# Table of contents

1. **Introduction** .......................................................................................................................... 9
  1.1 Manufacturer ......................................................................................................................... 9
  1.2 Subject to change without notice ............................................................................................ 9
  1.3 Completeness .......................................................................................................................... 9
  1.4 Safekeeping ............................................................................................................................ 9
  1.5 Notation conventions .............................................................................................................. 9
    1.5.1 Hazard communication system ....................................................................................... 10
    1.5.2 Information system ......................................................................................................... 11
    1.5.3 Instruction system .......................................................................................................... 11
    1.5.4 Typographic conventions ............................................................................................... 12

2. **Safety** .................................................................................................................................. 13
  2.1 General safety information ........................................................................................................ 13
  2.2 Appropriate use ..................................................................................................................... 13
  2.3 Inappropriate use ................................................................................................................... 13
  2.4 Personnel qualification ........................................................................................................... 13
  2.5 Operator’s duty of care .......................................................................................................... 14

3. **IT security** ............................................................................................................................ 15

4. **Product description** ............................................................................................................... 19
  4.1 Scope of delivery ..................................................................................................................... 19
  4.2 Function description of the voltage regulation ........................................................................ 20
  4.3 Performance features ............................................................................................................ 21
  4.4 Operating modes .................................................................................................................... 22
  4.5 Hardware ................................................................................................................................ 23
    4.5.1 Name plate ....................................................................................................................... 24
    4.5.2 Operating controls ............................................................................................................ 24
    4.5.3 Display elements .............................................................................................................. 26
    4.5.4 Serial interface ................................................................................................................. 28
    4.5.5 Modules ............................................................................................................................ 28

5. **Packaging, transport and storage** ......................................................................................... 33
  5.1 Packaging ............................................................................................................................... 33
    5.1.1 Purpose ........................................................................................................................... 33
    5.1.2 Suitability, structure and production .............................................................................. 33
## Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1.3</td>
<td>Markings</td>
<td>33</td>
</tr>
<tr>
<td>5.2</td>
<td>Transportation, receipt and handling of shipments</td>
<td>33</td>
</tr>
<tr>
<td>5.3</td>
<td>Storage of shipments</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>Mounting</td>
<td>36</td>
</tr>
<tr>
<td>6.1</td>
<td>Preparation</td>
<td>36</td>
</tr>
<tr>
<td>6.2</td>
<td>Mounting device</td>
<td>36</td>
</tr>
<tr>
<td>6.2.1</td>
<td>Flush panel mounting</td>
<td>38</td>
</tr>
<tr>
<td>6.2.2</td>
<td>Wall mounting with mounting brackets</td>
<td>39</td>
</tr>
<tr>
<td>6.2.3</td>
<td>Cap rail mounting</td>
<td>40</td>
</tr>
<tr>
<td>6.2.4</td>
<td>Wall mounting</td>
<td>41</td>
</tr>
<tr>
<td>6.2.5</td>
<td>Removing the door</td>
<td>42</td>
</tr>
<tr>
<td>6.3</td>
<td>Connecting device</td>
<td>43</td>
</tr>
<tr>
<td>6.3.1</td>
<td>Cable recommendation</td>
<td>44</td>
</tr>
<tr>
<td>6.3.2</td>
<td>Information about laying fiber-optic cable</td>
<td>45</td>
</tr>
<tr>
<td>6.3.3</td>
<td>Electromagnetic compatibility</td>
<td>46</td>
</tr>
<tr>
<td>6.3.4</td>
<td>Connecting cables to the system periphery</td>
<td>50</td>
</tr>
<tr>
<td>6.3.5</td>
<td>Supplying the voltage regulator using auxiliary voltage</td>
<td>50</td>
</tr>
<tr>
<td>6.3.6</td>
<td>Wiring device</td>
<td>51</td>
</tr>
<tr>
<td>6.3.7</td>
<td>Checking functional reliability</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>Commissioning</td>
<td>54</td>
</tr>
<tr>
<td>7.1</td>
<td>Setting the display contrast</td>
<td>54</td>
</tr>
<tr>
<td>7.2</td>
<td>Setting parameters</td>
<td>54</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Setting the language</td>
<td>55</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Setting further parameters</td>
<td>55</td>
</tr>
<tr>
<td>7.3</td>
<td>Calibrating the analog input</td>
<td>56</td>
</tr>
<tr>
<td>7.4</td>
<td>Function tests</td>
<td>57</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Checking control functions</td>
<td>58</td>
</tr>
<tr>
<td>7.4.2</td>
<td>Checking additional functions</td>
<td>59</td>
</tr>
<tr>
<td>7.4.3</td>
<td>Checking parallel operation</td>
<td>62</td>
</tr>
<tr>
<td>8</td>
<td>Operation</td>
<td>67</td>
</tr>
<tr>
<td>8.1</td>
<td>Key lock</td>
<td>67</td>
</tr>
<tr>
<td>8.2</td>
<td>General</td>
<td>67</td>
</tr>
<tr>
<td>8.2.1</td>
<td>Setting device ID</td>
<td>67</td>
</tr>
<tr>
<td>8.2.2</td>
<td>Setting the baud rate</td>
<td>68</td>
</tr>
<tr>
<td>8.2.3</td>
<td>Setting the switching pulse time</td>
<td>68</td>
</tr>
</tbody>
</table>
Table of contents

8.4.3 Bandwidth ........................................................................................................................................ 82
8.4.4 Setting delay time T1 .......................................................................................................................... 83
8.4.5 Setting control response T1 ................................................................................................................... 84
8.4.6 Setting delay time T2 .......................................................................................................................... 84
8.5 Limit values ............................................................................................................................................... 87
8.5.1 Setting undervoltage monitoring U<...................................................................................................... 87
8.5.2 Setting overvoltage monitoring U>......................................................................................................... 90
8.5.3 Setting overcurrent monitoring I>.......................................................................................................... 92
8.5.4 Set undercurrent monitoring I<........................................................................................................... 93
8.5.5 Activate/deactivate active power monitoring ......................................................................................... 94
8.5.6 Permitted tap positions .......................................................................................................................... 94
8.6 Compensation ........................................................................................................................................... 96
8.6.1 Line drop compensation ....................................................................................................................... 96
8.6.2 Z compensation ..................................................................................................................................... 96
8.7 Transformer data ....................................................................................................................................... 101
8.7.1 Setting the primary transformer voltage .............................................................................................. 101
8.7.2 Setting the secondary transformer voltage ............................................................................................ 102
8.7.3 Setting primary transformer current ...................................................................................................... 103
8.7.4 Setting the current transformer connection ........................................................................................... 103
8.7.5 Setting the phase difference for the current transformer/voltage transformer ..................................... 104
8.8 Parallel operation ....................................................................................................................................... 108
8.8.1 Assigning CAN bus address .................................................................................................................. 109
8.8.2 Selecting parallel operation method ..................................................................................................... 109
8.8.3 Assigning a parallel operation group .................................................................................................... 110
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8.4 Activating/deactivating blocking in simplex mode</td>
<td>114</td>
</tr>
<tr>
<td>8.8.5 Setting delay time for parallel operation error messages</td>
<td>114</td>
</tr>
<tr>
<td>8.8.6 Configuring the maximum permitted tap difference</td>
<td>115</td>
</tr>
<tr>
<td>8.8.7 Activating/deactivating follower tapping without measured voltage</td>
<td>115</td>
</tr>
<tr>
<td>8.8.8 Activating/deactivating parallel operation</td>
<td>116</td>
</tr>
<tr>
<td>8.9 Tap position capture</td>
<td>116</td>
</tr>
<tr>
<td>8.9.1 Digital tap position capture</td>
<td>116</td>
</tr>
<tr>
<td>8.9.2 Analog tap position capture</td>
<td>117</td>
</tr>
<tr>
<td>8.10 Setting the desired voltage level remotely</td>
<td>120</td>
</tr>
<tr>
<td>8.10.1 Activate/deactivate setting the desired voltage level remotely</td>
<td>120</td>
</tr>
<tr>
<td>8.10.2 Setting lower limit value for the desired value</td>
<td>121</td>
</tr>
<tr>
<td>8.10.3 Setting upper limit value for the desired value</td>
<td>122</td>
</tr>
<tr>
<td>8.11 Configurable inputs and outputs</td>
<td>123</td>
</tr>
<tr>
<td>8.11.1 Linking inputs with functions</td>
<td>123</td>
</tr>
<tr>
<td>8.11.2 Linking outputs with functions</td>
<td>125</td>
</tr>
<tr>
<td>8.12 LED selection</td>
<td>127</td>
</tr>
<tr>
<td>8.13 Communication interface (TAPCON® 230 expert only) with CI card</td>
<td>128</td>
</tr>
<tr>
<td>8.13.1 Selecting the communication protocol</td>
<td>129</td>
</tr>
<tr>
<td>8.13.2 Selecting transmission formats for MODBUS</td>
<td>130</td>
</tr>
<tr>
<td>8.13.3 Selecting communication port</td>
<td>131</td>
</tr>
<tr>
<td>8.13.4 Selecting communication baud rate</td>
<td>131</td>
</tr>
<tr>
<td>8.13.5 Assigning network address</td>
<td>132</td>
</tr>
<tr>
<td>8.13.6 Assigning TCP port</td>
<td>132</td>
</tr>
<tr>
<td>8.13.7 Setting fiber-optic cable transmission behavior</td>
<td>133</td>
</tr>
<tr>
<td>8.13.8 Setting local SCADA address</td>
<td>133</td>
</tr>
<tr>
<td>8.13.9 Setting SCADA master address</td>
<td>134</td>
</tr>
<tr>
<td>8.13.10 Enabling unsolicited messages</td>
<td>135</td>
</tr>
<tr>
<td>8.13.11 Setting number of attempts to transmit unsolicited messages</td>
<td>135</td>
</tr>
<tr>
<td>8.13.12 Timeout for application confirm responses</td>
<td>136</td>
</tr>
<tr>
<td>8.13.13 Setting transmission delay time for RS485 interface</td>
<td>136</td>
</tr>
<tr>
<td>8.14 Communication interface (TAPCON® 230 expert with &quot;IEC 61850&quot; card only)</td>
<td>137</td>
</tr>
<tr>
<td>8.14.1 Assigning network address</td>
<td>137</td>
</tr>
<tr>
<td>8.14.2 Assigning a network mask</td>
<td>137</td>
</tr>
<tr>
<td>8.14.3 Entering the time server address</td>
<td>138</td>
</tr>
<tr>
<td>8.14.4 Entering gateway address</td>
<td>138</td>
</tr>
<tr>
<td>8.14.5 Entering IED name</td>
<td>139</td>
</tr>
<tr>
<td>8.14.6 Assigning transmission medium</td>
<td>139</td>
</tr>
</tbody>
</table>
Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.14.7</td>
<td>Setting SSH encryption</td>
<td>140</td>
</tr>
<tr>
<td>8.14.8</td>
<td>Setting the IEC 61850 password</td>
<td>140</td>
</tr>
<tr>
<td>8.15</td>
<td>Information about device</td>
<td>141</td>
</tr>
<tr>
<td>8.15.1</td>
<td>Displaying info screen</td>
<td>142</td>
</tr>
<tr>
<td>8.15.2</td>
<td>Displaying measured values</td>
<td>142</td>
</tr>
<tr>
<td>8.15.3</td>
<td>Display calculated values</td>
<td>143</td>
</tr>
<tr>
<td>8.15.4</td>
<td>Carrying out LED test</td>
<td>144</td>
</tr>
<tr>
<td>8.15.5</td>
<td>Displaying status of the MIO card</td>
<td>144</td>
</tr>
<tr>
<td>8.15.6</td>
<td>Displaying status of the PIO card</td>
<td>145</td>
</tr>
<tr>
<td>8.15.7</td>
<td>Displaying parallel operation</td>
<td>146</td>
</tr>
<tr>
<td>8.15.8</td>
<td>Displaying data on CAN bus</td>
<td>147</td>
</tr>
<tr>
<td>8.15.9</td>
<td>Peak memory</td>
<td>147</td>
</tr>
<tr>
<td>8.15.10</td>
<td>Displaying CI card SCADA information (optional)</td>
<td>148</td>
</tr>
<tr>
<td>8.15.11</td>
<td>Displaying IEC 61850 card information</td>
<td>149</td>
</tr>
<tr>
<td>8.15.12</td>
<td>Resetting parameters</td>
<td>149</td>
</tr>
<tr>
<td>8.15.13</td>
<td>Displaying memory overview</td>
<td>149</td>
</tr>
<tr>
<td>8.15.14</td>
<td>Displaying event overview</td>
<td>150</td>
</tr>
<tr>
<td>8.16</td>
<td>Downloading the security log</td>
<td>150</td>
</tr>
<tr>
<td>9</td>
<td>Fault elimination</td>
<td>153</td>
</tr>
<tr>
<td>9.1</td>
<td>No regulation in AUTO mode</td>
<td>153</td>
</tr>
<tr>
<td>9.2</td>
<td>Unexplained tap change</td>
<td>153</td>
</tr>
<tr>
<td>9.3</td>
<td>Man-machine interface</td>
<td>154</td>
</tr>
<tr>
<td>9.4</td>
<td>Incorrect measured values</td>
<td>154</td>
</tr>
<tr>
<td>9.5</td>
<td>Parallel operation faults</td>
<td>155</td>
</tr>
<tr>
<td>9.6</td>
<td>Tap position capture incorrect</td>
<td>155</td>
</tr>
<tr>
<td>9.7</td>
<td>Customized GPIs/GPOs</td>
<td>156</td>
</tr>
<tr>
<td>9.8</td>
<td>General faults</td>
<td>156</td>
</tr>
<tr>
<td>9.9</td>
<td>Other faults</td>
<td>157</td>
</tr>
<tr>
<td>10</td>
<td>Messages</td>
<td>158</td>
</tr>
<tr>
<td>11</td>
<td>Disposal</td>
<td>160</td>
</tr>
<tr>
<td>12</td>
<td>Overview of parameters</td>
<td>161</td>
</tr>
<tr>
<td>13</td>
<td>Technical data</td>
<td>166</td>
</tr>
<tr>
<td>13.1</td>
<td>Display elements</td>
<td>166</td>
</tr>
<tr>
<td>13.2</td>
<td>Electrical data</td>
<td>166</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>13.3 Dimensions and weight</td>
<td>166</td>
<td></td>
</tr>
<tr>
<td>13.4 Ambient conditions</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>13.5 Electrical safety</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>13.6 Electromagnetic compatibility</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>13.7 Optical radiation</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>13.8 Environmental durability tests</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>13.9 Mechanical stability</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td><strong>Glossary</strong></td>
<td><strong>171</strong></td>
<td></td>
</tr>
<tr>
<td><strong>List of key words</strong></td>
<td><strong>172</strong></td>
<td></td>
</tr>
</tbody>
</table>
1 Introduction

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

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

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

1.1 Manufacturer

The product is manufactured by:
Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg, Germany
Tel.: (+49) 9 41/40 90-0
Fax: (+49) 9 41/40 90-7001
E-mail: sales@reinhausen.com

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

1.2 Subject to change without notice

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

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

1.3 Completeness

This technical file is incomplete without the supporting documentation.

1.4 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 of danger!**
Source of the danger and outcome.
► 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
1 Introduction

Pictograms warn of dangers:

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

Table 2: Pictograms used in warning notices

1.5.2 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. 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><strong>Bold</strong></td>
<td>Software operating controls</td>
<td>Press Continue button</td>
</tr>
<tr>
<td>...&gt;...&gt;...</td>
<td>Menu paths</td>
<td>Parameter &gt; Control parameter</td>
</tr>
<tr>
<td><em>Italics</em></td>
<td>System messages, error messages, signals</td>
<td>Function monitoring alarm triggered</td>
</tr>
<tr>
<td>[ ► Number of pages].</td>
<td>Cross reference</td>
<td>[ ► 41].</td>
</tr>
</tbody>
</table>

Table 3: Typographic conventions
2 Safety

2.1 General safety information
The technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.
- Read this technical file through carefully to familiarize yourself with the product.
- Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use
If used as intended and in compliance with the requirements and conditions specified in this technical document as well as with the warnings in this technical document and attached to the product, then the product does not present any danger 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 IT security

Observe the following recommendations for secure operation of the product.

General

- Ensure that only authorized personnel have access to the device. Use the device door lock for this purpose.
- Only use the device within an ESP (electronic security perimeter). Do not connect the device to the Internet in an unprotected state.
- Ensure that the device is only operated by trained personnel who are familiar with IT security.
- Do not assign any passwords that are easy to guess. The password should consist of upper-case letters, lower-case letters and numbers and should be 8 characters long.

Commissioning

Observe the following recommendations for device commissioning:

- Set the password duration to 5 minutes or less [▶ Section 8.2.12, Page 77].
- Assign a password for the COM1 front interface [▶ Section 8.2.11, Page 76].
- With IEC 61850:
  - Activate SSH encryption [▶ Section 8.14.7, Page 140].
  - Change the password for the IEC 61850 interfaces [▶ Section 8.14.8, Page 140].

Operation

Observe the following recommendations during device operation:

- Do not leave the device unattended when the entered password is active. The password entered is active if the Parallel operation LED flashes.
- Change the password at regular intervals.
- Export the security log [▶ Section 8.16, Page 150] at regular intervals.
Interaces

The device uses the following interfaces for communication:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RS485</td>
</tr>
<tr>
<td>2</td>
<td>RS232</td>
</tr>
<tr>
<td>3</td>
<td>Fiber-optic cable</td>
</tr>
<tr>
<td>4</td>
<td>CAN bus: Parallel operation</td>
</tr>
<tr>
<td>5</td>
<td>RJ45</td>
</tr>
</tbody>
</table>
3 IT security

Figure 2: IEC 61850 card

1 RJ45: SCADA, time server, data export (security log, ICD file)
2 Fiber-optic cable: SCADA, time server, data export (security log, ICD file)
3 RS232: Service interface
4 CAN bus: Parallel operation
5 Power supply

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Interface</th>
<th>TCP/UDP</th>
<th>Port</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>COM1</td>
<td>-</td>
<td>-</td>
<td>Serial interface¹</td>
</tr>
<tr>
<td>CI</td>
<td>RS485</td>
<td>-</td>
<td>-</td>
<td>Serial interface (SCADA)</td>
</tr>
<tr>
<td>CI</td>
<td>RS232</td>
<td>-</td>
<td>-</td>
<td>Serial interface (SCADA)</td>
</tr>
<tr>
<td>CI</td>
<td>RJ45/FO</td>
<td>TCP</td>
<td>1234</td>
<td>Modbus³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DNP³</td>
</tr>
<tr>
<td>CI</td>
<td>CAN</td>
<td>-</td>
<td>-</td>
<td>Communication with other devices (parallel operation)</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>RS232</td>
<td>-</td>
<td>-</td>
<td>Internal system interface</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>RJ45/FO</td>
<td>TCP</td>
<td>102</td>
<td>IEC 61850</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>RJ45/FO</td>
<td>TCP</td>
<td>21</td>
<td>FTP²</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>RJ45/FO</td>
<td>TCP</td>
<td>22</td>
<td>SSH, SFTP</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>CAN</td>
<td>-</td>
<td>-</td>
<td>Communication with other devices (parallel operation)</td>
</tr>
</tbody>
</table>

Table 4: Interfaces and open ports

¹ The port is only open if the COM1 password is active or no COM1 password is assigned.
2) The port is only open if SSH encryption is not activated.

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

Encryption standards

The device uses the following encryption standards in accordance with technical directive TR-02102-4 from Germany's Federal Office for Information Security:

- Key agreement:
  - diffie-hellman-group-exchange-sha1
  - diffie-hellman-group14-sha1
  - diffie-hellman-group1-sha1

- Encryption algorithms:
  - aes256-ctr
  - aes192-ctr
  - aes128-ctr

- MAC protection:
  - hmac-sha1

- Server authentication:
  - ssh-rsa

The device uses DES hashing and MD5 to save passwords.
4 Product description

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

4.1 Scope of delivery

The following components are included in the delivery:

- Voltage Regulator TAPCON® 230 expert
- Folder with all device documentation
- Quick reference guide (in the inside door of the device)
- ST to LC fiber-optic connector adapter cable (only with IEC 61850 card)
- Door key
- 3mm Allen key
- 2 countersunk head screws
- Control panel bracket pre-mounted on device's housing

![Figure 3: Control panel bracket](image)

- Mounting bracket for wall mounting

![Figure 4: Mounting bracket](image)

- Covering strip for door

![Figure 5: Covering strip](image)

- Alternative power supply plug for IEC 61850 card

Optional:

- Cap rail clip
Please note the following:
- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation.

4.2 Function description of the voltage regulation

The TAPCON® serves to keep constant the output voltage of a transformer with an on-load tap-changer.

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

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

The following diagram shows an overview of voltage regulation.
4.3 Performance features

The TAPCON® is responsible for controlling tapped transformers. Apart from control tasks, the TAPCON® provides additional functions such as:

- Integrated monitoring functions:
  - Undervoltage blocking and overvoltage blocking
  - Overvoltage detection with high-speed return
- Compensation for voltage drops on the line (line drop compensation)
- Compensation for voltage fluctuations in the meshed grid (Z compensation)
4 Product description

- Digital inputs and outputs can be individually programmed on-site by the customer
- Additional indicators using LEDs outside the display for freely selectable functions
- Display of all measured values such as voltage, current, active power, apparent power or reactive power, power factor (cos φ)
- Selection of 3 different desired values
- You can select the tap position capture when ordering:
  - Using analog signal 4…20 mA
  - Using analog signal via resistor contact series
  - Using digital signal via BCD code
- Additional digital inputs and outputs which can be freely parameterized by the customer
- Parallel operation of up to 6 transformers in 2 groups using the following methods:
  - Master/follower
  - Circulating reactive current minimization
- SCADA:
  - IEC 60870-5-101
  - IEC 60870-5-103
  - IEC 61850
  - DNP3
  - Modbus ASCII
  - Modbus RTU

4.4 Operating modes

The device can be operated in the following operating modes:

Auto mode (AUTO)

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

Manual mode (MANUAL)

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

Local mode (LOCAL)

There is no active management by a superordinate control system in this operating mode.
Remote mode (REMOTE)

In remote mode, you can perform commands using an external control level. In this case, manual operation of the \[\text{AUTO} \quad \text{MANUAL} \quad \text{AUTO}\] keys is disabled.

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

Table 5: Overview of operating modes

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

4.5 Hardware

Figure 8: Hardware

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating panel with display and LEDs</td>
</tr>
<tr>
<td>2</td>
<td>Door lock</td>
</tr>
<tr>
<td>3</td>
<td>Door</td>
</tr>
<tr>
<td>4</td>
<td>Metric cable glands</td>
</tr>
</tbody>
</table>
4.5.1 Name plate

The name plate is on the outside of the device:

![Figure 9: Name plate](image)

4.5.2 Operating controls

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

![Figure 10: Operating controls](image)

- **RAISE key**: Sends control command for raise tap-change to the motor-drive unit in manual mode.
- **LOWER key**: Sends control command for lower tap-change to the motor-drive unit in manual mode.
4 Product description

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>REMOTE</td>
<td>REMOTE key: Activate/deactivate &quot;Remote&quot; operating mode. When you deactivate this operating mode, the &quot;Local&quot; operating mode is automatically activated.</td>
</tr>
<tr>
<td>MANUAL</td>
<td>MANUAL key: Activate &quot;Manual mode&quot; operating mode.</td>
</tr>
<tr>
<td>AUTO</td>
<td>AUTO key: Activate &quot;Auto mode&quot; operating mode.</td>
</tr>
<tr>
<td>←</td>
<td>PREV key: Change measured value display and switch to previous parameters.</td>
</tr>
<tr>
<td>→</td>
<td>NEXT key: Change measured value display and switch to next parameters.</td>
</tr>
<tr>
<td>←</td>
<td>ENTER key: Confirm selection and save modified parameters.</td>
</tr>
<tr>
<td>ESC</td>
<td>ESC key: Escape current menu and select previous menu levels.</td>
</tr>
<tr>
<td>MENU</td>
<td>MENU key: Select main menu.</td>
</tr>
<tr>
<td>F1</td>
<td>F1 to F5 function keys: Select functions displayed on the screen.</td>
</tr>
</tbody>
</table>
4.5.3 Display elements

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating status LED, green</td>
</tr>
<tr>
<td>2</td>
<td>Overcurrent blocking LED, red</td>
</tr>
<tr>
<td>3</td>
<td>Undervoltage blocking LED, red</td>
</tr>
<tr>
<td>4</td>
<td>Overvoltage blocking LED, red</td>
</tr>
<tr>
<td>5</td>
<td>Parallel operation active LED, green</td>
</tr>
<tr>
<td>6</td>
<td>NORMset active LED, green</td>
</tr>
<tr>
<td>7</td>
<td>LED 1, function can be freely assigned, yellow</td>
</tr>
<tr>
<td>8</td>
<td>LED 2, function can be freely assigned, yellow</td>
</tr>
<tr>
<td>9</td>
<td>LED 3, function can be freely assigned, yellow/green</td>
</tr>
<tr>
<td>10</td>
<td>LED 4, function can be freely assigned, yellow/red</td>
</tr>
<tr>
<td>11</td>
<td>Graphics display</td>
</tr>
<tr>
<td>12</td>
<td>Auto operating mode active LED</td>
</tr>
<tr>
<td>13</td>
<td>Manual operating mode active LED</td>
</tr>
<tr>
<td>14</td>
<td>Remote operating mode active LED</td>
</tr>
<tr>
<td>15</td>
<td>Lower tap-change active LED</td>
</tr>
<tr>
<td>16</td>
<td>Raise tap-change active LED</td>
</tr>
</tbody>
</table>

Figure 11: Indicator elements
4 Product description

Display

Figure 12: Display

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Status line</td>
</tr>
<tr>
<td>2</td>
<td>Measured voltage $U_{\text{actual}}$</td>
</tr>
<tr>
<td>3</td>
<td>Desired voltage $U_{\text{desired}}$</td>
</tr>
<tr>
<td>4</td>
<td>Other measured values (use $\rightarrow$ or $\leftarrow$ to switch between them)</td>
</tr>
<tr>
<td>5</td>
<td>Tap position n-1; n; n+1</td>
</tr>
<tr>
<td>6</td>
<td>Bandwidth (upper and lower limit)</td>
</tr>
<tr>
<td>7</td>
<td>Time bar for delay time $T_1$</td>
</tr>
<tr>
<td>8</td>
<td>Mark for measured voltage $U_{\text{actual}}$</td>
</tr>
<tr>
<td>9</td>
<td>Mark for desired voltage $U_{\text{desired}}$</td>
</tr>
<tr>
<td>10</td>
<td>Remaining delay time $T_1$</td>
</tr>
</tbody>
</table>

Other measured values

In auto mode and manual mode the measured value display 4 can be set using the $\rightarrow$ or $\leftarrow$ keys. The following measured values can be displayed:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$dU$</td>
<td>Control deviation</td>
</tr>
<tr>
<td>$I$</td>
<td>Current</td>
</tr>
<tr>
<td>$S$</td>
<td>Apparent power</td>
</tr>
<tr>
<td>$P$</td>
<td>Active power</td>
</tr>
<tr>
<td>$Q$</td>
<td>Reactive power</td>
</tr>
<tr>
<td>Phase</td>
<td>Phase angle</td>
</tr>
<tr>
<td>Cos</td>
<td>Active factor: Cosine $\varphi$ (power factor)</td>
</tr>
</tbody>
</table>

Table 6: Measured value display
4.5.4 Serial interface

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

TAPCON®-trol software is needed for parameterization via the serial interface. The software and the associated user guide can be downloaded from www.reinhausen.com.

![Figure 13: Device connection to a PC](image)

4.5.5 Modules

The device has integrated modules:

- MIO card
- PIO card
- CI card (optional)
- IEC 61850 card (optional)

Carry out wiring in accordance with the supplied connection diagram. The relevant cards are described in the following sections.
4.5.5.1 MIO card

- Relay outputs (terminal X4)
- Current transformer connection (terminal X1)
- Signal inputs (terminal X4)
- Voltage transformer connection and network connection (terminal X2)
- Relay outputs (terminal X3)
- CAN bus connection

Figure 14: MIO card
4.5.5.2 PIO card

![PIO card diagram](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Signal inputs and auxiliary voltage generation (terminal X6)</td>
</tr>
<tr>
<td>2</td>
<td>Analog input (terminal X7)</td>
</tr>
<tr>
<td>3</td>
<td>Digital tap position inputs (terminal X6)</td>
</tr>
<tr>
<td>4</td>
<td>Relay outputs (terminal X5)</td>
</tr>
<tr>
<td>5</td>
<td>Relay outputs (terminal X5)</td>
</tr>
</tbody>
</table>

Figure 15: PIO card

4.5.5.3 CI card (optional)

The device has additional communication interfaces on the CI card. These communication interfaces are used for connecting the control system using various protocols, for instance, to carry out a parameterization of the device. The following protocols are available:

- DNP3
- MODBUS ASCII
- MODBUS RTU
- IEC 60870-5-101
- IEC 60870-5-103

The diagram below shows the communication interfaces available.

You have to configure the device accordingly so that the parameters can be adapted using the communication interface. Refer to the Communication interface section for more information about configuration.
4.5.5.4 IEC 61850 card (optional)

The device has additional communication interfaces on the IEC 61850 card. This communication interface is used for connecting the control system using various protocols, for instance, to carry out a parameterization of the device. The diagram below shows the communication interfaces available.

You have to configure the device accordingly so that the parameters can be adapted using the communication interface. Refer to the Communication interface section for more information about configuration.
Figure 17: IEC 61850 card communication interface

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RJ45 (terminal 12)</td>
</tr>
<tr>
<td>2</td>
<td>Fiber-optic cable, LC bush (terminal X13)</td>
</tr>
<tr>
<td>3</td>
<td>RS232 (terminal X11) (for operating system updates only)</td>
</tr>
<tr>
<td>4</td>
<td>CAN bus (terminal X9)</td>
</tr>
<tr>
<td>5</td>
<td>Voltage supply (terminal X10)</td>
</tr>
</tbody>
</table>

* Operating system updates must be carried out by Maschinenfabrik Reinhausen GmbH.
5 Packaging, transport and storage

5.1 Packaging

5.1.1 Purpose

The packaging is designed to protect the packaged goods during transport, loading and unloading as well as periods of storage in such a way that no (detrimental) changes occur. The packaging must protect the goods against permitted transport stresses such as vibration, knocks and moisture (rain, snow, condensation).

The packaging also prevents the packaged goods from moving impermissibly within the packaging. The packaged goods must be prepared for shipment before actually being packed so that the goods can be transported safely, economically and in accordance with regulations.

5.1.2 Suitability, structure and production

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

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

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

5.1.3 Markings

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect against moisture</td>
<td>Top</td>
</tr>
<tr>
<td>Center of mass</td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Shipping pictograms

5.2 Transportation, receipt and handling of shipments

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.
If a crate tips over, falls from a certain height (e.g. when slings tear) or is subject to an unbroken fall, damage must be expected regardless of the weight.

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

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

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

**Visible damage**

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

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

**Hidden damage**

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

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

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

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

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

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

**Electric shock!**

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

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

**WARNING**

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

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

**NOTICE**

Damage to the device!

Electrostatic discharge may cause damage to the device.

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

6.1 Preparation

The following tools are needed for mounting:

- Provided 3mm Allen key (included in delivery)
- Small screwdriver for connecting the signal lines and supply lines

Other tools may be needed depending on installation location.

6.2 Mounting device

You can mount the device in the following installation versions:

- Flush panel mounting
- Wall mounting
6 Mounting

- Wall mounting with mounting brackets
- Rail mounting (optional)

Preparing for mounting

Before commencing mounting, the two mounting brackets back on the rear of the device must be removed and the cable gland plate taken off. To do so, proceed as follows:

1. Loosen the 4 Allen screws with attached Allen key to remove the mounting brackets.

![Figure 18: Loosen mounting bracket](image1.png)

2. Loosen the 4 Allen screws with attached Allen key to remove the cable gland plate.

![Figure 19: Loosen cable gland plate](image2.png)

The mounting brackets and the cable gland plate are removed.
The relevant installation versions are described in the following sections.

6.2.1 Flush panel mounting

For flush panel mounting, the device is inserted through a cutout in the control panel and fixed to the control panel or control cabinet from behind using the mounting brackets. The diagram below shows the dimensions required for the control panel cutout.

![Diagram showing dimensions for the cutout]

A wall thickness of 2...5 mm (0.08...0.2 in) is needed for secure device fixing.

To mount the device in the control panel or control cabinet, proceed as follows:
1. Close the device's door.
2. Insert the device through the cutout in the control panel or control cabinet.
3. Screw both fixing brackets to the rear of the device with 2 hexagon socket screws each.

![Figure 21: Flush panel mounting](image)

The device is mounted and can be wired up.

Proceed with wiring as shown in the connection diagram and as described in the Connecting device section.

6.2.2 Wall mounting with mounting brackets

As an alternative to mounting the device directly on the wall, it can be fixed to the wall using the mounting brackets supplied.

Drill 4 holes, each 5.5 mm (0.22 in) in diameter, in the wall as shown in the drilling template below.

![Figure 22: Bores for wall mounting with mounting brackets](image)

To mount the device using the mounting brackets, proceed as follows:

1. Lay the device carefully on the door.
2. Screw the mounting brackets supplied to the back of the device using the hexagon socket screws.
3. Fix the device on the wall using 4 screws (maximum diameter of 5 mm/0.22 in) 2.

The screws for fixing to the wall are not included in the scope of supply. The screw length required depends on the wall thickness.

Figure 23: Wall mounting with mounting brackets

△ The device is mounted and can be wired up 3.

Proceed with wiring as shown in the connection diagram and as described in the Connecting device [▶ Section 6.3, Page 43] section.

6.2.3 Cap rail mounting

As an option, the device can be fitted with a cap rail clip (aluminum extrusion with wire spring integrated at center). This enables you to mount the device on a cap rail.

When attaching the cap rail, sufficient space for the device must be planned for. At least 5 cm (1.97 in) of space must be provided above and at least 35 cm (13.78 in) below the fixing screws of the cap rail for the device housing.

To mount the device using the cap rail, proceed as follows:
1. Lay the device carefully on the door.
2. Screw the cap rail clip into the two top holes on the rear with the M5 hexagon socket countersunk head screws provided 1.
3. Suspend the cap rail clip in the cap rail and push the underside carefully towards the wall until the clip can be heard to click into place.

![Figure 24: Cap rail mounting](image)

The device is mounted and can be wired up.

Proceed with wiring as shown in the connection diagram and as described in the Connecting device section.

### 6.2.4 Wall mounting

For wall mounting, the device is fixed directly to the wall. Drill 4 holes, each 5.5 mm in diameter, in the wall as shown in the drilling template below.

![Figure 25: Drilling template for wall mounting](image)

To mount the device directly on the wall, proceed as follows:
- Close the device's door.
- Fix the device on the wall from behind using 4 screws (M5).
The screws for wall mounting are not included in the scope of supply. The screw length required depends on the wall thickness.

![Figure 26: Wall mounting](image)

The device is mounted and can be wired up. Proceed with wiring as shown in the connection diagram and as described in the Connecting device section.

### 6.2.5 Removing the door

When the door is fitted, the device satisfies protection category IP54. The door may be removed if the device is used solely in a dry atmosphere protected from environmental influences. The device then satisfies protection category IP21.

Proceed as follows to remove the door:

1. Loosen the grounding strap on the door using an open-end wrench.

![Figure 27: Remove door](image)
2. Unscrew the fixing bolt using a slotted screwdriver and lift the door out of the upper mounting.

![Figure 28: Lift door from the suspension mount](image)

3. Hook the cover strip in the upper and lower suspension mount and fasten it with the provided raised countersunk head screws.

![Figure 29: Fasten covering strip](image)

→ The door is removed and the exposed attachment points for the door are covered.

### 6.3 Connecting device

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

**WARNING**

**Electric shock!**

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

- Ground the device with a protective conductor using the grounding screw on the housing.
- Note the phase difference of the secondary terminals for the current transformer and voltage transformer.
- Connect the output relays correctly to the motor-drive unit.
Supply the voltage via separators and ensure that current paths can be short circuited. Fit the separator, clearly labeled, close to the device's power supply so that it is freely accessible. This ensures that the device can be replaced with ease in the event of a defect.

**Wiring information**

Note this procedure for the wiring:

- ✓ To obtain a better overview when connecting cables, only use as many leads as necessary.
- ✓ Note the connection diagram.
- ✓ Use only the specified cables for wiring. Note the cable recommendation [⇒ Section 6.3.1, Page 44].
- ✓ Wire the leads to the system periphery [⇒ Section 6.3.4, Page 50].

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

**6.3.1 Cable recommendation**

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

Excessive line capacitance can prevent the relay contacts from breaking the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.

<table>
<thead>
<tr>
<th>Cable</th>
<th>Terminal</th>
<th>Cable type</th>
<th>Wire cross-section</th>
<th>Max. length</th>
<th>Max. permissible torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input</td>
<td>X7</td>
<td>Shielded</td>
<td>(&lt; 25 Ω/km)</td>
<td>1.5 mm²</td>
<td>400 m</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>X4</td>
<td>Shielded</td>
<td></td>
<td>1.5 mm²</td>
<td>-</td>
</tr>
<tr>
<td>RS232 SUB-D</td>
<td>-</td>
<td>Shielded</td>
<td></td>
<td>0.25 mm²</td>
<td>25 m</td>
</tr>
<tr>
<td>RS485</td>
<td>-</td>
<td>Shielded</td>
<td>(&lt; 50 Ω/km)</td>
<td>0.75 mm²</td>
<td>1000 m</td>
</tr>
<tr>
<td>OF (CI card)</td>
<td>-</td>
<td>Polymer fiber (POF) or HCS® 1 for 660 nm glass fiber or HCS® for 850 nm glass fiber (50/125 μm or 62.5/125 μm multi-mode fiber)</td>
<td>-</td>
<td>POF: 100 m; HCS® (660 nm): 200 m; HCS® (850 nm): 1000 m; Glass fibers: 2000</td>
<td>-</td>
</tr>
<tr>
<td>OF (IEC 61850 card)</td>
<td>-</td>
<td>50/125 μm or 62.5/125 μm multi-mode fiber</td>
<td>-</td>
<td>2000 m</td>
<td>-</td>
</tr>
</tbody>
</table>


### 6 Mounting

**Table 8: Cable recommendation for connection cable**

<table>
<thead>
<tr>
<th>Cable</th>
<th>Terminal</th>
<th>Cable type</th>
<th>Wire cross-section</th>
<th>Max. length</th>
<th>Max. permissible torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet RJ45</td>
<td>-</td>
<td>min. CAT5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Relay outputs*</td>
<td>X3</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Relay outputs* optional</td>
<td>X4</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Current measurement</td>
<td>X1:5/6/9</td>
<td>Unshielded</td>
<td>4 mm²</td>
<td>-</td>
<td>1.5 Nm</td>
</tr>
<tr>
<td>Voltage measurement</td>
<td>X2:1/2</td>
<td>Shielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Relay outputs</td>
<td>X5</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Signal inputs</td>
<td>X6</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Digital tap position inputs</td>
<td>X6</td>
<td>Shielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Auxiliary voltage</td>
<td>X6</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Power supply</td>
<td>X2:3/4</td>
<td>Unshielded</td>
<td>1.5 mm²</td>
<td>-</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>CAN bus</td>
<td>-</td>
<td>Shielded</td>
<td>1.0 mm²</td>
<td>2000 m</td>
<td>-</td>
</tr>
</tbody>
</table>

*) Observe line capacitance, see note above.

Cable clips X1 to X4 are on the MIO card of the device. Cable clips X5 to X7 are on the PIO card of the device.

#### 6.3.2 Information about laying fiber-optic cable

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

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

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

#### 6.3.3.1 Wiring requirement of installation site

Note the following when selecting the installation site:

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

#### 6.3.3.2 Wiring requirement of operating site

Note the following when wiring the operating site:

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

![Figure 30: Recommended wiring](image-url)

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

- Short-circuit and ground reserve lines.
- Never connect the device with a multi-wire collective pipe.
• For signal transmission, use shielded lines with individual conductors (out-going conductor / return conductor) twisted in pairs.

• Connect full surface of shielding (360°) to device or to a nearby grounding bar.

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

Figure 31: Recommended connection of the shielding

| 1 | Connection of the shielding via a single conductor |
| 2 | Full-surface connection of the shielding |

6.3.3.3 Wiring requirement in control cabinet

Note the following when wiring the control cabinet:

• The control cabinet where the device will be installed must be prepared in accordance with EMC requirements:
  – Functional division of control cabinet (physical separation)
  – Constant potential equalization (all metal parts are joined)
  – Line routing in accordance with EMC requirements (separation of lines which cause interference and those susceptible to interference)
  – Optimum shielding (metal housing)
  – Overvoltage protection (lightning protection)
  – Collective grounding (main grounding rail)
  – Cable bushings in accordance with EMC requirements
  – Any contactor coils present must be interconnected

• The device's connection cables must be laid in close contact with the grounded metal housing or in metallic cable ducts with a ground connection.
• Signal lines and power lines/switching lines must be laid in separate cable ducts.

• The device must be grounded at the screw provided, the protective grounding connection, using a ground strap (cross-section min. 8 mm²).

Figure 32: Ground strap connection

Ground connection for wiring inside the device

The diagram below shows the ground connection for wiring inside the device.

Figure 33: Grounding inside the device
6.3.3.4 Information about shielding the CAN bus

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

**NOTICE**

**Damage to the device!**

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

► Connect the devices to a potential equalization rail to equalize the potential.
► If both devices have different potentials, only connect the CAN bus cable 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 equalization rail to equalize the potential.
2. Connect the CAN bus cable shielding to all connected devices.

**Variant 2: The connected devices have different potentials**

Note that the shielding is less effective with this variant.

If the devices to be connected have different potentials, proceed as follows:

► Connect the CAN bus cable shielding to just one device.
6.3.4 Connecting cables to the system periphery

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

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

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

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

6.3.5 Supplying the voltage regulator using auxiliary voltage

The device is normally supplied by the voltage transformer. If the voltage transformer does not provide the supply voltage and power (see "Technical Data") needed for operation, the device must be supplied via a 88...265V AC/DC, 50...60Hz auxiliary supply.

Proceed as follows to supply the device with auxiliary voltage:

1. **NOTICE!** Voltage transformer damage Connecting an auxiliary voltage when bridges are present between the X2:1/3 and X2:2/4 terminals can result in voltage transformer damage. Remove the bridges between the terminals X2:1/3 and X2:2/4.

2. Connect the voltage transformer to terminals X2:1 and X2:2.
3. Connect the auxiliary voltage using the following terminals: X2:3 and X2:4.

Figure 35: Voltage transformer and auxiliary supply connections

Figure 36: Voltage transformer and auxiliary supply connections (with IEC 61850 card)

The connections between terminal X10 on the IEC 61850 card and terminal X2 on the MIO card are already pre-wired and do not have to be connected by you.

6.3.6 Wiring device

To obtain a better overview when connecting cables, only use as many leads as necessary.
To wire the device, proceed as follows:

- Use only the specified cables for wiring. Note the cable recommendation [► Section 6.3.1, Page 44].
- Wire the lines to the system periphery [► Section 6.3.4, Page 50].

1. Remove 4 hexagon socket screws from cover plate and take off cover plate.
2. Disconnect the connectors required.
3. Remove 4 hexagon socket screws from the cable gland plate and take off the cable gland plate.
4. Remove dummy plug from required cable glands in order to guide cables through.

Unnecessary cable glands must be sealed with dummy plugs to guarantee the IP54 protection category.

5. Strip insulation from lines and leads.
6. Crimp stranded wires with core cable ends.
7. Guide cables through the cable gland
9. Fasten screws for the corresponding terminals using a screwdriver.
10. Guide the cable gland plate into the device opening provided for this purpose.
11. Plug connectors into the correct slots.
12. Secure cable gland plate to device housing with 4 hexagon socket screws.

### 6.3.7 Checking functional reliability

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

**NOTICE**

**Damage to device and system periphery**

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

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

Check the following:

- Once you have connected the device to the grid, the screen displays the MR logo and then the operating screen.
- The green *Operating display* LED top left on the device's front panel lights up.
The device is fully mounted and can be configured. The actions required for this are described in the following chapter.
7 Commissioning

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

---

NOTICE

Damage to device and system periphery

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

► Check the entire configuration before commissioning.

► Prior to commissioning, be sure to check the actual voltage and operating voltage.

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

---

7.1 Setting the display contrast

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

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

![Figure 37: Setting the display contrast](image)

7.2 Setting parameters

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

7.2.1 Setting the language

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

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

To set the language, proceed as follows:

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

7.2.2 Setting further parameters

Set further parameters to commission the device. You will find more detailed information about the respective parameters in the "Operation" [► Section 8, Page 67] chapter.

Setting transformer data

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

1. Set primary transformer voltage [► Section 8.7.1, Page 102].
2. Set secondary transformer voltage [► Section 8.7.2, Page 102].
3. Set primary transformer current [► Section 8.7.3, Page 103].
4. Select current-transformer connection [► Section 8.7.4, Page 103].
5. Select transformer circuit [► Section 8.7.5, Page 104].

Setting NORMset

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

► Activate NORMset and set the relevant parameters [► Section 8.3, Page 77].

Setting control parameters

Set the following control parameters:

1. Set desired value 1 [► Section 8.4.1, Page 81].
2. Set the bandwidth [► Section 8.4.3.2, Page 84].
3. Set delay time T1 [► Section 8.4.4, Page 84].

**Setting line drop compensation (optional)**

If you need line drop compensation, you must set all important parameters for this:

1. Select the LDC compensation method [► Section 8.6.1, Page 96].
2. Set the line data for the ohmic voltage drop Ur [► Section 8.6.1.1, Page 98].
3. Set the line data for the inductive voltage drop Ux [► Section 8.6.1.2, Page 98].

**Setting parallel operation (optional)**

If you need parallel operation, you must set all important parameters for this:

1. Set parallel operation method to circulating reactive current method [► Section 8.8.2.1, Page 109].
2. Assign CAN bus address [► Section 8.8.1, Page 109].
3. Set circulating reactive current sensitivity [► Section , Page 110].
4. Set circulating reactive current blocking [► Section , Page 110].

**Setting tap position capture via analog input (optional)**

If you want to capture the tap position via the analog input, you must set the parameters required for this:

► Capture tap positions via analog input (PIO card terminal strip X7) [► Section 8.9.2, Page 117].

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

**Setting the desired voltage level remotely**

If you would like to set the desired voltage level remotely, you must configure the necessary parameters:

► Activate "Set the desired voltage level remotely" and set the relevant parameters [► Section 8.10, Page 120].

**Setting control system protocol (optional)**

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

### 7.3 Calibrating the analog input

Before you can use the analog input, you need to calibrate it. Calibration is used to adjust the external measuring circuit.
7 Commissioning

The F3 key can be used to cancel the calibration at any point.

To carry out the calibration, proceed as follows:

1. Menu > F5 Info > Press > until the desired measurement parameter is displayed.
   ⇒ PIO X7 analog input
2. Press F5 to start the calibration.
   ⇒ A screen containing instructions is displayed.
3. Connect resistor contact series (potentiometer series).
4. Turn resistor contact series into end position "Rmax".
5. Press F5 to carry out the calibration.

The procedure may take up to 3 minutes. If this time is exceeded, the "Check sliding contact" error message is displayed. In this case, make sure that the resistor contact series is correctly connected and is not faulty.

To configure further parameters for setting the tap position capture remotely, proceed as follows:

1. Select analog tap position capture [Section 8.10, Page 120].
2. Set lower limit value [Section 8.10.2, Page 121]
3. Set upper limit value [Section 8.10.3, Page 122]
   ⇒ The analog tap position capture is set.

7.4 Function tests

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

- You must ensure that REMOTE mode is disabled before you can control the on-load tap-changer manually in manual mode.
- You can only activate the on-load tap-changer manually in manual mode using the ↑↓ and ←→ keys.
- During the function test, you must set the most important parameters. Details on the parameters listed can be found in the Operation [Section 8, Page 67] chapter.
7.4.1 Checking control functions

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

- Supply voltage must be present.


2. Set transmission ratio for voltage transformer, current transformer and measuring set-up.

3. Measure actual voltage and compare with the measured value displayed on the device's main screen.

4. Press key several times to display the operating values for current, power and phase angle and compare them with values of service instruments.

5. Control the on-load tap-changer manually with the or keys until the measured voltage \( U_{\text{actual}} \) reaches the desired voltage \( U_{\text{desired}} \) set in the next stage.

6. Set desired value 1 to the value you want.

7. Set bandwidth depending on step voltage [Section 8.4.3, Page 83].

8. Set delay time T1 to 20 seconds [Section 8.4.4, Page 84].

9. Set control response T1 to linear [Section 8.4.5, Page 85].

10. Press to raise the on-load tap-changer 1 step.

11. Press Auto to select auto mode.

- After 20 seconds, the device returns the on-load tap-changer to the original operating position.


13. Press to lower the on-load tap-changer 1 step.

14. Press Auto to select auto mode.

- After 20 seconds, the device returns the on-load tap-changer to the original operating position.


16. Set delay time T2 to 10 seconds [Section , Page 86].

17. Activate delay time T2.

18. Press twice to raise the on-load tap-changer 2 steps.

19. Press Auto to select auto mode.

- After 20 seconds, the device lowers the on-load tap-changer one step and after another 10 seconds another step.


21. Set delay time T1 [Section 8.4.4, Page 84] and delay time T2 [Section , Page 86] to the desired value.
We recommend a temporary setting of 100 seconds for delay time T1 when commissioning the transformer. Depending on the operating conditions, you can also specify the delay time following a longer observation period. In this regard, it is useful to register how the actual voltage progresses and the number of tap-change operations per day.

### 7.4.2 Checking additional functions

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

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

Proceed as follows:

#### Checking undervoltage blocking U<

1. Press \( \text{MNL} \) to select manual mode.
2. Set undervoltage U < [%] to 85 %.
3. Set the U< blocking parameter to On \( \text{Section , Page 89} \).
4. Set desired value 1 such that the measured voltage Uactual is below the undervoltage U< [%] limit value.

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

   - The Undervoltage U< LED will light up.
   - After around 10 seconds the Undervoltage message appears in the display and the relevant signaling relay is activated. Contact X4:1/3 closes and contact X4:2/3 opens.

5. Press \( \text{AUT} \) to select auto mode.
   - The device blocks and does not issue any control commands.

6. Press \( \text{MNL} \) to select manual mode.
7. Reset the operating values for desired value 1 and undervoltage U< [%] to the desired operating values.
   - The function test for undervoltage blocking is complete.

#### Checking overvoltage blocking U>

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

<table>
<thead>
<tr>
<th>Measured voltage = 100 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired value 1 = Set to 85 V (less than $100,\text{V}/1.15 = 87,\text{V}$).</td>
</tr>
</tbody>
</table>

- The Overvoltage $U>\%$ LED will light up.
- The Overvoltage message appears in the display and the relevant signaling relay is activated. Contact $X4:1/3$ closes and contact $X4:2/3$ opens.

5. Press $\text{AUTO}$ to select auto mode.
- The LOWER output relay emits a control command every 1.5 seconds.

6. Press $\text{MANUAL}$ to select manual mode.

7. Reset the operating values for desired value 1 and overvoltage $U>\%$ to the desired operating values.
- The function test for overvoltage blocking is complete.

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

1. Press $\text{MANUAL}$ to select manual mode.
2. Set desired value 2 to the value you want.
3. Apply voltage $L+$ to terminal $X4:17$ desired value 2 (see connection diagram).
4. Press $\text{ESC}$ until the main screen is displayed.
   - Desired value 2 is shown on the main screen.
5. Set desired value 3 to the value you want.
6. Apply voltage $L+$ to terminal desired value 3 (see connection diagram).
7. Press $\text{ESC}$ until the main screen is displayed.
   - Desired value 3 is shown on the main screen.
   - The function test for desired value 2 and desired value 3 is complete.

**Checking line drop compensation**

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

1. Press $\text{MANUAL}$ to select manual mode.
2. Set the compensation method parameter to LDC.
3. Press $\text{ESC}$ until the main screen is displayed.
4. If necessary, press → until the control deviation $dU$ is shown.
   ⇒ The measured voltage must be within the bandwidth.
5. Set line drop compensation $Ur$ parameter to 20.0 V.
6. Press ESC until the main screen is displayed.
7. If necessary, press ← until the control deviation $dU$ is shown.
   ⇒ The value for control deviation $dU$ must be negative.
8. Set line drop compensation $Ur$ parameter to -20.0 V.
9. Press ESC until the main screen is displayed.
10. If necessary, press → until the control deviation $dU$ is shown.
    ⇒ The value for control deviation $dU$ must be positive.

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

11. Set the line drop compensation $Ur$ and line drop compensation $Ux$ parameters to the desired operating values.
    ⇒ The function test for line drop compensation is complete.

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

1. Press → to select manual mode.
2. Set all parameters for line drop compensation and Z compensation to 0.
3. Set the compensation method parameter to Z.
4. Press ESC until the main screen is displayed.
5. If necessary, press → until the control deviation $dU$ is shown.
   ⇒ The measured voltage must be within the bandwidth.
6. Set the Z compensation parameter to 15.0 V.
7. Press ESC until the main screen is displayed.
8. If necessary, press ← until the control deviation $dU$ is shown.
   ⇒ The control deviation $dU$ must be negative.

If the control deviation appears in the opposite direction, change the polarity of the current transformer.
9. Set the **Z compensation** and **Z compensation limit value** parameters to the desired operating values.

⇒ The function test for Z compensation is complete.

### 7.4.3 Checking parallel operation

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

#### Requirements

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

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

#### 7.4.3.1 Checking circulating reactive current sensitivity

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

1. Adjust both transformers in simplex mode to the same actual voltage by means of the on-load tap-changer.

⇒ When both devices are in a state of equilibrium, then the value of the control deviation $dV$ [%] is smaller than the set **bandwidth**. You can see this in the main screen if the mark for the measured voltage $U_{\text{actual}}$ is within the bandwidth.

2. Connect the transformers in parallel and enable the parallel control.

⇒ The two devices must still be in a state of equilibrium.

⇒ The **Parallel operation** LED on the front panel is illuminated.

3. On one of the two transformers, raise the tap position of the on-load tap-changer by one setting; on the second transformer, lower the tap position of the on-load tap-changer by one setting.

⇒ The two devices must still be in a state of equilibrium.

4. Adjust the **circulating reactive current sensitivity** until the result displayed exceeds the set value for the bandwidth by approx. 0.2 % to 0.3 %.

⇒ The value for the result changes in the help text in the last line of the display.

5. Set the value given in the previous step for all devices in parallel operation.
6. Press AUTO to select auto mode for both devices.
   ⇒ The devices return the on-load tap-changer units to the original tap positions.
   ⇒ The function test for circulating reactive current sensitivity is complete.

If the earlier tap positions are not reached, increase the value of the circulating reactive current sensitivity [► Section, Page 110] parameter.

If one of the two on-load tap-changer units switches one or more tap positions higher and the other switches the same amount lower, you need to reduce the value of the circulating reactive current sensitivity [► Section, Page 110] parameter.

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

### 7.4.3.2 Checking circulating reactive current blocking

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

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

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

3. Set the parallel operation method parameter to circulating reactive current.
4. The circulating reactive current blocking parameter should be reduced [► Section, Page 110] from the set value of 20 % in steps of 1 % until the Parallel operation error: circulating reactive current limit exceeded is displayed.
   ⇒ The Parallel operation LED lights up when the circulating reactive current blocking limit is reached.
   ⇒ Any further regulation is blocked.
5. After the set delay time for the parallel operation error message (time can be adjusted [► Section, Page 114]), the signaling relay X5:12 (default setting) is activated.
6. Increase the circulating reactive current blocking parameter again until the message Parallel operation error: circulating reactive current limit exceeded disappears.
7. Press **AUT** to select auto mode.
   ⇨ The motor-drive unit automatically returns to the original operating position.

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

If one or all devices indicate **Parallel operation error: circulating reactive current limit exceeded** although the control inputs are correctly connected for all the devices, then all the devices block.
This could be due to various causes. Further information is given in the chapter Troubleshooting [Section 9, Page 153].

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

### 7.4.3.3 Checking tap synchronization method

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

**NOTICE**

**Damage resulting from formation of circulating reactive current**

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

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

Before starting the function test, you must carry out the following steps:
1. Assign the master function to one device.
2. Assign the follower function to the other devices.
3. Compare the tap position displays of devices. All devices must display the same tap position; if not, switch them into the same one.
To perform the function test, proceed as follows:

1. Press \[ \text{Manual} \] on the follower to select manual mode.
2. If necessary, set the follower tapping direction.
3. Press \[ \text{Manual} \] on the master to select manual mode.
4. Press \[ \text{Up} \] or \[ \text{Down} \] on the master to manually change the tap position.
5. Press \[ \text{Auto} \] on the follower to select auto mode.
   \[ \Rightarrow \] The follower follows the master's control command.
6. Press \[ \text{Auto} \] on the master to select auto mode.
7. Press \[ \text{Manual} \] on the follower to select manual mode.
8. Press \[ \text{Up} \] or \[ \text{Down} \] on the follower to manually change the tap position.
   \[ \Rightarrow \] After expiry of the set delay time for parallel operation errors [► Section, Page 114], the Tap difference to follower error message is displayed in the main screen on the master.
9. Press \( \text{↑} \) several times on the follower to manually increase the tap position by the number of permitted steps (maximum permitted tap difference) and then one more step.

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

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

10. Press \( \text{AUTO} \) on the follower to select auto mode.

▶ There is no response. All devices remain blocked.

11. Press \( \text{MANUAL} \) on the master and follower to select manual mode.

12. Press \( \text{↑} \) or \( \text{↓} \) on the master and follower to manually set the desired step.

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

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

Installation and commissioning of the device is complete.
8 Operation

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

8.1 Key lock

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

Activating key lock

To activate the key lock, proceed as follows:

► Press ESC and F5 at the same time.

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

Deactivating key lock

To deactivate the key lock, proceed as follows:

► Press ESC and F5 at the same time.

The key lock is deactivated. Parameters can be entered.

8.2 General

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

▪ Language [► Section 7.2.1, Page 55]
▪ Regulator ID
▪ Baud rate (COM1 setting)
▪ Raise/Lower pulse duration
▪ Operations counter
▪ Display dimming
▪ Key lock
▪ Function monitoring
▪ Motor runtime
▪ Manual mode/auto mode
▪ Local/Remote

8.2.1 Setting device ID

You can use the device ID parameter to assign a 4-digit ID to the device. This ID is used to uniquely identify the device in the TAPCON®-trol software.
To set the device ID, proceed as follows:

1. **Configuration > F4 General > Press ➔** until the desired parameter is displayed.
   ⇒ Regulator ID.

2. Press **F1** to change the first digit.
   ⇒ If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.

3. Press **F1** (digit > 9) until another digit position appears.

4. If necessary, press **F4** in order to highlight the digit position.
   ⇒ The required digit is highlighted and can be changed.

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

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

7. Press ➔
   ⇒ The device ID is set.

### 8.2.2 Setting the baud rate

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

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

To set the baud rate, proceed as follows:

1. **Configuration > F4 General > Press ➔** until the desired parameter is displayed.
   ⇒ Baud rate.

2. Press **F1** or **F5** to select the required baud rate.

3. Press ➔
   ⇒ The baud rate is set.

### 8.2.3 Setting the switching pulse time

You can use this parameter to set the duration of the switching pulse for the motor-drive unit.

If you set the switching pulse time to 0 s, the motor-drive unit is activated with a continuous signal. The signal then remains active for as long as the **1** or **2** keys are pressed.
8 Operation

Switching pulse in normal mode

If you set the switching pulse time to 1.5 seconds for example, after the set delay time $T_1$ or delay time $T_2$ there will be a switching pulse of 1.5 seconds.

The waiting time between 2 consecutive switching pulses corresponds to the set delay time $T_1$ or delay time $T_2$.

Figure 40: Switching pulse time in normal mode

1 Set delay time $T_1$ or $T_2$

2 Set switching pulse time (for example 1.5 seconds)

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

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

![Diagram of switching pulse in rapid return control mode]

Figure 41: Switching pulse in rapid return control mode

1. Start of first raise switching pulse/lower switching pulse
2. Set switching pulse time (for example 1.5 seconds)
3. Earliest time for the next raise switching pulse/lower switching pulse (for example 1.5 seconds)

To set the pulse duration, proceed as follows:

1. Configuration > F4 General > Press until the desired parameter is displayed.
   - R/L pulse duration.
2. Press F1 or F5 to select the pulse duration you want.
3. Press ↵
   - The R/L pulse duration is now set.

8.2.4 Setting operations counter

The device's operations counter is automatically increased with every tap-change operation. You can use this parameter to set the number of tap-change operations for comparing with the operations counter of the motor-drive unit, for example.

To ensure correct operation counter function, the Motor running signal of the motor-drive unit must be connected with a configurable input (GPI 1...6) and then the Motor running function assigned to this input.
To set the operations counter, proceed as follows:

1. **MENU > F4 Configuration > F3 General > Press until the desired parameter is displayed.**
   - Operations counter.

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

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

4. Press **Enter**.
   - The operations counter is set.

### 8.2.5 Dimming display

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

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

Activating this function extends the display's service life.

To activate/deactivate automatic display dimming, proceed as follows:

1. Press **MENU > F4 Configuration > F3 General > Enter** until the desired parameter is displayed.
   - Display off.

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

3. Press **Enter**.
   - Automatic dimming is set.

### 8.2.6 Activating/deactivating the automatic key lock

Activating this function automatically activates the key lock if no keys are pressed for 15 minutes. You can also lock the keys manually. This function can be deactivated as well.
To set the automatic key lock, proceed as follows:

1. **Configuration > F4 General > Press ** until the desired parameter is displayed.

   Key lock

2. Press **F1** or **F5** to select **On** or **Off**.

3. Press **←**

   Automatic key lock is set.

### 8.2.7 "Function monitoring" message for monitoring messages <30 V

By default, the Function monitoring message is activated for measured voltages. This message is issued as soon as the measured voltage is under 30 V for longer than the set signaling delay time.

**Switched-off transformer**

You can suppress the message with this parameter to prevent the message from being continuously issued when a transformer is shut off.

The device behaves as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>The Function monitoring message is issued after the configured delay time if the measured voltage is less than 30 V.</td>
</tr>
<tr>
<td>Off</td>
<td>The Function monitoring message is suppressed if the measured voltage is less than 30 V.</td>
</tr>
</tbody>
</table>

Table 9: Settings

**Activate/deactivate message**

To activate/deactivate function monitoring, proceed as follows:

1. **Configuration > F4 General > Press ** until the desired parameter is displayed.

   Function monitoring

2. Press **F1** or **F5** to select **On** or **Off**.

3. Press **←**

   The Function monitoring message for is activated/deactivated for measured voltages <30 V.

**Setting delay time**

You can configure the delay time after which the Function monitoring message is to be issued. If you select 0, function monitoring is deactivated.
8 Operation

To set the delay time for the *Function monitoring* message, proceed as follows:

1. Press **MENU > F4 Configuration > F3 General > Press ➡️ ➡️ ➡️** until the desired parameter is displayed.
   - Delay function monitoring
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press **⬅️**.
   - The delay time for the *Function monitoring* message is set.

### 8.2.8 Setting motor runtime monitoring

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

#### Behavior

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

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

#### Parameterizing control input

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

If you want to monitor the motor runtime, the device and motor-drive unit must be connected and parameterized as shown below.

Figure 43: Wiring for motor runtime monitoring

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

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

If the runtime monitoring is set to "0.0 s", this equates to it being switched off.
To set the motor runtime, proceed as follows:

1. Press \text{[F4]} Configuration > \text{[F3]} General > Press \text{[→]} until the desired parameter is displayed.
   ⇒ Motor runtime.

2. Press \text{[F4]} to highlight the position.
   ⇒ The desired position is highlighted and the value can be changed.

3. Press \text{[F1]} to increase the value or \text{[F5]} to reduce it.

4. Press \text{[→]}.
   ⇒ The motor runtime is set.

8.2.9 Activate manual mode/auto mode

This parameter can be used to activate the \textit{Manual} or \textit{Automatic} operation modes. This parameter has the same functions as the Manual and Auto keys.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
</table>
| Manual    | Device is no longer controlling automatically.  
            You can set or change parameters manually.  
            You can control the motor-drive unit using the control panel. |
| Auto      | The device is controlling the voltage automatically.  
            You cannot set or change any parameters.  
            You cannot control the motor-drive unit using the control panel. |

Table 10: Adjustable parameters

To select the operating mode, proceed as follows:

1. Press \text{[F4]} Configuration > \text{[F3]} General > Press \text{[→]} until the desired parameter is displayed.
   ⇒ Manual/Automatic

2. Press \text{[F1]} or \text{[F5]} to select the operating mode you want.

3. Press \text{[→]}
   ⇒ The operating mode is set.
8.2.10 Activating Local/Remote

This parameter can be used to activate the Local or Remote operation modes. This parameter has the same functions as the keys.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>You can operate the device using the control panel.</td>
</tr>
<tr>
<td>Remote</td>
<td>You can operate the device using an external control level. Manual operation is disabled.</td>
</tr>
</tbody>
</table>

Table 11: Adjustable parameters

To activate Manual or Automatic operating mode, proceed as follows:

1. Configuration > F4 General > Press until the desired parameter is displayed.
2. Local/Remote
3. Press F1 or F5 to select the operating mode you want.
4. Press The operating mode is set.

8.2.11 Setting the COM1 password

You can use this parameter to enter a password for the COM1 front interface and the Cl card RS232 interface. This enables you to protect the device against unauthorized access via these interfaces. If a COM1 password is assigned, you must first enter the correct password to establish a connection via the interfaces.

Note the following information:

- The password must be at least 1 character long and must not exceed 8 characters. If you enter an empty password (only an end marker), then the COM1 password is deactivated.
- You can enter alphanumeric characters (A to Z, a to z, 0 to 9) and an end marker (space).
- If you want to use a password with fewer than 8 characters, you must select the end marker after the last character of your password.
- Once you save the password, the display changes to xxxxxxxx. The password is only displayed in plain text during text input.
Proceed as follows to set the COM1 password:

1. **MENU** \(\rightarrow\) **F4** Configuration \(\rightarrow\) **F3** General \(\rightarrow\) Press \(\leftarrow\) until the desired parameter is displayed.

   ⇔ COM1 password.

2. Enter the current COM1 password. Press **F1** or **F5** to change a character and **F4** to select the next character.

3. Press **\(\leftarrow\)**.

   ⇔ The Parallel operation active LED flashes. You can establish a connection via the front interface or enter a new password.

4. Press **F1** or **F5** to change a character and **F4** to select the next character.

5. Press **\(\leftarrow\)**.

   ⇔ The COM1 password is set. The display changes to xxxxxxxxx.

### 8.2.12 Setting the password duration

You can use this parameter to set the period for which the password is active once it has been entered. If the password is active, the Parallel operation active LED flashes.

If you establish a connection via the COM1 front interface or via the CI card RS232 interface, the password remains active for as long as data is being transferred via the interface. The set password duration expires the moment that no more data is transmitted.

To set the password duration, proceed as follows:

1. **MENU** \(\rightarrow\) **F4** Configuration \(\rightarrow\) **F3** General \(\rightarrow\) Press \(\leftarrow\) until the desired parameter is displayed.

   ⇔ Password duration.

2. Press **F1** or **F5** to increase or decrease the value.

3. Press **\(\leftarrow\)**

   ⇔ The password duration is set.

### 8.3 NORMset

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

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

- Normset activation
- Desired value 1
• Primary voltage
• Secondary voltage

Line drop compensation cannot be performed in NORMset mode.

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

**Activating/deactivating NORMset**

You can use this parameter to activate NORMset mode.

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

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

To activate/deactivate NORMset mode, proceed as follows:

1. \[ Menu \rightarrow F2 \] NORMset
   ⇒ NORMset activation.
2. Press \[ F1 \] or \[ F5 \] to activate NORMset by selecting On or to deactivate NORMset by selecting Off.
3. Press \[ \] ⇒ NORMset is activated/deactivated.

**Setting the primary voltage**

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

To set the primary voltage, proceed as follows:

1. \[ Menu \rightarrow F2 \] NORMset \rightarrow Press \[ \ldots \] until the desired parameter is displayed.
   ⇒ Primary voltage.
2. Press \[ F1 \] to increase the value or \[ F5 \] to reduce it.
3. Press \[ \] ⇒ The primary voltage is set.

**Setting the secondary voltage**

With this parameter, you can set the voltage transformer's secondary voltage.
To set the secondary voltage, proceed as follows:
1. Press F2 NORMset > Press until the desired parameter is displayed.
   ⇒ Secondary voltage.
2. Press F1 to increase the value or F5 to reduce it.
3. Press .
   ⇒ The secondary voltage is set.

**Setting desired value 1**

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

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

To set the desired value, proceed as follows:
1. Press F2 NORMset > Press until the desired parameter is displayed.
   ⇒ Desired value 1.
2. Press F1 to increase the value or F5 to reduce it.
3. Press .
   ⇒ The desired value is set.

**8.4 Control parameters**

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

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

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

If the measured voltage \( U_{\text{actual}} \) is within the set bandwidth \( 6 \), 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 \( 6 \) within the set delay time \( T1 \) \( 4 \). However, if the measured voltage deviates from the set bandwidth for a long period \( C \) a tap-change command \( D \) 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 46: Behavior of the regulation function with delay time T1](image)

<table>
<thead>
<tr>
<th>1</th>
<th>+ B %: Upper limit</th>
<th>4</th>
<th>Set delay time T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>( U_{\text{desired}} ): Desired value</td>
<td>5</td>
<td>( U_{\text{actual}} ): Measured voltage</td>
</tr>
<tr>
<td>3</td>
<td>- B %: Lower limit</td>
<td>6</td>
<td>B%: Tolerance bandwidth</td>
</tr>
</tbody>
</table>

\( A \) \( U_{\text{actual}} \) is outside the bandwidth. Delay time \( T1 \) starts.

\( B \) \( U_{\text{actual}} \) is within the bandwidth before delay time \( T1 \) is complete.

\( C \) \( U_{\text{actual}} \) is outside the bandwidth. Delay time \( T1 \) starts.

\( D \) \( U_{\text{actual}} \) is still outside the bandwidth when delay time \( T1 \) is complete. Tap-change operation is initiated.

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 \( U_{\text{actual}} \) deviates from the set bandwidth for a long period \( A \), a control impulse is output to the motor-drive unit after the set delay time \( T1 \) \( B \). If the measured voltage \( U_{\text{actual}} \) 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 47: Behavior of the regulation function with delay times T1 and T2

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

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

### 8.4.1 Setting desired value 1...3

You can use this parameter to set up to 3 desired voltage values U_{Ref}. The desired voltage value is specified as a fixed value. The desired value 1 is the default desired value. Desired values 2 and 3 are activated if there is a continuous signal at factory-preset control inputs X4:17 or X4:18 provided you have programmed these previously. If there is a signal at several control inputs at the same time, desired value 2 is activated.
8 Operation

Options for setting the desired values

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

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

Reference of kV and V for voltage transformer

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

To set the desired value, proceed as follows:

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

8.4.2 Selecting a desired value

You can use this parameter to select the active desired value 1, 2 or 3.

If you select the desired value using appropriately configured GPIs, this parameter's setting is ignored. Refer to the Configuration (Section 8.11, Page 123) section for more information about GPI configuration.

Proceed as follows to select a desired value:

1. Control parameter > Voltage regulation > Press until the desired parameter is displayed. Desired value selection
2. Press F1 or F5 to select an active desired value.
3. Press The selected desired value is active.
8.4.3 Bandwidth

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

8.4.3.1 Determining bandwidth

In order to set the correct value, the transformer’s step voltage and nominal voltage must be known.

Too small/large a bandwidth

You have to set the bandwidth in such a way that the output voltage of the transformer ($U_{\text{Act}}$) returns to within the specified tolerance bandwidth after the tap change. If too small a bandwidth is defined, the output voltage exceeds the bandwidth selected and the device immediately issues a tap-change command in the opposite direction. If a very large bandwidth is selected, this results in a major control deviation.

The following value is recommended for the bandwidth setting:

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

Figure 49: Recommended 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 recommended bandwidth:

*Nominal voltage* $U_{\text{nom}} = 11,000$ V

*Step voltage in tap position 4* $U_{\text{Step4}} = 11,275$ V

*Step voltage in tap position 5* $U_{\text{Step5}} = 11,000$ V

$$\pm B\% \geq 0.6 \cdot \frac{U_{\text{Step4}} - U_{\text{Step5}}}{U_{\text{nom}}} \cdot 100\%$$

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

$$\pm B\% \geq 1.5\%$$

The following section describes how you can set the bandwidth.
8.4.3.2 Setting the bandwidth

To enter the determined bandwidth, proceed as follows:

1. **MENU > F3** Parameter > **F2** Control parameter > Press ‣ until the desired parameter is displayed.

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

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

4. Press ‣
   ⇨ The bandwidth is set.

8.4.3.3 Visual display

The deviation from the set bandwidth is shown visually in the device’s display. The measured voltage 3 highlighting shows whether the measured voltage is above, within or below the set bandwidth 1. Progress of delay time T1 is indicated by the gradual filling of the time bar 2. The seconds display 5 above this indicates the remaining delay time T1.

---

![Visual display of deviation from desired value](image)

---

8.4.4 Setting delay time T1

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

1. Press `Menu` > `F3` Parameter > `F2` Control parameter > Press `→` until the desired parameter is displayed.

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

3. Press `F1` to increase the time or `F5` to reduce it.

4. Press `←` ⇒ The delay time T1 is set.

### 8.4.5 Setting control response T1

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

**Linear control response T1**

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

**Integral control response T1**

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

![Diagram showing integral control response](image)

Figure 51: Diagram showing integral control response

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

1. \textbf{Parameter > Control parameter > Press until the desired parameter is displayed.}
2. Press \textbf{F1} or \textbf{F5} to set the response you want.
3. Press \textbf{←}.

$\Rightarrow$ The control response T1 is set.

### 8.4.6 Setting delay time T2

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

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

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

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

To set the delay time T2, proceed as follows:

1. \textbf{Parameter > Control parameter > Press until the desired parameter is displayed.}

$\Rightarrow$ Delay time T2.
2. Press \textbf{F1} to increase the time or \textbf{F5} to reduce it.
3. Press \textbf{←}.

$\Rightarrow$ The delay time T2 is set.

### Activating/deactivating delay time T2

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

1. \textbf{Parameter > Control parameter > Press until the desired parameter is displayed.}

$\Rightarrow$ T2 activation.
2. Press \textbf{F5} or \textbf{F1} to activate/deactivate T2.
3. Press \textbf{←}.

$\Rightarrow$ The delay time T2 is activated/deactivated.
8.5 Limit values

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

- Undervoltage $U<$
- Overvoltage $U>$
- Overcurrent $I>$

Limit value monitoring is used to reduce damage to the system periphery. The following sections describe how you can set the parameters.

8.5.1 Setting undervoltage monitoring $U<$

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

If the measured voltage $U_{actual}$ falls below the set limit value $4$, the red LED $U< \text{ lights up}$. The switching pulses to the motor-drive unit are blocked at the same time provided you have activated the blocking undervoltage $U<$ parameter. Once the set signaling delay time $\text{Section , Page 89}$ $6$ has passed, the signaling relay activates. The Undervoltage $U<$ message appears in the display. The message is reset as soon as the measured voltage $U_{actual}$ again exceeds the limit value for undervoltage $E$. If the measured voltage $U_{actual}$ falls below 30 V $\text{Section , Page 90}$, the undervoltage message is also displayed. You can however suppress this message.

![Figure 52: Response to value falling below limit value](image)

| Figure 52: Response to value falling below limit value |
|---|---|
| 1 | + B%: Upper limit |
| 2 | $U_{desired}$: Desired value |
| 3 | - B%: Lower limit |
| 4 | Set limit value for undervoltage $U<$ |
| 5 | Limit value for suppressing alarms below 30 V |
| 6 | Set signaling delay time for limit value for undervoltage $U<$ |
| 7 | $U_{actual}$: Measured voltage |
| A | Value falls below limit value |
| B | Undervoltage $U<$ message is displayed |
| C | Voltage falls below 30 V |
| D | Voltage exceeds 30 V again |
| E | Value exceeds limit value |

**Setting undervoltage monitoring $U<$ in %**

Use the parameter to set the limit value as a relative value.
To set the limit value for undervoltage $U <$ as %, proceed as follows:

1. Press $\text{Menu} > F3 \text{ Control parameter} > F3 \text{ Limit values} > \text{Press } \Rightarrow$ until the desired parameter is displayed.
   $\Rightarrow U <$ Undervoltage (%)
2. Press $F1$ to increase the value or $F5$ to reduce it.
3. Press $\leftarrow$.
   $\Rightarrow$ The limit value for undervoltage $U <$ is set.

### Setting signaling delay for undervoltage $U <$

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

To set the delay time for this message, proceed as follows:

1. Press $\text{Menu} > F3 \text{ Control parameter} > F3 \text{ Limit values} > \text{Press } \Rightarrow$ until the desired parameter is displayed.
   $\Rightarrow U <$ Delay
2. Press $F4$ to highlight the position.
   $\Rightarrow$ The desired position is highlighted and the value can be changed.
3. Press $F1$ to increase the time or $F5$ to reduce it.
4. Press $\leftarrow$.
   $\Rightarrow$ The signaling delay time for undervoltage $U <$ is set.

### Activating/deactivating undervoltage blocking

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

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

Table 12: Behavior
To activate/deactivate the undervoltage blocking, proceed as follows:

1. \textbf{Control parameter} > \textbf{Limit values} > Press until the desired parameter is displayed.
   \( \Rightarrow \) \textbf{U<} blocking.

2. Press \textbf{F1} for \textbf{On} setting or \textbf{F5} for \textbf{Off} setting.

3. Press \( \Rightarrow \)
   \( \Rightarrow \) Undervoltage blocking is activated/deactivated.

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

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

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

Table 13: Response

To activate/deactivate the message, proceed as follows:

1. \textbf{Control parameter} > \textbf{Limit values} > Press until the desired parameter is displayed.
   \( \Rightarrow \) \textbf{U<} also under 30 V.

2. Press \textbf{F1} for \textbf{On} setting or \textbf{F5} for \textbf{Off} setting.

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

**8.5.2 Setting overvoltage monitoring \textit{U>}**

You can use these parameters to set the limit values for overvoltage monitoring. This overvoltage monitoring triggers tap-change operations to return to the desired operating status. If the operating status can no longer be corrected, a message is triggered by the \textit{Function monitoring} relay.
8 Operation

**Response to high-speed return**

If the measured voltage $U_{\text{actual}}$ exceeds the set limit value $A$, the red LED $U>$ and associated signaling relay activate. The Overvoltage $U>$ message appears in the display. At the same time, the high-speed return function is activated without delay time $T_1$. Once the set switching pulse time $B$ has passed, the tap position is lowered $C$ by activating the motor-drive unit until the measured voltage $U_{\text{actual}}$ again falls below the limit value $B$. The Overvoltage $U>$ message is reset.

![Diagram](image)

**Figure 53: Response to limit value being exceeded**

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

**Response to overvoltage blocking**

If you activated the overvoltage blocking, all switching pulses to the motor-drive unit are blocked when a limit value is exceeded. At the same time, the red LED $U>$ lights up and the Overvoltage $U>$ message is displayed. As soon as the measured voltage $U_{\text{actual}}$ has again fallen below the limit value, blocking and the message are reset.

The following sections describe how you can set the parameters for the overvoltage $U>$ limit value.
Setting overvoltage $U>$ as %

The limit value is entered as a relative value (%) of the set desired value. To set the limit value, proceed as follows:

1. Press $\text{Control parameter } \rightarrow \text{Limit values } \rightarrow \text{Press } \rightarrow$ until the desired parameter is displayed.
   - $U>$ Overvoltage (%)

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

3. Press $\leftarrow$.
   - The limit value is set.

Activating overvoltage blocking/high-speed return

You can use this parameter to set how the device responds to overvoltage. The following settings are possible:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>During overvoltage, the device blocks all switch pulses to the motor-drive unit.</td>
</tr>
<tr>
<td>Off</td>
<td>In the event of overvoltage, a high-speed return is undertaken until the value again falls below the limit value.</td>
</tr>
</tbody>
</table>

Table 14: Possible settings

To set the device’s response to overvoltage, proceed as follows:

1. Press $\text{Control parameter } \rightarrow \text{Limit values } \rightarrow \text{Press } \rightarrow$ until the desired parameter is displayed.
   - Overvolt. blocking $U>$.

2. Press $\text{F1}$ or $\text{F5}$ to set the option you want.

3. Press $\leftarrow$.
   - The response is set.

8.5.3 Setting overcurrent monitoring $I>$

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

If the measured current exceeds the set limit value, the red LED $I>$ lights up. The Overcurrent message appears in the display. The device’s output pulses are blocked at the same time.
Setting overcurrent I> as %

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

1. Control parameter > Limit values > Press until the desired parameter is displayed.
   ⇒ Overcurrent I>
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵
   ⇒ The limit value is set.

Activating/deactivating overcurrent blocking

To activate/deactivate overcurrent blocking, proceed as follows:

1. Control parameter > Limit values > Press until the desired parameter is displayed.
   ⇒ Blocking Overcurr. I>
2. Press F1 or F5 to activate (ON)/deactivate (OFF) overcurrent blocking.
3. Press ↵.
   ⇒ The overcurrent blocking is activated/deactivated.

8.5.4 Set undercurrent monitoring I<

These parameters are used to set undercurrent monitoring. As soon as the measured current falls below the set limit value, control is blocked.

Setting undercurrent I<

To set the limit value for undercurrent monitoring, proceed as follows:

1. Control parameter > Limit values > Press until the desired parameter is displayed.
   ⇒ Undercurrent I< [%]
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵
   ⇒ The I< undercurrent limit value is set.
Activating/deactivating I< undercurrent blocking

To activate/deactivate undercurrent monitoring, proceed as follows:

1. **MENU** > **F3** Control parameter > **F3** Limit values > Press until the desired parameter is displayed.

   ⇒ Blocking undercurrent I>.

2. Press **F1** or **F5** to activate (ON)/deactivate (OFF) undercurrent blocking.

3. Press **↓**

   ⇒ The I< undercurrent blocking is activated/deactivated.

**8.5.5 Activate/deactivate active power monitoring**

This parameter can be used to set active power monitoring. If blocking is activated, the control is blocked if a negative active power flow is detected. However, this is only possible if the current transformer connection is connected and correctly set. When regulator blocking is deactivated, then the sign of the active power does not affect the regulation.

To activate/deactivate regulator blocking, proceed as follows:

1. **MENU** > **F3** control parameter > **F4** Compensation > Press until the desired parameter is displayed.

   ⇒ Neg. active power block.

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

3. Press **↓**

   ⇒ Blocking the regulator with negative active power is activated/deactivated.

**8.5.6 Permitted tap positions**

You can use the parameters described below to restrict the permissible range of tap positions in auto mode. If you activate this function, the device does not switch to tap positions outside the set limits in auto mode.

In manual mode, for manual tap changes on the motor-drive unit or for remote tap changes via a SCADA system, monitoring of the step limits is not active. This may result in the set limits being exceeded.

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

**8.5.6.1 Setting the lowest tap position blocking limit**

You can define a lower tap position blocking limit to limit the number of tap positions available in operation. When the tap position defined as lower tap position blocking limit is reached, tap position blocking is activated. This prevents any further tap change downwards.
To define the lower tap position blocking limit, proceed as follows:

1. **Menu > Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ** until the desired parameter is displayed.
   - Lowest tap position

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

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

4. Press **←**
   - The lower tap position blocking limit is defined.

### 8.5.6.2 Setting highest tap position blocking limit

You can define an upper tap position blocking limit to limit the number of tap positions available in operation. When the tap position defined as the upper tap position blocking limit is reached, tap position blocking is activated. This prevents any further tap change upwards.

To define the upper tap position blocking limit, proceed as follows:

1. **Menu > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ** until the desired parameter is displayed.
   - Highest tap position

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

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

4. Press **←**
   - The upper blocking limit is defined.

### 8.5.6.3 Setting the tap position blocking mode

You can set the tap position blocking mode in relation to the upper and lower tap position blocking limits:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>The tap position blocking mode is deactivated</td>
</tr>
<tr>
<td>Directional</td>
<td>During raise and lower tap changes, the device blocks as soon as the defined upper/lower tap position limit is reached or exceeded. Further tap changes are prevented.</td>
</tr>
<tr>
<td>Non-directional</td>
<td>The device blocks in both directions as soon as the defined lower/upper tap position limit is reached or exceeded. Further tap changes are prevented.</td>
</tr>
</tbody>
</table>

Table 15: Tap position blocking mode
To set the tap position blocking mode, proceed as follows:

1. Press \( \text{MAN} \) to select manual mode.
2. Press \( \text{t} \) to change back manually into the defined tap position limits.

1. **Configuration > Continue > Continue > Tap position > Press \( \rightarrow \) until the desired parameter is displayed.**
2. Press \( F1 \) or \( F5 \) to set the option you want.
3. Press \( \leftarrow \).

\( \rightarrow \) The tap position blocking mode is set.

### 8.6 Compensation

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

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

#### 8.6.1 Line drop compensation

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

To set R&X compensation correctly, you need to calculate the ohmic and inductive voltage drop in \( V \) with reference to the secondary side of the voltage transformer. You also need to correctly set the transformer circuit used.

![Figure 56: Equivalent circuit](image)
You can calculate the ohmic and inductive voltage drop using the following formulas. This voltage drop calculation relates to the relativized voltage on the secondary side of the voltage transformer.

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

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

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

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(U_r)</td>
<td>Voltage drop in V due to ohmic line resistance</td>
</tr>
<tr>
<td>(U_x)</td>
<td>Voltage drop in V due to inductive line resistance</td>
</tr>
<tr>
<td>(I_N)</td>
<td>Nominal current (amps) of selected current-transformer connection on device: 1 A; 5 A</td>
</tr>
<tr>
<td>(k_{CT})</td>
<td>Current transformer ratio</td>
</tr>
<tr>
<td>(k_{VT})</td>
<td>Voltage transformer ratio</td>
</tr>
<tr>
<td>(r)</td>
<td>Ohmic resistance load in Ω/km per phase</td>
</tr>
<tr>
<td>(x)</td>
<td>Inductive resistance load in Ω/km per phase</td>
</tr>
<tr>
<td>(L)</td>
<td>Length of line in km</td>
</tr>
<tr>
<td>(K)</td>
<td>Nominal current factor</td>
</tr>
</tbody>
</table>
8.6.1.1 Setting the ohmic voltage drop Ur

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

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

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

1. Press or to select the LDC compensation method.
2. Press until the desired parameter is displayed.
3. Press to increase the value or to reduce it.
4. Press .

8.6.1.2 Setting the inductive voltage drop Ux

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

If you do not want to use line drop compensation, you have to set the value 0.0 V.
To set the inductive voltage drop $U_x$, proceed as follows:

1. Select the LDC compensation method.
   - Press $F_3$ Parameter $\rightarrow F_4$ Compensation $\rightarrow$ until the desired parameter is displayed.
   - $U_x$ line drop compensation.
2. Press $F_4$ to highlight the position.
   - The desired position is highlighted and the value can be changed.
3. Press $F_1$ to increase the value or $F_5$ to reduce it.
4. Press $\leftarrow$.
   - The inductive voltage drop $U_x$ is set.

### 8.6.2 Z compensation

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

![Figure 59: Z compensation](image)

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

$$\Delta U = 100 \cdot \frac{U_{I} - U_{load}}{U_{load}} \cdot \frac{I_{N} \cdot k_{CT}}{I}$$

<table>
<thead>
<tr>
<th>$\Delta U$</th>
<th>Voltage increase</th>
<th>$I$</th>
<th>Load current in A</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_{I}$</td>
<td>Transformer voltage with current $I$</td>
<td>$I_{N}$</td>
<td>Nominal current of current-transformer connection in A (1 A; 5 A)</td>
</tr>
<tr>
<td>$U_{load}$</td>
<td>Voltage on line end with current $I$ and on-load tap-changer in same operating position</td>
<td>$k_{CT}$</td>
<td>Current transformer ratio</td>
</tr>
</tbody>
</table>
Sample calculation: \( U_T = 100.1 \text{ V} \), \( U_{\text{load}} = 100.0 \text{ V} \), \( I_N = 5 \text{ A} \), \( k_{CT} = 200 \text{ A/5 A} \), \( I = 100 \text{ A} \)

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

The following sections describe how you can set the parameters you need for Z compensation.

### Select Z compensation

To select the line drop compensation, proceed as follows:

1. Press \( \text{F1} \) or \( \text{F5} \) until the Z option is displayed.
2. The Z compensation is selected.

The following sections describe how you can set the required parameters for Z compensation.

8.6.2.1 Setting Z compensation

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

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

To set the current dependent voltage increase, proceed as follows:

1. Press \( \text{F1} \) to increase the value or \( \text{F5} \) to reduce it.
2. The current-dependent voltage increase is set.

8.6.2.2 Setting the Z compensation limit value

You can use this parameter to define the maximum permissible voltage increase to avoid excess voltage on the transformer.
If you do not want to use a limit value, you have to set the value 0.0 %.

To set the limit value for the current-dependent voltage increase, proceed as follows:

- Select Z compensation.
- Set the “Z compensation” parameter

1. Press \( F_3 \) Parameter > \( F_4 \) Compensation > Press \( \rightarrow \) until the desired parameter is displayed.
   ⇒ Z comp. limit value.

2. Press \( F_1 \) to increase the value or \( F_5 \) to reduce it.

3. Press \( \leftarrow \).
   ⇒ The limit value is set.

8.7 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.

The following parameters are available for this purpose:
- Primary voltage
- Secondary voltage
- Primary current
- Secondary current (current transformer connection)
- Transformer circuit

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

<table>
<thead>
<tr>
<th>Parameter set</th>
<th>Measured value display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary voltage</td>
</tr>
<tr>
<td>Primary voltage</td>
<td>-</td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>-</td>
</tr>
<tr>
<td>Primary current</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### 8.7.1 Setting the primary transformer voltage

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

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

To set the primary transformer voltage, proceed as follows:

1. **Configuration > Transformer data.**
   - Primary voltage.
2. Press **F3** to highlight the decimal place.
   - The decimal place is defined and the value can be changed.
3. Press **F4** to highlight the position.
   - The desired position is highlighted and the value can be changed.
4. Press **F1** to increase the value or **F5** to reduce it.
5. Press **<**
   - The primary transformer voltage is set.

### 8.7.2 Setting the secondary transformer voltage

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

To set the secondary transformer voltage, proceed as follows:

1. **Configuration > Transformer data > Press F4** until the desired parameter is displayed.
   - Secondary voltage.
2. Press **F4** to highlight the position.
   - The desired position is highlighted and the value can be changed.
3. Press **F1** to increase the value or **F5** to reduce it.
8.7.3 Setting primary transformer current

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

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

To set the primary transformer current, proceed as follows:

1. Press \[ \text{F4} \] Configuration > \[ \text{F2} \] Transformer data > Press [ ] until the desired parameter is displayed.
   \( \Rightarrow \) Primary current.

2. Press \[ \text{F4} \] to highlight the position.
   \( \Rightarrow \) The desired position is highlighted and the value can be changed.

3. Press \[ \text{F1} \] to increase the value or \[ \text{F5} \] to reduce it.

4. Press \[ \text{F1} \] \( \Rightarrow \) The primary transformer current is set.

8.7.4 Setting the current transformer connection

This parameter can be used to set the current transformer connection. This setting is needed for the device to display the correct secondary current in the info screen.
If you select the "Unknown" option, the percentage of current (with reference to the current transformer connection used) is displayed in the info screen.

- 1 A
- 5 A

Proceed as follows to set the current-transformer connection:

1. **Menu > Configuration > Transformer data > Press ▶ ▶ until the desired parameter is displayed.**
   - Current-transformer connection

2. Press F1 or F5 to select a current-transformer connection.

3. Press ◀
   - The current-transformer connection is set.

### 8.7.5 Setting the phase difference for the current transformer/voltage transformer

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

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

Table 18: Set values for transformer circuit

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

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

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

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

Figure 64: Phase difference 0 3PH

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

Circuit D

Figure 65: Phase difference 90 3PH

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

Circuit E

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

Circuit F

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT is looped into the outer conductor L1.
- The current \( I_{L1} \) lags behind \( U_{L1} - U_{L2} \) by 30°. This corresponds to a phase shift of -30°.
- The voltage drop on an outer conductor is determined by the current \( I_{L1} \).
To set the phase difference for the transformer circuit, proceed as follows:

1. MENU > F4 Configuration > F2 Transformer data > Press → until the desired parameter is displayed.

   ⇒ Transformer circuit.

2. Press F1 or F5 to select the required phase difference.

3. Press ←

   ⇒ The phase difference is set.

### 8.8 Parallel operation

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

**Conditions for parallel operation**

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

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

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

**Parallel operation method**

The device supports parallel operation following the methods described below:

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

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

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

- CAN bus address
8 Operation

8.8.1 Assigning CAN bus address

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

To enter the CAN bus address, proceed as follows:

1. **Menu** > **F4** Configuration > **F4** Parallel operation > Press until the desired parameter is displayed.

   ✐ CAN address.

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

3. Press **←**

   ✐ The CAN bus address is saved.

8.8.2 Selecting parallel operation method

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

▪ Circulating reactive current minimization

▪ Tap synchronization (master/follower)

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

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

8.8.2.1 Setting circulating reactive current method

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

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

1. **Configuration > Parallel operation > Press** until the desired parameter is displayed.
   ⇒ Parallel operation method

2. Press **F1** or **F5** until circulating reactive current appears in the display.

3. Press **←**
   ⇒ The parallel operation method is set.

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

**Setting circulating reactive current sensitivity**

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

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

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

1. **Configuration > Parallel operation > Press** until the desired parameter is displayed.
   ⇒ Circulating reactive current sensitivity

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

3. If necessary, press **F3** to highlight the decimal place.
   ⇒ The decimal place is now highlighted and the value can be changed.

4. Press **←**
   ⇒ The circulating reactive current sensitivity is set.

**Setting circulating reactive current blocking**

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

- Parallel operation error
All devices operating in parallel are blocked. Depending on the set delay time for the parallel operation error message, the signaling relay Parallel operation error is activated.

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

1. Configuration > Parallel operation > Press until the desired parameter is displayed.
   - Circulating reactive current blocking
2. Press to increase the value or to reduce it.
3. Press
   - The blocking limit for the maximum permitted circulating reactive current is set.

8.8.2.2 Setting tap synchronization

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

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

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

Table 19: Tap synchronization method

In parallel operation, an individual CAN bus address must be assigned to each voltage regulator. Up to 16 CAN participants are supported.
To set the tap synchronization method, proceed as follows:

1. **MENU > F4 Configuration > F4 Parallel operation > Press until the desired parameter is displayed.**
   - Parallel operation method.
2. Press **F1** or **F5** until the desired parameter is displayed.
3. Press **←**
   - The tap synchronization method is set.

### 8.8.2.2.1 Setting the follower tapping direction

With this parameter, you can set how the follower behaves in the event of a raise or lower tap change.

As in "Tap synchronization (master/follower)" parallel operation the tap positions of the transformers which are running in parallel are compared, it is absolutely essential that these transformers have the same position designation. Ensure that all higher tap change operations or lower tap change operations produce the same voltage change in all transformers.

You can select the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Follower sends a raise tap change command to increase the voltage. Follower</td>
</tr>
<tr>
<td><strong>dV&gt;0</strong></td>
<td>sends a lower tap change command to reduce the voltage. Follower sends a</td>
</tr>
<tr>
<td></td>
<td>raise tap change command to increase the voltage.</td>
</tr>
<tr>
<td></td>
<td>Follower sends a lower tap change command to reduce the voltage.</td>
</tr>
<tr>
<td></td>
<td>Follower sends a raise tap change command to increase the voltage. Follower</td>
</tr>
<tr>
<td></td>
<td>sends a lower tap change command to reduce the voltage. Follower sends a</td>
</tr>
<tr>
<td></td>
<td>raise tap change command to increase the voltage.</td>
</tr>
<tr>
<td></td>
<td>Follower sends a lower tap change command to reduce the voltage.</td>
</tr>
</tbody>
</table>

Table 20: Device behavior

Please note whether the voltage regulator is defined as master or follower when setting the tapping direction. The tapping direction can only be swapped for a follower.
To select the tapping direction, proceed as follows:

1. **MENU > F4 Configuration > F4 Parallel operation > Press →** until the desired parameter is displayed.
   ⇒ Follower tapping direction.

2. Press **F1** or **F5** to select the required tapping direction.

3. Press **←**.
   ⇒ The tapping direction is selected.

### 8.8.2.2 Setting the master/follower circulating reactive current blocking limit

This monitoring function is available in the "Master/follower tap synchronization" parallel operation mode in conjunction with a current measurement. The device is blocked as soon as the circulating reactive current reaches the blocking limit.

To activate/deactivate the circulating reactive current blocking limit, proceed as follows:

1. **MENU > F4 Configuration > F4 Parallel operation > Press →** until the desired parameter is displayed.
   ⇒ Master/follower current blocking.

2. Press **F1** or **F5** to activate blocking by selecting **Blocking** or to deactivate blocking by selecting **Off**.

3. Press **←**.
   ⇒ The blocking is activated.

### 8.8.3 Assigning a parallel operation group

You can use this parameter to assign a transformer group to the device. You can create a total of 2 groups. The parallel operation group can be selected only if you have not programmed an allocation using a GPI control input.

The following groupings are possible:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Device not assigned to any parallel operation group</td>
</tr>
<tr>
<td>Group 1</td>
<td>Device assigned to parallel operation group 1</td>
</tr>
<tr>
<td>Group 2</td>
<td>Device assigned to parallel operation group 2</td>
</tr>
<tr>
<td>Group 1 and group 2</td>
<td>Device assigned to parallel operation groups 1 and 2</td>
</tr>
</tbody>
</table>

Table 21: Parallel operation groups
To assign the device to a parallel operation group, proceed as follows:

1. Configure > Parallel operation > Press \( \rightarrow \) until the desired parameter is displayed.
   \( \rightarrow \) Parallel operation group.

2. Press \( F_1 \) or \( F_5 \) until the desired setting is displayed.

3. Press \( \leftarrow \)
   \( \rightarrow \) The device is assigned to a parallel operation group.

### 8.8.4 Activating/deactivating blocking in simplex mode

With this parameter, you can configure if you want to prevent one single device handling regulation. This function is activated if only this one device is recognized in the parallel operation group using the CAN bus.

To activate/deactivate the Simplex mode blocking function, proceed as follows:

To activate/deactivate the simplex mode blocking function, proceed as follows:

1. Configure > Parallel operation > Press \( \rightarrow \) until the desired parameter is displayed.
   \( \rightarrow \) Simplex mode blocking.

2. Press \( F_1 \) or \( F_5 \) to activate blocking by selecting On or to deactivate blocking by selecting Off.

3. Press \( \leftarrow \)
   \( \rightarrow \) Blocking in simplex mode is activated.

### 8.8.5 Setting delay time for parallel operation error messages

You can use this parameter to set the delay time for a parallel operation error message so that brief fault messages are not received if the motor-drive units involved in the parallel operation have different runtimes. Once the set delay time has elapsed, the event is issued at the output relay.

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

1. Configure > Parallel operation > Press \( \rightarrow \) until the desired parameter is displayed.
   \( \rightarrow \) Error message.

2. Press \( F_1 \) to increase the value or \( F_5 \) to reduce it.

3. Press \( \leftarrow \)
   \( \rightarrow \) The delay time for the parallel operation error message is set.
8.8.6 Configuring the maximum permitted tap difference

With this parameter, you can configure on the follower the maximum permitted tap difference between the follower and master.

In the tap synchronization parallel operation method, the tap positions of all transformers connected in parallel must be identical. Provided the tap difference is not greater than the maximum tap difference, the follower follows the master. If the tap difference is greater than the maximum tap position deviation, the follower and master block regulation immediately. After the set delay time for parallel operation error messages, the follower triggers the Parallel operation error message.

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

1. **Configuration > Parallel operation > Press** until the desired parameter is displayed.
   - **Max. tap difference.**

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

3. Press **←**.
   - The maximum permitted tap difference is configured.

8.8.7 Activating/deactivating follower tapping without measured voltage

If the follower does not have its own voltage measurement or an existing voltage measurement has no function, this function can be used to define whether the device should block or should continue to carry out the master’s control commands.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Follower also taps without measured voltage</td>
</tr>
<tr>
<td>Off</td>
<td>Follower only taps with measured voltage</td>
</tr>
</tbody>
</table>

Table 22: Device behavior

To activate/deactivate this function, proceed as follows:

1. **Configuration > Parallel operation > Press** until the desired parameter is displayed.
   - **Follower tapping without U_meas.**

2. Press **F1** or **F5** to activate the function by selecting **On** or to deactivate the function by selecting **Off**.

3. Press **←**.
   - The function is set.
8.8.8 Activating/deactivating parallel operation

This parameter can be used to activate or deactivate parallel operation. When activating parallel operation, make sure you have configured the following parameters:

- CAN bus address
- Assigning a parallel operation group

To deactivate parallel operation, proceed as follows:

1. MINI > F4 Configuration > F4 Parallel operation.
   ⇩ Parallel operation activation

2. Press F1 or F5 to activate parallel operation by selecting On or deactivate parallel operation by selecting Off.

3. Press ←
   ⇩ Parallel operation is deactivated.

8.9 Tap position capture

The current tap position of the on-load-tap-changer is transferred from the motor-drive unit to the device. In accordance with your order, the tap position is transferred in one of the following ways:

- Digital signal
  - BCD
  - DUAL
  - GRAY
  - N/O contact series (external module)
- Analog signal
  - Injected current (0/4...20 mA)
  - Resistor contact series (200...2,000 ohms)

The following sections describe how you can set the required parameters for tap position capture. Additional parameters for the tap position limit values can be found in the section titled “Permitted tap positions” [Section 8.5.6, Page 94].

8.9.1 Digital tap position capture

There is the option of transferring the tap position as a digital signal from the motor-drive unit to the device.

- BCD
- Binary code
- Gray code
To select the digital tap position capture, proceed as follows:

1. Configuration > Continue > Continue > Tap position
   ⇒ Tap pos. capture

2. Press F1 or F5 to set the desired option (Binary/BCD/Gray).

3. Press ↵.
   ⇒ The digital tap position capture is set.

No further settings are necessary.

8.9.2 Analog tap position capture

If the current tap position of the on-load tap-changer is captured using an analog signal, then the analog input (terminal strip X7) must be adapted to the signal of the tap position transmitter.

The analog input (terminal strip X7) can be used either for the input of the tap position or for setting the desired voltage level remotely.

You can use the following tap position transmitters:

<table>
<thead>
<tr>
<th>PIO card (Terminal strip X7)</th>
<th>Resistor contact series</th>
<th>Injected current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistive contact series</td>
<td>200...2,000 ohms</td>
<td>0/4...20 mA</td>
</tr>
</tbody>
</table>

Table 23: Analog tap position capture

Adjustment to the existing tap position transmitter must be carried out during commissioning.

To select an analog position capture, proceed as follows:

1. Configuration > Continue > Continue > Tap position
   ⇒ Tap pos. capture

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

3. Press ↵.
   ⇒ The tap position capture is set.

No further settings are necessary.
### 8.9.2.1 Setting lower limit value

These parameters can be used to set the lower value for the tap position. To do this, you must set the lower value of the signal range and the linked lowest tap position.

You can undertake the settings for each input on the analog input card.

**For example:** To capture a tap position range of 1...19 via input 1 as 4...20 mA, you must set 20% for the "Analog value [%] Tap pos. min" parameter and 1.0 for the "Lowest tap position" parameter.

#### Setting lower limit value of input signal [%]

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

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

**Table 24: Parameter settings**

To assign the minimum tap position to the analog value, proceed as follows:


   ⇒ Analog Val. [%] Tap pos. min.

2. **Press [F4] to highlight a digit.**

   ⇒ The desired position is highlighted and the value can be changed.

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

4. **Press [←]**

   ⇒ The analog value for the minimum tap positions is assigned.

#### Setting lower value of input signal

To configure the analog input, an absolute value must be assigned to the lower value of the applied signal.
To set the lowest tap position, proceed as follows:
1. \textbf{MENU} > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press \textbf{→} until the desired parameter is displayed.
   \(\Rightarrow\) Lowest tap position
2. Press F1 to increase the value or F5 to reduce it.
3. Press \textbf{←}.
   \(\Rightarrow\) The lowest tap position is set.

### 8.9.2.2 Setting upper limit value

These parameters can be used to set the upper value for the tap position. To do this, you must set the upper value of the signal range and linked highest tap position.

You can undertake the settings for each input on the analog input card.

For example: To capture a tap position range of 1...19 via input 1 as 4...20 mA, you must set 100\% for the "Analog value [%] Tap pos. max" parameter and 19.0 for the "Highest tap position" parameter.

#### Setting upper limit value of input signal [%]

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

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

Table 25: Parameter settings

To assign the maximum tap position to the analog value, proceed as follows:
1. \textbf{MENU} > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press \textbf{→} until the desired parameter is displayed.
   \(\Rightarrow\) Analog Val. [%] Tap pos. max.
2. Press F4 to highlight a digit.
   \(\Rightarrow\) The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press \textbf{←}.
   \(\Rightarrow\) The analog value for the maximum tap position is assigned.
Setting upper value of input signal

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

To set the highest tap position, proceed as follows:

1. Configuration > Continue > Continue > Tap position > Press \rightarrow until the desired parameter is displayed. ⇒ Highest tap position
2. Press \textbf{F1} to increase the value or \textbf{F5} to reduce it.
3. Press \rightarrow
⇒ The highest tap position is set.

8.10 Setting the desired voltage level remotely

The analog input can also be used to change the desired voltage value remotely. This requires the analog input (terminal strip X7) to be adapted to the voltage level transmitter signal.

The analog input (terminal strip X7) can be used either for the input of the tap position or for setting the desired voltage level remotely.

The following options are available for setting the desired voltage level remotely:

Analog setting of desired voltage level remotely
• Injected current: 0/4...20 mA
• Resistor contact series (200...2000 ohms)

8.10.1 Activate/deactivate setting the desired voltage level remotely.

You can use this parameter to activate or deactivate setting the desired voltage level remotely.

To activate/deactivate setting the desired voltage level remotely, proceed as follows:

1. Configuration > Continue > Continue > \textbf{F4} Set desired voltage level remotely > Press \rightarrow until the desired parameter is displayed. ⇒ Set desired voltage level remotely.
2. Press \textbf{F1} or \textbf{F5} to activate (On) or deactivate (Off) setting the desired voltage level remotely.
3. Press \[ \leftarrow \].

\( \Rightarrow \) Setting the desired voltage level remotely has been activated/deactivated.

### 8.10.2 Setting lower limit value for the desired value

To configure the analog input, state the analog value for the minimum desired value.

If you are using a desired value transmitter with a resistor contact series, select 20%.

If you are using a desired value transmitter with injected current as the transmitter signal, either select 0% (for 0 mA) or 20% (for 4 mA).

<table>
<thead>
<tr>
<th>Desired value</th>
<th>Current</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum desired value 90 V</td>
<td>0 mA</td>
<td>0% (of analog input signal range)</td>
</tr>
<tr>
<td></td>
<td>4 mA</td>
<td>20% (of analog input signal range)</td>
</tr>
</tbody>
</table>

Table 26: Examples of configuration for the analog input (desired value transmitter with injected current)

To set the analog value for the minimum desired value, proceed as follows:

1. \[ \text{Configuration} \] > \[ F4 \] Continue > \[ F5 \] Continue > \[ F4 \] Remote Volt. Level Setting > Press \[ \leftarrow \] until the desired parameter appears.

\( \Rightarrow \) Analog value % desired value min.

2. Press \[ F4 \] to highlight a digit.

\( \Rightarrow \) The desired position is highlighted and the value can be changed.

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

4. Press \[ \leftarrow \]

\( \Rightarrow \) The analog value for the minimum desired value is set.

To configure the analog input, the minimum desired value must be assigned to the minimum analog value.

To set the minimum desired value, proceed as follows:

1. \[ \text{Configuration} \] > \[ F4 \] Continue > \[ F5 \] Continue > \[ F5 \] Continue > \[ F4 \] Remote Volt. Level Setting > Press \[ \leftarrow \] until the desired parameter is displayed.

\( \Rightarrow \) Minimum desired value

2. Press \[ F1 \] to increase the value or \[ F5 \] to reduce it.
3. Press \( \Rightarrow \)

\( \Rightarrow \) The minimum desired value is set.

### 8.10.3 Setting upper limit value for the desired value

To configure the analog input, state the analog value for the maximum desired value.

If you are using a desired value transmitter with a resistor contact series, select 100%.

If you are using a desired value transmitter with injected current as the transmitter signal, select 100% (for 20 mA).

<table>
<thead>
<tr>
<th>Desired value</th>
<th>Current</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum desired value</td>
<td>20 mA</td>
<td>100% (of analog input signal range)</td>
</tr>
</tbody>
</table>

Table 27: Example of configuration for the analog input (desired value transmitter with injected current)

To set the analog value for the maximum desired value, proceed as follows:

1. \( \text{MENU} \) > \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F4} \) Remote Volt. Level Setting > Press \( \Rightarrow \) until the desired parameter is displayed.

\( \Rightarrow \) Analog value % desired value max

2. Press \( \text{F4} \) to highlight a digit.

\( \Rightarrow \) The desired position is highlighted and the value can be changed.

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

4. Press \( \Rightarrow \)

\( \Rightarrow \) The analog value for the maximum desired value is set.

To configure the analog input, the maximum desired value must be assigned to the maximum analog value.

To set the maximum desired value, proceed as follows:

1. \( \text{MENU} \) > \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F4} \) Remote Volt. Level Setting > Press \( \Rightarrow \) until the desired parameter is displayed.

\( \Rightarrow \) Maximum desired value

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

3. Press \( \Rightarrow \)

\( \Rightarrow \) The maximum desired value is set.
8.11 Configurable inputs and outputs

You can individually configure the digital inputs (GPI) and outputs (GPO).

The following digital inputs and outputs are available:

- 8 digital inputs (GPI1...8)
- 7 digital outputs (GPO1...7)

8.11.1 Linking inputs with functions

You can activate the inputs as follows:

- Statically using signal statuses
  - The input signal must be continually present (status: high level).
- Dynamically using pulses
  - A pulse (rising edge) is needed at the input. The input signal must change its status from "Low" to "High". If you are using a pulsed input, you can trigger the assigned function at the same time as the keys connected to the inputs also using the control system.

You can recognize pulsed inputs from the preceding "P:". The note "Warning: P = pulsed inputs" is displayed on the screen.

You can assign one of the following functions to each of the digital inputs (GPI 1...8):

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>No function selected</td>
</tr>
<tr>
<td>Master/Foll.</td>
<td>Define master/follower mode.</td>
</tr>
<tr>
<td></td>
<td>Signal on: Master mode active</td>
</tr>
<tr>
<td></td>
<td>Signal off: Follower mode active.</td>
</tr>
<tr>
<td>Remote/Loc.</td>
<td>Define remote/local mode.</td>
</tr>
<tr>
<td></td>
<td>Signal on: &quot;Remote&quot; operating mode active.</td>
</tr>
<tr>
<td></td>
<td>Signal off: &quot;Local&quot; operating mode active.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Block automatic regulation.</td>
</tr>
<tr>
<td>Quick Tap</td>
<td>Activating quick reset (deactivating delay time T1/T2)</td>
</tr>
<tr>
<td>MPS tripped</td>
<td>Input for MPS tripped feedback.</td>
</tr>
<tr>
<td>MD in progr.</td>
<td>Input for MD in progr. feedback.</td>
</tr>
<tr>
<td>DVL 2</td>
<td>Activate desired value level 2</td>
</tr>
<tr>
<td>DVL 3</td>
<td>Activate desired value level 3</td>
</tr>
<tr>
<td>Remote VL</td>
<td>Activate setting the desired voltage level remotely.</td>
</tr>
</tbody>
</table>
## 8 Operation

### ParGroup1
Assign parallel operation group 1

### ParGroup2
Assign parallel operation group 2

### Blk U raise
Block tap-change operations (raise).

### Blk U low.
Block tap-change operations (lower).

### P: Par. on
Activate parallel operation.

### P: S. mode
Deactivate parallel operation (independent).

### P: Master
Define master parallel mode.

### P: Follower
Define follower parallel mode.

### P: Syn. aut.
Define "Automatic tap synchronization" parallel mode.

### P: Cir. curr.
Define circulating reactive current mode.

### P: DV 1
Activate desired value 1

### P: DV 2
Activate desired value 2

### P: DV 3
Activate desired value 3

<table>
<thead>
<tr>
<th>Table 28: Functions for digital inputs (GPI 1...8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you assign the same functionality to two inputs, the device produces an event message [► Section 10, Page 158]. This also applies if you assign the same functionality via a static input and via a pulsed input.</td>
</tr>
</tbody>
</table>

Other examples of double assignment of functions are (n, m = 1...8):

- GPI n = master/follower and GPI m = P: Follower
- GPI n = master/follower and GPI m = P: Master

To assign a function to a digital input or to deactivate it, proceed as follows:

1. **MENU** > F4 Configuration > F5 Continue > F3 User I/Os (press ➔ for further GPIs).

   ➔ GPI

2. Press F1 or F5 until the desired function is displayed.

3. Press ➔

   ➔ The function is set.

Functions can be assigned to all other GPIs as described above. You can select the GPIs as follows:

<table>
<thead>
<tr>
<th>GPI</th>
<th>Press ➔</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPI1 – X4:13</td>
<td>-</td>
</tr>
<tr>
<td>GPI2 – X4:14</td>
<td>1x</td>
</tr>
<tr>
<td>GPI3 – X4:15</td>
<td>2x</td>
</tr>
<tr>
<td>GPI4 – X4:16</td>
<td>3x</td>
</tr>
</tbody>
</table>
### 8.11.2 Linking outputs with functions

You can assign one of the following functions to the digital outputs (GPO 1...7):

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>No function selected</td>
</tr>
<tr>
<td>Master</td>
<td>Assign master</td>
</tr>
<tr>
<td>Follower</td>
<td>Assign follower</td>
</tr>
<tr>
<td>ParState</td>
<td>Assign parallel operation status</td>
</tr>
<tr>
<td>ParError</td>
<td>Assign parallel operation error</td>
</tr>
<tr>
<td>Local/Rem.</td>
<td>Message: Local control/remote control</td>
</tr>
<tr>
<td>Undervoltage</td>
<td>Message: Undervoltage blocking</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>Message: Overvoltage blocking</td>
</tr>
<tr>
<td>Undercurrent</td>
<td>Message: Undercurrent blocking</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>Message: Overcurrent blocking</td>
</tr>
<tr>
<td>Desired value 1</td>
<td>Message: Desired value 1</td>
</tr>
<tr>
<td>Desired value 2</td>
<td>Message: Desired value 2</td>
</tr>
<tr>
<td>Desired value 3</td>
<td>Message: Desired value 3</td>
</tr>
<tr>
<td>MPS triggered</td>
<td>Message: Motor protective switch was triggered</td>
</tr>
<tr>
<td>Motor runtime &gt;</td>
<td>Message: Motor runtime exceeded</td>
</tr>
<tr>
<td>Motor running</td>
<td>Message: Motor running*</td>
</tr>
<tr>
<td>Bandwidth &lt;</td>
<td>Message: Value fallen below bandwidth</td>
</tr>
<tr>
<td>Bandwidth &gt;</td>
<td>Message: Bandwidth exceeded</td>
</tr>
<tr>
<td>GPI 1</td>
<td>Message: GPI 1 active</td>
</tr>
<tr>
<td>GPI 2</td>
<td>Message: GPI 2 active</td>
</tr>
</tbody>
</table>

Also refer to

- Messages [► 158]
Table 30: Functions for digital outputs (GPO 1...7)

If the device cannot determine the tap position, ? is displayed in the tap position display. The relays of all outputs with BCD functionality (NC) are switched off.

To assign a function to a digital output or to deactivate it, proceed as follows:

1. Press \text{F4} \rightarrow \text{Configuration} \rightarrow \text{F5} \rightarrow \text{Continue} \rightarrow \text{F3} \rightarrow \text{User I/Os} \rightarrow \text{Press } \rightarrow \text{GPO.}
   \(\Rightarrow\) The desired parameter is displayed.

2. Press \text{F1} or \text{F5} until the desired function is displayed.

3. Press \(\leftarrow\) until the desired function is displayed.

   \(\Rightarrow\) The function is set.

Functions can be assigned to all other GPOs as described above. You can select the GPOs as follows:
### 8.12 LED selection

You can use this parameter to assign functions to the free LEDs which light up when an event occurs. You can use labeling strips to label the LED.

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

#### Functions available for LEDs

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

<table>
<thead>
<tr>
<th>Functions available</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>LED deactivated</td>
</tr>
<tr>
<td>GPI x</td>
<td>There is a signal at control input GPI x (e.g. GPI 1)</td>
</tr>
<tr>
<td>GPO x</td>
<td>The signaling relay at the GPO x (e.g. GPO 1) output has activated</td>
</tr>
<tr>
<td>Undercurrent</td>
<td>Undercurrent present</td>
</tr>
<tr>
<td>Par. error</td>
<td>Parallel operation error present</td>
</tr>
<tr>
<td>MPS triggered</td>
<td>Motor protective switch triggered</td>
</tr>
<tr>
<td>Blocking</td>
<td>Regulation is blocked</td>
</tr>
<tr>
<td>Circ. reactive cur-</td>
<td>Circulating reactive current parallel oper-</td>
</tr>
<tr>
<td>rent</td>
<td>ation method is activated</td>
</tr>
<tr>
<td>Master</td>
<td>Device in parallel operation activated as master</td>
</tr>
<tr>
<td>Follower</td>
<td>Device in parallel operation activated as follower</td>
</tr>
<tr>
<td>Bandwidth &lt;</td>
<td>Value is below bandwidth</td>
</tr>
<tr>
<td>Bandwidth &gt;</td>
<td>Value is above bandwidth</td>
</tr>
<tr>
<td>Desired value 1</td>
<td>Desired value 1 activated</td>
</tr>
<tr>
<td>Desired value 2</td>
<td>Desired value 2 activated</td>
</tr>
</tbody>
</table>
Assigning function

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

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

All additional LEDs can be assigned as described previously. The LEDs available can be called up as follows:

<table>
<thead>
<tr>
<th>LED (parameter)</th>
<th>Characteristics</th>
<th>Press</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED 1</td>
<td>Single-colored</td>
<td>-</td>
</tr>
<tr>
<td>LED 2</td>
<td>Single-colored</td>
<td>1x</td>
</tr>
<tr>
<td>LED 3 yellow</td>
<td>Two-colored</td>
<td>2x</td>
</tr>
<tr>
<td>LED 3 green</td>
<td>Two-colored</td>
<td>3x</td>
</tr>
<tr>
<td>LED 4 rot</td>
<td>Two-colored</td>
<td>4x</td>
</tr>
<tr>
<td>LED 4 yellow</td>
<td>Two-colored</td>
<td>5x</td>
</tr>
</tbody>
</table>

Table 33: Configurable LEDs

**8.13 Communication interface (TAPCON® 230 expert only) with CI card**

If the device is fitted with a CI card, the following interfaces are available:

- RS232
- RS485
8 Operation

- Ethernet
- Fiber-optic cable

The procedure for configuring the ports and functions is described in the following sections.

8.13.1 Selecting the communication protocol

You can activate one of the following communication protocols:
- TAPCON-trol® (visualization software)
- DNP3
- MODBUS ASCII
- MODBUS RTU
- IEC 60870-5-101
- IEC 60870-5-103

Only one communication protocol can be selected. Simultaneous use of several communication protocols is not possible.

Proceed as follows to select the communication protocol:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface
   ⇒ Communication protocol

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

3. Press **←**
   ⇒ The communication portal is selected.
### 8.13.2 Selecting transmission formats for MODBUS

The table shows the transmission formats available.

<table>
<thead>
<tr>
<th>Interface protocol</th>
<th>Transmission format abbreviation and description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MODBUS ASCII</strong></td>
<td></td>
</tr>
<tr>
<td>7O1</td>
<td>7 data bit Odd number of parity bits <strong>odd</strong></td>
</tr>
<tr>
<td></td>
<td>1 stop bit</td>
</tr>
<tr>
<td>7E1</td>
<td>7 data bit Even number of parity bits <strong>even</strong></td>
</tr>
<tr>
<td></td>
<td>1 stop bit</td>
</tr>
<tr>
<td>7N2</td>
<td>7 data bit No parity bits <strong>none</strong></td>
</tr>
<tr>
<td></td>
<td>2 stop bit</td>
</tr>
<tr>
<td><strong>MODBUS RTU</strong></td>
<td></td>
</tr>
<tr>
<td>8O1</td>
<td>8 data bit Odd number of parity bits <strong>odd</strong></td>
</tr>
<tr>
<td></td>
<td>1 stop bit</td>
</tr>
<tr>
<td>8E1</td>
<td>8 data bit Even number of parity bits <strong>even</strong></td>
</tr>
<tr>
<td></td>
<td>1 stop bit</td>
</tr>
<tr>
<td>8N1</td>
<td>8 data bit No parity bits <strong>none</strong></td>
</tr>
<tr>
<td></td>
<td>1 stop bit</td>
</tr>
<tr>
<td>8N2</td>
<td>8 data bit No parity bits <strong>none</strong></td>
</tr>
<tr>
<td></td>
<td>2 stop bit</td>
</tr>
</tbody>
</table>

*Table 34: Transmission formats for MODBUS interface protocols*

This setting only applies to the MODBUS interface protocols.

Only one transmission format can be selected. Simultaneous use of several transmission formats is not possible.
Proceed as follows to select the transmission format:

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

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

3. Press **←**.
   - Transmission format is selected.

### 8.13.3 Selecting communication port

This allows the physical interface to be activated. The following options are available:

- RS232
- RS485
- Ethernet
- Fiber-optic cable

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

To select the communication port, proceed as follows:

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

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

3. Press **←**.
   - The communication port is selected.

### 8.13.4 Selecting communication baud rate

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

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

This parameter is only provided for the following control system protocols:
- DNP3
- IEC 60870-5-101
- IEC 60870-5-103
- MODBUS ASCII/RTU
- ABB SPA

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

1. Press \[\text{MENU}\] > \[\text{F4}\] Configuration > \[\text{F5}\] Continue > \[\text{F5}\] Continue > \[\text{F5}\] Comm. interface > Press \[\text{------}\] until the desired parameter is displayed.
   - Baud rate communication

2. Press \[\text{F1}\] or \[\text{F5}\] to set the option you want.

3. Press \[\text{------}\] .
   - The baud rate is selected.

### Assigning network address

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

To assign the network address, proceed as follows:

1. Press \[\text{MENU}\] > \[\text{F4}\] Configuration > \[\text{F5}\] Continue > \[\text{F5}\] Continue > \[\text{F5}\] Comm. interface > Press \[\text{------}\] until the desired parameter is displayed.
   - Network address

2. Press \[\text{F4}\] in order to highlight the position.
   - The position is highlighted and the value can be changed.

3. Press \[\text{F1}\] to increase the value or \[\text{F5}\] to reduce it.

4. Press \[\text{------}\] .
   - The network address is assigned.

### Assigning TCP port

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

1. \text{Menu} > \text{F4 Configuration} > \text{F5 Continue} > \text{F5 Continue} > \text{F5 Comm.}
   \text{interface} > \text{Press} \rightarrow \text{until the desired parameter is displayed.}
   \Rightarrow \text{TCP port}

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

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

4. Press \leftarrow
   \Rightarrow \text{The TCP port is assigned.}

### 8.13.7 Setting fiber-optic cable transmission behavior

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

<table>
<thead>
<tr>
<th>Setting</th>
<th>Logical 1</th>
<th>Logical 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>Light on</td>
<td>Light off</td>
</tr>
<tr>
<td>OFF</td>
<td>Light off</td>
<td>Light on</td>
</tr>
</tbody>
</table>

Table 35: Transmission behavior for various parameter settings

To set the transmission behavior, proceed as follows:

1. \text{Menu} > \text{F4 Configuration} > \text{F5 Continue} > \text{F5 Continue} > \text{F5 Comm.}
   \text{interface} > \text{Press} \rightarrow \text{until the desired parameter is displayed.}
   \Rightarrow \text{Fiber-optic cable light On / Off.}

2. Press \text{F1} or \text{F5} to set the option you want.

3. Press \leftarrow
   \Rightarrow \text{The transmission behavior is set.}

### 8.13.8 Setting local SCADA address

You can use this parameter to assign a SCADA address to the device. You have to define this parameter if the device is to communicate via the control system protocol.
To set the SCADA address, proceed as follows:

1. **[Menu]** > **[F4]** Configuration > **[F5]** Continue > **[F5]** Continue > **[F5]** Comm. interface > Press \(\rightarrow\) until the desired parameter is displayed.
   - Local SCADA Address

2. Press **[F1]** to change the first digit.
   - If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.

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

4. Press **[F4]** to highlight a digit position.
   - The required digit is highlighted and can be changed.

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

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

7. Press \(\leftarrow\).
   - The SCADA address is set.

---

8.13.9 Setting SCADA master address

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

To set the SCADA master address, proceed as follows:

1. **[Menu]** > **[F4]** Configuration > **[F5]** Continue > **[F5]** Continue > **[F5]** Comm. interface > Press \(\rightarrow\) until the desired display appears.
   - SCADA Master Address

2. Press **[F1]** to change the first digit.
   - If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.

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

4. Press **[F4]** to highlight a digit position.
   - The required digit is highlighted and can be changed.

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

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

7. Press \(\leftarrow\).
   - The SCADA master address is set.
8.13.10 Enabling unsolicited messages

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

The device must be restarted after changing this setting.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Unsolicited messages are transmitted</td>
</tr>
<tr>
<td>Off</td>
<td>Unsolicited messages are not transmitted</td>
</tr>
</tbody>
</table>

Table 36: Setting range for unsolicited messages

To enable or block unsolicited messages, proceed as follows:

1. Configuration > Continue > Comm. interface > Press until the desired parameter is displayed.

   Unsolicited messages

2. Press or to enable (On) or block (Off) unsolicited messages.

3. Press

   Unsolicited messages are enabled or blocked.

8.13.11 Setting number of attempts to transmit unsolicited messages

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

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

If the value 0 is set, then an infinite number of attempts is made to transmit.
To set the maximum number of attempts to transmit unsolicited messages, proceed as follows:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface > Press ↑ until the desired parameter is displayed.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press .

The maximum number of attempts to transmit unsolicited messages is set.

**8.13.12 Timeout for application confirm responses**

You can use this parameter to define the permissible time which the device waits for the following feedback from the master device:

- Application confirmation response
- Confirmation of unsolicited message

If the permissible time is exceeded, another transmission request is sent to the master device. The number of requests sent is dependent on the set number of attempts to transmit unsolicited messages (Section 8.13, Page 135).

To set the timeout for application confirm responses, proceed as follows:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface 1 > Press ↑ until the desired parameter is displayed.
2. Press **F1** to increase the value or **F5** to reduce it.
3. Press .

The timeout for application confirm responses is set.

**8.13.13 Setting transmission delay time for RS485 interface**

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

1. Configuration > Continue > Continue > Comm. interface 1 > Press \(\text{\textit{F5}}\) until the desired parameter is displayed.
   \(\Rightarrow\) RS485 transmit delay time
2. Press \(\text{\textit{F1}}\) to increase the value or \(\text{\textit{F5}}\) to reduce it.
3. Press \(\text{\textit{F3}}\).
   \(\Rightarrow\) The transmission delay time for the RS485 interface is set.

8.14 Communication interface (TAPCON® 230 expert with "IEC 61850" card only)

If the device is fitted with an IEC 61850 card, the following interfaces are available:
- RS232 (only for software updates)
- RJ45
- LC (fiber-optic cable)

IEC 61850 protocol is used for communication via RJ45 or LC (fiber-optic cable). The procedure for configuring the ports and functions is described in the following sections.

8.14.1 Assigning network address

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

To assign the network address, proceed as follows:

1. Configuration > Continue > Continue > Comm. interface > Press \(\text{\textit{F5}}\) until the desired parameter is displayed.
   \(\Rightarrow\) Network address
2. Press \(\text{\textit{F4}}\) in order to highlight the position.
   \(\Rightarrow\) The position is highlighted and the value can be changed.
3. Press \(\text{\textit{F1}}\) to increase the value or \(\text{\textit{F5}}\) to reduce it.
4. Press \(\text{\textit{F3}}\).
   \(\Rightarrow\) The network address is assigned.

8.14.2 Assigning a network mask

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

To assign a network mask, proceed as follows:

   ⇒ Network mask.
2. Press [F4] in order to highlight the position.
   ⇒ The desired position is highlighted and the value can be changed.
3. Press [F1] to increase the value or [F5] to reduce it.
4. Press ↹
   ⇒ The network mask is assigned.

8.14.3 Entering the time server address

On this screen, you can enter the IP address of the SNTP time server (time server address 2 optional) to ensure that the time is synchronized in the communication network.

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

   ⇒ Time server address.
2. Press [F4] in order to highlight the position.
   ⇒ The desired position is highlighted and the value can be changed.
3. Press [F1] to increase the value or [F5] to reduce it.
4. Press ↹
   ⇒ The time server address is entered.

8.14.4 Entering gateway address

You can enter the gateway address on this screen. If you do not use a gateway, you have to assign the device a valid IP address in order to ensure the function of the communication interface.
To enter the gateway address, proceed as follows:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface > Press \(→\) until the desired parameter is displayed.
   \(→\) Gateway.

2. Press **F4** in order to highlight the position.
   \(→\) The desired position is highlighted and the value can be changed.

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

4. Press \(←\)
   \(→\) The gateway address is entered.

### 8.14.5 Entering IED name

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

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

To enter the IED name, proceed as follows:

1. **MENU** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface > Press \(→\) until the desired parameter is displayed.
   \(→\) IED name.

2. Press **F4** in order to highlight the position.
   \(→\) The desired position is highlighted and the value can be changed.

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

4. Press \(←\)
   \(→\) The IED name is entered.

### 8.14.6 Assigning transmission medium

This parameter can be used to select the transmission medium.

You can select the following transmission media:

- "100Base-TX" for wire connections via the RJ-45 port
- "100Base-FX" for fiber-optic connections via the LC port (or ST port via fiber-optic cable adapter).
Proceed as follows to select the transmission medium:

1. Press \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F5} \) Comm. interface > Press \( \rightarrow \) until the desired parameter is displayed.

\( \Rightarrow \) Transmission medium

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

3. Press \( \leftarrow \)

\( \Rightarrow \) The transmission medium is selected.

8.14.7 Setting SSH encryption

You can use this parameter to activate SSH encryption during data transmission via the IEC 61850 card. You can select the following options:

- Yes: SSH encryption is active. You can only establish a connection to the IEC 61850 card via SFTP.
- No: SSH encryption is not active. You can establish a connection to the IEC 61850 card via FTP or SFTP.

To activate/deactivate SSH encryption, proceed as follows:

1. Press \( \text{F4} \) Configuration > \( \text{F5} \) Continue > \( \text{F5} \) Continue > \( \text{F5} \) Comm. interface > Press \( \rightarrow \) until the desired parameter is displayed.

\( \Rightarrow \) SSH encryption.

2. Press \( \text{F1} \) or \( \text{F5} \) to activate/deactivate SSH encryption.

3. Press \( \leftarrow \)

4. Restart the device in order that the modified parameter is adopted.

\( \Rightarrow \) SSH encryption is set.

8.14.8 Setting the IEC 61850 password

You can use this parameter to set a password for establishing a connection via the IEC 61850 card. The password is required if you want to establish a connection via (S)FTP with the user "update". The user "guest" only has access via FTP and is not assigned a password.

Note the following information:

- The password must be at least 1 character long and must not exceed 8 characters.
- You can enter alphanumeric characters (A to Z, a to z, 0 to 9) and an end marker (space).
- If you want to use a password with fewer than 8 characters, you must select the end marker after the last character of your password.
- Once you save the password, the display changes to \( \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \). The password is only displayed in plain text during text input.
To set the IEC 61850 password, proceed as follows:

1. **Menu** > **F4** Configuration > **F5** Continue > **F5** Continue > **F5** Comm. interface > Press **→** until the desired parameter is displayed. ⇒ 61850 password.

2. Enter the current IEC 61850 password. Press **F1** or **F5** to change a character and **F4** to select the next character.

3. Press **←**.
   ⇒ The **Parallel operation active** LED flashes and you can enter a new password.

4. Press **F1** or **F5** to change a character and **F4** to select the next character.

5. Press **←**.
   ⇒ The IEC 61850 password is set. The display changes to xxxxxxxx.

### 8.15 Information about device

You can view general information about the voltage regulator in this display. You can call up the following information:

- Measured values
- Calculated values
- Functional reliability of the LEDs (LED test)
- MIO card digital inputs
- MIO card digital outputs
- PIO card digital inputs
- PIO card digital outputs
- PIO card analog input
- Parallel operation
- Data on CAN bus
- Peak memory
- CI or IEC 61850 card information
- Default parameter
- Memory overview
- Event overview
8.15.1 Displaying info screen

The info screen displays the following information:

```
   1 Type designation   4 Additional cards
   2 Software version   5 RAM memory
   3 Serial number
```

To display the info screen, proceed as follows:

```
► Menu > F5 Info.
⇒ Info.
```

8.15.2 Displaying measured values

The current measured values are shown in this display. The values on the right in rows 1, 2 and 4 are only displayed if the transformer data [Section 8.7, Page 101] has been entered previously. In row 4, the value actually measured can be seen on the left and the value converted to the transformer circuit is on the right.
The following measured values can be displayed:

The values in the rows on the right are only displayed if the transformer data has been entered previously.

---

8.15.3 Display calculated values

Calculated values are shown on this screen. The following values can be displayed:

The values in the rows on the right are only displayed if the transformer data has been entered previously.
To display the calculated values, proceed as follows:

- **MENU > F5 Info > Press ▶ until the desired display appears.**
- **Calculated values**

### 8.15.4 Carrying out LED test

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

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

Table 37: Arrangement of keys for the LED test

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

To carry out the LED test, proceed as follows:

1. **MENU > F5 Info > Press ▶ until the desired display appears.**
2. **LED test.**
3. To carry out the function test, press the function key for the LED you want to test.

### 8.15.5 Displaying status of the MIO card

The status of the digital inputs and outputs are shown in this display.
Digital inputs

The status of the optocoupler inputs is shown in the "MIO card digital inputs" display. As soon as a continuous signal is present at the input, status 1 is displayed. 0 indicates no signal at the input.

 Proceed as follows to display the status:

► MENU > F5 Info > Press ⏯ until the desired display appears.

♫ MIO card digital inputs

Digital outputs

The status of the relays is shown in the "MIO card digital outputs" display. As soon as a relay has activated, status 1 is displayed. If status 0 is displayed, the relay has not activated.

 Proceed as follows to display the status:

► MENU > F5 Info > Press ⏯ until the desired display appears.

♫ MIO card digital outputs

8.15.6 Displaying status of the PIO card

Information about the digital inputs, outputs and the analog input is shown in this display.

Digital inputs

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

To display the "PIO card digital inputs" screen, proceed as follows:

► MENU > F5 Info > Press ⏯ until the desired display appears.

♫ PIO card digital inputs
Digital outputs

The statuses of the relays are shown in this display. As soon as a relay has activated, status 1 is displayed. If status 0 is displayed, the relay hasn’t activated.

To display the "PIO card digital outputs" screen, proceed as follows:

► MENU > F5 Info > Press ➔ until the desired display appears.

PIO card digital outputs

Analog input

Information relating to the analog input is shown in this display.

If Not yet calibrated! is displayed, you need to calibrate [► Section 7.3, Page 56] the analog input in order to use it to capture the tap position or set the desired voltage level remotely.

To display information about the analog input, proceed as follows:

► MENU > F5 Info > Press ➔ until the desired display appears.

PIO X7 analog input

8.15.7 Displaying parallel operation

This display indicates the control number for parallel operation (= CAN bus address) and the number of devices which are currently operating in parallel.

To display data for parallel operation, proceed as follows:

► MENU > F5 Info > Press ➔ until the desired display appears.

Parallel operation.
8.15.8 Displaying data on CAN bus

The CAN bus data of the connected devices is shown in this display.

![CAN bus data](image)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAN bus address of device</td>
<td>Actual voltage (U_{\text{act}}) in V</td>
<td>Active current in %</td>
<td>Reactive current in %</td>
<td>Tap position</td>
</tr>
</tbody>
</table>

To display information about data on the CAN bus, proceed as follows:

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

2. Data on CAN bus.

8.15.9 Peak memory

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

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

![Peak memory](image)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum measured voltage (U)</td>
<td>Maximum measured current (I)</td>
<td>Minimum measured power factor (\cos \phi)</td>
<td>Minimum on-load tap-changer tap position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Detailed peak memory information](image)
To display data stored in the peak memory, proceed as follows:
➤ MENU > F5 info > Press ➤ until the desired display appears.
☞ Peak memory.

8.15.10 Displaying CI card SCADA information (optional)

If the device is fitted with a CI card, you will see the following information about the SCADA connection and interface card on this screen:

- Protocol
- Data format
- BOOT version

You can also reset the SCADA Ethernet connection.

To display the information, proceed as follows:
➤ MENU > F5 info > Press ➤ until the desired display appears.
☞ CI card SCADA Information
☞ The information is displayed.

Reset SCADA information

To reset the Ethernet connection via the CI card, proceed as follows:
➤ MENU > F5 info > Press ➤ until the desired display appears.
☞ CI card SCADA Information
➤ Press F3 and F4 at the same time.
☞ The Ethernet connection is reset.
8.15.11 Displaying IEC 61850 card information

If the device is fitted with an IEC 61850 card, you will see the version number of the interface card on this screen:

To display information about the interface card, proceed as follows:

► Info > Press \[→\] until the desired display appears.

⇒ 61850 card information.

8.15.12 Resetting parameters

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

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

To reset all parameters, proceed as follows:

1. Info > Press \[→\] until the desired display appears.

⇒ Default parameter

2. Press \[F3\] and \[←\] at the same time.

⇒ "Default parameter active" is displayed.

⇒ All parameters have been reset to the factory settings.

8.15.13 Displaying memory overview

The memory overview can be used to display various database entries with the relevant number of data records. The information is not relevant for operation. It is only needed for service checks. The following information is displayed:

- Parameter file
- Event data bits
- Flash file
- Events
To display the database entries, proceed as follows:

1. 

![fd5778]

> F5 Info > Press ➤ until the desired display appears.

➤ Memory overview

2. Press F1 or F5 to select an entry.

➤ The relevant number of data records is displayed.

### 8.15.14 Displaying event overview

This display can be used to display the number of current red and yellow events. The events are marked as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Corresponds to an advance warning or status information.</td>
</tr>
<tr>
<td>Red</td>
<td>Automatic regulation can block.</td>
</tr>
</tbody>
</table>

Table 38: Coding of events

A list with all events can be found in the Messages [► Section 10, Page 158] section.

To view the event overview, proceed as follows:

➤ 

![fd5778]

> F5 Info > Press ➤ until the desired display appears.

➤ Event overview.

### 8.16 Downloading the security log

The device records all security-related instances of access to the IEC 61850 card in the security log. The security log is structured as follows:

**Service timestamp: message**

**Example:**


The follow services may appear:

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>syslogd</td>
<td>Logging service</td>
</tr>
<tr>
<td>ssbd</td>
<td>Service for SSH/SFTP</td>
</tr>
</tbody>
</table>
### Table 39: Services

You will find a list of possible messages and their causes below. The list may not be exhaustive.

<table>
<thead>
<tr>
<th>Service</th>
<th>Message</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>vsftpd</td>
<td>Server listening on 0.0.0.0 port 22.</td>
<td>SSH service started</td>
</tr>
<tr>
<td></td>
<td>Accepted password for USER from IP ADDRESS port PORT ssh2</td>
<td>The password entered for USER was correct.</td>
</tr>
<tr>
<td></td>
<td>ssh_dispatch_run_fatal: Connection to IP ADDRESS no matching host key type found</td>
<td>The client is not using compatible server authentication</td>
</tr>
<tr>
<td></td>
<td>Failed password for USER from IP ADDRESS port PORT ssh2</td>
<td>The password entered for USER was incorrect.</td>
</tr>
<tr>
<td></td>
<td>Invalid USER from IP ADDRESS</td>
<td>User USER not present</td>
</tr>
<tr>
<td></td>
<td>Failed none for invalid USER from IP ADDRESS port PORT ssh2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>error: Could not get shadow information for NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Failed password for invalid USER from IP ADDRESS port PORT ssh2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Did not receive identification string from IP ADDRESS</td>
<td>Possible attack or unauthorized attempt to access data</td>
</tr>
<tr>
<td></td>
<td>Could not write ident string to UNKNOWN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bad protocol version identification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protocol major versions differ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CONNECT: Client &quot;xxx.xxx.xxx&quot;</td>
<td>Connection established from IP address xxx.xxx.xxx</td>
</tr>
<tr>
<td></td>
<td>[USER] FAIL LOGIN: Client &quot;xxx.xxx.xxx&quot;</td>
<td>Incorrect password entered for user USER</td>
</tr>
<tr>
<td></td>
<td>[USER] OK LOGIN: Client &quot;xxx.xxx.xxx&quot;</td>
<td>User USER logged in</td>
</tr>
<tr>
<td></td>
<td>[USER] OK DOWNLOAD: Client &quot;xxx.xxx.xxx&quot;, &quot;FILE&quot;, ...</td>
<td>User USER has downloaded the FILE file</td>
</tr>
<tr>
<td></td>
<td>[USER] OK DELETE: Client &quot;xxx.xxx.xxx&quot;, &quot;FILE&quot;</td>
<td>User USER has deleted the FILE file</td>
</tr>
<tr>
<td></td>
<td>[USER] OK UPLOAD: Client &quot;xxx.xxx.xxx&quot;, &quot;FILE&quot;, ...</td>
<td>User USER has uploaded the FILE file</td>
</tr>
</tbody>
</table>
You can download the security log from the device via SFTP access. To do this, you have to establish an Ethernet connection between the device and your computer.

Use an SFTP client (e.g. FileZilla) to establish an SFTP connection with the device.

Proceed as follows to download the security log:
1. Establish an Ethernet connection with the IEC 61850 card.
2. Start the SFTP client.
3. In the `Server` field, enter the IP address of the IEC 61850 card.
4. In the `User name` field, enter `update`.
5. In the `Password` field, enter the password for the IEC 61850 card (default setting: `mrupdate`).
6. In the `Port` field, enter the port **22** (SFTP).
7. Press the `Connect` button to establish a connection.
9 Fault elimination

This chapter describes how to rectify simple operating faults.

9.1 No regulation in AUTO mode

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device control commands have no effect.</td>
<td>LOCAL/REMOTE switch in motor-drive unit switched to LOCAL.</td>
<td>Check operating mode. Correct if necessary.</td>
</tr>
<tr>
<td>RAISE/LOWER LEDs light up periodically</td>
<td>No connection</td>
<td>Check wiring as per connection diagram.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Reverse power lock active.</td>
<td>Check parameters. Correct if necessary.</td>
</tr>
<tr>
<td></td>
<td>Negative power flow</td>
<td>Check current transformer polarity.</td>
</tr>
<tr>
<td></td>
<td>Function assigned to several GPIs.</td>
<td>Check parameterization of GPIs. Correct if necessary.</td>
</tr>
<tr>
<td></td>
<td>One of the GPIs is parameterized with &quot;Blocking&quot; and has an appropriate input signal.</td>
<td>Check parameterization and status in &quot;Info&quot; menu. Correct if necessary.</td>
</tr>
<tr>
<td></td>
<td>NORMset active</td>
<td>Carry out manual tap-change operation with ( \text{#} ) or ( \underline{\text{#}} ) keys.</td>
</tr>
<tr>
<td></td>
<td>Undercurrent blocking active</td>
<td>Check parameters. Correct if necessary.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Undervoltage blocking active</td>
<td>Check parameters. Correct if necessary.</td>
</tr>
<tr>
<td>U&lt; LED illuminated</td>
<td>Overvoltage blocking active</td>
<td>Check parameters. Correct if necessary.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Overcurrent blocking active</td>
<td>Check parameters. Correct if necessary.</td>
</tr>
<tr>
<td>I&gt; LED illuminated</td>
<td>-</td>
<td>Determine the recommended bandwidth</td>
</tr>
</tbody>
</table>

Table 41: No regulation in AUTO mode

9.2 Unexplained tap change

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation activated</td>
<td>Setting:</td>
<td>Check parameters.</td>
</tr>
<tr>
<td></td>
<td>Line drop compensation</td>
<td>Correct if necessary.</td>
</tr>
<tr>
<td></td>
<td>Z compensation</td>
<td></td>
</tr>
</tbody>
</table>

Table 42: Unexplained tap change
### 9.3 Man-machine interface

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keys</td>
<td>REMOTE operating mode active and LED in key illuminated.</td>
<td>Press to activate LOCAL mode.</td>
</tr>
<tr>
<td>Keys</td>
<td>Parameter error</td>
<td>Reset parameters to factory settings.</td>
</tr>
<tr>
<td>Display</td>
<td>Contrast incorrectly set.</td>
<td>Set contrast [Section 7.1, Page 54].</td>
</tr>
<tr>
<td>Display</td>
<td>Voltage supply interrupted.</td>
<td>Check voltage supply.</td>
</tr>
<tr>
<td>Display</td>
<td>Fuse faulty.</td>
<td>Contact Maschinenfabrik Reinhausen.</td>
</tr>
<tr>
<td>LEDs</td>
<td>Customized LED parameterization.</td>
<td>Check parameters.</td>
</tr>
<tr>
<td>LEDs</td>
<td>Input signal not constant.</td>
<td>Check input signal.</td>
</tr>
<tr>
<td>COM1</td>
<td>Different baud rates set.</td>
<td>Check baud rate set on device and PC.</td>
</tr>
</tbody>
</table>

| Table 43: Man-machine interface |

### 9.4 Incorrect measured values

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured voltage</td>
<td>Connection has no contact in the plug terminal.</td>
<td>Check wiring and plug terminal.</td>
</tr>
<tr>
<td>Measured voltage</td>
<td>Voltage drop on measuring lead.</td>
<td>Check measured voltage at plug terminal X2:1/ X2:2.</td>
</tr>
<tr>
<td>Measured voltage</td>
<td>Possible sources of fault: Leads laid in parallel.</td>
<td>Check measured voltage at plug terminal X2:1/ X2:2.</td>
</tr>
<tr>
<td>Measured voltage</td>
<td>Possible sources of fault: Tap-change operations.</td>
<td>Increase distance from source of interference. Install filter if necessary.</td>
</tr>
<tr>
<td>Measured current</td>
<td>Line to current transformer interrupted.</td>
<td>Check wiring.</td>
</tr>
<tr>
<td>Measured current</td>
<td>Short-circuiting jumper in current transformer not removed.</td>
<td>Remove short-circuiting jumper.</td>
</tr>
</tbody>
</table>
9 Fault elimination

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured current</td>
<td>Transmission ratio not correctly</td>
<td>Correct parameterization.</td>
</tr>
<tr>
<td></td>
<td>parameterized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incorrect input connected.</td>
<td>Remove short-circuiting jumper.</td>
</tr>
<tr>
<td>Phase angle</td>
<td>Fault in external transformer circuit.</td>
<td>Check transformer circuit.</td>
</tr>
<tr>
<td></td>
<td>Transformer circuit incorrectly parameterized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compare with system connection diagram.</td>
<td>Correct parameters.</td>
</tr>
<tr>
<td></td>
<td>Compare measurement values on info screen.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transpose current transformer connection.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check polarity of transformer circuit.</td>
<td>Correct if necessary.</td>
</tr>
<tr>
<td></td>
<td>Correct if necessary.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check circuit.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correct if necessary.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check measurement points.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correct if necessary.</td>
<td></td>
</tr>
</tbody>
</table>

Table 44: Incorrect measured values

9.5 Parallel operation faults

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAN bus address of device set to &quot;0&quot;.</td>
<td>Set CAN bus address (anything but 0).</td>
</tr>
<tr>
<td>Problem with CAN bus.</td>
<td>Device incorrectly connected (plug twisted, offset).</td>
<td>Check connections.</td>
</tr>
<tr>
<td></td>
<td>Devices have the same CAN bus addresses.</td>
<td>Set different CAN bus addresses.</td>
</tr>
</tbody>
</table>

Table 45: Parallel operation faults

9.6 Tap position capture incorrect

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

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step display incorrect.</td>
<td>Interference.</td>
<td>Shield the line.</td>
</tr>
<tr>
<td>■ Display fluctuates.</td>
<td></td>
<td>Increase distance from source of interference.</td>
</tr>
<tr>
<td>■ Increase distance from source of interference.</td>
<td></td>
<td>Lay interference lines separately.</td>
</tr>
<tr>
<td>■ Lay interference lines separately.</td>
<td></td>
<td>Route signal in separate lines (filter, shielded lines).</td>
</tr>
</tbody>
</table>

| No step display.  | No measurement signal. | Connect signal as shown in connection diagram. |
| ■ "-" is displayed.  | No L- for digital input. | Connect wiring. |
| ■ Connect signal as shown in connection diagram. | | Display MIO card status. |
| ■ Display PIO card status. | | Display MIO card status. |

| No step display.  | Bit combination (code) impermissible. | Check wiring. |
| ■ "?" is displayed.  | | MIO card status. |
| ■ "Motor running" signal present. | | Display PIO card status. |
| ■ | Connect as shown in connection diagram. |

### Table 46: Tap position capture

<table>
<thead>
<tr>
<th>9.7</th>
<th>Customized GPIs/GPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics/detail</td>
<td>Cause</td>
</tr>
<tr>
<td>Function expected from the factory setting does not take place</td>
<td>Parameterization has been overwritten manually or via TAPCON®-trol.</td>
</tr>
<tr>
<td>Signal discontinuous.</td>
<td>Intermittent DC voltage.</td>
</tr>
<tr>
<td>No signal</td>
<td>Supply voltage too low</td>
</tr>
<tr>
<td>Info screens &quot;Bandwidth!&quot;, &quot;Delay time T1&quot;, &quot;Control response T1&quot;, &quot;Delay time T2&quot; display 0.</td>
<td></td>
</tr>
</tbody>
</table>

### Table 47: Fault elimination: GPIs and GPOs

<table>
<thead>
<tr>
<th>9.8</th>
<th>General faults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics/detail</td>
<td>Cause</td>
</tr>
<tr>
<td>No function</td>
<td>No power supply</td>
</tr>
<tr>
<td>■ Operating status LED does not illuminate</td>
<td>Fuse tripped</td>
</tr>
</tbody>
</table>
9 Fault elimination

<table>
<thead>
<tr>
<th>Characteristics/detail</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relays chatter</td>
<td>Supply voltage too low</td>
<td>Check the supply voltage</td>
</tr>
<tr>
<td></td>
<td>High EMC load</td>
<td>Use shielded cables or external filters</td>
</tr>
<tr>
<td></td>
<td>Poor grounding</td>
<td>Check protective ground</td>
</tr>
</tbody>
</table>

Table 48: General faults

9.9 Other faults

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

- Serial number
  - Name plate (Outer right side when viewed from the front [Section 4.5.1, Page 24])
  - Info screen (MENU > F5 Info)

Please provide answers to the following questions:

- Has a firmware update been carried out?
- Has there previously been a problem with this device?
- Have you previously contacted Maschinenfabrik Reinhausen about this issue? If yes, then who was the contact?
## 10 Messages

<table>
<thead>
<tr>
<th>No.</th>
<th>Event (yellow/red)</th>
<th>Event message</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Red</td>
<td>Undervoltage</td>
<td>Message is displayed in the event of undervoltage. Set the Undervoltage U&lt; [► Section , Page 87] parameter.</td>
</tr>
<tr>
<td>4</td>
<td>Red</td>
<td>Overvoltage</td>
<td>Message is displayed in the event of overvoltage. Set the Overvoltage U&gt; [► Section , Page 90] parameter.</td>
</tr>
<tr>
<td>5</td>
<td>Red</td>
<td>Overcurrent</td>
<td>Message is displayed in the event of overcurrent. Set the Overcurrent I&gt; [► Section , Page 92] parameter.</td>
</tr>
<tr>
<td>6</td>
<td>Red</td>
<td>Parallel operation error: Different parallel operation methods</td>
<td>Message is displayed if different parallel operation methods are set for 2 or more devices in the same parallel operation group. Set the Parallel operation method parameter.</td>
</tr>
<tr>
<td>7</td>
<td>Yellow</td>
<td>Motor protection device</td>
<td>Triggered by the motor protective switch input.</td>
</tr>
<tr>
<td>9</td>
<td>Yellow</td>
<td>Undercurrent</td>
<td>Message is displayed in the event of undercurrent. Set the Undercurrent I&lt; [► Section , Page 93] parameter.</td>
</tr>
<tr>
<td>11</td>
<td>Red</td>
<td>Error when setting user inputs (duplicate assignment)</td>
<td>At least 2 user inputs are parameterized to the same function. Message is displayed after the 2nd parameter has been confirmed with [→].</td>
</tr>
<tr>
<td>12</td>
<td>Yellow</td>
<td>Function monitoring (voltage not adjusted within set time)</td>
<td>Message is displayed if the voltage has not been adjusted within the set time (presetting: 15 minutes).</td>
</tr>
<tr>
<td>13</td>
<td>Yellow</td>
<td>Motor-drive unit runtime monitoring</td>
<td>Message is displayed if the set motor runtime is exceeded. Setting motor runtime monitoring [► Section 8.2.8, Page 73] parameters.</td>
</tr>
<tr>
<td>14</td>
<td>Red</td>
<td>Analog input value too high. Check your connection to terminal X7!</td>
<td>Message is displayed when the maximum permissible current of 20 mA is exceeded for connection X7.</td>
</tr>
<tr>
<td>15</td>
<td>Yellow</td>
<td>Negative analog input value Check your connection to terminal X7!</td>
<td>Message is displayed in the event of reverse polarity or if X7 connection is incorrectly connected.</td>
</tr>
<tr>
<td>16</td>
<td>Red</td>
<td>Parameter reloaded! Confirm with F3 &amp; Enter</td>
<td>Message is displayed if the current set of parameters is corrupt or damaged and the system has therefore switched to the standard set of parameters.</td>
</tr>
<tr>
<td>17</td>
<td>Yellow</td>
<td>Check sliding contact.</td>
<td>Message is displayed if the resistor contact series is incorrectly connected or has a loose contact.</td>
</tr>
<tr>
<td>18</td>
<td>Yellow</td>
<td>No other CAN bus participants present</td>
<td>Message is displayed if parallel operation has been set but there is not a device in the same parallel operation group or the CAN bus is actually interrupted.</td>
</tr>
<tr>
<td>19</td>
<td>Red</td>
<td>Parallel operation error: Circulating reactive current blocking limit exceeded</td>
<td>Message is displayed if the parallel operation method is using circulating reactive current or master/follower and the blocking limit is activated. The circulating reactive current limit must also be exceeded.</td>
</tr>
<tr>
<td>20</td>
<td>Red</td>
<td>Parallel operation error: Invalid tap position present on parallel regulators</td>
<td>Message is displayed if a tap position on a parallel voltage regulator is invalid.</td>
</tr>
<tr>
<td>No.</td>
<td>Event (yellow/red)</td>
<td>Event message</td>
<td>Remark</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------</td>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>21</td>
<td>Red</td>
<td>Parallel operation error: Tap difference to follower</td>
<td>Message is displayed on master if a follower still has the same tap position as the master after the set delay time. Set delay time T1. [▷ Section 8.4.4, Page 84] parameter.</td>
</tr>
<tr>
<td>22</td>
<td>Red</td>
<td>Parallel operation error: Permitted tap difference to master exceeded</td>
<td>Message is displayed on follower if a follower is still not within the permitted tap difference to the master's tap position after the set delay time.</td>
</tr>
<tr>
<td>23</td>
<td>Red</td>
<td>Parallel operation error: Number of masters on CAN bus &gt;1</td>
<td>Message is displayed if several regulators in a parallel operation group have been set as the master.</td>
</tr>
<tr>
<td>24</td>
<td>Red</td>
<td>Parallel operation error: No master present or master tap position invalid</td>
<td>Message is displayed if no device has been set as the master or the master is reporting an invalid tap position.</td>
</tr>
<tr>
<td>25</td>
<td>Red</td>
<td>Parallel operation error: CAN bus address selected already in use</td>
<td>Message is displayed if the set CAN address is already in use.</td>
</tr>
<tr>
<td>26</td>
<td>Red</td>
<td>Parallel operation error: Circulating reactive current invalid</td>
<td>Message is displayed if the current measurement for at least one device is invalid and the circulating reactive current to be calculated is therefore invalid when the &quot;Circulating reactive current&quot; parallel operation method is active.</td>
</tr>
<tr>
<td>27</td>
<td>Red</td>
<td>Parallel operation error: Blocking initiated by other regulator</td>
<td>Message is displayed if blocking is initiated by another device.</td>
</tr>
<tr>
<td>28</td>
<td>Red</td>
<td>Parallel operation error: No other regulators in parallel operation group</td>
<td>Message is displayed if there are no more devices in the parallel operation group.</td>
</tr>
<tr>
<td>30</td>
<td>Red</td>
<td>Blocking: Signal at blocking user input</td>
<td>Message is displayed if there is a signal at the set &quot;Automatic regulation blocked&quot; (blocking) user input.</td>
</tr>
<tr>
<td>31</td>
<td>Red</td>
<td>Blocking: Negative active power</td>
<td>Message is displayed if the active power is negative and blocking is activated for negative active power.</td>
</tr>
<tr>
<td>32</td>
<td>Red</td>
<td>Blocking: User input Lower tap-change blocking</td>
<td>Message is displayed if there is a signal at the set &quot;Raise pulse blocked&quot; (Blk U raise) user input.</td>
</tr>
<tr>
<td>33</td>
<td>Red</td>
<td>Blocking: Signal at block raise user input</td>
<td>Message is displayed if there is a signal at the set &quot;Lower pulse blocked&quot; user input.</td>
</tr>
<tr>
<td>34</td>
<td>Red</td>
<td>Blocking: Lower blocked because tap position limit reached or exceeded</td>
<td>Message is displayed if lower is blocked because the corresponding tap position limit has been reached or exceeded.</td>
</tr>
<tr>
<td>35</td>
<td>Red</td>
<td>Blocking: Raise blocked because tap position limit reached or exceeded</td>
<td>Message is displayed if raise is blocked because the corresponding tap position limit has been reached or exceeded.</td>
</tr>
<tr>
<td>36</td>
<td>Yellow</td>
<td>Tap position limit reached or exceeded</td>
<td>Message is displayed if the tap position limit has been reached or exceeded.</td>
</tr>
<tr>
<td>37</td>
<td>Yellow</td>
<td>Negative active power</td>
<td>Message is displayed if the active power is negative.</td>
</tr>
<tr>
<td>38</td>
<td>Yellow</td>
<td>No connection to communication interface card</td>
<td>Message is displayed if communication to the communication interface card IEC 61850 card is not possible.</td>
</tr>
</tbody>
</table>

Table 49: Event message
11 Disposal

Observe the national requirements applicable in the country of use.
12 Overview of parameters

This section contains an overview of the relevant menus and parameters. The availability of individual parameters varies depending on your device function.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMset</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normset activation</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Desired value 1</td>
<td>49...140 V</td>
<td>100 V</td>
<td></td>
</tr>
<tr>
<td>Primary voltage</td>
<td>0...9999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>57...123 V</td>
<td>100 V</td>
<td></td>
</tr>
<tr>
<td>Control parameters &gt; Voltage regulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desired value 1</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Desired value 2</td>
<td>49...140 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Desired value 3</td>
<td>49...140 V</td>
<td>100.0 %</td>
<td></td>
</tr>
<tr>
<td>Desired value selection</td>
<td>Desired value 1; Desired value 2; Desired value 3</td>
<td>Desired value 1</td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.5...9 %</td>
<td>2.00 %</td>
<td></td>
</tr>
<tr>
<td>Delay time T1</td>
<td>0...600 s</td>
<td>40 s</td>
<td></td>
</tr>
<tr>
<td>Control response T1</td>
<td>T1 linear/T1 integral</td>
<td>T1 linear</td>
<td></td>
</tr>
<tr>
<td>Activation T2</td>
<td>T2 on/T2 off</td>
<td>T2 off</td>
<td></td>
</tr>
<tr>
<td>Delay time T2</td>
<td>1...10 s</td>
<td>10.0 s</td>
<td></td>
</tr>
<tr>
<td>Control parameters &gt; Limit values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undervoltage U&lt; [%]</td>
<td>60...100 %</td>
<td>90 %</td>
<td></td>
</tr>
<tr>
<td>Delay time U&lt;</td>
<td>0...20 s</td>
<td>10.0 s</td>
<td></td>
</tr>
<tr>
<td>Undervolt. blocking U&lt;</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>U&lt; below 30 V</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Overvoltage U&gt; [%]</td>
<td>100...140 %</td>
<td>110 %</td>
<td></td>
</tr>
<tr>
<td>Overvolt. blocking U&gt;</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Overcurrent I&gt; [%]</td>
<td>50...210 %</td>
<td>110 %</td>
<td></td>
</tr>
<tr>
<td>Overcurr. blocking I&gt;</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Undercurrent I&lt; [%]</td>
<td>0...210 %</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>Undercurr. blocking I&lt;</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Neg. active power block.</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Control parameters &gt; Compensation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation method</td>
<td>LDC/Z</td>
<td>LDC</td>
<td></td>
</tr>
<tr>
<td>line drop compensation Ur</td>
<td>-25...25 V</td>
<td>0.0 V</td>
<td></td>
</tr>
<tr>
<td>line drop compensation Ux</td>
<td>-25...25 V</td>
<td>0.0 V</td>
<td></td>
</tr>
<tr>
<td>Z compensation</td>
<td>0...15 %</td>
<td>0.0 %</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Setting range</td>
<td>Factory setting</td>
<td>Current setting</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Z comp. limit value</td>
<td>0...15 %</td>
<td>0.0 %</td>
<td></td>
</tr>
<tr>
<td><strong>Configuration &gt; Transformer data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary voltage</td>
<td>0...9999 kV</td>
<td>0 kV</td>
<td></td>
</tr>
<tr>
<td>Secondary voltage</td>
<td>57...123 V</td>
<td>100.0 V</td>
<td></td>
</tr>
<tr>
<td>Primary current</td>
<td>0...10000 A</td>
<td>0 a</td>
<td></td>
</tr>
<tr>
<td>Current transformer connection</td>
<td>Unknown; 1 A; 5 A</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Transformer circuit</td>
<td>See [► Section 8.7.5, Page 104]</td>
<td>0 1PH</td>
<td></td>
</tr>
<tr>
<td>Display kV / V</td>
<td>kV/V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Display %/A</td>
<td>%/A</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td><strong>Configuration &gt; General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>See [► Section 7.2.1, Page 55]</td>
<td>German</td>
<td></td>
</tr>
<tr>
<td>Regulator ID</td>
<td>-</td>
<td>0000</td>
<td></td>
</tr>
<tr>
<td>Baud rate</td>
<td>9.6 kilobaud; 19.2 kilobaud; 38.4 kilobaud; 57.6 kilobaud</td>
<td>57.6 kilobaud</td>
<td></td>
</tr>
<tr>
<td>R/L pulse duration</td>
<td>0...10 s</td>
<td>1.5 s</td>
<td></td>
</tr>
<tr>
<td>Operation counter</td>
<td>0...99999999</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Display dimming</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Key lock</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Function monitoring</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>Delay function monitoring</td>
<td>0...120 min</td>
<td>15 min</td>
<td></td>
</tr>
<tr>
<td>Motor runtime</td>
<td>0...30 s</td>
<td>0.0 s</td>
<td></td>
</tr>
<tr>
<td>Local/Remote</td>
<td>Local/Remote</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td>COM1 password</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Password duration</td>
<td>1...50 min</td>
<td>5 min</td>
<td></td>
</tr>
<tr>
<td><strong>Configuration &gt; Parallel operation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallel operation activation</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Parallel operation method</td>
<td>Circulating reactive current; Master; Follower; Auto synchronization</td>
<td>Circulating reactive current</td>
<td></td>
</tr>
<tr>
<td>Parallel operation group</td>
<td>None; Group 1; Group 2; Group 1 and Group 2</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>CAN address</td>
<td>0...16</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Simplex mode blocking</td>
<td>On/Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Circulating reactive current sensi-</td>
<td>0...100 %</td>
<td>0.0 %</td>
<td></td>
</tr>
</tbody>
</table>

12 Overview of parameters
### 12 Overview of parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulating reactive current blocking</td>
<td>0.5...40 %</td>
<td>20.0 %</td>
<td></td>
</tr>
<tr>
<td>Master/follower current blocking</td>
<td>Blocking/Off</td>
<td>Blocking</td>
<td></td>
</tr>
<tr>
<td>Parallel error delay</td>
<td>1...999 s</td>
<td>10 s</td>
<td></td>
</tr>
<tr>
<td>Follower tapping direction</td>
<td>Standard/Swapped</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Max. tap difference</td>
<td>1...4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Follower tapping without (U_{\text{max}})</td>
<td>On/Off</td>
<td>Off</td>
<td></td>
</tr>
</tbody>
</table>

#### Configuration > User In/Outputs

| GPI 1 – X4:13 | See [▶ Section 8.11, Page 123] | Off          |
| GPI 2 – X4:14 |                             | Off          |
| GPI 3 – X4:15 |                             | Off          |
| GPI 4 – X4:16 |                             | Quick Tap    |
| GPI 5 – X4:17 |                             | Desired value 2 |
| GPI 6 – X4:18 |                             | Desired value 3 |
| GPI 7 – X6:1 |                             | ParGroup1    |
| GPI 8 – X6:2 |                             | ParGroup2    |
| GPO 1 – X4:9 |                             | Off          |
| GPO 2 – X4:12|                             | Off          |
| GPO 3 – X5:9 |                             | ParState     |
| GPO 4 – X5:12|                             | ParError     |
| GPO 5 – X5:18|                             | Undervoltage |
| GPO 6 – X5:21|                             | Overvoltage  |
| GPO 7 – X5:24|                             | Overcurrent  |

#### Configuration > LED selection

| LED1 | See [▶ Section 8.12, Page 127] | GPI 1 |
| LED2 |                                | GPI 2 |
| LED3 yellow |                           | Off   |
| LED3 green  |                                | Off   |
| LED4 yellow |                                | Off   |
| LED4 red    |                                | Off   |

#### Configuration - Tap position options

<table>
<thead>
<tr>
<th>Tap pos. capture</th>
<th>See [▶ Section 8.9, Page 116]</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Val. [%] Tap pos. min</td>
<td>0...100 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Analog Val. [%] Tap pos. max.</td>
<td>0...100 %</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Lowest tap position</td>
<td>-40...40</td>
<td>0</td>
</tr>
<tr>
<td>Highest tap position</td>
<td>-40...40</td>
<td>19</td>
</tr>
<tr>
<td>Parameter</td>
<td>Setting range</td>
<td>Factory setting</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Lower tap position blocking</td>
<td>-128...128</td>
<td>0</td>
</tr>
<tr>
<td>Upper tap position blocking</td>
<td>-128...128</td>
<td>40</td>
</tr>
<tr>
<td>Tap position limits blocking behavior</td>
<td>Off; Directional; Non-directional</td>
<td></td>
</tr>
<tr>
<td><strong>Configuration &gt; Set desired voltage level remotely.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set desired voltage level remotely</td>
<td>Off; 0/4..20 mA; potentiometer series</td>
<td>Off</td>
</tr>
<tr>
<td>Analog value desired value min</td>
<td>0...100 %</td>
<td>0.0 5</td>
</tr>
<tr>
<td>Analog value desired value max</td>
<td>0...100 %</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Minimum desired value</td>
<td>0...140 V</td>
<td>80.0 V</td>
</tr>
<tr>
<td>Maximum desired value</td>
<td>0...140 V</td>
<td>140.0 V</td>
</tr>
<tr>
<td><strong>Configuration &gt; Communication interface (TAPCON® 230 expert only with CI card)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol</td>
<td>See [报酬 Section 8.13.1, Page 129]</td>
<td>Modb. ASCII</td>
</tr>
<tr>
<td>Modbus format</td>
<td>See [报酬 Section 8.13.2, Page 130]</td>
<td>8E1</td>
</tr>
<tr>
<td>Communication port</td>
<td>RS232; RS485; Ethernet; OF</td>
<td>RS232</td>
</tr>
<tr>
<td>Baud rate communication</td>
<td>9.6 kilobaud; 19.2 kilobaud; 38.4 kilobaud; 57.6 kilobaud</td>
<td>9.6 kilobaud</td>
</tr>
<tr>
<td>Network address</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>TCP port</td>
<td>0...32767</td>
<td>1234</td>
</tr>
<tr>
<td>OF light on/off</td>
<td>On/Off</td>
<td>Off</td>
</tr>
<tr>
<td>Local SCADA address</td>
<td>0...9999</td>
<td>0</td>
</tr>
<tr>
<td>SCADA master address</td>
<td>0...9999</td>
<td>0</td>
</tr>
<tr>
<td>Unsolicited messages</td>
<td>On/Off</td>
<td>Off</td>
</tr>
<tr>
<td>Repeat unsolicited messages</td>
<td>0...100</td>
<td>3</td>
</tr>
<tr>
<td>Appl. confirm. Timeout confirmation</td>
<td>1...60 s</td>
<td>5 s</td>
</tr>
<tr>
<td>RS485 transmit delay time</td>
<td>0...254 s</td>
<td>5 s</td>
</tr>
<tr>
<td><strong>Configuration &gt; Communication interface (TAPCON® 230 expert with IEC 61850 card)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network address</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>Network mask</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>Time server address 1</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>Time server address 2</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>Gateway</td>
<td>0.0.0.0...255.255.255.255</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>IED name</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Transmission medium</td>
<td>100Base-TX; 100Base-FX</td>
<td>100BASE-TX</td>
</tr>
</tbody>
</table>
### 12 Overview of parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
<th>Factory setting</th>
<th>Current setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSH encryption</td>
<td>Yes/No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>61850 password</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Info</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measured values</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calculated values</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LED test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MIO card digital inputs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MIO card digital outputs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PIO card digital inputs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PIO card digital outputs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PIO X7 analog input</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parallel operation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data on CAN bus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Peak memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CI card information (TAPCON® 230 with CI card)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>61850 card information (TAPCON® 230 with IEC 61850 card)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Default parameter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Memory overview</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Event memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 50: Overview of parameters
13 Technical data

13.1 Display elements

<table>
<thead>
<tr>
<th>Display</th>
<th>LCD, monochrome, graphics-capable 128 x 128 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEDs</td>
<td>15 LEDs for operation display and messages of which 4 LEDs are freely programmable (2x yellow, 1x yellow/green, 1x yellow/red)</td>
</tr>
</tbody>
</table>

Table 51: Display elements

13.2 Electrical data

<table>
<thead>
<tr>
<th>Permissible voltage range</th>
<th>90...264 V AC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100...353 V DC</td>
</tr>
<tr>
<td>U_n</td>
<td>100...240 V AC</td>
</tr>
<tr>
<td></td>
<td>U_n 100...353 V DC</td>
</tr>
<tr>
<td>Permissible frequency range</td>
<td>50 / 60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>15 VA</td>
</tr>
</tbody>
</table>

Table 52: Electrical data

13.3 Dimensions and weight

<table>
<thead>
<tr>
<th>Housing (W x H x D)</th>
<th>198 x 310 x 135.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door (W x H)</td>
<td>244 x 342 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>7.0 kg</td>
</tr>
</tbody>
</table>

Table 53: Dimensions and weight
Figure 83: Front view and side view

Figure 84: View from above with installed door
13 Technical data

13.4 Ambient conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-25°C...+70°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°C...+85°C</td>
</tr>
</tbody>
</table>

Table 54: Ambient conditions

13.5 Electrical safety

<table>
<thead>
<tr>
<th>Standard</th>
<th>Safety Requirements</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>
<tr>
<td>IEC 61010-2-030</td>
<td>• Protection class 1</td>
</tr>
<tr>
<td>IEC 61010-2-201</td>
<td>• Overvoltage category III</td>
</tr>
<tr>
<td></td>
<td>• Contamination level 2</td>
</tr>
<tr>
<td></td>
<td>• Measurement category III</td>
</tr>
<tr>
<td>IEC 61131-2</td>
<td>Dielectric test with operating frequency 350 V AC...5870 V AC (depending on the operating voltage of the power circuit)</td>
</tr>
<tr>
<td>IEC 60255</td>
<td>Dielectric test with impulse voltage 5 kV, 1.2/50 μs</td>
</tr>
<tr>
<td>VDE 0435</td>
<td>Short-time current and long-term load capacity of current transformer inputs</td>
</tr>
<tr>
<td></td>
<td>• 100 x I, 1 s</td>
</tr>
<tr>
<td></td>
<td>• 2 x I, continuous</td>
</tr>
</tbody>
</table>

Table 55: Electrical safety
13.6 Electromagnetic compatibility

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61000-4-2</td>
<td>Electrostatic discharges (ESD) 8 kV/15 kV</td>
</tr>
<tr>
<td>IEC 61000-4-3</td>
<td>Electromagnetic fields (HF) 20 V/m 80...3000 MHz</td>
</tr>
<tr>
<td>IEC 61000-4-4</td>
<td>Fast transients (burst) 6.5 kV</td>
</tr>
<tr>
<td>IEC 61000-4-5</td>
<td>Surge transient immunity 2 kV (outer conductor/outer conductor), 4 kV (outer conductor/ground)</td>
</tr>
<tr>
<td>IEC 61000-4-6</td>
<td>HF interference immunity (lines) 10 V, 150 kHz...80 MHz</td>
</tr>
<tr>
<td>IEC 61000-4-8</td>
<td>Power frequency magnetic field immunity 1000 A/m</td>
</tr>
<tr>
<td>IEC 61000-6-2</td>
<td>Immunity requirements for industrial environments</td>
</tr>
<tr>
<td>IEC 61000-6-4</td>
<td>Emission standard for industrial environments</td>
</tr>
</tbody>
</table>

Table 56: Electromagnetic compatibility

13.7 Optical radiation

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GZS/AEL Class 1</td>
<td>Safety of laser equipment and protection from optical radiation.</td>
</tr>
<tr>
<td>EN 60825-1 (+A11)</td>
<td>Checked for conformity by manufacturer subject to the conditions of individual errors.</td>
</tr>
<tr>
<td></td>
<td>TÜV certification: R 02071015</td>
</tr>
</tbody>
</table>

Table 57: Optical radiation (TAPCON® 230 expert with IEC 61850 card)

13.8 Environmental durability tests

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIN EN 60529</td>
<td>Determination of protection class for &quot;protection against contact, ingress of foreign objects and water for electrical equipment&quot; Level IP54</td>
</tr>
<tr>
<td>IEC 60068-2-1</td>
<td>Dry cold - 25 °C / 16 hours</td>
</tr>
<tr>
<td>IEC 60068-2-2</td>
<td>Dry heat + 70 °C / 16 hours</td>
</tr>
<tr>
<td>IEC 60068-2-3</td>
<td>Constant moist heat + 40 °C / 93% / 21 days</td>
</tr>
<tr>
<td>IEC 60068-2-30</td>
<td>Cyclic moist heat (12 + 12 hours) + 55 °C / 93% and + 25 °C / 95% / 6 cycles</td>
</tr>
</tbody>
</table>

Table 58: Environmental durability tests
13.9 Mechanical stability

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60068-2-31</td>
<td>Drop and topple, unpacked 100 mm fall height</td>
</tr>
<tr>
<td>IEC 60068-2-32</td>
<td>Free fall, unpacked 250 mm fall height</td>
</tr>
<tr>
<td>IEC 255-21-1 Class 1</td>
<td>Bounce test</td>
</tr>
<tr>
<td>IEC 255-21-2 Class 1</td>
<td>Shock and bump test</td>
</tr>
<tr>
<td>IEC 255-21-3 Class 1</td>
<td>Seismic test</td>
</tr>
</tbody>
</table>

Table 59: Mechanical stability
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASCII</strong></td>
<td>7-bit character coding (American Standard Code for Information Interchange)</td>
</tr>
<tr>
<td><strong>DNP</strong></td>
<td>Official communication standard for telecontrol (Distributed Network Protocol). The protocol is used as a general transmission protocol between control systems and substations.</td>
</tr>
<tr>
<td><strong>EMC</strong></td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td><strong>GPI</strong></td>
<td>General Purpose Input</td>
</tr>
<tr>
<td><strong>GPO</strong></td>
<td>General Purpose Output</td>
</tr>
<tr>
<td><strong>IEC</strong></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><strong>IED</strong></td>
<td>Intelligent Electronic Device</td>
</tr>
<tr>
<td><strong>IP</strong></td>
<td>Internet Protocol</td>
</tr>
<tr>
<td><strong>LDC</strong></td>
<td>Line drop compensation</td>
</tr>
<tr>
<td><strong>LED</strong></td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td><strong>MR</strong></td>
<td>Maschinenfabrik Reinhausen GmbH</td>
</tr>
<tr>
<td><strong>OF</strong></td>
<td>Abbreviation for fiber-optic cable</td>
</tr>
<tr>
<td><strong>R/L</strong></td>
<td>Raise/lower</td>
</tr>
<tr>
<td><strong>RTU</strong></td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td><strong>SCADA</strong></td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td><strong>SNTP</strong></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>TCP</strong></td>
<td>Transmission Control Protocol</td>
</tr>
</tbody>
</table>
List of key words

A

Analog input
Calibrating 56
Analog value [%] Tap pos. max 119
Analog value [%] Tap pos. min 118
Application timeout confirmation response 136
Auxiliary supply 50

B

Bandwidth 83
Calculation 83
Visual display 84
Baud rate 68, 131

C

Cable recommendation 44
Calculated values 143
CAN bus 109
Data 147
Cap rail clip 40
Cl card 128
Cl-card - SCADA information 148
Circulating reactive current 109
Blocking 110
Master/Follower current blocking 113
Sensitivity 110
COM1 password 76
COM1 setting 68
Communication port 131
Communication protocol 129
Compensation 96
Z compensation 99
Connection 43
Contrast 54
Control parameter
Desired value 81
control parameters 79
Control response T1 85

D

Delay time T1 84
Delay time T2 86
Activating 86
Deactivating 86
Desired value 79
Desired value 81
Device ID 67
Display contrast 54
Display dimming 71

E

Electromagnetic compatibility 46
Factory setting 149, 161
Fiber-optic cable
Information about laying 45
flush panel mounting 38
Follower
without measured voltage 115
Follower tapping direction 112
Follower tapping without Umeas 115
Function monitoring
Delay time 72
Suppress message 72
Function test
Additional functions 59
Circulating reactive current blocking 63
Circulating reactive current sensitivity 62
Control functions 58
Desired value 2 60
Desired value 3 60
Line drop compensation 60
Overvoltage U> 59
Parallel operation 62
Tap synchronization 64
Undervoltage U< 59
Z compensation 61
Function tests
LDC 57

F

Info 142
Information 141

G

Gateway 138
GPI 123

H

Highest tap position 119
highest tap position blocking limit 95
High-speed return 91, 92

I

IEC 61850 card 31, 137
Information 149
IEC 61850 password 140
IED name 139
Indicator elements
Indicator elements 26
LED 26
Info 142
Information 141

K

Key lock 67
automatic 71

L

Language 55
LED selection 127
Limit value
Limit value monitoring 87
Overvoltage U> 90
Undervoltage U< 87
Line drop compensation 98
Inductive voltage drop
Ohmic voltage drop 98
Lowest tap position 118
lowest tap position blocking limit 94

M

Measured values 142
Memory overview 149
Motor runtime 73
Output relay 74
<table>
<thead>
<tr>
<th>List of key words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
</tr>
<tr>
<td>Neg. active power flow</td>
</tr>
<tr>
<td>Network address</td>
</tr>
<tr>
<td>Network mask</td>
</tr>
<tr>
<td>NORMset</td>
</tr>
<tr>
<td><strong>O</strong></td>
</tr>
<tr>
<td>Operating controls</td>
</tr>
<tr>
<td>Operating mode</td>
</tr>
<tr>
<td>Auto mode</td>
</tr>
<tr>
<td>Local mode</td>
</tr>
<tr>
<td>Manual mode</td>
</tr>
<tr>
<td>Remote mode</td>
</tr>
<tr>
<td>operation mode</td>
</tr>
<tr>
<td>Local</td>
</tr>
<tr>
<td>Manual</td>
</tr>
<tr>
<td>Remote</td>
</tr>
<tr>
<td>Operations counter</td>
</tr>
<tr>
<td>Optical fiber transmission behavior</td>
</tr>
<tr>
<td>Overcurrent blocking</td>
</tr>
<tr>
<td>overcurrent I&gt; relative</td>
</tr>
<tr>
<td>Overview of parameters</td>
</tr>
<tr>
<td>Overvoltage U&gt; Relative</td>
</tr>
<tr>
<td><strong>P</strong></td>
</tr>
<tr>
<td>Parallel operation</td>
</tr>
<tr>
<td>Activate</td>
</tr>
<tr>
<td>CAN bus</td>
</tr>
<tr>
<td>Circulating reactive current</td>
</tr>
<tr>
<td>Deactivate</td>
</tr>
<tr>
<td>Parallel operation error message</td>
</tr>
<tr>
<td>parallel operation group</td>
</tr>
<tr>
<td>Parallel operation method</td>
</tr>
<tr>
<td>tap difference</td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Bandwidth</td>
</tr>
<tr>
<td>High-speed return</td>
</tr>
<tr>
<td>Overcurrent blocking</td>
</tr>
<tr>
<td>Peak memory</td>
</tr>
<tr>
<td>Phase difference</td>
</tr>
<tr>
<td>Primary voltage</td>
</tr>
<tr>
<td><strong>R</strong></td>
</tr>
<tr>
<td>R&amp;X compensation</td>
</tr>
<tr>
<td>Raise/Lower pulse duration</td>
</tr>
<tr>
<td>Rectifying faults</td>
</tr>
<tr>
<td>Regulator ID</td>
</tr>
<tr>
<td>Repeat unsolicited messages</td>
</tr>
<tr>
<td>Reset parameters</td>
</tr>
<tr>
<td><strong>S</strong></td>
</tr>
<tr>
<td>SCADA address</td>
</tr>
<tr>
<td>Device</td>
</tr>
<tr>
<td>Master</td>
</tr>
<tr>
<td>Scope of delivery</td>
</tr>
<tr>
<td>Secondary voltage</td>
</tr>
<tr>
<td>Security log</td>
</tr>
<tr>
<td>Send delay time RS485</td>
</tr>
<tr>
<td>Short-circuit capacity</td>
</tr>
<tr>
<td>Simplex mode blocking</td>
</tr>
<tr>
<td>SNTP time server address</td>
</tr>
<tr>
<td><strong>T</strong></td>
</tr>
<tr>
<td>Tap difference</td>
</tr>
<tr>
<td>follower</td>
</tr>
<tr>
<td>master</td>
</tr>
<tr>
<td>Tap pos. blocking mode</td>
</tr>
<tr>
<td>Tap position blocking mode</td>
</tr>
<tr>
<td>Tap position blocking unit highest</td>
</tr>
<tr>
<td>lowest</td>
</tr>
<tr>
<td>tap position capture analog</td>
</tr>
<tr>
<td>Digital</td>
</tr>
<tr>
<td>Tapping direction</td>
</tr>
<tr>
<td>TCP port</td>
</tr>
<tr>
<td>Throughput capacity</td>
</tr>
<tr>
<td>Time server address</td>
</tr>
<tr>
<td>Transformer Primary current</td>
</tr>
<tr>
<td>Transformer data Current transformer connection</td>
</tr>
<tr>
<td>103 Primary voltage</td>
</tr>
<tr>
<td>Secondary voltage</td>
</tr>
<tr>
<td>Transformer circuit</td>
</tr>
<tr>
<td>transmission format MODBUS</td>
</tr>
<tr>
<td>Transmission medium</td>
</tr>
<tr>
<td><strong>U</strong></td>
</tr>
<tr>
<td>U&lt; blocking</td>
</tr>
<tr>
<td>U&lt;delay</td>
</tr>
<tr>
<td>Undercurrent I&lt; Relative</td>
</tr>
<tr>
<td>undervoltage</td>
</tr>
<tr>
<td>Undervoltage monitoring relative</td>
</tr>
<tr>
<td>Unsolicited messages</td>
</tr>
<tr>
<td><strong>V</strong></td>
</tr>
<tr>
<td>V&lt; also below 30 V</td>
</tr>
<tr>
<td><strong>W</strong></td>
</tr>
<tr>
<td>Wall mounting</td>
</tr>
<tr>
<td>Wiring</td>
</tr>
<tr>
<td><strong>Z</strong></td>
</tr>
<tr>
<td>Z compensation</td>
</tr>
<tr>
<td>Activate</td>
</tr>
<tr>
<td>Limit value</td>
</tr>
</tbody>
</table>