap position table.
2. Select the desired tap position.

![Figure 68: Tap position table](image)

3. Enter designation for tap position and for control system.

![Figure 69: Entering tap position](image)

4. Click on the Accept button.
6.16 Displaying information about contact wear (only OILTAP®)

If you are monitoring an on-load tap-changer of type OILTAP®, you can display the current wear values of the main switching contacts (MSCA, MSCB) and transition contacts (TCA, TCB).

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

To display the information about contact wear, proceed as follows:
► Go to Information > Contact wear.

6.17 Configuring analog inputs and outputs (optional)

You can flexibly configure the device’s analog inputs and outputs.

**NOTICE**

**Damage to the device**

Incorrectly connected and configured analog inputs/outputs may result in damage to the device and sensor.
► Follow information about connecting analog sensors [► 32].
► Configure analog inputs and outputs according to the connected sensors [► 110].

You can set the following parameters:
- Function: Select function of analog sensor.
  - You can adjust the designation of the analog sensor.
  - You cannot change grayed out entries.
- Slot/channel: Select slot and channel of analog sensor. Note the connection diagram supplied.
Signal type: Select signal type of analog sensor or deactivate analog input.

Min/Max: Set the minimum and maximum values of the sensor, e.g. with a 4...20 mA signal, the corresponding measured value for 4 mA and the corresponding value for 20 mA.

Figure 71: Configuring analog inputs/outputs

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

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

- User name: admin
- Password: admin

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

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

Configuring AIO  To configure the device's analog inputs and outputs, proceed as follows:

1. Go to Settings > AIO configuration.
2. Configure the properties as desired.
3. Press the Accept button.
4. Confirm the security prompt with Save to save the changes.
Determining slot/channel of AIO assembly

The AIO, CPU, and UI assemblies are connected via a busbar. The connection diagram shows the slot on the busbar to which the corresponding AIO assembly is connected. If you do not have a connection diagram, you can determine the slot as follows:

Note that the DIO, SW, and MC slots are not connected via busbar and do not therefore have to be taken into consideration when determining the slot.

- The busbar slot numbers increase from the left when viewed from the rear. Note that the CPU assembly always occupies 2 slots.

Figure 72: Determining slot of AIO assembly

- The channels correspond to the plugs of the AIO assembly. The plug with pins 1...5 is channel 1, the plug with pins 6...10 is channel 2 etc.

Also refer to

Information about connecting analog sensors [► 32]

6.18 Configuring digital inputs and outputs

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

- Input: High active
- Output: Normally open contact (NO)

You can change this configuration if necessary.
Ensure that the configuration of the digital inputs and outputs is suitable for the functions used. Otherwise malfunctions may occur in the device and the connected periphery.

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>DI: Digital input</td>
</tr>
<tr>
<td></td>
<td>DO: Digital output</td>
</tr>
<tr>
<td><strong>Function</strong></td>
<td>Function of the digital input (I: ...) or of the digital output (O: ...)</td>
</tr>
<tr>
<td><strong>Configuration</strong></td>
<td>DI: High active or low active</td>
</tr>
<tr>
<td></td>
<td>DO: Normally open (NO), normally closed (NC); Note: If the device is disconnected or in the event of an error, the digital outputs are always open (no bi-stable relay).</td>
</tr>
<tr>
<td><strong>Channel</strong></td>
<td>Channel of the DIO assembly to which the function is linked. Functions that are not linked with a channel are identified with &quot;-&quot;. Note the connection diagram supplied.</td>
</tr>
</tbody>
</table>

Table 30: Configuration of the digital inputs and outputs

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

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

- **User name:** admin
- **Password:** admin
Creating a backup

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

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

Configuring DIO

To configure the device’s digital inputs and outputs, proceed as follows:

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

6.19 Name plate (optional)

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

6.19.1 Enter the name plate data

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

<table>
<thead>
<tr>
<th>Settings</th>
<th>Parameter</th>
<th>Name plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>Tx serial number</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx year of construction</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx type</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx description</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx manufacturer</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx standard</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx phases</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx insulation medium</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx rated voltage</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tx frequency</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Figure 74: Name plate

To enter the name plate data, proceed as follows:

1. Go to Settings > Parameter > Name plate.
2. Enter the desired values.
3. Click on the Accept button.
6.19.2 Displaying the name plate

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

To display the name plate data, proceed as follows:

1. Select the **Information** entry in the primary navigation.
2. Select **Name plate** from the selection list.

The name plate data is displayed.

6.20 Maintenance (optional)

The device monitors the following maintenance:

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTC maintenance</td>
<td>The on-load tap-changer must be maintained in accordance with the MR standards.</td>
</tr>
<tr>
<td>OLTC replacement</td>
<td>The on-load tap-changer must be replaced with a new on-load tap-changer.</td>
</tr>
<tr>
<td>DSI replacement</td>
<td>The diverter switch insert must be replaced with a new diverter switch insert.</td>
</tr>
<tr>
<td>Contact wear</td>
<td>The main switching contacts or transition contacts of the on-load tap-changer must be replaced.</td>
</tr>
<tr>
<td>Oil change and cleaning</td>
<td>The oil must be changed and the diverter switch insert, oil compartment, and oil conservator must be cleaned.</td>
</tr>
<tr>
<td>Selector maintenance</td>
<td>The on-load tap-changer's selector must be maintained.</td>
</tr>
</tbody>
</table>
### Maintenance

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Description</th>
</tr>
</thead>
</table>
| Oil sample           | After maintenance: The oil must be replaced; the limit values specified by MR for added insulating oil must be observed.  
                       | During operation: An oil sample must be taken and analyzed; the limit values specified by MR for added insulating oil must be observed.    |
| Oil filter unit      | The oil filter of the oil filter unit must be replaced.                                                                                     |
| OLTC operator interval | Maintenance interval for the on-load tap-changer dependent on number of tap-change operations or time, which the operator can specify. |
| Transformer operator interval | Time-dependent maintenance interval for the transformer, which the operator can specify.                                                      |

**Table 31: Maintenance**

### 6.20.1 Setting operator interval for OLTC maintenance

You can define the maintenance interval of your choice for the on-load tap-changer. You can define the maintenance interval as dependent on time and/or number of tap-change operations. If the limit is reached (100 %), the device triggers an event message (red).

**Interval type**

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

- **Deactivated**: The maintenance interval is deactivated.
- **Time**: The maintenance interval is dependent on time.

![Figure 76: Operator maintenance on OLTC](image-url)
• Counter: The maintenance interval is dependent on number of tap-change operations.

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

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

Duration and date of next maintenance
You can use the parameter for the date of the next maintenance to define the target date for the next maintenance. The duration parameter sets how long this interval is to be. The device uses this to calculate the current maintenance progress.

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

To set the parameters for the operator interval, proceed as follows:
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the Accept button to save the modified parameter.
6.20.2 Setting operator interval for transformer maintenance

You can define a maintenance interval of your choice for the transformer. The maintenance interval is dependent on time. If the limit is reached (100 %), the device triggers an event message (red).

![Figure 77: Operator interval for transformer maintenance](image)

**Activate interval**

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

**Duration and date of next maintenance**

You can use the parameter for the date of the next maintenance to define the target date for the next maintenance. The duration parameter sets how long this interval is to be. The device uses this to calculate the current maintenance progress.

**Event (yellow)**

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

To set the parameters for the operator interval, proceed as follows:

1. Go to Settings > Parameters > Maintenance: Transformer operator.
2. Select the parameter you want.
3. Set the parameter you want.
4. Press the Accept button to save the modified parameter.

6.20.3 Undertaking and confirming maintenance

Once you have undertaken maintenance, you can confirm this on the device and thereby reset the maintenance interval.
To confirm maintenance, proceed as follows:

1. Go to **Settings > Maintenance wizard**.

![Maintenance wizard](image)

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

![Undertaking and confirming maintenance](image)

5. Press the **Accept** button to save the changed parameters.

### 6.20.4 Displaying maintenance overview

The maintenance overview displays the progress of the individual maintenance intervals. You can also see the limit values for the "yellow" and "red" event messages.
If you have deactivated the "OLTC operator maintenance" or "Transformer operator maintenance" interval, the interval is shown grayed out in the maintenance overview.

![Maintenance overview](image)

**Figure 80: Maintenance overview**

To display the maintenance overview, proceed as follows:

► Go to **Information > Maintenance**.

### 6.21 Event management

The device is equipped with event management, which allows you to detect various device operating statuses and to adapt the behavior of the device. You can find an overview of the events available in the Event messages section.

#### 6.21.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

► Go to **Events**.

⇒ A list of events currently active appears.
Acknowledging events

Acknowledgeable events must be acknowledged in the event overview so that they are no longer displayed. All other events are automatically removed once the cause is remedied (e.g. limit value no longer infringed).

To acknowledge the events, proceed as follows:

► To acknowledge the events, highlight the desired events in the column then press the **Acknowledgement** button.

⇒ The events are acknowledged.

### 6.21.2 Configuring events

The events have the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High active (not configurable)</td>
<td>High active: The device issues a signal if the event is active. Low active: The device issues a signal for as long as the event is not active. If the event is active, the signal is reset.</td>
</tr>
<tr>
<td>Can be set multiple times (not configurable)</td>
<td>The event can be triggered several times without having been deactivated in the meantime.</td>
</tr>
<tr>
<td>Acknowledgeable (not configurable)</td>
<td>Acknowledgeable events must be acknowledged in the event overview so that they are no longer displayed. All other events are automatically removed once the cause is remedied (e.g. limit value no longer infringed).</td>
</tr>
</tbody>
</table>
### Table 32: Properties of events

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event name</td>
<td>Brief name of event. If you delete all of the text, the standard text is displayed.</td>
</tr>
<tr>
<td>Event description</td>
<td>Description of event. If you delete all of the text, the standard text is displayed.</td>
</tr>
<tr>
<td>Event remedy</td>
<td>Troubleshooting information for cause of event. If you delete all of the text, the standard text is displayed.</td>
</tr>
</tbody>
</table>
| Category          | • Error (red)  
                      • Warning (yellow)  
                      • Info (grey)  
                      This setting affects the color of the Alarm LED and the event symbol in the primary navigation. |
| Message           | If you activate this option, the event is shown on the display and, if configured accordingly, issued via an output and the control system protocol. |
| Storage           | If you activate this option, the event is stored in the event memory. |

To configure an event, proceed as follows:

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

#### 6.21.3 Displaying event memory

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

<table>
<thead>
<tr>
<th>#</th>
<th>Consecutive number of events</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Event number for clear identification</td>
</tr>
<tr>
<td>!</td>
<td>Event category:</td>
</tr>
<tr>
<td></td>
<td>▪ Error (red)</td>
</tr>
<tr>
<td></td>
<td>▪ Warning (yellow)</td>
</tr>
<tr>
<td></td>
<td>▪ Info (gray)</td>
</tr>
<tr>
<td>Event</td>
<td>Event text</td>
</tr>
<tr>
<td>Time</td>
<td>Date and time of event (DD.MM.YYYY, HH:MM:SS/ms)</td>
</tr>
<tr>
<td>▶</td>
<td>Event coming/going:</td>
</tr>
<tr>
<td></td>
<td>▪ Event coming</td>
</tr>
<tr>
<td></td>
<td>▪ Event going</td>
</tr>
</tbody>
</table>

**Table 33: Event memory**

To call up the event memory, proceed as follows:

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

![Figure 83: Event memory](image)

### Filtering events

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

1. Press the **Filter** button.
2. Set the desired filter and press the **Accept** button.

### Exporting events

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

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

The data is exported.

### 6.22 Measured values

You can display the measured values for the device. Note that the displayed measured values may differ from the raw values displayed in the information display of assembly UI 1 or UI 3. The measured values are prepared for the measured value display by device as follows:

- The circuit set for the current transformer and voltage transformer is taken into account, as is a corresponding phase displacement.
- The assemblies UI 1 or UI 3 use the generator sign convention. The device displays the measured values using the load sign convention.

You can change the measured value display to the generator sign convention by activating the Retrofit TAPCON® 2xx [► 84] parameter.

#### 6.22.1 Displaying current measured values

The current measured values can be displayed in the measured value screen. The following measured values are displayed:

- Voltage
- Current
- Power factor (cos φ)
- Frequency
- Reactive power
- Active power
- Apparent power
To display the current measured values, proceed as follows:

► Go to **Measured values**.

### 6.22.2 Displaying measured value recorder (optional)

You can use the optional measured value recorder function to display the progress of measured values and signals.

Depending on device configuration, you can select the following measured values and signals for the display:

<table>
<thead>
<tr>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_m L1</td>
<td>Active power L1 (average value)</td>
</tr>
<tr>
<td>P_m L2</td>
<td>Active power L2 (average value)</td>
</tr>
<tr>
<td>P_m L3</td>
<td>Active power L3 (average value)</td>
</tr>
<tr>
<td>P_m</td>
<td>Active power in total (average value)</td>
</tr>
<tr>
<td>S_m L1</td>
<td>Apparent power L1 (average value)</td>
</tr>
<tr>
<td>S_m L2</td>
<td>Apparent power L2 (average value)</td>
</tr>
<tr>
<td>S_m L3</td>
<td>Apparent power L3 (average value)</td>
</tr>
<tr>
<td>S_m</td>
<td>Apparent power in total (average value)</td>
</tr>
<tr>
<td>U_m Desired</td>
<td>Desired voltage value (average value)</td>
</tr>
<tr>
<td>f_m</td>
<td>Frequency (average value)</td>
</tr>
<tr>
<td>φ_m U1/I1</td>
<td>Phase angle U1/I1 (average value)</td>
</tr>
<tr>
<td>φ_m U2/I2</td>
<td>Phase angle U2/I2 (average value)</td>
</tr>
<tr>
<td>φ_m U3/I3</td>
<td>Phase angle U3/I3 (average value)</td>
</tr>
<tr>
<td>cos(φ_m) L1</td>
<td>Power factor L1 (average value)</td>
</tr>
<tr>
<td>cos(φ_m) L2</td>
<td>Power factor L2 (average value)</td>
</tr>
<tr>
<td>cos(φ_m) L3</td>
<td>Power factor L3 (average value)</td>
</tr>
<tr>
<td>cos(φ_m)</td>
<td>Power factor in total (average value)</td>
</tr>
<tr>
<td>Signal</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>I_m N</td>
<td>Neutral conductor current (average value)</td>
</tr>
<tr>
<td>I_m L1</td>
<td>Current L1 (average value)</td>
</tr>
<tr>
<td>I_m L2</td>
<td>Current L2 (average value)</td>
</tr>
<tr>
<td>I_m L3</td>
<td>Current L3 (average value)</td>
</tr>
<tr>
<td>U_m L1</td>
<td>Voltage L1 (average value)</td>
</tr>
<tr>
<td>U_m L2</td>
<td>Voltage L2 (average value)</td>
</tr>
<tr>
<td>U_m L3</td>
<td>Voltage L3 (average value)</td>
</tr>
<tr>
<td>Q_m L1</td>
<td>Reactive power L1 (average value)</td>
</tr>
<tr>
<td>Q_m L2</td>
<td>Reactive power L2 (average value)</td>
</tr>
<tr>
<td>Q_m L3</td>
<td>Reactive power L3 (average value)</td>
</tr>
<tr>
<td>Q_m</td>
<td>Total reactive power (average value)</td>
</tr>
<tr>
<td>Auto block</td>
<td>Auto mode blocked</td>
</tr>
<tr>
<td>HSR tap position ↓</td>
<td>High-speed return lower step</td>
</tr>
<tr>
<td>HSR tap position ↑</td>
<td>High-speed return raise step</td>
</tr>
<tr>
<td>Req. HSR tap position ↓</td>
<td>High-speed return request lower step</td>
</tr>
<tr>
<td>Req. HSR tap position ↑</td>
<td>High-speed return request raise step</td>
</tr>
<tr>
<td>I&gt;&gt;</td>
<td>Limit value I&gt;&gt; exceeded</td>
</tr>
<tr>
<td>U&gt;&gt;</td>
<td>Limit value U&gt;&gt; exceeded</td>
</tr>
<tr>
<td>U Desired (prim.)</td>
<td>Desired voltage value (on primary side)</td>
</tr>
<tr>
<td>U Desired</td>
<td>Desired voltage value (on primary or secondary side, in accordance with configuration of measured value display parameter)</td>
</tr>
<tr>
<td>Tap position</td>
<td>Tap position</td>
</tr>
<tr>
<td>P L1</td>
<td>Active power L1</td>
</tr>
<tr>
<td>P L2</td>
<td>Active power L2</td>
</tr>
<tr>
<td>P L3</td>
<td>Active power L3</td>
</tr>
<tr>
<td>P</td>
<td>Active power in total</td>
</tr>
<tr>
<td>S L1</td>
<td>Apparent power L1</td>
</tr>
<tr>
<td>S L2</td>
<td>Apparent power L2</td>
</tr>
<tr>
<td>S L3</td>
<td>Apparent power L3</td>
</tr>
<tr>
<td>S</td>
<td>Apparent power in total</td>
</tr>
<tr>
<td>f</td>
<td>Frequency</td>
</tr>
<tr>
<td>φ U1/I1</td>
<td>Phase angle U1/I1</td>
</tr>
<tr>
<td>φ U2/I2</td>
<td>Phase angle U2/I2</td>
</tr>
<tr>
<td>φ U3/I3</td>
<td>Phase angle U3/I3</td>
</tr>
<tr>
<td>cos(φ) L1</td>
<td>Power factor L1</td>
</tr>
<tr>
<td>cos(φ) L2</td>
<td>Power factor L2</td>
</tr>
<tr>
<td>cos(φ) L3</td>
<td>Power factor L3</td>
</tr>
</tbody>
</table>
### Table 34: Measured values and signals

If you call up the measured value recorder directly on the device display, you can select a maximum of 3 measured values. If you access it via the web visualization, you can select a maximum of 10 measured values.

To display the measured value recorder, proceed as follows:

1. Go to **Recorder**.

   ![Figure 85: Recorder](image)

2. Select the signals to be displayed in the **list**.

3. If necessary, set the desired **axis** for each signal.
4. Enter the **start time** and **end time** for the measured value display.
5. Press **Display** to call up the measured value display (data log).

![Data log](image)

Figure 86: Data log

The operation described below is only possible if you access the visualization via a PC.

6. Move the mouse pointer to a **measurement point** for more information.
7. Use the mouse to produce a selection window or turn the mouse wheel to zoom into or out of the diagram. If necessary, you can move an enlarged diagram with the right mouse button.
8. Press **Save** to save the measured values displayed as a csv file.

### 6.23 SCADA

The following section describes how you can configure the device to connect to a control system (SCADA).
6.23.1 Configuring IEC 61850 (optional)

If you want to use the IEC 61850 control system protocol, you must set the following parameters.

**Figure 87: Setting parameters for IEC 61850**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address</td>
<td>192.168.10.204</td>
</tr>
<tr>
<td>Subnet mask</td>
<td>255.255.255.0</td>
</tr>
<tr>
<td>Gateway address</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>IED name</td>
<td>IED</td>
</tr>
<tr>
<td>Device ID</td>
<td>IBM</td>
</tr>
<tr>
<td>Access point</td>
<td>MRTCAP</td>
</tr>
<tr>
<td>Edition</td>
<td>Edition 1</td>
</tr>
</tbody>
</table>

**IP address**

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

To set the IP address, proceed as follows:

1. Go to Settings > Parameters > IEC 61850 > IP address.
2. Enter IP address.
3. Press the Accept button to save the modified parameter.

**Subnet mask**

You can use this parameter to set the subnet mask.

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

To set the subnet mask, proceed as follows:

1. Go to Settings > Parameters > IEC 61850 > Subnet mask.
2. Enter subnet mask.
3. Press the Accept button to save the modified parameter.
Gateway address

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 set the gateway address, proceed as follows:
1. Go to Settings > Parameters > IEC 61850 > Gateway address.
2. Enter gateway address.
3. Press the Accept button to save the modified parameter.

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 set the IED name, proceed as follows:
1. Go to Settings > Parameters > IEC 61850 > IED name.
2. Enter IED name.
3. Press the Accept button to save the modified parameter.

Device ID

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

To set the device ID, proceed as follows:
1. Go to Settings > Parameters > IEC 61850 > Device ID.
2. Enter a device ID.
3. Press the Accept button to save the modified parameter.

Access point

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

To set the access point name, proceed as follows:
1. Go to Settings > Parameters > IEC 61850 > Access point.
2. Enter access point.
3. Press the Accept button to save the modified parameter.
Edition
You can use this parameter to switch between edition 1 and edition 2 of the control system protocol IEC 61850.

To select the edition of the IEC 61850 control system protocol, proceed as follows:
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

Downloading ICD file
You can download the ICD file from the device via the Import/Export Manager [► 158]. To do this, 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.

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

Serial interface
You can use this parameter to select the serial interface for data transmission. You can select the following options:
- RS232
- RS485
To select the serial interface, proceed as follows:
2. Select serial interface.
3. Press the Accept button to save the modified parameter.

**Baud rate**

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

To set the baud rate, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > Baud rate.
2. Select baud rate.
3. Press the Accept button to save the modified parameter.

**Transmission procedure**

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

To set the transmission procedure, proceed as follows:
2. Select transmission procedure.
3. Press the Accept button to save the modified parameter.

**Octet number of link address**

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

To set the octet number of the link address, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > Octet number of link address.
2. Set octet number of link address.
3. Press the Accept button to save the modified parameter.

**Link address**

You can use this parameter to set the link address.
To set the link address, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-101 > Link address**.
2. Set link address.
3. Press the **Accept** button to save the modified parameter.

**Octet number of ASDU address**

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

To set the octet number of the ASDU address, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-101 > Octet number of ASDU address**.
2. Set octet number of ASDU address.
3. Press the **Accept** button to save the modified parameter.

**ASDU address**

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

To set the ASDU address, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-101 > ASDU address**.
2. Set ASDU address.
3. Press the **Accept** button to save the modified parameter.

**Octet number of information object address**

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

To set the octet number of the information object address, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-101 > Octet number of information object address**.
2. Set octet number of information object address.
3. Press the **Accept** button to save the modified parameter.

**Octet number of cause of transmission**

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

To set the octet number of the cause of transmission, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-101 > Octet number of cause of transmission**.
2. Set octet number of cause of transmission.
3. Press the **Accept** button to save the modified parameter.
Number of databits
You can use this parameter to set the number of databits.
To set the number of databits, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > Number of databits.
2. Set number of databits.
3. Press the Accept button to save the modified parameter.

Parity
You can use this parameter to set the parity. You can select the following options:
- None
- Even
- Odd
To set the parity, proceed as follows:
2. Select parity.
3. Press the Accept button to save the modified parameter.

Number of stop bits
You can use this parameter to set the number of stop bits.
To set the number of stop bits, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > Number of stop bits.
2. Set number of stop bits.
3. Press the Accept button to save the modified parameter.

Single character confirmation
With this parameter, you can set whether a confirmation is to be sent as single characters instead of as a complete message. Single character confirmation is only possible for requesting data of class 2 (Class 2 Request).
To set single character confirmation, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > ASDU single character confirmation.
2. Select the desired option.
3. Press the Accept button to save the modified parameter.

RES bit test
With this parameter, you can set whether the device is to check the RES bit (Reserved Bit) in the control field. You can select the following options:
Option | Description
--- | ---
On | Messages from the master with RES bit = 1 are declined by the device.
Off | Messages from the master with RES bit = 1 are accepted by the device.

Table 35: RES bit test

To set the Res bit test, proceed as follows:
2. Select the desired option.
3. Press the Accept button to save the modified parameter.

ASDU sequence optimization

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

You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>The device does not optimize the ASDU types.</td>
</tr>
<tr>
<td>Ed. 1</td>
<td>Optimization in accordance with IEC 60870 Edition 1 (Type 1, 3, 9, 11, 21, 126).</td>
</tr>
<tr>
<td>Ed. 1 Amendment2</td>
<td>Optimization in accordance with IEC 60870 Edition 1, Amendment 2 (Type 1, 3, 9, 11, 13, 15, 21, 126).</td>
</tr>
<tr>
<td>Ed. 2</td>
<td>Optimization in accordance with IEC 60870 Edition 2 (Type 1, 3, 5, 7, 9, 11, 13, 15, 20, 21, 126).</td>
</tr>
</tbody>
</table>

Table 36: ASDU sequence optimization

To set the ASDU sequence optimization, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-101 > ASDU sequence optimization.
2. Select the desired option.
3. Press the Accept button to save the modified parameter.
6.23.3 Configuring IEC 60870-5-103 (optional)

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

Serial interface

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

- RS232
- RS485

To select the serial interface, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > Serial interface.
2. Select serial interface.
3. Press the Accept button to save the modified parameter.

Baud rate

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

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

To set the baud rate, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > Baud rate.
2. Select baud rate.
3. Press the Accept button to save the modified parameter.
ASDU address
You can use this parameter to set the address of the ASDU.
To set the ASDU address, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > ASDU address.
2. Set ASDU address.
3. Press the Accept button to save the modified parameter.

Number of databits
You can use this parameter to set the number of databits.
To set the number of databits, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > Number of databits.
2. Set number of databits.
3. Press the Accept button to save the modified parameter.

Parity
You can use this parameter to set the parity. You can select the following options:
- None
- Even
- Odd
To set the parity, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > Parity.
2. Select parity.
3. Press the Accept button to save the modified parameter.

Number of stop bits
You can use this parameter to set the number of stop bits.
To set the number of stop bits, proceed as follows:
1. Go to Settings > Parameters > IEC 60870-5-103 > Number of stop bits.
2. Set number of stop bits.
3. Press the Accept button to save the modified parameter.

DFC compatibility
With this parameter, you can set how the device is to use the DFC bit (Data Flow Control) in the control field. You can select the following options:
### Option | Description
---|---
Standard | The device sets the DFC bit in each response to a command. The device thus indicates that the master may not send any further commands. The master must react to the ACD bit (Access Demand) and retrieve the response to the command e.g. via a request for data of class 1 from the slave queue.

Alternative | The device sets the DFC bit in a response if a second command is received without the master having previously sent a request for data of class 1.

Table 37: DFC compatibility

To set the DFC compatibility, proceed as follows:

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

### 6.23.4 Configuring IEC 60870-5-104 (optional)

If you want to use the IEC 60870-5-104 control system protocol, you must set the following parameters.

**Figure 90: Setting parameters for IEC60870-5-104**

**IP address**

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

To set the IP address, proceed as follows:
Assign IP addresses to both web-based visualization and SCADA (optional) in different subnets. Otherwise you will not be able to establish a connection.

1. Go to **Settings > Parameters > IEC 60870-5-104 > IP address**.
2. Enter the IP address.
3. Press the **Accept** button to save the modified parameter.

### Subnet mask

You can use this parameter to set the subnet mask.

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

To set the subnet mask, proceed as follows:

1. Go to **Settings > Parameters > IEC 60870-5-104 > Subnet mask**.
2. Enter the subnet mask.
3. Press the **Accept** button to save the modified parameter.

### Gateway address

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 set the gateway address, proceed as follows:

1. Go to **Settings > Parameters > IEC 60870-5-104 > Gateway address**.
2. Enter the gateway address.
3. Press the **Accept** button to save the modified parameter.

### TCP port

You can use this parameter to set the TCP port.

To set the TCP port, proceed as follows:

1. Go to **Settings > Parameters > IEC 60870-5-104 > TCP port**.
2. Enter the TCP port.
3. Press the **Accept** button to save the modified parameter.

### ASDU address

You can use this parameter to set the address of the ASDU.
To set the ASDU address, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-104 > ASDU address**.
2. Set ASDU address.
3. Press the **Accept** button to save the modified parameter.

**ASDU sequence optimization**

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

You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>The device does not optimize the ASDU types.</td>
</tr>
<tr>
<td>Ed. 1</td>
<td>Optimization in accordance with IEC 60870 Edition 1 (Type 1, 3, 9, 11, 21, 126).</td>
</tr>
<tr>
<td>Ed. 1 Amendment2</td>
<td>Optimization in accordance with IEC 60870 Edition 1, Amendment 2 (Type 1, 3, 9, 11, 13, 15, 21, 126).</td>
</tr>
<tr>
<td>Ed. 2</td>
<td>Optimization in accordance with IEC 60870 Edition 2 (Type 1, 3, 5, 7, 9, 11, 13, 15, 20, 21, 126).</td>
</tr>
</tbody>
</table>

Table 38: ASDU sequence optimization

To set the ASDU sequence optimization, proceed as follows:
1. Go to **Settings > Parameters > IEC 60870-5-104 > ASDU sequence optimization**.
2. Select the desired option.
3. Press the **Accept** button to save the modified parameter.
6.23.5 Configuring Modbus (optional)

If you want to use the Modbus control system protocol, you must set the corresponding parameters depending on the Modbus type selected.

**Figure 91: Setting parameters for Modbus**

<table>
<thead>
<tr>
<th>Modbus type</th>
<th>RTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address</td>
<td>192.168.10.254</td>
</tr>
<tr>
<td>TCP port</td>
<td>502</td>
</tr>
<tr>
<td>Maximum TCP connections</td>
<td>10</td>
</tr>
<tr>
<td>TCP Keepalive</td>
<td>Off</td>
</tr>
<tr>
<td>Modbus address</td>
<td>1</td>
</tr>
<tr>
<td>Serial interface</td>
<td>RS232</td>
</tr>
<tr>
<td>Baud rate</td>
<td>9600</td>
</tr>
<tr>
<td>Number of datatables</td>
<td>8</td>
</tr>
<tr>
<td>Parity</td>
<td>Even</td>
</tr>
</tbody>
</table>

**Modbus type**

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

- RTU
- TCP
- ASCII

To set the Modbus type, proceed as follows:

1. Go to **Settings > Parameters > Modbus > Modbus type**.
2. Select Modbus type.
3. Press the **Accept** button to save the modified parameter.

**Modbus address**

You can use this parameter to set the Modbus address.

To set the Modbus address, proceed as follows:

1. Go to **Settings > Parameters > Modbus > Modbus address**.
2. Enter Modbus address.
3. Press the **Accept** button to save the modified parameter.

**TCP port (only with Modbus-TCP)**

You can use this parameter to set the TCP port.

To set the TCP port, proceed as follows:

1. Go to **Settings > Parameters > Modbus > TCP port**.
2. Enter TCP port.
3. Press the **Accept** button to save the modified parameter.

**Maximum TCP connections (only with Modbus-TCP)**

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

To set the maximum number of TCP connections, proceed as follows:

1. Go to **Settings > Parameters > Modbus > Maximum TCP connections**.
2. Enter maximum TCP connections.
3. Press the **Accept** button to save the modified parameter.

**TCP Keepalive (only with Modbus-TCP)**

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

To activate/deactivate the "TCP Keepalive" function, proceed as follows:

1. Go to **Settings > Parameters > Modbus > TCP Keepalive**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

**IP address (only with Modbus-TCP)**

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

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

1. Go to **Settings > Parameters > Modbus > IP address**.
2. Enter IP address.
3. Press the **Accept** button to save the modified parameter.

**Serial interface (only with Modbus-RTU and Modbus-ASCII)**

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

- RS232
- RS485

To select the serial interface, proceed as follows:

1. Go to **Settings > Parameters > Modbus > Serial interface**.
2. Select serial interface.
3. Press the **Accept** button to save the modified parameter.
Baud rate (only with Modbus-RTU and Modbus-ASCII)

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

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

To select the baud rate, proceed as follows:

1. Go to Settings > Parameters > Modbus > Baud rate.
2. Select baud rate.
3. Press the Accept button to save the modified parameter.

Number of databits (only with Modbus-RTU and Modbus-ASCII)

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

To set the number of databits, proceed as follows:

1. Go to Settings > Parameters > Modbus > Number of databits.
2. Set number of databits.
3. Press the Accept button to save the modified parameter.

Parity (only with Modbus-RTU and Modbus-ASCII)

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

- None
- Even
- Odd

To set the parity, proceed as follows:

1. Go to Settings > Parameters > Modbus > Parity.
2. Select parity.
3. Press the Accept button to save the modified parameter.

Number of stop bits (only with Modbus-RTU and Modbus-ASCII)

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

To set the number of stop bits, proceed as follows:

1. Go to Settings > Parameters > Modbus > Number of stop bits.
2. Set number of stop bits.
3. Press the Accept button to save the modified parameter.
6.23.6 Configuring DNP3 (optional)

If you want to use the DNP3 control system protocol, you must set the following parameters.

![Figure 92: Setting parameters for DNP3](image)

**DNP3 transmission type**

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

- TCP
- Serial

To set the transmission type, proceed as follows:

1. Go to **Settings > Parameters > DNP3 > DNP3 transmission type**.
2. Select DNP3 transmission type.
3. Press the Accept button to save the modified parameter.

**IP address (only with TCP transmission type)**

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

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

1. Go to **Settings > Parameters > DNP3 > IP address**.
2. Enter IP address.
3. Press the Accept button to save the modified parameter

**Subnet mask (only with TCP transmission type)**

You can use this parameter to set the subnet mask.
Be sure to enter a valid network mask that is not 0.0.0.0, otherwise it will not be possible to connect to the device.

To set the subnet mask, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Subnet mask.
2. Enter subnet mask.
3. Press the Accept button to save the modified parameter.

**Gateway address (only with TCP transmission type)**

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 set the gateway address, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Gateway address.
2. Enter gateway address.
3. Press the Accept button to save the modified parameter.

**TCP port (only with TCP transmission type)**

You can use this parameter to set the TCP port.

To set the TCP port, proceed as follows:
1. Go to Settings > Parameters > DNP3 > TCP port.
2. Enter TCP port.
3. Press the Accept button to save the modified parameter.

**Serial interface (only with serial transmission type)**

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

To select the serial interface, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Serial interface.
2. Select serial interface.
3. Press the Accept button to save the modified parameter.
Baud rate (only with serial transmission type)

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

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

To set the baud rate, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Baud rate.
2. Select baud rate.
3. Press the Accept button to save the modified parameter.

Device address

You can use this parameter to set the device’s link address. To set the device address, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Device address.
2. Enter device address.
3. Press the Accept button to save the modified parameter.

Destination address

You can use this parameter to set the link address of the destination master. To set the destination address, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Destination address.
2. Enter destination address.
3. Press the Accept button to save the modified parameter.

Unsolicited report mode

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

To set support for unsolicited messages, proceed as follows:
1. Go to Settings > Parameters > DNP3 > Unsolicited messages.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

Repetition of unsolicited messages

You can use this parameter to set how often the device is to send an unsolicited message until it receives a response from the DNP3 master.
To set the number of retries for unsolicited messages, proceed as follows:

1. Go to Settings > Parameters > DNP3 > Repetition of unsolicited messages.
2. Enter the desired number.
3. Press the Accept button to save the modified parameter.

Repeat unsolicited messages indefinitely

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

To set the indefinite number of unsolicited message repeats, proceed as follows:

1. Go to Settings > Parameters > DNP3 > Repeat unsolicited messages indefinitely.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

Timeout confirmation

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

To set the timeout for unsolicited messages, proceed as follows:

1. Go to Settings > Parameters > DNP3 > Timeout.
2. Enter the timeout.
3. Press the Accept button to save the modified parameter.

Timeout for response confirmation

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

To set the timeout for response confirmation, proceed as follows:

1. Go to Settings > Parameters > DNP3 > Timeout for response confirmation.
2. Enter the timeout.
3. Press the Accept button to save the modified parameter.

User ID code

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

To set the user ID code, proceed as follows:

1. Go to Settings > Parameters > DNP3 > User ID code.
2. Enter the user ID code.
3. Press the Accept button to save the modified parameter.
6.24 Time synchronization

You can synchronize the device time automatically using an SNTP time server. The device must be connected to an SNTP time server via Ethernet for this purpose. You can set the following parameters:

- Time synchronization via SNTP
- Activate second time server (optional)
- SNTP time server (for the first and second SNTP time servers)
- Synchronization interval
- Reference time
- Time zone

Figure 93: Setting time synchronization

The following sections describe how you can set these parameters.

6.24.1 Activating time synchronization using SNTP

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

To activate time synchronization using SNTP, proceed as follows:

1. Go to **Settings > Parameters > Time synchronization > Time synchronization via SNTP**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

Second time server (optional)

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

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

To activate the second time server, proceed as follows:
1. Go to **Settings > Parameters > Time synchronization > Activate sec-
   ond time server**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

### 6.24.2 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.

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.

To enter the time server address of the SNTP server, proceed as follows:
1. Go to **Settings > Parameters > Time synchronization > SNTP time
   server**.
2. Enter time server address.
3. Press the **Accept** button to save the modified parameter.

**Entering time server address of second time server (optional)**

You can use this parameter to enter the IP address of the second time serv-
er as an option.

To enter the time server address of the second SNTP server, proceed as fol-
lows:
1. Go to **Settings > Parameters > Time synchronization > SNTP time
   server 2**.
2. Enter time server address.
3. Press the **Accept** button to save the modified parameter.
6.24.3 Setting the time zone

If the time information is conveyed to the device by a network service (SNTP or SCADA), this time is transferred depending on the set reference time [► 150]. To adjust the device time to your local time, you can use the time shift parameter to set the time shift to UTC.

Example:

<table>
<thead>
<tr>
<th>Region</th>
<th>Time shift to UTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai, India</td>
<td>UTC +5:30 h</td>
</tr>
<tr>
<td>Beijing, China</td>
<td>UTC +8:00 h</td>
</tr>
<tr>
<td>Rio de Janeiro, Brazil</td>
<td>UTC -4:00 h</td>
</tr>
</tbody>
</table>

Table 39: Time shift to UTC (Coordinated Universal Time)

To set the time zone, proceed as follows:

1. Go to Settings > Parameters > Time synchronization > Time zone.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.

6.24.4 Setting synchronization interval

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

To set the synchronization interval, proceed as follows:

1. Go to Settings > Parameters > Time synchronization > Synchronization interval.
2. Enter synchronization interval.
3. Press the Accept button to save the modified parameter.

6.24.5 Reference time

You can use this parameter to set the reference time for time synchronization that the device is to adopt and display. The following options are available:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTC</td>
<td>The set UTC time is applied</td>
</tr>
<tr>
<td>Local time</td>
<td>The local time of the device is applied</td>
</tr>
</tbody>
</table>

Table 40: Reference time

To set the reference time, proceed as follows:

1. Go to Settings > Parameters > Time synchronization > Reference time.
2. Select the option you want.
3. Press the Accept button to save the modified parameter.
6.25 User administration

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

6.25.1 User roles

The access rights to device functions and settings are controlled using a hierarchical system of roles. The system has 5 different roles with different access rights. Some of these access rights are fixed, but you can configure the access rights to particular parameters and events. Note the Setting access rights to parameters and events [► 155] section.

If you are not logged in on the device, you will assume the "Data display" user role.

Upon delivery, the following roles are provided:

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data display</td>
<td>User who can only view data of relevance to operation.</td>
</tr>
<tr>
<td></td>
<td>• Display all parameters</td>
</tr>
<tr>
<td></td>
<td>• Display all events</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>User who can view data and log data of relevance to operation.</td>
</tr>
<tr>
<td></td>
<td>• Display all parameters</td>
</tr>
<tr>
<td></td>
<td>• Display all events</td>
</tr>
<tr>
<td></td>
<td>• Export log data</td>
</tr>
<tr>
<td>Operator</td>
<td>User who can view data of relevance to operation and acknowledge events.</td>
</tr>
<tr>
<td></td>
<td>• Display all parameters</td>
</tr>
<tr>
<td></td>
<td>• Display and acknowledge all events</td>
</tr>
<tr>
<td>Parameter configurator</td>
<td>User who can view and modify data of relevance to operation.</td>
</tr>
<tr>
<td></td>
<td>• Display and modify all parameters</td>
</tr>
<tr>
<td></td>
<td>• Import and export parameters</td>
</tr>
<tr>
<td></td>
<td>• Display, modify, and acknowledge all events</td>
</tr>
<tr>
<td>Administrator</td>
<td>User who can view and modify all data.</td>
</tr>
<tr>
<td></td>
<td>• Read all parameters</td>
</tr>
<tr>
<td></td>
<td>• Display, modify, and acknowledge all events</td>
</tr>
</tbody>
</table>

Table 41: Roles in delivery status
Access to the following areas of the device is linked to the roles:

<table>
<thead>
<tr>
<th>Role</th>
<th>Data display</th>
<th>Diagnostics</th>
<th>Operator</th>
<th>Parameter config.</th>
<th>Administrator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Import</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Export</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Set date and time</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Call up commissioning wizard</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Calibrate resistor contact series</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Actuation of the RAISE, LOWER, REMOTE, AVR AUTO, AVR MANUAL keys</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 42: Access rights permanently linked to the roles

### 6.25.2 Changing password

All users can change their passwords provided that the user account is not set up as a group account. You can only change a group account's password if you are logged in as the administrator.

Note that the password must satisfy the following requirements:

- At least 8 characters
- At least 3 of the 4 following character types
  - Upper case letters
  - Lower case letters
  - Numbers
  - Special characters
To change the password, proceed as follows:

1. Select the **user name** in the status line.

![Changing password](Image)

Figure 94: Changing password

2. Enter the new **password** twice.

3. Press the **Accept** button to save the modified password.

### 6.25.3 Creating, editing and deleting users

You can set the following options for all users:

- **Username and password**
- **Role**: You can assign a role to every user. The access rights to parameters and events are linked to the roles.
- **Group account**: With this option, you can declare a user account to be a group account (e.g. for access by different people). Users with a group account cannot change their own password. The password can only be changed by the administrator.
- **Active**: You can activate or deactivate the user. Deactivated users cannot log in. The user data is still stored in the device.
- **Auto login**: You can activate the Auto-login function for a user. This user is automatically logged in when the system is restarted or another user logs out.
You can only create, edit, and delete users if you are assigned an administrator role.

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

- **User name:** admin
- **Password:** admin

### Creating users

To create a new user, proceed as follows:

1. Go to **Settings > Administration > User**.
2. Press the **Create user** button.
3. Enter the **user name** once and the **password** twice.
4. Select the **role** you want.
5. If necessary activate the **Group account**, **Active** or **Auto login** options.
6. Press the **Accept** button to save the user.

### Editing users

To edit an existing user, proceed as follows:

1. Go to **Settings > Administration > User**.
2. Select the desired user in the list.
3. Make the amendments desired.
4. Press the **Accept** button to save the user.
Deleting user

To delete an existing user, proceed as follows:
1. Go to **Settings > Administration > User**.
2. Select the desired user in the list.
3. Press the **Delete user** button.
4. Press the **Accept** button to delete the user.

6.25.4 Setting access rights to parameters and events

You can configure access rights to parameters and events for the available roles. The following options are available for this purpose:
- Read: Parameter/event may be displayed.
- Write: Parameter/event may be modified.
- Acknowledge: Event may be acknowledged.

![Figure 96: Setting access rights for an event](image)

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

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

To set the access rights to parameters and events, proceed as follows:
1. Go to **Settings > Administration > Parameters/events**.
   - A list of all parameters or events appears.
2. Select the desired entry in the list.
3. Select the options you want.
4. Press the Accept button to save the change.

### 6.26 Information about device

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

#### 6.26.1 Hardware

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

To retrieve information on the hardware, proceed as follows:

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

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

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial number</td>
<td>1234567</td>
</tr>
<tr>
<td>Application</td>
<td>3.132</td>
</tr>
<tr>
<td>System</td>
<td>2.3</td>
</tr>
<tr>
<td>Configuration schema</td>
<td>1</td>
</tr>
<tr>
<td>Logging</td>
<td>3.1</td>
</tr>
<tr>
<td>Logging schema</td>
<td>1</td>
</tr>
<tr>
<td>IEC 61850 Version</td>
<td>2.01</td>
</tr>
</tbody>
</table>

Figure 98: Information on the device's software

To retrieve information on the device's software, proceed as follows:
► Go to Information > Software.

6.26.3 Parallel operation

Under parallel operation, you can display information about the devices which are connected by CAN bus.

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✂️</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>CAN addr.</td>
</tr>
<tr>
<td>Grp.</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>__</td>
</tr>
<tr>
<td>U [V]</td>
</tr>
<tr>
<td>I_p [%]</td>
</tr>
<tr>
<td>I_q [%]</td>
</tr>
<tr>
<td>🚦</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 43: Information about parallel operation
Figure 99: Parallel operation

To retrieve information on parallel operation, proceed as follows:

► Go to Information > Parallel operation.

6.27 Import/export manager

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

To transfer the data, the following options are available:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td>Data transfer via USB port on rear of CPU I assembly.</td>
</tr>
<tr>
<td>PC</td>
<td>Data transfer via PC using web-based visualization.</td>
</tr>
</tbody>
</table>

Table 44: Data transfer options

6.27.1 Exporting data

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

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System image</td>
<td>Complete image of the system (software and configuration). If you are using the option “with history”, all the event memory entries are exported too.</td>
</tr>
<tr>
<td>Customer program</td>
<td>Customer program export (TPLE).</td>
</tr>
<tr>
<td>Event memory</td>
<td>All event memory entries.</td>
</tr>
<tr>
<td>Recorder</td>
<td>Measured value memory export.</td>
</tr>
<tr>
<td>Parameter list</td>
<td>Parameter list with descriptive texts and values (min, max, current).</td>
</tr>
</tbody>
</table>
Table 45: Exporting data

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event list</td>
<td>Complete list of all possible events.</td>
</tr>
<tr>
<td>SCADA configuration</td>
<td>Control system configuration (e.g., ICD file for IEC 61850).</td>
</tr>
<tr>
<td>Operating instructions</td>
<td>Operating instructions, protocol specifications.</td>
</tr>
<tr>
<td>Settings</td>
<td>Configuration of parameters and events.</td>
</tr>
<tr>
<td>Security log</td>
<td>Logbook of all instances of access and amendments relating to security.</td>
</tr>
<tr>
<td>Data point configuration</td>
<td>Data point configuration of the control system.</td>
</tr>
</tbody>
</table>

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

To export data, proceed as follows:
1. Go to **Settings > Export**.
2. Select the option you want for the export.

### 6.27.2 Importing data (software version 3.44 and later)

You can import the following data:

Table 46: Importing data

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System image</td>
<td>Complete image of the system (software and configuration), with or without history.</td>
</tr>
<tr>
<td>Settings</td>
<td>All device settings:</td>
</tr>
<tr>
<td></td>
<td>• Parameter settings</td>
</tr>
<tr>
<td></td>
<td>• Event settings</td>
</tr>
<tr>
<td></td>
<td>• Administrative settings (users, access rights)</td>
</tr>
<tr>
<td></td>
<td>The settings can also be imported from another device.</td>
</tr>
<tr>
<td>Software</td>
<td>Import of device software (e.g. software update)</td>
</tr>
<tr>
<td>Language</td>
<td>Import of additional languages. You can install a maximum of 5 different languages on the device. If 5 languages are already installed, you will be asked to delete one during the import process.</td>
</tr>
<tr>
<td>SSL certificate</td>
<td>Import of an SSL certificate with associated key. For the import, you will have to package the certificate (<em>.crt) and key (</em>.pem) in a zip file.</td>
</tr>
</tbody>
</table>
**NOTICE**

### Damage to the file system

Damage to the file system due to improper data transfer may result in the device no longer functioning properly.

- Do not disconnect the device from the power supply during the import.
- During the import, do not remove the USB stick or disconnect the network connection.

To import data, proceed as follows:

1. Go to **Settings > Import**.
2. Select the option you want for data transmission (PC or USB).
3. Select the file to be imported.
   - The file is checked.
4. Press the **Import** button.
   - The data is imported, then the device is restarted.

---

### 6.28 Linking signals and events

The device allows you to link digital inputs (GPI) and control system commands (SCADA) with device functions, digital outputs (GPO), and control system messages.

The digital inputs available are each permanently linked to a **Generic digital input** event message and the control system commands available are each permanently linked to a **Generic SCADA command** event message for this purpose.

<table>
<thead>
<tr>
<th>Input/command</th>
<th>Event message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital input 1&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>Generic digital input 1</td>
</tr>
<tr>
<td>Digital input 2&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>Generic digital input 2</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Digital input 42&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>Generic digital input 42</td>
</tr>
<tr>
<td>Generic SCADA command 1</td>
<td>Generic SCADA command 1</td>
</tr>
<tr>
<td>Generic SCADA command 2</td>
<td>Generic SCADA command 2</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Generic SCADA command 10</td>
<td>Generic SCADA command 10</td>
</tr>
</tbody>
</table>

Table 47: Linking of digital inputs and control system commands with event messages

<sup>1)</sup> The number of available digital inputs depends on the order-specific device configuration.

You can link the event messages with device functions, digital outputs, and control system messages. You can also link all other event messages (e.g. *undervoltage U<*) with digital outputs and control system messages. Corresponding parameters, for which you need to enter the relevant event number, are provided for this purpose.
### 6.28.1 Linking functions

You can link the *Generic digital input* or *Generic SCADA command* events with device functions. This allows you to remotely control the device using digital inputs or commands via the control system (SCADA). Depending on your device configuration, the following parameters are available for this purpose:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master parallel operation method</td>
<td>If the assigned event is active, the device activates the master parallel operation method.</td>
</tr>
<tr>
<td>Follower parallel operation method</td>
<td>If the assigned event is active, the device activates the follower parallel operation method.</td>
</tr>
<tr>
<td>Automatic tap synchronization parallel operation method</td>
<td>If the assigned event is active, the device activates the automatic tap synchronization parallel operation method.</td>
</tr>
<tr>
<td>Independent regulation</td>
<td>If the assigned event is active, the device activates simplex mode.</td>
</tr>
<tr>
<td>Deactivate parallel operation</td>
<td>If the assigned event is active, the device deactivates parallel operation.</td>
</tr>
<tr>
<td>Blocking</td>
<td>If the assigned event is active, automatic voltage regulation is blocked.</td>
</tr>
<tr>
<td>Activate remote mode</td>
<td>If the assigned event is active, the device activates remote mode.</td>
</tr>
<tr>
<td>High-speed return</td>
<td>If the assigned event is active, the device activates high-speed return.</td>
</tr>
<tr>
<td>Target-tap-position operation</td>
<td>If the assigned event is active, the device switches to the defined target tap position.</td>
</tr>
<tr>
<td>Activate desired value 1</td>
<td>If the assigned event is active, the device activates desired value 1.</td>
</tr>
<tr>
<td>Activate desired value 2</td>
<td>If the assigned event is active, the device activates desired value 2.</td>
</tr>
<tr>
<td>Activate desired value 3</td>
<td>If the assigned event is active, the device activates desired value 3.</td>
</tr>
<tr>
<td>Activate desired value 4</td>
<td>If the assigned event is active, the device activates desired value 4.</td>
</tr>
<tr>
<td>Activate desired value 5</td>
<td>If the assigned event is active, the device activates desired value 5.</td>
</tr>
<tr>
<td>Increase desired value</td>
<td>If the assigned event is active, the device prompts an increase in the desired value.</td>
</tr>
</tbody>
</table>
### Table 48: Functions available

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease desired value</td>
<td>If the assigned event is active, the device prompts a decrease in the desired value.</td>
</tr>
</tbody>
</table>

**Figure 100: Link functions**

In order to establish the link, you have to enter the corresponding event number at the desired parameter.

Note that you can only enter the event numbers of the *Generic digital input* or *Generic SCADA command* events.

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

To link the function, proceed as follows:
- The desired event number is known.
  1. Go to **Settings > Parameters > Link functions**.
  2. Select the parameter you want.
  3. Enter the desired event number.
  4. Press the **Accept** button to save the modified parameter.

### 6.28.2 Linking digital outputs and control system messages

You can link each event with a digital output or control system message. Depending on your device configuration, the device provides a maximum of 20 digital outputs and 10 SCADA messages for this purpose.

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

When you link a digital output to an event, the device issues a signal to that output if the event occurs. The signal persists until the event stops. A parameter is available for each available digital output.

![Figure 101: Linking digital outputs](image)

In order to establish the link, you have to enter the corresponding event number at the desired parameter.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic digital output 1</td>
<td>500</td>
</tr>
<tr>
<td>Generic digital output 2</td>
<td>500</td>
</tr>
</tbody>
</table>

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

To link the digital output, proceed as follows:

1. The desired event number is known.
2. Go to Settings > Parameter > Link outputs.
3. Select the desired parameter.
4. Enter the desired event number.
5. Press the Accept button to save the modified parameter.
Linking SCADA messages

When you link a SCADA message to an event, the device sets the data point to "On" when the event occurs. When the event stops, the device sets the data point to "Off". A parameter is available for each available SCADA message.

Figure 102: Linking SCADA messages

In order to establish the link, you have to enter the corresponding event number at the desired parameter.

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

To link the SCADA message, proceed as follows:

- The desired event number is known.
1. Go to **Settings > Parameter > Link messages**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.
6.29 Motor Current Index (MCI)

The term Motor Current Index (in accordance with IEEE PC57.143) describes the area below the curve of the motor current during an on-load tap-change operation. The Motor Current Index is a measurement that takes into account the inrush current, the present tap-change conditions and the tap-change duration.

![Motor Current Index Graph]

Figure 103: Example illustration of the temporal progression of the motor current \( I \) and of the Motor Current Index \( MCI \) calculated from this in comparison with the values of the \( MCI \) for further on-load tap-change operations.

The motor runtime and therefore the Motor Current Index differ depending on the type of tap-change operation. The Motor Current Index will therefore be categorized in accordance with the following types of tap-change operation to aid comparison:

<table>
<thead>
<tr>
<th>Tap-change operation type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSO/CSO</td>
<td>The switching direction is the same as the previous switching direction. Example:</td>
</tr>
<tr>
<td>Tap selector operation /</td>
<td>- Previous tap-change operation: pos. 2 → pos. 3</td>
</tr>
<tr>
<td>change-over selector operation</td>
<td>- Current tap-change operation: pos. 3 → pos. 4</td>
</tr>
<tr>
<td>RSO</td>
<td>The switching direction is not the same as the previous switching direction. Example:</td>
</tr>
<tr>
<td>Reverse tap-change operation</td>
<td>- Previous tap-change operation: pos. 2 → pos. 3</td>
</tr>
<tr>
<td></td>
<td>- Current tap-change operation: pos. 3 → pos. 2</td>
</tr>
</tbody>
</table>

\[
\text{Motor Current Index (MCI)}
\]
### Tap-change operation type

<table>
<thead>
<tr>
<th>Tap-change operation type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>The tap-change operation type is unknown. This is the case after the device has been restarted or if the motor protective switch has been triggered.</td>
</tr>
</tbody>
</table>

Table 49: Tap-change operation types

For the correct determination of the Motor Current Index, you must use a signaling module for the tap position that also signals the pass-through position as a separate tap position.

### 6.29.1 Setting MCI monitoring

The device can monitor the Motor Current Index (MCI) and trigger an event message if the Motor Current Index is outside of the permissible range. If you would like to monitor the Motor Current Index, you must set the following parameters.

![Figure 104: Motor Current Index](image)

**Determining the limit values**

Upon delivery, the limit values have not been determined. Maschinenfabrik Reinhausen GmbH recommends the following procedure for determining the limit values:

1. When commissioning the product, deactivate limit value monitoring.
2. After one year, display the minimum and maximum values of the Motor Current Index (MCI extreme values [► 167]).
3. Use the maximum value of the MCI + 20% for the upper limit value, and the minimum value of the MCI - 20% for the lower limit value.
4. Repeat this procedure annually, and then reset the MCI extreme values.
Limit value monitoring

You can use this parameter to activate or deactivate Motor Current Index monitoring.

To activate/deactivate Motor Current Index monitoring, proceed as follows:
1. Go to Settings > Parameters > Motor Current Index > Limit value monitoring.
2. Select the desired option.
3. Press the Accept button to save the modified parameter.

TSO/CSO > and TSO/CSO <

You can set two limit values for tap selector operations / change-over selector operations:
- TSO/CSO >: upper limit value
- TSO/CSO <: lower limit value

If the Motor Current Index is greater than the upper limit value or is less than the lower limit value, the device triggers an event message.

To set the TSO/CSO > and TSO/CSO < limit values, proceed as follows:
1. Go to Settings > Parameters > Motor Current Index > TSO/CSO > / TSO/CSO <.
2. Enter the desired value.
3. Press the Accept button to save the modified parameter.

RSO > and RSO <

You can set two limit values for reverse tap-change operation:
- RSO >: upper limit value
- RSO <: lower limit value

If the Motor Current Index is greater than the upper limit value or is less than the lower limit value, the device triggers an event message.

To set the RSO > and RSO < limit values, proceed as follows:
1. Go to Settings > Parameters > Motor Current Index > RSO > / RSO <.
2. Enter the desired value.
3. Press the Accept button to save the modified parameter.

6.29.2 Displaying the MCI

You can display the progression and the extreme values of the Motor Current Index.
MCI values

In the MCI values menu, you can display the Motor Current Index recorded values and the corresponding tap position of the last 3000 tap-change operations.

The following buttons are available for navigation within the diagram:

- ![First Page](image1.png): Call up first page.
- ![Previous Page](image2.png): Call up previous page.
- ![Next Page](image3.png): Call up next page.
- ![Last Page](image4.png): Call up last page.
- ![Update Display](image5.png): Update the display.

To call up the MCI values, proceed as follows:
1. Go to Information > MCI values.
2. Where necessary, select the navigation buttons to change pages.
### MCI extreme values

In the MCI extreme values menu, you can display the maximum and minimum values of the Motor Current Index and the corresponding dates.

**Figure 106: MCI extreme values**

To call up the MCI extreme values, proceed as follows:

1. Go to **Information > MCI extreme values**.
2. Where necessary, select the **Reset** button to clear the displayed extreme values.

### Measured value recorder (optional)

You can display the values of the Motor Current Index in the measured value recorder if the device has the measured value recorder option. You will find more information in the section Display measured value recorder [► 125].

Note that the tap-change operation type is displayed as follows:

- 0: Unknown tap-change operation type
- 1: Tap selector operation / change-over selector operation (TSO/CSO)
- 2: Reverse tap-change operation (RSO)
7 Fault elimination

This chapter describes how to rectify simple operating faults.

7.1 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>• Device not starting</td>
<td>Fuse tripped</td>
<td>Contact Maschinenfabrik Reinhausen GmbH</td>
</tr>
<tr>
<td>No function</td>
<td>Rotary switch of CPU II assembly moved</td>
<td>Correct position of rotary switch:</td>
</tr>
<tr>
<td>• ERR LED of CPU II assembly lights up</td>
<td></td>
<td>• 0 position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• RUN position</td>
</tr>
<tr>
<td></td>
<td>Configuration error</td>
<td>Contact Maschinenfabrik Reinhausen GmbH</td>
</tr>
<tr>
<td>Relays chatter</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 50: General faults

7.2 Human-machine interface

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No display/mask is not loaded</td>
<td>Power supply interrupted.</td>
<td>Check power supply.</td>
</tr>
<tr>
<td></td>
<td>Error when loading the current mask in the browser.</td>
<td>Press [F5] key to update the mask.</td>
</tr>
<tr>
<td></td>
<td>Fuse faulty.</td>
<td>Contact Maschinenfabrik Reinhausen.</td>
</tr>
<tr>
<td>Connection cannot be established with visualization</td>
<td>Connection cable defective.</td>
<td>Check connection cable.</td>
</tr>
<tr>
<td></td>
<td>IP addresses of visualization and SCADA are in the same subnet.</td>
<td>Check the setting of the IP addresses of the device and correct where necessary.</td>
</tr>
<tr>
<td></td>
<td>PC not in same subnet as visualization.</td>
<td>Check the setting of the IP addresses of the device and PC and correct where necessary.</td>
</tr>
</tbody>
</table>

Table 51: Human-machine interface

7.3 Other faults

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

- Serial number
  - Name plate (can be found on CPU assembly)
- Software version [► 156]
7 Fault elimination

Please provide answers to the following questions:

- Has the software been updated?
- Has there previously been a problem with this device?
- Have you previously contacted Maschinenfabrik Reinhausen about this issue? If yes, then who was the contact?
8 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.
9 Technical data

9.1 Voltage supply

<table>
<thead>
<tr>
<th></th>
<th>G1 PULS QS3.241</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible voltage range</td>
<td>85...276 V AC</td>
</tr>
<tr>
<td></td>
<td>88...375 V DC</td>
</tr>
<tr>
<td></td>
<td>Uₚ: 100...240 V AC</td>
</tr>
<tr>
<td></td>
<td>Uₚ: 110...300 V DC</td>
</tr>
<tr>
<td>Permissible frequency range</td>
<td>50 / 60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Max. 130 W</td>
</tr>
<tr>
<td>Inrush current impulse</td>
<td>Typ. 10 A, max. 13 A</td>
</tr>
</tbody>
</table>

Table 52: Voltage supply

9.2 Voltage measurement and current measurement

<table>
<thead>
<tr>
<th>Measurement</th>
<th>UI 1</th>
<th>UI 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage measurement</td>
<td>Uₚ (RMS): 100 V AC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range (RMS): 19.6...150 V AC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring accuracy (at Uₚ): ±0.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrinsic consumption: &lt; 1 VA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measurement category III in accordance with IEC 61010-2-30</td>
<td></td>
</tr>
<tr>
<td>Current measurement</td>
<td>Iₚ: 0.2 / 1 / 5 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range: 0.01...2.1 · Iₚ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overload capacity: 12.5 A (continuous), 500 A (for 1 s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring accuracy (at Iₚ): ±0.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrinsic consumption: &lt; 1 VA</td>
<td></td>
</tr>
<tr>
<td>Phase angle</td>
<td>Measuring accuracy (-25...+70 °C): Uₚ/Iₚ &lt;±0.5%; Uₚ/Uₚ &lt;±0.3°</td>
<td></td>
</tr>
<tr>
<td>Frequency measurement</td>
<td>fₚ: 50 / 60 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring range: 45...65 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring accuracy (-25...+70 °C): &lt;±0.03%</td>
<td></td>
</tr>
</tbody>
</table>

Table 53: Technical data for the UI 1 and UI 3 assemblies
### Interfaces

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UI 1 N L NC NC</td>
<td>N</td>
<td>Voltage input for neutral conductor</td>
</tr>
<tr>
<td>UI 3 N L1 L2 L3</td>
<td>L, L1</td>
<td>Voltage input for phase L (UI 1) or L1 (UI 3)</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>Voltage input for phase L2 (only UI 3)</td>
</tr>
<tr>
<td></td>
<td>L3</td>
<td>Voltage input for phase L3 (only UI 3)</td>
</tr>
</tbody>
</table>

Table 54: Voltage measurement

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UI 1 k k1</td>
<td>k, k1</td>
<td>Current input for phase L (UI 1) or L1 (UI 3)</td>
</tr>
<tr>
<td>UI 3 l l1</td>
<td>l, l1</td>
<td>Current output for phase L (UI 1) or L1 (UI 3)</td>
</tr>
<tr>
<td></td>
<td>l2</td>
<td>Current output for phase L2 (only UI 3)</td>
</tr>
<tr>
<td></td>
<td>l3</td>
<td>Current output for phase L3 (only UI 3)</td>
</tr>
</tbody>
</table>

Table 55: Current measurement

### 9.3 Digital inputs and outputs

<table>
<thead>
<tr>
<th>DIO 28-15</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs (plug-based electrical isolation)</td>
<td>Quantity</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Logical 0</td>
<td>0…10 V AC (RMS) 0…10 V DC</td>
</tr>
<tr>
<td>Logical 1</td>
<td>18…260 V AC (RMS) 18…260 V DC (RMS)</td>
</tr>
<tr>
<td>Input current</td>
<td>min. 1.3 mA</td>
</tr>
<tr>
<td>Simultaneity factor (at 70 °C ambient temperature and input voltage ≥ 230 V)</td>
<td>max. 50%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Outputs (floating relay outputs)</td>
<td>Number (number of change-over contacts in parentheses)</td>
</tr>
<tr>
<td></td>
<td>15 (9)</td>
</tr>
<tr>
<td>Contact loadability</td>
<td>Alternating current mode: $U_n$: 230 V AC; $I_n$: 5 A</td>
</tr>
<tr>
<td></td>
<td>Direct current mode: See diagram</td>
</tr>
</tbody>
</table>
9 Technical data

<table>
<thead>
<tr>
<th>Outputs (floating relay outputs)</th>
<th>Simultaneity factor (if output is loaded with 5 A)</th>
<th>DIO 28-15 up to 60 °C: 100%, &gt; 60 °C: -5%/K</th>
</tr>
</thead>
</table>

Table 56: Technical data for the DIO 28-15 assembly

![Graph](image)

Figure 107: Contact loadability DIO

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

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

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td>1 9 17 25</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>2 10 18 26</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>3 11 19 27</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>4 12 20 28</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>5 13 21 29</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>6 14 22 30</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>7 15 23 31</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>8 16 24 32</td>
<td>Common</td>
</tr>
</tbody>
</table>

Table 57: Digital inputs
9.4 Analog inputs and outputs

<table>
<thead>
<tr>
<th>Channels (input or output)</th>
<th>AIO 2</th>
<th>AIO 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring range</td>
<td>0...10 V</td>
<td>0...10 V</td>
</tr>
<tr>
<td></td>
<td>0...20 mA</td>
<td>0...20 mA</td>
</tr>
<tr>
<td></td>
<td>4...20 mA</td>
<td>4...20 mA</td>
</tr>
<tr>
<td>Load resistance</td>
<td>max. 300 Ω</td>
<td>max. 500 Ω</td>
</tr>
<tr>
<td>(0/4...20 mA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal range</td>
<td>0...10 V</td>
<td>0...10 V</td>
</tr>
<tr>
<td></td>
<td>0...20 mA</td>
<td>0...20 mA</td>
</tr>
<tr>
<td></td>
<td>4...20 mA</td>
<td>4...20 mA</td>
</tr>
<tr>
<td>Load resistance</td>
<td>max. 500 Ω</td>
<td>max. 500 Ω</td>
</tr>
<tr>
<td>(0/4...20 mA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistor contact series</td>
<td>Maximum resistance of 100 Ω...10 kΩ, max. 35 tap positions</td>
<td>Maximum resistance of 100 Ω...10 kΩ, max. 35 tap positions</td>
</tr>
</tbody>
</table>

Table 59: Technical data for the AIO 2 and AIO 4 assemblies
### 9.5 Central processing unit

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>266 MHz</td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>256 MB</td>
<td></td>
</tr>
<tr>
<td>Interfaces</td>
<td>1x serial RS232/485 (electrically isolated)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3x Ethernet 10/100 Mbit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x USB 2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x CAN (electrically isolated)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x CAN</td>
<td></td>
</tr>
<tr>
<td>NVRAM (SRAM with battery backup)</td>
<td>256 kB</td>
<td></td>
</tr>
<tr>
<td>Application memory</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>+24 V DC (18...36 V DC)</td>
<td></td>
</tr>
</tbody>
</table>

Table 61: Technical data for the CPU I assembly

### Interfaces

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>2</td>
<td>RXD (RS232)</td>
</tr>
<tr>
<td>Interface</td>
<td>3</td>
<td>TXD (RS232)</td>
</tr>
<tr>
<td>Interface</td>
<td>5</td>
<td>GND (RS232, RS485)</td>
</tr>
<tr>
<td>Interface</td>
<td>6</td>
<td>RXD+/TXD+ (RS485)</td>
</tr>
<tr>
<td>Interface</td>
<td>9</td>
<td>RXD-/TXD- (RS485)</td>
</tr>
</tbody>
</table>

Table 62: COM2 (RS232, RS485)

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>1</td>
<td>VCC</td>
</tr>
<tr>
<td>Interface</td>
<td>2</td>
<td>D-</td>
</tr>
<tr>
<td>Interface</td>
<td>3</td>
<td>D+</td>
</tr>
<tr>
<td>Interface</td>
<td>4</td>
<td>GND</td>
</tr>
</tbody>
</table>

Table 63: USB 2.0
### 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>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>4</td>
<td>NC</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>NC</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>RxD-</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>NC</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>NC-</td>
</tr>
</tbody>
</table>

Table 64: ETH1, ETH 2.1, ETH 2.2 (RJ45)

### Interface Transport protocol Port Description

<table>
<thead>
<tr>
<th>Interface</th>
<th>Transport protocol</th>
<th>Port</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>21</td>
<td>FTP(^1) (only for MR service)</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>990</td>
<td>FTPS (only for MR service)</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>80</td>
<td>HTTP(^1)</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>8080</td>
<td>HTTP(^1)</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>443</td>
<td>HTTPS</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>TCP</td>
<td>8081</td>
<td>HTTPS</td>
</tr>
<tr>
<td>ETH 2.x</td>
<td>UDP</td>
<td>123</td>
<td>SNTP</td>
</tr>
<tr>
<td>ETH 1</td>
<td>TCP</td>
<td>102</td>
<td>Only with IEC 61850 (MMS)</td>
</tr>
<tr>
<td>ETH 1</td>
<td>TCP</td>
<td>502(^2)</td>
<td>Only with Modbus TCP</td>
</tr>
<tr>
<td>ETH 1</td>
<td>TCP</td>
<td>20000(^2)</td>
<td>Only with DNP3 via TCP</td>
</tr>
<tr>
<td>ETH 1</td>
<td>TCP</td>
<td>2404(^2)</td>
<td>Only with IEC 60870-5-104</td>
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<tr>
<td>ETH 1</td>
<td>UDP</td>
<td>123</td>
<td>SNTP</td>
</tr>
</tbody>
</table>

Table 65: List of open Ethernet ports

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

2) Default setting; if you have modified the port for the control system protocol, only the set port is opened.

### Interface Pin Description

<table>
<thead>
<tr>
<th>Interface</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>CAN-L</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>CAN-GND</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>CAN-H</td>
</tr>
</tbody>
</table>

Table 66: CAN1, CAN2
### 9.6 Ambient conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-25...+70 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40...+85 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10...95% non-condensing</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Corresponds to 3,000 m above sea level; derating for altitudes up to 4,500 m of -0.5 K/100 m</td>
</tr>
<tr>
<td>Minimum spacing to other devices/control cabinet</td>
<td>Top/Bottom: 88.9 mm (3.5 in; corresponds to 2 RU), back 30 mm (1.2 in)</td>
</tr>
</tbody>
</table>

Table 68: Permissible ambient conditions

### 9.7 Standards and directives

#### Electrical safety

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61010-1</td>
<td>Safety requirements for electrical measurement and control and regulation equipment and laboratory instruments</td>
</tr>
</tbody>
</table>
| IEC 61010-2-030 | • Protection class 1  
|               | • Overvoltage category III  
|               | • Contamination level 2 |
| IEC 60950-1 | Information technology equipment – Safety                                   |

Table 69: Electrical safety

---

CAN bus | Terminating resistor
- | -
- | D-SUB plug connector (9 pins)
- | R = 120 Ω

Connector with terminal strip for directly connecting CAN lines

Media converter for COM2 interface (only RS232) | Adapter from D-SUB (9 pins) to fiber-optic cable:
- | ACF660/ST: F-ST, 660 nm, range max. 60 m at 40 kilobaud
- | ACF660/SMA: F-SMA, 660 nm, range max. 60 m at 40 kilobaud
- | ACF850/ST: F-ST, 850 nm, range max. 1000 m at 40 kilobaud
- | ACF850/SMA: F-SMA, 850 nm, range max. 1000 m at 40 kilobaud

Table 67: Optional accessories
### Electromagnetic compatibility

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IEC 61000-4-2</strong></td>
<td>Immunity from electrostatic discharge (ESD)</td>
</tr>
<tr>
<td></td>
<td>- Front panel and operating elements</td>
</tr>
<tr>
<td></td>
<td>- Contact: ±8 kV</td>
</tr>
<tr>
<td></td>
<td>- Air: ±15 kV</td>
</tr>
<tr>
<td></td>
<td>- Terminals, plug connectors, and interfaces:</td>
</tr>
<tr>
<td></td>
<td>- Contact: ±6 kV</td>
</tr>
<tr>
<td></td>
<td>- Air: ±8 kV</td>
</tr>
<tr>
<td><strong>IEC 61000-4-3</strong></td>
<td>Immunity from high-frequency electromagnetic fields</td>
</tr>
<tr>
<td></td>
<td>- 20 V/m; 80…4000 MHz; 80% AM</td>
</tr>
<tr>
<td></td>
<td>- 20 V/m; 900 MHz ±5 MHz; PM</td>
</tr>
<tr>
<td><strong>IEC 61000-4-4</strong></td>
<td>Immunity from quick, transient electrical disturbances (burst)</td>
</tr>
<tr>
<td></td>
<td>- Power supply: 4 kV</td>
</tr>
<tr>
<td></td>
<td>- Measurement (UI1/3): 4 kV</td>
</tr>
<tr>
<td></td>
<td>- Digital I/O: 4 kV</td>
</tr>
<tr>
<td></td>
<td>- Analog I/O, shielding on both sides: 4 kV</td>
</tr>
<tr>
<td></td>
<td>- Communication interfaces, shielding on both sides: 4 kV</td>
</tr>
<tr>
<td><strong>IEC 61000-4-5</strong></td>
<td>Immunity from surges</td>
</tr>
<tr>
<td></td>
<td>- AC power supply: 4 kV CM, 2 kV DM</td>
</tr>
<tr>
<td></td>
<td>- DC power supply: 2 kV CM, 1 kV DM</td>
</tr>
<tr>
<td></td>
<td>- Measurement (UI1/3): 4 kV CM, 2 kV DM</td>
</tr>
<tr>
<td></td>
<td>- Digital I/O: 2 kV CM, 1 kV DM</td>
</tr>
<tr>
<td></td>
<td>- Analog I/O, shielding on both sides: 2 kV CM</td>
</tr>
<tr>
<td></td>
<td>- Communication interfaces, shielding on both sides: 2 kV CM</td>
</tr>
<tr>
<td><strong>IEC 61000-4-6</strong></td>
<td>Immunity from conducted disturbances, induced by high-frequency fields</td>
</tr>
<tr>
<td></td>
<td>- 10 V, 150 kHz…80 MHz, 80 % AM</td>
</tr>
<tr>
<td><strong>IEC 61000-4-8</strong></td>
<td>Immunity from power frequency magnetic fields</td>
</tr>
<tr>
<td></td>
<td>- 100 A/m, 50/60 Hz, continuously</td>
</tr>
<tr>
<td></td>
<td>- 1000 A/m, 50/60 Hz, for 1 s</td>
</tr>
<tr>
<td><strong>IEC 61000-4-11</strong></td>
<td>Immunity to drops in voltage, intermittent interrupts, and voltage fluctuations</td>
</tr>
<tr>
<td></td>
<td>- 40 % $U_n$ for 300 ms</td>
</tr>
<tr>
<td></td>
<td>- 0 % $U_n$ for 100 ms</td>
</tr>
</tbody>
</table>

Table 70: Immunity in accordance with IEC 61000-6-2
### 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 IP52 for the front, IP 20 for the rear</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>
<tr>
<td>IEC 60068-2-78</td>
<td>Constant moist heat + 40 °C / 93% / 4 days, no dew</td>
</tr>
<tr>
<td>ASTM D 4169-09</td>
<td>Standard Practice for Performance Testing of Shipping Containers and Systems</td>
</tr>
<tr>
<td>IEC 60255-21-1</td>
<td>Vibrations (3 cycles, 0.5·g 1 octave/min; 60 cycles, 1.0·g, 1 octave/min)</td>
</tr>
<tr>
<td>IEC 60255-21-2</td>
<td>Shocks (11 ms, 5·g, 15·g, 3 axes)</td>
</tr>
<tr>
<td>IEC 60255-21-3</td>
<td>Earthquakes (1...35 Hz; 3.5 mm/1·g horizontal; 1.5 mm/0.5·g vertical; 1 octave/min, 10 min/axis)</td>
</tr>
</tbody>
</table>

Table 71: Emitted interference in accordance with IEC 61000-6-4

Table 72: Environmental durability tests
## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>CSO</td>
<td>Change-over selector operation</td>
</tr>
<tr>
<td>DGA</td>
<td>Analysis of the gases dissolved in the oil (Dissolved Gas Analysis)</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsches Institut für Normung (German Institute for Standardization)</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EN</td>
<td>European standard</td>
</tr>
<tr>
<td><strong>Generator sign convention</strong></td>
<td>Definition for describing electrical circuits. The arrows for current rating and voltage on a “consumer” absorbing electrical power (e.g. a resistor) face opposite directions. ( U^* I ) is the power generated in the component and ( -U^* I ) is the power absorbed by the component.</td>
</tr>
<tr>
<td>GPI</td>
<td>General Purpose Input</td>
</tr>
<tr>
<td>GPO</td>
<td>General Purpose Output</td>
</tr>
<tr>
<td><strong>Load sign convention</strong></td>
<td>Definition for describing electrical circuits. The arrows for current rating and voltage on a “consumer” absorbing electrical power (e.g. a resistor) face the same direction. ( U^* I ) is the power absorbed by the component.</td>
</tr>
<tr>
<td>Hot-spot</td>
<td>Point of highest temperature in the transformer winding.</td>
</tr>
<tr>
<td>ICD</td>
<td>IED Capability Description</td>
</tr>
<tr>
<td>IEC</td>
<td>The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.</td>
</tr>
<tr>
<td>IEEE</td>
<td>Worldwide association of engineers, mainly from the fields of electrical engineering and IT (Institute of Electrical and Electronics Engineers)</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td><strong>Motor Current Index</strong></td>
<td>Integral (area under) of the motor current curve in accordance with IEEE PC57.143</td>
</tr>
<tr>
<td>RSO</td>
<td>Reverse tap-change operation</td>
</tr>
<tr>
<td>SCADA</td>
<td>Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)</td>
</tr>
<tr>
<td>SNTP</td>
<td>NTP (Network Time Protocol) is a standard for synchronizing clocks in computer systems using packet-based communication networks. SNTP (Simple Network Time Protocol) is the simplified version of NTP.</td>
</tr>
<tr>
<td><strong>TDSC</strong></td>
<td>TAPCON® Dynamic Set Point Control</td>
</tr>
<tr>
<td>TILA</td>
<td>TAPCON® Interactive Launch Assist</td>
</tr>
</tbody>
</table>
Glossary

TSO
Tap selector operation
List of key words

A
Access rights 155
Aging rate
Display 93
Setting calculation 96
AIO 2 20
AIO 4 20
Analog inputs and outputs 110
ASDU address 133, 137, 139
ASDU sequence optimization 135, 140
Assembly
AIO 20
CPU I 20
DIO 19
QS3 18
UI 19

B
Bandwidth 63
Bandwidth monitoring 90
Baud rate 132, 136, 143, 146
Behavior if no communication present 84

C
Cable recommendation 27
CAN bus 83
Channel (AIO) 32
Circulating reactive current 81
Circulating reactive current blocking limit 82
Circulating reactive current sensitivity 81
Commissioning wizard 42
Connection 27
Contact wear 110
Control
Bandwidth 63
Delay time T1 65
Delay time T2 66
Time response T1 65
Control parameters 49
Control system 128
Control variable 77
Cooling system
Alternating mode 103
Configuring cooling stage 98
Load-dependent mode 101
Periodic mode 102
Status 104
CPU I 20
Current monitoring 89
Current transformer
Primary current 69
Secondary current 69
Current-transformer circuit 75

D
Data
Import/export 158
Databits 134, 137, 143
Date 41
Delay time T1 65
Delay time T2 66
desired value 49, 50, 51, 52, 62
Desired value adjustment
Active power-dependent 52, 56
desired value setting
BCD 60
Max. 51
Min. 52
Desired value step width 52
Device name 130
DFC compatibility 137
DGA 94
Curve 107
Digital inputs and outputs 112
DIO 28-15 19
DNP3 144
DNP3 transmission type 144

E
Electromagnetic compatibility 34
Event memory 122
Events 120
Acknowledge 120
Configure 121
Display 120
Exporting 123
Filtering 123
Export 158

F
Function monitoring 90

G
Gateway
General 46
Gateway address 130, 139, 145
General 44
GPI 160
GPO 160
<table>
<thead>
<tr>
<th>List of key words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H</strong></td>
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<tr>
<td>Hardware</td>
</tr>
<tr>
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</tr>
<tr>
<td>Hot-spot</td>
</tr>
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<td><strong>I</strong></td>
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<td>IEC 60870-5-101</td>
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<td>Measuring mode</td>
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<td>Octet number</td>
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<tr>
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<td>Cause of transmission</td>
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<tr>
<td>Information object address</td>
</tr>
<tr>
<td>Link address</td>
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<tr>
<td>Operating duration</td>
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<tr>
<td>Outputs</td>
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</tr>
<tr>
<td>Overvoltage</td>
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<td><strong>P</strong></td>
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<td>Parallel operation</td>
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<td>CAN bus</td>
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<tr>
<td>Circulating reactive current</td>
</tr>
<tr>
<td>Information</td>
</tr>
<tr>
<td>Parallel operation error message</td>
</tr>
<tr>
<td>Parallel operation method</td>
</tr>
<tr>
<td>Tap synchronization</td>
</tr>
<tr>
<td>Parity</td>
</tr>
<tr>
<td>Password</td>
</tr>
<tr>
<td>Phase angle correction</td>
</tr>
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<td>Power monitoring</td>
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<td>Protective device status</td>
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<td><strong>Q</strong></td>
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<td>Regulation</td>
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<td>Regulation mode</td>
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<td>Repeat unsolicited messages indefinitely</td>
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<td>RES bit test</td>
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<td>Second time server</td>
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<td>Select desired value</td>
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<td>setting of the desired value analog</td>
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<tr>
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<td>Synchronization interval</td>
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### List of Key Words

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<tr>
<td>Tap difference</td>
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<tr>
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