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<td>11.1.3</td>
<td>Read out software version (F6)</td>
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<td>95</td>
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1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product. In addition, this file contains technical data for selecting the appropriate product for a respective application. 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 Validity

This technical file applies to the ECOTAP VPD MD&C motor-drive unit with control unit. You will find the description for the associated ECOTAP VPD on-load tap-changer in separate operating instructions.

1.2 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.

1.3 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.

1.4 Completeness

This technical file is incomplete without the further applicable documentation.

The following documents apply:
• Operating instructions for the associated ECOTAP VPD on-load tap-changer
• Connection diagrams
• Routine test report

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

1.5 Safekeeping

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

1.6 Notation conventions

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

1.6.1 Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="symbol.png" alt="Wrench size" /></td>
<td>Wrench size</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Tightening torque" /></td>
<td>Tightening torque</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Number and type of fastening material used" /></td>
<td>Number and type of fastening material used</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Fill with oil" /></td>
<td>Fill with oil</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Cut open, cut through" /></td>
<td>Cut open, cut through</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Clean" /></td>
<td>Clean</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Visual inspection" /></td>
<td>Visual inspection</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Use your hand" /></td>
<td>Use your hand</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Adapter ring" /></td>
<td>Adapter ring</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Apply a coat of paint" /></td>
<td>Apply a coat of paint</td>
</tr>
</tbody>
</table>
1.6.2 Hazard communication system

Warnings in this technical file are displayed as follows.

1.6.2.1 Warning relating to section

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

⚠️ WARNING

Type and source of danger

Consequences

► Action

► Action
1.6.2.2 Embedded warning information

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

⚠️ **DANGER!** Instruction for avoiding a dangerous situation.

1.6.2.3 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 2: Signal words in warning notices

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 3: Pictograms used in warning notices
1.6.3 Information system

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

Important information.

1.6.4 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).

1.6.5 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, keys</td>
<td>AVR MANUAL</td>
</tr>
<tr>
<td>Bold</td>
<td>Displays/menus</td>
<td>P21</td>
</tr>
<tr>
<td>Italics</td>
<td>System messages/LED displays</td>
<td>ERROR LED</td>
</tr>
</tbody>
</table>
### 1 Introduction

<table>
<thead>
<tr>
<th>Typographic convention</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>[► Number of pages]</td>
<td>Cross reference</td>
<td>[► 41].</td>
</tr>
</tbody>
</table>

Table 4: Typographic conventions
2 Safety

2.1 General safety information

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

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

2.2 Appropriate use

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

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

The following is considered appropriate use:

- Only operate the product in accordance with this technical file and the agreed delivery conditions and technical data.
- Only use the ECOTAP VPD on-load tap-changer in systems set up in accordance with IEC 61936-1.
- Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file.
- You will find the standard valid for the product and the year of issue on the name plate.
- The ECOTAP VPD on-load tap-changer is suitable for use in distribution transformers.
- Use the product only with the transformer specified in the order.
- Only operate standard design on-load tap-changers in entirely oil-filled transformers. Use in transformers with a gas cushion below the transformer cover is only permitted with an appropriate special design. It is essential that the minimum oil fill height stated on the dimensional drawing supplied is observed for such use.
- Operation with alternative insulating liquids is possible in accordance with the specification in the "Technical data" [► 89]. In such cases, you must ensure compliance with the limited temperature ranges by means of a "temperature blockade" [► 62].
- Only operate ECOTAP VPD on-load tap-changer and ECOTAP VPD MD&C motor-drive unit in this combination. Operation with another on-load tap-changer or motor-drive unit is not permitted.
• The serial numbers of the motor-drive unit, on-load tap-changer, and control unit must match.

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.

2.6 Personal protective equipment

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

- Always wear the personal protective equipment required for the job at hand.
- Follow information about personal protective equipment provided in the work area.

<table>
<thead>
<tr>
<th>Always wear</th>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective clothing</td>
<td>Close-fitting work clothing with a low breaking strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.</td>
</tr>
<tr>
<td>Safety shoes</td>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td>Hard hat</td>
<td>To protect from falling and flying parts and materials.</td>
</tr>
</tbody>
</table>

Table 5: Personal protective equipment to be worn at all times
Wear the following in special environments

<table>
<thead>
<tr>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hearing protection</strong></td>
</tr>
<tr>
<td>To protect from hearing damage.</td>
</tr>
<tr>
<td><strong>Protective gloves</strong></td>
</tr>
<tr>
<td>For protection from mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>

Table 6: Personal protective equipment to be worn in special environments
3 Product description

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

3.1 Scope of delivery

The product is packaged with protection against moisture and is delivered as follows:

- Motor-drive unit with connection cable
- Control unit
- Technical files

Note the following information:

- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation.
- The product must remain in its airtight, protective wrapping and may only be removed immediately before installation

You will find more information in the "Packaging, transport, and storage" [► 27] chapter.

3.2 Function description

The motor-drive unit adjusts the operating position of on-load tap-changers in regulating transformers to the individual operating requirements.

The tap-change operation is initiated by activating the motor-drive unit (a single control impulse triggered). This operation is always completed regardless of any other control pulses emitted during the tap-change operation. In the standard design, the next tap-change operation can only proceed once all control devices have reached their resting positions.

Behavior in the event of a voltage interruption

Should the voltage be interrupted during an on-load tap-change operation, the motor-drive unit completes the started tap-change operation. Further on-load tap-change operations are blocked until the voltage supply is restored.

This response can be adapted using the "Target position for loss of voltage" [► 72] function so that the on-load tap-changer is moved into a previously defined position before this blocking. For this purpose, the control unit is equipped with an energy accumulator, the readiness of which is indicated by the continuous lighting of the LED. After a loss of voltage or a deliberate disconnection from the mains, it takes around 30 minutes for this energy accumulator to discharge.
Voltage regulation

The motor-drive unit is equipped with a control unit which enables automatic voltage regulation. This is used to keep constant the output voltage of a transformer with an on-load tap-changer.

The control unit 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 ($dU$).

You can set all parameters needed to set the voltage regulation via a parameterization menu.
In AVR AUTO auto mode, voltage regulation works as follows:

- 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 $B$ to the tolerance bandwidth within the set delay time $T_1$.

- However, if the measured voltage deviates from the set bandwidth for a longer period $C$, a tap-change command $D$ occurs after expiration of the set delay time. The on-load tap-changer carries out a tap-change in a raise or lower direction to return to the tolerance bandwidth.

![Figure 1: Regulation function response](image)

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

A $U_{\text{actual}}$ is outside the bandwidth. Delay time $T$ starts.

B $U_{\text{actual}}$ is back within the bandwidth before delay time $T$ is complete.

C $U_{\text{actual}}$ is outside the bandwidth. Delay time $T$ starts.

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

### 3.3 Operating modes

There are 3 operating modes on the control unit for controlling the on-load tap-changer:
AVR AUTO auto mode
In AVR AUTO auto mode, the voltage is automatically regulated in accordance with the set parameters. The voltage is measured in a single phase via the supply voltage. You have to switch to AVR MANUAL manual mode to configure the control unit.

Control via EXTERNAL CONTROL
In the EXTERNAL CONTROL operating mode, the commands of the PRO CONTROL control unit (available separately) are carried out. In this case, manual operation using the LOWER and RAISE keys is not possible.

AVR MANUAL manual mode

NOTICE
Damage to property from uncontrolled tap-change operations!
As a result of uncontrolled manual tap-change operations, the line voltage of the consumers may exceed the permitted limit values. This may result in damage to the device and follow-on damage.

➤ Only undertake manual tap-change operations if no consumers are connected or if you can ensure that the line voltage on the consumer side does not leave the permitted operating range.

In AVR MANUAL manual mode, there is no automatic control. The motor-drive unit can be controlled via the device's operating panel. The device settings can be changed.
3.4 Design

**ECOTAP VPD MD&C motor-drive unit with control unit**

Figure 2: Motor-drive unit and control unit

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor</td>
</tr>
<tr>
<td>2</td>
<td>Name plate</td>
</tr>
<tr>
<td>3</td>
<td>Connection cable</td>
</tr>
<tr>
<td>4</td>
<td>Sealing flange cover</td>
</tr>
<tr>
<td>5</td>
<td>Control unit</td>
</tr>
</tbody>
</table>
3 Product description

Front of control unit with operating interfaces

Figure 3: Front of control unit

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="VOLTAGE LED" /></td>
<td>2</td>
<td><img src="image2" alt="CAPACITY LED" /></td>
<td>3</td>
<td><img src="image3" alt="MOTOR LED" /></td>
<td>4</td>
<td><img src="image4" alt="ERROR LED" /></td>
<td>5</td>
<td>Display</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><img src="image1" alt="VOLTAGE LED" /></td>
<td></td>
<td><img src="image2" alt="CAPACITY LED" /></td>
<td></td>
<td><img src="image3" alt="MOTOR LED" /></td>
<td></td>
<td><img src="image4" alt="ERROR LED" /></td>
<td>7</td>
<td>DOWN key</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><img src="image1" alt="VOLTAGE LED" /></td>
<td></td>
<td><img src="image2" alt="CAPACITY LED" /></td>
<td></td>
<td><img src="image3" alt="MOTOR LED" /></td>
<td></td>
<td><img src="image4" alt="ERROR LED" /></td>
<td>9</td>
<td>EXTERNAL CONTROL key</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><img src="image1" alt="VOLTAGE LED" /></td>
<td></td>
<td><img src="image2" alt="CAPACITY LED" /></td>
<td></td>
<td><img src="image3" alt="MOTOR LED" /></td>
<td></td>
<td><img src="image4" alt="ERROR LED" /></td>
<td>11</td>
<td>AVR AUTO key</td>
<td></td>
</tr>
</tbody>
</table>

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4899657/01 EN

ECOTAP VPD MD&C 21
LED displays

<table>
<thead>
<tr>
<th>LED</th>
<th>State</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>![ ](VOLTAGE, blue)</td>
<td>Off</td>
<td>Motor without power supply (X2)</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td>Inrush interlock</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>Ready</td>
</tr>
<tr>
<td>![ ](CAPACITY, blue)</td>
<td>Off</td>
<td>Energy accumulator not ready</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td>Is charging</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>Ready</td>
</tr>
<tr>
<td>![ ](MOTOR, blue)</td>
<td>Off</td>
<td>Motor stationary</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>Motor running</td>
</tr>
<tr>
<td>![ ](ERROR, red)</td>
<td>Off</td>
<td>Ready</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>Fault</td>
</tr>
</tbody>
</table>

Table 7: LED displays

Display

The 7-segment display switches between the following displays at a 3s interval:
- Current number of tap-change operations
- Current operating position
- Actual voltage

In the event of an error, error codes are also displayed.

Operating controls

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU</td>
<td>Start/end of parameterization menu</td>
</tr>
<tr>
<td>AVR AUTO</td>
<td>Choice of operating mode for automatic voltage regulation</td>
</tr>
<tr>
<td>UP</td>
<td>In AVR MANUAL operating mode: Raise tap-change operation</td>
</tr>
<tr>
<td></td>
<td>In parameterization menu: Increase displayed value</td>
</tr>
<tr>
<td>UP + AUTO</td>
<td>In parameterization menu: Increase displayed value quickly</td>
</tr>
</tbody>
</table>
3 Product description

### Key

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOWN</td>
<td>In AVR MANUAL operating mode:</td>
</tr>
<tr>
<td></td>
<td>Lower tap-change operation</td>
</tr>
<tr>
<td></td>
<td>In parameterization menu:</td>
</tr>
<tr>
<td></td>
<td>Decrease displayed value</td>
</tr>
<tr>
<td>DOWN + AUTO</td>
<td>In parameterization menu:</td>
</tr>
<tr>
<td></td>
<td>Decrease displayed value quickly</td>
</tr>
<tr>
<td>AVR MANUAL</td>
<td>Choice of operating mode for manual voltage regulation</td>
</tr>
<tr>
<td>EXTERNAL CONTROL</td>
<td>Choice of operating mode for automatic voltage regulation by external control</td>
</tr>
</tbody>
</table>

Table 8: Operating controls

To activate a function, you have to press and hold the corresponding key for at least 300 ms.

### Physical interfaces of the control unit

The control unit has the following physical interfaces, which are located on its underside:

![Figure 4: Control unit connections](image)

<table>
<thead>
<tr>
<th>X1</th>
<th>Control unit power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2</td>
<td>Motor power supply</td>
</tr>
<tr>
<td>X3</td>
<td>Signal for blocking</td>
</tr>
<tr>
<td>X4</td>
<td>Control gear signal line</td>
</tr>
<tr>
<td>X5</td>
<td>Customer messages</td>
</tr>
<tr>
<td>X6</td>
<td>RS 485 communication interface</td>
</tr>
<tr>
<td>F1</td>
<td>Fine-wire fuse, 230 V, T, 4 A</td>
</tr>
</tbody>
</table>
3.5 Control unit operating concept

You can operate the device using the operating controls on the front panel.

You can use the AVR MANUAL, AVR AUTO, and EXTERNAL CONTROL keys to select the operating mode [► 18].

You access the settings for voltage regulation and other functions as follows:

1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select the desired parameter level or function level.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select the desired parameter or function.
5. Press AVR MANUAL key to confirm selection.
6. Parameter: Use the UP/DOWN arrow keys to select the desired value and confirm by pressing the AVR MANUAL key. Or:
7. Function: Press AVR MANUAL key to activate the selected function.

Settings are only saved once the parameterization menu is exited using the MENU key. If you do not press the MENU key within 30 s, the parameterization menu is exited automatically and the changes are not saved.

Process for setting parameters P1/P5/P6/P7 (1 parameter level)

<table>
<thead>
<tr>
<th>Operating mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU key → Parameterization mode</td>
</tr>
<tr>
<td>UP/DOWN arrow keys → Parameter selection</td>
</tr>
<tr>
<td><strong>P1</strong>: Desired voltage $U_{\text{desired}}$</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td><strong>P5</strong>: Blocking contact</td>
</tr>
<tr>
<td><strong>P6</strong>: Target position for loss of voltage</td>
</tr>
<tr>
<td><strong>P7</strong>: Number of operating positions</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>AVR MANUAL key → Confirm selection</td>
</tr>
<tr>
<td>UP/DOWN arrow keys → Set value selection</td>
</tr>
<tr>
<td>AVR MANUAL key → Confirm set value selection</td>
</tr>
<tr>
<td>MENU key → Save setting</td>
</tr>
<tr>
<td>Return to operating mode (end of parameterization menu)</td>
</tr>
</tbody>
</table>
### Process for setting parameters P2.1/P2.2/P3.1/P3.2/P4.1/P4.2/P8.1/P8.2 (2 parameter levels)

#### Operating mode

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU key</td>
<td>Parameterization mode</td>
</tr>
<tr>
<td>UP/DOWN arrow keys</td>
<td>Parameter level selection</td>
</tr>
<tr>
<td></td>
<td>P2: Normal regulation mode</td>
</tr>
<tr>
<td></td>
<td>P3: Fast regulation</td>
</tr>
<tr>
<td></td>
<td>P4: Voltage blocking</td>
</tr>
<tr>
<td></td>
<td>P8: Regulating range</td>
</tr>
<tr>
<td>AVR MANUAL key</td>
<td>Confirm selection</td>
</tr>
<tr>
<td>UP/DOWN arrow keys</td>
<td>Parameter selection</td>
</tr>
<tr>
<td>P2.1: Regulation bandwidth B1</td>
<td>P2.2: Delay time T1</td>
</tr>
<tr>
<td>P3.1: Regulation bandwidth B2</td>
<td>P3.2: Delay time T2</td>
</tr>
<tr>
<td>P4.1: Undervoltage / P4.2:</td>
<td>Overvoltage</td>
</tr>
<tr>
<td>P8.1: Lowest position/</td>
<td>P8.2: Highest position</td>
</tr>
<tr>
<td>AVR MANUAL key</td>
<td>Confirm selection</td>
</tr>
<tr>
<td>UP/DOWN arrow keys</td>
<td>Set value selection</td>
</tr>
<tr>
<td>AVR MANUAL key</td>
<td>Confirm selection</td>
</tr>
<tr>
<td>MENU key</td>
<td>Save setting</td>
</tr>
</tbody>
</table>

Return to operating mode (end of parameterization menu)

### Selection of functions

#### Operating mode

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU key</td>
<td>Parameterization mode</td>
</tr>
<tr>
<td>UP/DOWN arrow keys</td>
<td>Function selection</td>
</tr>
<tr>
<td></td>
<td>F1: Automatic adjustment function</td>
</tr>
<tr>
<td></td>
<td>F2: Display remaining life function</td>
</tr>
<tr>
<td></td>
<td>F3: LED function test function</td>
</tr>
<tr>
<td></td>
<td>F4: Software update function</td>
</tr>
<tr>
<td></td>
<td>F5: Invert travel commands function</td>
</tr>
<tr>
<td></td>
<td>F6: Read out software version</td>
</tr>
<tr>
<td>AVR MANUAL key</td>
<td>Activate selected function</td>
</tr>
<tr>
<td></td>
<td>Function starts</td>
</tr>
<tr>
<td>E:</td>
<td>Read out error memory</td>
</tr>
<tr>
<td>Press AVR MANUAL key repeatedly</td>
<td>Read out error codes</td>
</tr>
</tbody>
</table>

Maschinenfabrik Reinhausen GmbH 2016
### Overview of set values

<table>
<thead>
<tr>
<th>Parameter/ Function</th>
<th>Setting range/ Set values</th>
<th>Default</th>
<th>Step size</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1: ( U_{\text{desired}} )</td>
<td>85...265 V</td>
<td>225 V</td>
<td>1 V</td>
</tr>
<tr>
<td>P2.1: B1</td>
<td>0.5...8 %</td>
<td>2 %</td>
<td>0.5 %</td>
</tr>
<tr>
<td>P2.2: T1</td>
<td>5...1800 s</td>
<td>10 s</td>
<td>5 s/30 s</td>
</tr>
<tr>
<td>P3.1: B2</td>
<td>(B1 + 0.5 %)...9 %</td>
<td>4 %</td>
<td>0.5 %</td>
</tr>
<tr>
<td>P3.2: T2</td>
<td>For ( T1 \leq 10 \text{ s} ): 2 s...(( T1 – 1 \text{ s} )) For ( T1 &gt; 10 \text{ s} ): 2 s...(( T1 – 5 \text{ s} ))</td>
<td>2 s</td>
<td>1 s/30 s</td>
</tr>
<tr>
<td>P4.1</td>
<td>85...265 V</td>
<td>1 V/10 V</td>
<td></td>
</tr>
<tr>
<td>P4.2</td>
<td>85...265 V</td>
<td>1 V/10 V</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>0 = inactive/1 = active</td>
<td>0 = inactive</td>
<td>1</td>
</tr>
<tr>
<td>P6</td>
<td>0 = inactive/22 = active</td>
<td>0 = inactive</td>
<td>1</td>
</tr>
<tr>
<td>P7</td>
<td>9…32</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>P8.1</td>
<td>1…9 (32)*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P8.2</td>
<td>1…9 (32)*</td>
<td>9 (32)*</td>
<td>1</td>
</tr>
<tr>
<td>F5</td>
<td>0 = inactive/1 = active</td>
<td>0 = inactive</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 9: Set values

*) Dependent on the maximum number of operating positions in accordance with the on-load tap-changer design (standard design: 9 operating positions).

You will find a detailed description of all control unit parameters and functions in the "Configuring control unit" [► 64] chapter.
4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with a sealed packaging and sometimes also dried depending on what is required.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. Products that have also been dried are identified by a yellow label on the sealed packaging.

The information in the following sections should be applied as appropriate.

4.1.1 Suitability

**NOTICE**

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods!

- Only stack up to 2 equally sized crates on top of one another.
- Do not stack crates above a height of 1.5 m.

The packaging is suitable for undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a stable crate. This crate ensures that when in the intended transportation position the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. The packaged goods are protected from humidity using a desiccant. The plastic foil is bonded after the drying agent is added.

4.1.2 Markings

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect against moisture</td>
<td>Top</td>
</tr>
<tr>
<td>Fragile</td>
<td>Attach lifting gear here</td>
</tr>
<tr>
<td>Center of mass</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Shipping pictograms
4.2 Transportation, receipt and handling of shipments

**WARNING**

Danger of death and damage to property!

- Transport crate only when closed.
- Do not remove the mounting material used in the crate during transport.
- Only trained and appointed persons may select the sling gear and secure the load.
- Do not walk under the hanging load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

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

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

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

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

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

**Visible damage**

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

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately onsite together with the carrier involved. This is essential for any claim for damages!
- 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).
- **NOTICE!** Be absolutely sure to also check the sealed packaging. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either dry the dried packaged goods again as per the operating instructions for the relevant on-load tap-
4 Packaging, transport and storage

changer/de-energized tap-changer or contact Maschinenfabrik Reinhausen GmbH to agree on how to proceed with drying. If this is not done, the packaged goods may be damaged.

- Name the damaged parts.

**Hidden damage**

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

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

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

4.3 Storage of shipments

**Packaged goods dried by Maschinenfabrik Reinhausen**

Upon receipt of the shipment, immediately remove the packaged goods dried by Maschinenfabrik Reinhausen from the sealed packaging and store airtight in dry insulating oil until used if the packaged goods were not supplied in oil.

**Non-dried packaged goods**

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.

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.

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.
If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

- Correctly regenerate the drying agent and restore the sealed packaging.
- Unpack the packed goods and store in suitable storage space (well ventilated, as dust-free as possible, humidity < 50 % where possible).

4.4 Unpacking shipments and checking for transportation damages

- **NOTICE!** Transport the packaged crate to the place where installation will take place. Do not open the sealed packaging until just before installation. If this is not done, damage to the packaged goods may occur due to ineffectively sealed packaging.

- **WARNING!** When unpacking, check the condition of the packaged goods. Secure packaged goods in an upright crate from tipping out. If this is not done, the packaged goods may be damaged and serious injuries may result.

- Check completeness of supplementary parts on the basis of the delivery slip.
5 Mounting

This chapter describes how to correctly install and connect the device.

**WARNING**

Risk of severe injury or death!
An energized transformer and energized on-load tap-changer components can cause death or serious injuries when installing the motor-drive unit!

- Ensure de-energized state of transformer and on-load tap-changer components during the installation of the motor-drive unit.

5.1 Mounting motor-drive unit

1. Take off transport locking plate and remove any kerosene residue from the sealing module. Keep transport locking plate for use later on.

Figure 5: Removing transport locking plate
2. Clean sealing surfaces on sealing module and underside of motor-drive unit and check that o-ring is in the correct position.

Figure 6: Cleaning sealing surfaces of motor-drive unit

3. There is another small o-ring on the motor shaft, which serves as a transport lock for the feather key. Now remove this o-ring, ensuring that the feather key is seated correctly.

Figure 7: Removing o-ring from motor shaft

4. Attach motor-drive unit to sealing module.
5. **NOTICE!** To fasten the motor-drive unit, gradually tighten screws crosswise without warping or deforming them as described below. Otherwise the motor-drive unit is not correctly connected to the on-load tap-changer, which may result in damage to the on-load tap-changer and transformer.

6. Evenly tighten screws crosswise by hand.
7. Tighten screws crosswise to a pre-tightening torque of 4 Nm.
8. Check seat of flange and seal for regularity.
9. Tighten screws crosswise to the full tightening torque of 7.5 Nm.

![Figure 8: Mounting motor-drive unit](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-tightening torque</strong></td>
<td><strong>4 Nm</strong></td>
</tr>
<tr>
<td><strong>Full tightening torque</strong></td>
<td><strong>7.5 Nm</strong></td>
</tr>
</tbody>
</table>

10. Tighten screws again to full tightening torque, working clockwise and tightening one screw after another until they won't tighten any further.
11. Connect motor-drive unit and transformer cover with a grounding line. For the ground connection on the motor-drive unit, we recommend using an M8 cable shoe.

Figure 9: Grounding motor-drive unit

Whenever the motor-drive unit is replaced or mounted, undertake "automatic adjustment" [► 38].
5.2 Connecting control unit at the transformer manufacturer's site

This section describes how you connect the control unit before initial commissioning. Connection and mounting of the control unit for permanent operation are described in the Commissioning transformer at operating site [► 48] chapter.

⚠️ DANGER

Risk of fatal injury due to electrical voltage!

Danger of death due to electrical voltage when assembling and connecting the device.

► De-energize the device and system peripherals and lock them to prevent them from being switched back on.

5.2.1 Cable recommendation

Please note the following recommendation from Maschinenfabrik Reinhausen GmbH when wiring the device for the connection provided by the customer:

<table>
<thead>
<tr>
<th>Cable type</th>
<th>Conductor cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unshielded</td>
<td>1.5 mm² with wire end sleeve</td>
</tr>
<tr>
<td></td>
<td>2.5 mm² without wire end sleeve</td>
</tr>
</tbody>
</table>

The connection cable between the control unit and motor-drive unit is supplied as standard. This connection cable is resistant to oil and heat. It contains the power supply for the motor and signal line to the control gear in the motor-drive unit.

Plug connectors for connection on control unit

![Figure 10: Control unit connections](image)

The connection cable between the control unit and motor-drive unit is pre-assembled with the necessary plug connectors (X2, X4).
Plug connectors suitable for the following connections are also supplied as standard:

- X1: Control unit power supply
- X3: Signal for blocking
- X5: Customer messages

### 5.2.2 Connecting motor-drive unit and voltage supply

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

The equipment may only be connected to circuits with an external isolating device for all poles so the equipment can be fully de-energized if required.

1. Connect connection cable of motor-drive unit to terminals X2 (0.5 Nm) and X4 (0.4 Nm) with the pre-assembled plugs on the control unit.

![Figure 11: Connecting connection cable](image)
2. **DANGER!** Ensure that all cables in the working area are de-energized and that the shutdown equipment is locked so it cannot be switched on again. If this is not done, there is a risk of fatal injury due to electrical voltage.

3. Screw down (0.5 Nm) power supply for control unit to plug connector for X1 as shown in the supplied connection diagram. Screw down (0.5 Nm) plug connector to terminal X1.

### 5.3 Commissioning motor-drive unit and control unit

**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.

For the initial commissioning, proceed as follows:

1. Activate power supply for motor-drive unit and control unit.
   - The control unit starts automatically. The \( \bigcirc \) LED flashes for 10 s to display the inrush interlock. After 10 s, this LED lights up blue permanently.
   - The \( \Delta \) LED also starts by flashing and then lights up permanently as soon as the internal energy accumulator is fully charged.
   - At the same time, the red \( \bigtriangleup \) LED on the control unit lights up and the "E4" error code appears on the display to indicate that adjustment is needed.

2. Next carry out automatic adjustment and trial tap-change operations as described below.

Also note the information provided in the "Commissioning the on-load tap-changer at the transformer manufacturer's site" section in the operating instructions for the ECOTAP VPD on-load tap-changer.
5.3.1 Carrying out automatic adjustment

Before commissioning, automatic adjustment of on-load tap-changer and motor-drive unit must be undertaken. Activate automatic adjustment as described below:

1. Press MENU key.
   - LED above the MENU key lights up.
2. Press arrow keys until F1 appears on the display.
3. Press AVR MANUAL key.
   - Automatic adjustment starts.
   - First the control unit moves the on-load tap-changer into operating position 1, then into the highest operating position.
   - Once the end positions have been approached, the control unit moves the on-load tap-changer into the middle operating position, which ends automatic adjustment.
4. Complete the process by again pressing the MENU key.
5.3.2 Performing trial tap-change operations

Before you energize the transformer, you must carry out trial tap-change operations to check the mechanical and electrical functions of on-load tap-changer and motor-drive unit.

- You have already completed automatic adjustment [► 38] of on-load tap-changer and motor-drive unit.

- Activate manual mode by pressing the AVR MANUAL key.

> The status LED above the key lights up.

1. **NOTICE!** Use the UP/DOWN arrow keys to undertake trial tap-change operations across the entire range of settings. Maintain a delay time of 3 seconds between two tap changes. Check that the control unit records and correctly displays every position. Failure to do so may result in damage to the on-load tap-changer.

2. Check, in both end positions, the function of the mechanical end stop. To do this, issue another tap-change command in both end positions.

> If the motor-drive unit is stationary and no changes occur, the mechanical end stop function is OK. Otherwise contact Maschinenfabrik Reinhausen GmbH.
Transmission ratio

If necessary, you can check the transmission ratios of the individual operating positions. To do so, proceed as follows:

1. Run through all operating positions one after another and measure the voltage on the low-voltage side of the transformer in each position.
2. Compare voltages with details on the transformer name plate.

Check the transformer configuration in accordance with the supplied connection diagrams if the tap-change operation is in the opposite direction.

The behavior of the control unit (lowest voltage at smallest or largest position) can be adjusted accordingly using parameterization. To do this, follow the description in the "Invert travel commands" [► 72] section.
5.4 Disassembly before transformer drying

After the trial tap-change operations, first perform the transformer ratio test and DC resistance measurement as described in the operating instructions for the ECOTAP VPD on-load tap-changer.

To prepare for transformer drying, then proceed as follows:

1. Disconnect connection cable from control unit by loosening screws of plug connectors X2 and X4 on underside of control unit.

![Figure 14: Disconnecting connection cable](image)

2. Wind up connection cable and fix on motor-drive unit.
3. Remove motor-drive unit by loosening the six screws. Keep the screws for the next mounting step.

Figure 15: Disassembling motor-drive unit
4. Attach transport locking plate before drying and fasten with the six screws.

![Figure 16: Fastening transport locking plate](image)

For drying the on-load tap-changer and transformer, note the information provided in the "Drying the on-load tap-changer" chapter in the operating instructions for the ECOTAP VPD on-load tap-changer.

In order to perform on-load tap-change operations during the transformer test, you will again need to mount and commission the motor-drive unit and control unit. To do this, follow the description provided in the "Mounting motor-drive unit" [► 31] section.
5.5 Tests on the transformer

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

5.5.1 Electrical high-voltage tests on the transformer

**WARNING**

Danger of death or severe injury from explosive gases when testing the transformer!

Danger of death from flying debris and spraying of hot oil if incorrect action is taken when explosive gases accumulate under the transformer cover, in the piping, in the oil conservator, and at the dehydrating breather opening!

- Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.
- Ensure that the on-load tap-changer is fully submerged in oil.
- Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.
- Ensure that all safety equipment is ready for use.
- Use suitable personal protective equipment/clothing.
- Keep away from the danger area during the transformer test.
- Observe applicable fire protection regulations.
- Make sure that only trained technicians perform work on the transformer.

Every on-load tap-changer has been specially designed by the manufacturer for the transformer in the respective purchase order and is subjected to strict tests and quality controls at the manufacturer’s factory.

However, joint operation of transformer and on-load tap-changer cannot be simulated by the manufacturer and cannot be tested on the on-load tap-changer alone.

For this reason, irregularities or malfunctions cannot be completely ruled out during the transformer test (i.e. testing the first joint operation of transformer and on-load tap-changer).

It is essential that you ensure only trained, instructed expert personnel who are familiar with and comply with the pertinent safety and technical regulations, who are aware of the potential risks, and who consistently use the occupational safety equipment provided to prevent injury and property damage are assigned to perform such a transformer test.
Remove all leads used for testing before the high voltage test as these function as antennas. Ensure that the clearance needed between bushings and motor-drive unit, including the connection cable, is observed at all times.

If you have any questions about possible sources of danger, consult the manufacturer before starting to test the transformer.

Only undertake the electrical tests required for transformer acceptance once the aforementioned work is complete.

5.5.2 Dielectric tests on transformer wiring

Note the following points for dielectric tests on the transformer wiring:

The motor-drive unit and control unit are put through dielectric tests before delivery. Another dielectric test is not needed.

The control unit has an internal overvoltage protection and an internal energy accumulator. These may produce incorrect results during a dielectric test. You can prevent this by disconnecting the control unit.

To do so, proceed as follows:

1. To disconnect the connection cable from the control unit, loosen screws of plug connectors X2 and X4 on the underside of the control unit.

Figure 17: Connection cable
2. Wind up connection cable, fix on motor-drive unit.
3. Disconnect control unit from power supply by loosening the 2 screws of plug connector X1 on underside of control unit and disconnecting the plug connector.

The LED remains lit up until the energy accumulator is fully discharged. This may take up to 30 minutes.

You can then perform the dielectric test.
6 Transporting transformer to the operating site

**Risk of life-threatening injury due to electric shock!**

If the device and system peripherals are not disconnected from the mains, electric shock may occur!

- De-energize the device and system peripherals and lock them to prevent them from being switched back on.

**Damage to the on-load tap-changer!**

Damage to the on-load tap-changer due to incorrect positioning!

- Do not disconnect the motor-drive unit from the on-load tap-changer after the on-load tap-changer's automatic adjustment.

1. To transport the transformer, disconnect connection cable from control unit. You will find a description of this process in the "Dielectric tests on the transformer wiring" [45] section.
2. Wind up connection cable, fix on motor-drive unit, and use plastic film and adhesive tape to protect from moisture.
3. **NOTICE!** If you do not package the connection cable correctly, moisture may get in and cause damage to the motor-drive unit.
4. Transport control unit in MR packaging used for delivery.
5. **NOTICE!** The control unit is not intended for operation, transport or storage outdoors.
7 Commissioning transformer at operating site

Before energizing the transformer, you must mount and connect the control unit and perform trial tap-change operations.

7.1 Mounting control unit

Depending on design, you can mount the control unit as follows:

- Mounting on a flat surface
- Mounting on low-voltage busbar using device carrier
- Mounting in optional control cabinet for outdoor use

Note the description below.

7.1.1 Mounting on a flat surface

To mount the control unit on a flat surface, proceed as follows:

- Secure control unit to the flat surface using the fixing brackets provided for this purpose. Note the dimensional drawing in the appendix [► 90].

![Mounting control unit](image)

Figure 18: Mounting control unit

7.1.2 Mounting on low-voltage busbar

You can mount the control unit on the low-voltage busbar using a device carrier.


**Risk of life-threatening injury due to electric shock!**

If the low-voltage busbar is not disconnected from the mains when the device carrier is being mounted, this may result in electric shock!

- To mount the device carrier, disconnect the low-voltage busbar from the mains.
- If the low-voltage busbar cannot be disconnected from the mains, observe national requirements for working on live equipment.

To mount, proceed as follows:

1. Attach device carrier to stud bolts of low-voltage busbar with retaining brackets and screw down.

![Figure 19: Attaching device carrier to stud bolts of low-voltage busbar](image)

<table>
<thead>
<tr>
<th>1</th>
<th>Device carrier</th>
<th>2</th>
<th>Stud bolt of low-voltage busbar</th>
</tr>
</thead>
</table>

![Figure 20: Fastening device carrier](image)
2. Attach control unit to device carrier and fasten using washers, spring washers, and nuts.

Figure 21: Fastening control unit

7.1.3 Mounting in optional control cabinet for outdoor use

As an option, the control unit is supplied screwed down to the mounting plate in the control cabinet.
To mount the control cabinet on a flat surface, proceed as follows:

1. Secure control cabinet to the flat surface using the fixing brackets provided for this purpose. Note dimensional drawing supplied with control cabinet.

![Figure 22: Mounting control cabinet](image)

2. The control cabinet must be grounded at the screw provided using a ground strap or grounding cable (cross-section of at least 8 mm²).

![Figure 23: Grounding control cabinet](image)

**7.2 Connecting control unit at operating site**

The following section describes how to make the electrical connection to the control unit at the operating site.
Risk of fatal injury due to electrical voltage!
Danger of death due to electrical voltage when assembling and connecting the device.
► De-energize the device and system peripherals and lock them to prevent them from being switched back on.

7.2.1 Cable recommendation

Please note the following recommendation from Maschinenfabrik Reinhausen GmbH when wiring the device for the connection provided by the customer:

<table>
<thead>
<tr>
<th>Cable type</th>
<th>Conductor cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unshielded</td>
<td>1.5 mm² with wire end sleeve</td>
</tr>
<tr>
<td></td>
<td>2.5 mm² without wire end sleeve</td>
</tr>
</tbody>
</table>

The connection cable between the control unit and motor-drive unit is supplied as standard. This connection cable is resistant to oil and heat. It contains the power supply for the motor and signal line to the control gear in the motor-drive unit.

Plug connectors for connection on control unit

The connection cable between the control unit and motor-drive unit is pre-assembled with the necessary plug connectors (X2, X4).

Plug connectors suitable for the following connections are also supplied as standard:
- X1: Control unit power supply
- X3: Signal for blocking
- X5: Customer messages
7 Commissioning transformer at operating site

7.2.2 Electromagnetic compatibility

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

7.2.2.1 Wiring requirement of installation site

Note the following when selecting the installation site:

- The system's overvoltage protection must be effective.
- The system's ground connection must comply with all technical regulations.
- Separate system parts must be joined by a potential equalization.

7.2.2.2 Wiring requirement of operating site

Note the following when wiring the operating site:

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

![Recommended Wiring Diagram](image)

**Figure 25: Recommended wiring**

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

- Short-circuit and ground reserve lines.
- Never connect the device with a collective line containing numerous wires.
• To transmit signals, use shielded lines with individual conductors (outgo-
ing conductor/return conductor) twisted in pairs.
• The shield must be connected across the entire surface (360º).

For optional installation of the control unit in a control cabinet, also note the following:

1. If both the control cabinets in which the start and end of the cable are
connected are on the same potential: Use shield on both sides.

2. **NOTICE!** If both the control cabinets in which the start and end of the
cable are connected are on a different potential: Only use shield on one
side. Otherwise circulating currents caused by potential equalization will
arise which may cause damage due to grounding loops.

Figure 26: Example: Shield with cable screw connections
7.2.3 Connecting control unit

The equipment may only be connected to circuits with an external isolating device for all poles so the equipment can be fully de-energized if required.

Connect the wiring described below in accordance with the connection diagram supplied.

7.2.3.1 Connecting control unit in standard design

1. Connect connection cable of motor-drive unit to terminals X2 (0.5 Nm) and X4 (0.4 Nm) with the pre-assembled plugs on the control unit.

2. **DANGER!** Ensure that all cables in the working area are de-energized and that the shutdown equipment is locked so it cannot be switched on again. If this is not done, there is a risk of fatal injury due to electrical voltage.

3. Screw down (0.4 Nm) signal for blocking (e.g. door interlock or temperature blockade) to the supplied plug connector for X3. Screw down (0.4 Nm) plug connector to terminal X3.
4. Screw down (0.4 Nm) wiring for "Customer messages" interface (OK/error) to the supplied plug connector for X5. Screw down (0.4 Nm) plug connector to terminal X5.

The electrical voltage of the motor-drive unit and control unit has to be supplied by the controlled transformer itself because this signal is also used as the measurement signal.

5. Screw down (0.5 Nm) power supply for control unit to plug connector for X1. Screw down (0.5 Nm) plug connector to terminal X1.

### 7.2.3.2 Connecting control unit in control cabinet for outdoor installation

#### Cable bushings

There are flexible cable bushings on the floor of the control cabinet. The cable bushings can be individually removed and opened.

![Figure 28: Cable bushings](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cable bushing sealing frame</td>
</tr>
<tr>
<td>2</td>
<td>Recess for screwdriver</td>
</tr>
<tr>
<td>3</td>
<td>Locking lever in locked position</td>
</tr>
<tr>
<td>4</td>
<td>Sealing module</td>
</tr>
<tr>
<td>5</td>
<td>Hook on sealing module</td>
</tr>
</tbody>
</table>

To insert the cables, proceed as follows:

1. Insert screwdriver into recess on side of sealing module and carefully lever outwards to release the locking lever’s lock.
2. Pull out locking lever and remove screwdriver again.

![Figure 29: Removing sealing module](image)

4. Press together the sealing module's 4 hooks with thumb and forefinger of both hands to separate the two halves.

![Figure 30: Opening sealing module](image)

5. Insert cable and press two halves of sealing module back together.

![Figure 31: Pressing sealing module together](image)

6. Insert sealing module in sealing frame.

7. Press locking lever inwards and move into vertical position.
8. Slide locking lever back into sealing module until the locked position is reached.
9. Check sealing module is secure.
10. Repeat mounting steps for other cables.

Connecting control unit

To connect wiring to control unit, proceed as follows:

1. Connect connection cable of motor-drive unit to terminals X2.1 (0.5 Nm) and X4.1 (0.4 Nm) with pre-assembled plugs in control cabinet.

2. **DANGER!** Ensure that all cables in the working area are de-energized and that the shutdown equipment is locked so it cannot be switched on again. If this is not done, there is a risk of fatal injury due to electrical voltage.

3. Connect signal for blocking (e.g. door interlock or temperature blockade) to X3.1 terminal in control cabinet.

4. Connect wiring for "customer messages" interface (OK/error) to X5.1 terminal in control cabinet.

The electrical voltage of the motor-drive unit and control unit has to be supplied by the controlled transformer itself because this signal is also used as the measurement signal.

5. Connect power supply for control unit to X1.1 terminal in control cabinet.

7.3 Switching on power supply

To protect the consumers from impermissible fluctuations in voltage, only activate the consumer circuits (low-voltage busbars) once all tests are complete.

To activate motor-drive unit and control unit, proceed as follows:

1. Switch on medium voltage (transformer is idle).

   - The control unit starts automatically after a few seconds. The **LED** flashes for 10 s to display the inrush interlock. After 10 s, this LED lights up blue permanently.

   - The **LED** also starts by flashing and then lights up permanently as soon as the internal energy accumulator is fully charged.

   - If the \(\Delta\) LED is not lit up, the control unit is ready and you can continue with the "Performing trial tap-change operations" [► 60] section.

   - If the red \(\triangle\) LED is lit up and the "E4" error code appears in the display, the motor-drive unit and control unit have not yet been adjusted to one another.
2. Next carry out automatic adjustment (if needed) and trial tap-change operations as described below.

7.4 Carrying out automatic adjustment

Before commissioning, automatic adjustment of on-load tap-changer and motor-drive unit must be undertaken. Activate automatic adjustment as described below:

1. Press MENU key.
   - LED above the MENU key lights up.
2. Press arrow keys until F1 appears on the display.
3. Press AVR MANUAL key.
   - Automatic adjustment starts.
   - First the control unit moves the on-load tap-changer into operating position 1, then into the highest operating position.
   - Once the end positions have been approached, the control unit moves the on-load tap-changer into the middle operating position, which ends automatic adjustment.
4. Complete the process by again pressing the MENU key.

Figure 32: Automatic adjustment
7.5 Performing trial tap-change operations

Before you energize the transformer, you must carry out trial tap-change operations to check the mechanical and electrical functions of on-load tap-changer and motor-drive unit.

- You have already completed automatic adjustment [► 59] of on-load tap-changer and motor-drive unit.
- Activate manual mode by pressing the AVR MANUAL key.

The status LED above the key lights up.

1. **NOTICE!** Use the UP/DOWN arrow keys to undertake trial tap-change operations across the entire range of settings. Maintain a delay time of 3 seconds between two tap changes. Check that the control unit records and correctly displays every position. Failure to do so may result in damage to the on-load tap-changer.

2. Check, in both end positions, the function of the mechanical end stop. To do this, issue another tap-change command in both end positions.
   - If the motor-drive unit is stationary and no changes occur, the mechanical end stop function is OK. Otherwise contact Maschinenfabrik Reinhausen GmbH.
Transmission ratio

If necessary, you can check the transmission ratios of the individual operating positions. To do so, proceed as follows:

1. Run through all operating positions one after another and measure the voltage on the low-voltage side of the transformer in each position.
2. Compare voltages with details on the transformer name plate.

Check the transformer configuration in accordance with the supplied connection diagrams if the tap-change operation is in the opposite direction. The behavior of the control unit (lowest voltage at smallest or largest position) can be adjusted accordingly using parameterization. To do this, follow the description in the "Invert travel commands" [► 72] section.

7.6 Checking control parameters

Next compare the requirements of your application with the set control parameters. The table below contains the defaults set ex factory.

<table>
<thead>
<tr>
<th>Parameter/Function</th>
<th>Setting range/Default</th>
<th>Set values</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1: Desired voltage $U_{\text{desired}}$</td>
<td>85 V … 265 V</td>
<td>225 V</td>
</tr>
<tr>
<td>P2: Normal regulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2.1: Regulation bandwidth B1</td>
<td>0.5 %…8 %</td>
<td>2 %</td>
</tr>
<tr>
<td>P2.2: Delay time T1</td>
<td>5 s…1800 s</td>
<td>10 s</td>
</tr>
<tr>
<td>P3: Fast regulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3.1: Regulation bandwidth B2</td>
<td>$(B1 + 0.5 %)$…9 %</td>
<td>4 %</td>
</tr>
<tr>
<td>P3.2: Delay time T2</td>
<td>For $T1 \leq 10$ s: 2 s…($T1 - 1$ s) For $T1 &gt; 10$ s: 2 s…($T1 - 5$ s)</td>
<td>2 s</td>
</tr>
<tr>
<td>P4: Voltage blocking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4.1: Undervoltage</td>
<td>85 V … 265 V</td>
<td></td>
</tr>
<tr>
<td>P4.2: Overvoltage</td>
<td>85 V … 265 V</td>
<td></td>
</tr>
<tr>
<td>P8: Regulating range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8.1: Lowest position</td>
<td>1…9 (32)</td>
<td>1</td>
</tr>
<tr>
<td>P8.2: Highest position</td>
<td>1…9 (32)</td>
<td>9 (32)</td>
</tr>
<tr>
<td>F5: Invert travel commands function</td>
<td>0 = inactive/1 = active</td>
<td>0 = inactive</td>
</tr>
</tbody>
</table>

Table 11: Set values

You will find explanations for these parameters and details of how to adapt the set values in the "Configuring control unit" [► 64] chapter.
7.7 Checking automatic voltage regulation

To check the automatic voltage regulation, proceed as follows:

1. Measure voltage on low-voltage side of transformer.
2. Activate manual mode by pressing the AVR MANUAL key.
   - The LED above the AVR MANUAL key lights up.
3. Use the UP/DOWN arrow keys to perform tap changes until the measured voltage is outside the range of the set bandwidth (desired voltage value ± bandwidth).
4. Activate auto mode by pressing the AVR AUTO key.
   - The LED above the AVR AUTO key lights up.
   - After the delay time, the on-load tap-changer moves back into the range of the set bandwidth.
5. Activate manual mode by pressing the AVR MANUAL key.
   - The LED above the AVR MANUAL key lights up.
   - Automatic voltage regulation is checked.

If the automatic voltage regulation isn't working as you would like, check the set parameters of the voltage regulator (e.g. desired value, bandwidth, delay time).

7.8 Activating temperature blockade

Operation with alternative insulating liquids is possible in accordance with the specification in the "Technical data" [► 89] chapter. In such cases, you must ensure compliance with the limited temperature range by means of a temperature blockade.

It is the job of the temperature blockade to reliably prevent switching operations should the temperature fall below the lower temperature limit value.

One way of achieving this is to use the control unit's blocking function. To do so, proceed as follows:

✓ A temperature sensor, installed in the transformer tank and adjusted to suit the permissible limit values, must provide a signal in the form of a potential-free contact.
1. Connect signal line of potential-free contact of temperature sensor with control unit's X3 terminal bar as shown in supplied connection diagram.
2. Press AVR MANUAL key on control unit.
3. Press UP/DOWN arrow keys until parameter P5 appears in the display.
4. Press AVR MANUAL key to confirm selection.
5. To activate blocking, set the value 1 with the UP/DOWN arrow keys.
6. Press AVR MANUAL key to confirm selection.
7. Press the MENU key to save the setting.
7 Commissioning transformer at operating site

7.9 Switching on the low-voltage busbar

**NOTICE**

Damage to the on-load tap-changer and transformer!

An inrush current impulse which has not fully subsided can damage the on-load tap-changer and transformer in the event of an on-load tap changing operation!

► Once the transformer has been switched on, ensure that the inrush current impulse has fully subsided before undertaking an on-load tap changing operation. The inrush current impulses are usually a multiple of the transformer rated current and can overload the on-load tap-changer during the diverter switch operation.

Once you have connected the control unit and undertaken test tap-change operations, you can commission the low-voltage busbar as follows:

1. Move on-load tap-changer to mid-position.

It may be a good idea to move the on-load tap-changer into a position other than the mid-position. This allows you to reduce the voltage differences between the grids to be connected and thereby minimize the inrush current impulse.

2. On the control unit, set the desired operating mode by pressing the corresponding key:
   - Auto mode: AVR AUTO
   - Manual mode: AVR MANUAL
   - Control via remote connection: EXTERNAL CONTROL.

3. Switch on the low-voltage busbar.

4. Once the transformer has been switched on, ensure that the inrush current impulse has subsided.

► On-load tap-change operations can now be undertaken both when idling and under load conditions.
8 Configuring the control unit

This chapter describes how to configure the control unit.

Settings are only saved once the parameterization menu is exited using the MENU key. If you do not press the MENU key within 30 s, the parameterization menu is exited automatically and the changes are not saved.

To adjust the regulator settings and operating behavior or to read out the error codes, proceed as follows:

1. First familiarize yourself with the control unit’s operating controls and operating concept by reading the explanations provided in the "Product description" [► 16] chapter.

2. Press AVR MANUAL key to activate manual operating mode.

3. To configure the control unit, follow the descriptions provided in the following sections.

Regulation
- Normal regulation mode (P2) [► 65]
  - Bandwidth B1 (P2.1)
  - Delay time T1 (P2.2)
- Fast regulation (P3) [► 67]
  - Bandwidth B2 (P3.1)
  - Delay time T2 (P3.2)
- Voltage blocking (P4) [► 68]
  - Undervoltage (P4.1)
  - Overvoltage (P4.2)
- Number of operating positions (P7) [► 69]
- Regulating range (P8) [► 70]
  - Lowest position (P8.1)
  - Highest position (P8.2)

Control
- Automatic adjustment (F1) [► 71]
- Blocking contact (P5) [► 71]
- Target position for loss of voltage (P6) [► 72]
- Invert travel commands (F5) [► 72]
- Software update (F4) [► 73]
8 Configuring the control unit

Additional functions

You will find a description of the following additional functions in the "Inspection and maintenance" [► 84] chapter:

- Read out error memory (E) [► 84]
- Read out software version (F6) [► 85]
- Display remaining life (F2) [► 86]
- LED function test (F3) [► 86]

8.1 Control

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

Settings are only saved once the parameterization menu is exited using the MENU key. If you do not press the MENU key within 30 s, the parameterization menu is exited automatically and the changes are not saved.

8.1.1 Desired voltage (P1)

The control unit 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 desired voltage is set in 1 V steps and may be between 85 V and 265 V. The preset value is 225 V.

To set the desired voltage \(U_{\text{desired}}\), proceed as follows:

1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter P1.
3. Press AVR MANUAL key to confirm selection.
4. Use the UP/DOWN arrow keys to select the desired value and confirm by pressing the AVR MANUAL key.
5. Press MENU key to save the new setting.

The setting is complete and you are back in manual operating mode.

8.1.2 Normal regulation mode (P2)

Below you will find a description of how to set the control parameters for normal regulation mode.

8.1.2.1 Bandwidth B1 (P2.1)

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

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

The bandwidth must always be greater than the following value:

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

Figure 34: Calculation of minimum bandwidth

- \( U_{n-1} \): Step voltage of tap position n-1
- \( U_n \): Step voltage of tap position n
- \( U_{\text{nom}} \): Nominal voltage

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

- Nominal voltage \( U_{\text{nom}} = 11,000 \text{ V} \)
- Step voltage in tap position 4 \( U_{\text{Step4}} = 11,275 \text{ V} \)
- Step voltage in tap position 5 \( U_{\text{Step5}} = 11,000 \text{ V} \)

\[ \pm B\% \geq 0.6 \cdot \frac{U_{\text{Step4}} - U_{\text{Step5}}}{U_{\text{nom}}} \cdot 100\% \]
\[ \pm B\% \geq 0.6 \cdot \frac{11275 \text{ V} - 11000 \text{ V}}{11000 \text{ V}} \cdot 100\% \]
\[ \pm B\% \geq 1.5\% \]

Setting bandwidth B1 (P2.1)

The bandwidth is set in 0.5 % steps and may be between 0.5 % and 8 % symmetrically around \( U_{\text{desired}} \). The preset value is 2 %.

To set the bandwidth, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter level P2.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P2.1.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value and confirm by pressing the AVR MANUAL key.
7. Press MENU key to save the new setting.
   ⇨ The setting is complete and you are back in manual operating mode.
8.1.2.2 Delay time T1 (P2.2)

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

The setting is made in 5 s steps or in 30 s steps and may be between 5 s and 1,800 s. The preset value is 10 s.

To set the delay time T1, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter level P2.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P2.2.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value. Pressing the AUTO key at the same time increases the step size to 30 s.
7. Press AVR MANUAL key to confirm selection.
8. Press MENU key to save the new setting.

The setting is complete and you are back in manual operating mode.

8.1.3 Fast regulation (P3)

Below you will find a description of how to set the control parameters for fast regulation. This allows the regulator to trigger a tap position change sooner than in normal regulation mode should a larger B2 bandwidth be exceeded.

8.1.3.1 Bandwidth B2 (P3.1)

You can use this parameter to set the maximum permissible deviation in measured voltage $U_{\text{actual}}$ from the desired value $U_{\text{desired}}$ for the fast regulation.

The bandwidth is set in 0.5 % steps and may be between $B1 + 0.5 \%$ and 9 % symmetrically around $U_{\text{desired}}$. The preset value is 4 %.

To set the B2 bandwidth, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter level P3.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P3.1.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value and confirm by pressing the AVR MANUAL key.
7. Press MENU key to save the new setting.

The setting is complete and you are back in manual operating mode.
8.1.3.2 Delay time T2 (P3.2)

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

Delay time T2 enables a faster response to larger changes in voltage compared with T1.

The setting is made in 1 s steps or in 30 s steps. The preset value is 2 s. The setting range depends on T1:
- For $T_1 \leq 10$ s: $T_2 = 2$ s...($T_1 - 1$ s)
- For $T_1 > 10$ s: $T_2 = 2$ s...($T_1 - 5$ s)

To set the delay time T2 proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter level P3.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P3.2.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value. Pressing the AUTO key at the same time increases the step size to 30 s.
7. Press AVR MANUAL key to confirm selection.
8. Press MENU key to save the new setting.

The setting is complete and you are back in manual operating mode.

8.1.4 Voltage blocking (P4)

You can use voltage blocking to define limit values for blocking the regulation function. Tap changes can thereby be prevented if the mains fluctuations are too great.

Undervoltage blocking: Blocking is activated as soon as the voltage reaches or falls below the limit value.

Overt voltage blocking: Blocking is activated as soon as the voltage reaches or exceeds the limit value.

This function is used if sudden major changes in voltage are likely within the T1 and T2 delay times. The voltage blocking prevents the tap changer from having to undertake cycles unnecessarily.

8.1.4.1 Undervoltage blocking (P4.1)

The setting is made in 1 V steps and may be between 85 V and 265 V. The preset value is 85 V.

To set the undervoltage blocking, proceed as follows:
1. Press MENU key to switch to parameterization mode.
8 Configuring the control unit

2. Press UP/DOWN arrow keys to select parameter level P4.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P4.1.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value. Pressing the AUTO key at the same time increases the step size to 10 V.
7. Press AVR MANUAL key to confirm selection.
8. Press MENU key to save the new setting.
   ✧ The setting is complete and you are back in manual operating mode.

8.1.4.2 Overvoltage blocking (P4.2)

The setting is made in 1 V steps and may be between 85 V and 265 V. The preset value is 265 V.

To set overvoltage blocking, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter level P4.
3. Press AVR MANUAL key to confirm selection.
4. Press UP/DOWN arrow keys to select parameter P4.2.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the desired set value. Pressing the AUTO key at the same time increases the step size to 10 V.
7. Press AVR MANUAL key to confirm selection.
8. Press MENU key to save the new setting.
   ✧ The setting is complete and you are back in manual operating mode.

8.1.5 Number of operating positions (P7)

The control unit can be configured for different types of ECOTAP VPD on-load tap-changer. You have to set the number of operating positions accordingly.

The setting is made in steps of 1 and may be between 9 and 32.

The preset value is 9.

To set the number of operating positions, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select parameter P7.
3. Press AVR MANUAL key to confirm selection.
4. Use the UP/DOWN arrow keys to select the desired value and confirm by pressing the AVR MANUAL key.
5. Press MENU key to save the new setting.
   ✧ The setting is complete and you are back in manual operating mode.
8.1.6 Regulating range (P8)

This setting can be used to limit the control unit’s regulating range. To do this, you can individually define both the lowest and highest position that may be approached.

8.1.6.1 Lowest position (P8.1)

The setting is made in steps of 1 and may be between 1 and the highest available operating position. The preset value is 1.

1. To set the lowest position for the regulating range, proceed as follows:
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select parameter level P8.
4. Press AVR MANUAL key to confirm selection.
5. Press UP/DOWN arrow keys to select parameter P8.1.
6. Press AVR MANUAL key to confirm selection.
7. Use the UP/DOWN arrow keys to select the desired set value.
8. Press AVR MANUAL key to confirm selection.
9. Press MENU key to save the new setting.
   The setting is complete and you are back in manual operating mode.

8.1.6.2 Highest position (P8.2)

The setting is made in steps of 1 and may be between 1 and the highest available operating position. The preset value is the maximum operating position.

1. To set the highest position for the regulating range, proceed as follows:
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select parameter level P8.
4. Press AVR MANUAL key to confirm selection.
5. Press UP/DOWN arrow keys to select parameter P8.2.
6. Press AVR MANUAL key to confirm selection.
7. Use the UP/DOWN arrow keys to select the desired set value.
8. Press AVR MANUAL key to confirm selection.
9. Press MENU key to save the new setting.
   The setting is complete and you are back in manual operating mode.

8.2 Control

This section describes how you can adapt the control unit’s operating behavior.
8 Configuring the control unit

Settings are only saved once the parameterization menu is exited using the MENU key. If you do not press the MENU key within 30 s, the parameterization menu is exited automatically and the changes are not saved.

8.2.1 Automatic adjustment (F1)

This function starts the on-load tap-changer's automatic adjustment. The entire regulating range of the tap-changer is passed through until the signals of the relevant micro-switch for recording the end position are detected. Afterwards the position indicator for the tap changer position is synchronized.

Automatic adjustment is needed, for example, if a new control unit is being connected to a tap changer. If the control unit is not yet adjusted to the tap changer, message E4 appears on the display.

Only carry out automatic adjustment with an open busbar on the low-voltage side since the on-load tap-changer moves through the entire regulating range and this can result in excessive voltage deviations for consumers.

To start the automatic adjustment, proceed as follows:
1. Press AVR MANUAL key to activate manual operating mode.
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select F1.
4. Press AVR MANUAL key to confirm selection.
   \[\Rightarrow\] Automatic adjustment starts.
   \[\Rightarrow\] Once automatic adjustment is complete, the on-load tap-changer is in the middle operating position.

8.2.2 Blocking contact (P5)

The control unit can be connected to say a door contact switch or temperature sensor so that tap-change operations in auto mode are prohibited when the door is open or a temperature limit value is exceeded.

If the function is activated and blocking is effective, this is indicated by the LED lighting up.

There are two set values for this function:
- 0 = inactive (default)
- 1 = active

To activate this function, proceed as follows:
✓ You have already wired the external blocking contact in accordance with the "Connecting control unit" [► 55] section. Next you need to activate the P5 blocking contact function.
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select **P5**.
3. Press AVR MANUAL key to confirm selection.
4. Use the UP/DOWN arrow keys to select the value 1 and confirm by pressing the AVR MANUAL key.
5. Press MENU key to save the new setting.
   ⇒ The setting is complete and you are back in manual operating mode.

### 8.2.3 Target position for loss of voltage (P6)

The control unit is fitted with an integrated energy accumulator so that started tap-change operations can be reliably completed even if the voltage fails. This energy accumulator can also be used to move the tap changer into a defined position should voltage be lost and therefore to achieve a defined transformer transmission ratio when the voltage returns.

There are two set values for this function:
- 0 = inactive (default)
- 22 = active

**NOTICE!** When this function is activated, the inrush interlock is taken out of operation. As a result, a considerable amount of damage may be done to the device and associated transformer should the voltage be restored while changing position.

To activate the "Target position for loss of voltage" function, proceed as follows:
1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select **P6**.
3. Press AVR MANUAL key to confirm selection.
4. Use UP/DOWN arrow keys to enter target position.
5. Press AVR MANUAL key to confirm selection.
6. Use the UP/DOWN arrow keys to select the value 22.
7. Press AVR MANUAL key to confirm selection.
8. Press MENU key to save the new setting.
   ⇒ The setting is complete and you are back in manual operating mode.

### 8.2.4 Invert travel commands (F5)

The "Invert travel commands" function swaps the Raise/Lower travel commands for all operating modes and therefore allows the direction of travel to be corrected.

There are two set values for this function:
- 0 = inactive (default): Lowest voltage in position 1
- 1 = active: Highest voltage in position 1
To activate this function, proceed as follows:

1. Press MENU key to switch to parameterization mode.
2. Press UP/DOWN arrow keys to select **F5**.
3. Press AVR MANUAL key to confirm selection.
4. Use the UP/DOWN arrow keys to select the value 1 and confirm by pressing the AVR MANUAL key.
5. Press MENU key to save the new setting.

⚠️ The setting is complete and you are back in manual operating mode.

### 8.2.5 Software update (F4)

You can use this function to undertake future software updates. This function is not yet activated.
9 Operation

On-load tap-change operations can be undertaken both manually and automatically. You can see the selected operating mode on the LED display on the control unit.

In AVR AUTO operating mode, the tap-change operations are undertaken automatically depending on the set control parameters.

By simply pressing the AVR MANUAL key, you can switch to manual mode and then perform tap-change operations by pressing the UP/DOWN arrow keys.

Standard mode is not designed for tap-change operations without a control unit.

Should you experience problems in operating the control unit or on-load tap-changer, consult the "Fault elimination" [► 75] chapter.
10 Fault elimination

The table below is intended to assist with detecting and, where possible, remedying faults.

Read the error memory if an error occurs. You will find a description of this in the "Read out error memory (E) [► 84]" section. Also read Software version of control unit (F6) [► 85] and add this data to the fault report.

In the event of faults on the on-load tap-changer, motor-drive unit, or control unit, which cannot be easily corrected on site, please inform your authorized MR representative, the transformer manufacturer or contact Maschinenfabrik Reinhausen GmbH (MR) directly.

Maschinenfabrik Reinhausen GmbH

Technical Service
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93025 Regensburg
Germany
Tel.: +49 94140 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com
<table>
<thead>
<tr>
<th>Error code</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1: EXTERNAL CONTROL</td>
<td>No connection to EXTERNAL CONTROL</td>
<td>Check that cable connection between control unit and EXTERNAL CONTROL is correct. Check that EXTERNAL CONTROL is working correctly. Note the corresponding operating instructions. If the error is still present, contact MR.</td>
</tr>
<tr>
<td>E2: Remote control</td>
<td>EXTERNAL CONTROL command could not be performed.</td>
<td>Check EXTERNAL CONTROL operating mode setting. Check whether the on-load tap-changer is in a permitted position. Do this by setting the operating mode to MANUAL and testing manual tap-change operations. After a successful manual tap-change operation in EXTERNAL CONTROL operating mode, test the remote control. If the error is still present, contact MR.</td>
</tr>
<tr>
<td>E3: Drive unit</td>
<td>Error in connection between control unit and motor-drive unit</td>
<td>Check that all plug connections on the control unit are tight and correct. Check that the connection cable is not damaged. Has the factory-set wiring on X2 or X4 been changed? If yes, restore to original status. If the error is still present, contact MR.</td>
</tr>
<tr>
<td>E4: Control unit</td>
<td>Automatic adjustment not undertaken or incorrect.</td>
<td>Carry out automatic adjustment (again). Check correct setting of &quot;Target position for loss of voltage&quot; function (P6). The target position must be within the regulating range. Check remaining life (F2). If the error is still present, contact MR.</td>
</tr>
<tr>
<td>E5: Power supply</td>
<td>System not ready</td>
<td>Check readiness: LED (power supply) and LED (energy accumulator) must light up continuously. Compare power supply with specification. If the error is still present, contact MR.</td>
</tr>
<tr>
<td>E6: Motor</td>
<td>Travel command cannot be performed</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>E7: Positioning</td>
<td>Correct positioning not possible</td>
<td>Has the factory-set wiring on X2 or X4 been changed? If yes, restore to original status. Perform automatic adjustment. If the error is still present, contact MR.</td>
</tr>
</tbody>
</table>

Table 12: Fault elimination

You will find detailed information of how to operate and parameterize the control unit in the corresponding chapters of the operating instructions for the ECOTAP VPD MD&C motor-drive unit.
Figure 35: Front of control unit

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(VOLTAGE) LED</td>
</tr>
<tr>
<td>2</td>
<td>(CAPACITY) LED</td>
</tr>
<tr>
<td>3</td>
<td>(MOTOR) LED</td>
</tr>
<tr>
<td>4</td>
<td>(ERROR) LED</td>
</tr>
<tr>
<td>5</td>
<td>Display</td>
</tr>
<tr>
<td>6</td>
<td>UP key</td>
</tr>
<tr>
<td>7</td>
<td>DOWN key</td>
</tr>
<tr>
<td>8</td>
<td>AVR MANUAL key</td>
</tr>
<tr>
<td>9</td>
<td>EXTERNAL CONTROL key</td>
</tr>
<tr>
<td>10</td>
<td>MENU key</td>
</tr>
<tr>
<td>11</td>
<td>AVR AUTO key</td>
</tr>
</tbody>
</table>

The transformer can be operated in the current operating position safely despite the red signal light. Further switching operations are blocked.
10 Fault elimination

10.1 Checking adjustment position

If you are not able to attach the motor-drive unit to the sealing module when mounting, you must check the adjustment position. To do so, proceed as follows:

1. Check motor-drive unit adjustment position: The feather key 1 of the motor shaft must be facing the red mark 2.

![Figure 36: Checking motor-drive unit adjustment position](image)

2. Check on-load tap-changer adjustment position: The mark on the cam disk 1 must be in the cover recess 2.

![Figure 37: Checking on-load tap-changer adjustment position](image)

3. If either the motor-drive unit or the on-load tap-changer is not in the adjustment position, correct the position as described in the "Actuating motor-drive unit with emergency drive shaft" [► 79] section.
10 Fault elimination

10.2 Actuating motor-drive unit with emergency drive shaft

**WARNING**

Danger of death and severe injury!

Improper actuation of the motor-drive unit may result in death or serious injury!

- Fully de-energize the transformer and lock to prevent it from being switched back on.
- If the full de-energization of the transformer on all sides cannot be ensured, you must be qualified in accordance with applicable legislation and operating instructions for work on energized equipment.
- Emergency actuation is only permitted if the transformer is without load.
- Only actuate motor-drive unit with emergency drive shaft to set the adjustment position or for emergency operation. Emergency operation is to be understood as the failure of the motor-drive unit's power supply when there is an urgent need to perform a tap change.
- Only actuate motor-drive unit with the emergency drive shaft installed in the motor-drive unit housing.

To do so, proceed as follows:

1. Disconnect connection cable from control unit by loosening screws of plug connectors X2 and X4 on underside of control unit.

![Connection cable](image)
2. Loosen screws and lift motor-drive unit off sealing module.

3. **NOTICE!** Do not twist output shaft on underside of motor-drive unit. If you do, you will not be able to mount the motor-drive unit on the on-load tap-changer after the emergency tap-change operation. The correct output shaft position is described in the "Checking adjustment position" section.

4. The emergency drive shaft is fixed into a bracket on the underside of the motor-drive unit with a screw. Loosen screw and remove emergency drive shaft.
5. Attach emergency drive shaft on top of shaft of on-load tap-changer with hexagon.

![Figure 41: Attaching emergency drive shaft](image)

6. Rotate emergency drive shaft in direction of desired operating position using an appropriate tool.

![Figure 42: Emergency drive shaft actuation](image)

7. **NOTICE!** Using the emergency drive shaft, turn in one direction until one complete revolution has been undertaken and the red dot can again be seen in the cover recess. Otherwise the tap-change operation is not completed correctly, which may result in damage to the on-load tap-changer and transformer.

   - The operating position reached is displayed by the control wheel.
10 Fault elimination

8. Take off emergency drive shaft and put back into bracket with feather key.


10. Re-attach motor-drive unit to sealing module of on-load tap-changer and fasten.

11. NOTICE! To fasten the motor-drive unit, gradually tighten screws cross-wise without warping or deforming them as described below. Otherwise the motor-drive unit is not correctly connected to the on-load tap-changer, which may result in damage to the on-load tap-changer and transformer.

12. Evenly tighten screws crosswise by hand.

13. Tighten screws crosswise to a pre-tightening torque of 4 Nm.
10 Fault elimination

14. Check seat of flange and seal for regularity.
15. Tighten screws crosswise to the full tightening torque of 7.5 Nm.

![Diagram](image)

**Figure 46: Fastening motor-drive unit**

<table>
<thead>
<tr>
<th>Torque Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-tightening torque</td>
<td>4 Nm</td>
</tr>
<tr>
<td>Full tightening torque</td>
<td>7.5 Nm</td>
</tr>
</tbody>
</table>

16. Tighten screws again to full tightening torque, working clockwise and tightening one screw after another until they won't tighten any further.
17. Reconnect control unit.
11 Inspection and maintenance

**DANGER**
**Risk of life-threatening injury due to electric shock!**
Electrical accidents have thermal and muscle-paralyzing effects which may be fatal.

► Work on the device and system peripherals may only be undertaken by qualified specialists, who are also familiar with the safety rules applicable in electrical operating facilities.

**WARNING**
**Danger of death or severe injury from explosive gases during maintenance work!**
Danger of death from flying debris and spraying of hot oil if incorrect action is taken when explosive gases accumulate under the transformer cover, in the piping, in the oil conservator, and at the dehydrating breather opening!

► Ensure that there are no naked flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none occur.

► Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

► Use suitable personal protective equipment/clothing.

► Observe applicable fire protection regulations.

► Ensure that the on-load tap-changer is fully submerged in oil again after the maintenance.

► Ensure that all safety equipment is ready for use after the maintenance.

► Make sure that only trained technicians perform work on the transformer.

### 11.1 Inspection

When inspecting the transformer, at the same time undertake an inspection of the motor-drive unit and control unit. To do so, proceed as follows:

#### 11.1.1 Visual check

Start with the visual check as follows:

► Check whether any external damage or leaks are visible.

≡ In the event of visible damage, contact Maschinenfabrik Reinhausen GmbH's Technical Service department [► 75].

#### 11.1.2 Read out error memory (E)

The error memory shows you the saved error codes. Follow the "Fault elimination" [► 75] section for troubleshooting. The following error codes may appear:
## 11 Inspection and maintenance

### Table 13: Error codes

<table>
<thead>
<tr>
<th>System status (error code)</th>
<th>Error description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>No connection to EXTERNAL CONTROL</td>
</tr>
<tr>
<td>E2</td>
<td>EXTERNAL CONTROL command could not be performed</td>
</tr>
<tr>
<td>E3</td>
<td>Error in connection between control unit and motor-drive unit</td>
</tr>
<tr>
<td>E4</td>
<td>Control unit fault</td>
</tr>
<tr>
<td>E5</td>
<td>System not ready</td>
</tr>
<tr>
<td>E6</td>
<td>Travel command cannot be performed</td>
</tr>
<tr>
<td>E7</td>
<td>Correct positioning not possible</td>
</tr>
</tbody>
</table>

With the exception of error code **E6**, all error codes are reset once the fault has been eliminated and the next correct tap-change operation has been completed. Error code **E6** can only be reset by the Technical Service department of Maschinenfabrik Reinhausen GmbH.

To call up the error memory, proceed as follows:

1. Press AVR MANUAL key to activate manual operating mode.
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select **E**.
4. Press AVR MANUAL key to confirm selection.
   - The first error code is displayed. Take note of error code.
5. Press AVR MANUAL key repeatedly until no new error codes are displayed. Take note of all error codes.
   - **E** again appears in the display.
6. Press MENU key to exit the display.
   - The reading of the error codes is complete and you are back in manual operating mode.
   - Send error codes along with description of error to Maschinenfabrik Reinhausen GmbH's Technical Service department.

You will find more information about possible causes of errors and troubleshooting in the "Fault elimination" [► 75] chapter.

### 11.1.3 Read out software version (F6)

If a problem occurs and you want to contact Maschinenfabrik Reinhausen GmbH, first read out the software version.

To read out the software version, proceed as follows:

1. Press AVR MANUAL key to activate manual operating mode.
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select **F6**.
4. Press AVR MANUAL key.  
   ⇒ The control unit's software version is displayed.
5. Take note of software version.
6. Press AVR MANUAL key to exit the function.  
   ⇒ The function is complete and you are back in manual operating mode.

11.1.4 Reading remaining life (F2)

The control unit's integrated energy accumulator is continually monitored. This function can be used to query the present status.

To start the remaining life query, proceed as follows:
1. Press AVR MANUAL key to activate manual operating mode.
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select F2.
4. Press AVR MANUAL key to confirm selection.  
   ⇒ A value of between 0 % and 100 % appears. This corresponds to the control unit's remaining life.
   ⇒ If the remaining life is less than 20 %, contact Maschinenfabrik Reinhausen GmbH's Technical Service department. Prepare to replace the control unit.
5. Press AVR MANUAL key to exit the display.

11.1.5 LED function test (F3)

You can use this to test the function of all LEDs on the front of the control unit at the same time.

To start the LED function test, proceed as follows:
1. Press AVR MANUAL key to activate manual operating mode.
2. Press MENU key to switch to parameterization mode.
3. Press UP/DOWN arrow keys to select F3.
4. Press AVR MANUAL key to start the LED function test.  
   ⇒ All LEDs on front of control unit light up briefly.
5. Press AVR MANUAL key to exit the function test.  
   ⇒ The function is complete and you are back in manual operating mode.

11.1.6 Checking temperature blockade

When using alternative insulating liquids, ensure compliance with a limited temperature range by means of a "temperature blockade" [► 62].

Check the effectiveness of the temperature blockade as follows:
✓ First ensure that the temperature sensor is working perfectly in accordance with the manufacturer's details.
11 Inspection and maintenance

1. Simulate the temperature limit values being exceeded by bridging contacts 2 and 3 on the X3 terminal bar on the underside of the control unit (also note the supplied connection diagram).
   ⇒ Blocking is now active.
2. Press AVR MANUAL key to switch to manual operation.
3. Press UP/DOWN arrow keys to trigger a switching command.
   ⇒ No switching operation may be undertaken. The switching command is blocked.
4. Press AVR MANUAL key again to finish the check.

To complete these checks, again activate the desired operating mode.

You will find more details about the control unit in the corresponding chapters of the operating instructions for the ECOTAP VPD MD&C motor-drive unit.

11.1.7 Oil quality
1. Check the quality of the transformer oil at regular intervals.
2. Determine dielectric strength and water content at oil temperature of 20 °C ± 5 °C.
3. The dielectric strength and water content must comply with the limit values provided in the "Appendix" chapter.
   ⇒ If these limit values are not observed, change the oil.

11.2 Maintenance

ECOTAP VPD on-load tap-changer and ECOTAP VPD MD&C motor-drive unit require no maintenance.

The control unit should be replaced after 20 years at the latest.

11.3 Care

You can clean the device's housing with a dry cloth.
12 Disposal

For disposal, observe the national requirements applicable in the country of use.

If you have any questions about disassembly and disposal, please contact Maschinenfabrik Reinhausen GmbH's Technical Service department.
13 Technical data

13.1 Technical data for the motor-drive unit

| Duration of the tap-change operation         | approx. 300 ms            |
| Shortest gap between tap-change operations  | 3 s                      |
| Permissible ambient temperature during operation | -25 °C – +70 °C         |
| Permissible storage temperature              | -25 °C – +85 °C          |
| Air pressure                                 | Corresponds to 2000 m above sea level |
| Protection class                             | IP 54                    |
| Operating site                               | Interior, exterior       |

Table 14: Technical data for the motor-drive unit

13.2 Technical data of the control unit

| Permissible voltage range | 100...240 VAC, 50/60 Hz |
| Note: The measured voltage is the supply voltage | $U_N$: 230 V, 50 Hz |
| Input current             | Max. 1.5 A              |
| Power consumption         | Max. 345 VA             |
| Internal fuse (F1)        | Fine-wire fuse, 230 V, T, 4 A |

Table 15: Power supply

| Permissible ambient temperature during operation |
| - Continuous operation:                       |
| - Briefly (maximum of 2 h per day):            |
| -25 °C – +50 °C                               |
| -25 °C – +70 °C                               |
| Permissible storage temperature                | -25 °C – +85 °C          |
| Relative humidity                              | 10...95 % non-condensing |
| Air pressure                                   | Corresponds to 2000 m above sea level |
| Protection class                               | IP 30                    |
| - Standard:                                    |
| - Outdoor installation with optional housing: |
| IP 54                                          |
| Operating site                                 | Indoors, also suited to outdoor use in separate housing |

Table 16: Ambient conditions
Appendix

The dimensional drawings actually provided with the on-load tap-changer apply.
14.1 Dimensional drawing of standard design on-load tap-changer and motor-drive unit (10014090)
Dimensional drawing of standard design on-load tap-changer and motor-drive unit (10014090) -2-
Dimensional drawing of standard design on-load tap-changer and motor-drive unit (10014090) -3-
14.2 Dimensional diagram for control unit (10014680)
14.3 Connection diagram for mounting motor-drive unit and control unit (4784850)
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