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

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 MD&C motor-drive unit with control unit.
1 Introduction

- 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="image" alt="Wrench size" /></td>
<td>Wrench size</td>
</tr>
<tr>
<td><img src="image" alt="Tightening torque" /></td>
<td>Tightening torque</td>
</tr>
<tr>
<td><img src="image" alt="Number and type of fastening material used" /></td>
<td>Number and type of fastening material used</td>
</tr>
<tr>
<td><img src="image" alt="Fill with oil" /></td>
<td>Fill with oil</td>
</tr>
<tr>
<td><img src="image" alt="Cut open, cut through" /></td>
<td>Cut open, cut through</td>
</tr>
<tr>
<td><img src="image" alt="Clean" /></td>
<td>Clean</td>
</tr>
<tr>
<td><img src="image" alt="Visual inspection" /></td>
<td>Visual inspection</td>
</tr>
<tr>
<td><img src="image" alt="Use your hand" /></td>
<td>Use your hand</td>
</tr>
<tr>
<td><img src="image" alt="Adapter ring" /></td>
<td>Adapter ring</td>
</tr>
<tr>
<td><img src="image" 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](warning_icon.png)

**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>Italiccs</td>
<td>System messages/LED displays</td>
<td>ERROR LED</td>
</tr>
<tr>
<td>Typographic convention</td>
<td>Purpose</td>
<td>Example</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<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" [► 56]. In such cases, you must ensure compliance with the limited temperature ranges by means of a "temperature blockade".
- 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.
2 Safety

- 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 you use the product 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.
- Risk of personal injury or damage to property if product is used in a field of application not authorized for measuring devices in accordance with IEC 61010-2-030. Only operate the product within the field of application authorized in accordance with the "Technical data" [► 56] chapter.
- 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.

### Always wear

<table>
<thead>
<tr>
<th>Protective clothing</th>
</tr>
</thead>
<tbody>
<tr>
<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety shoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
</tbody>
</table>

Table 5: Personal protective equipment to be worn at all times

<table>
<thead>
<tr>
<th>Wear the following in special environments</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>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>
Wear the following in special environments | Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.

| **Hearing protection** | To protect from hearing damage. |
| **Protective gloves** | For protection from mechanical, thermal, and electrical hazards. |

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:

- On-load tap-changer
- Gasket
- Fixing screws with locking washers
- Technical files

The crimp barrels that may be needed for the connection are not included in the scope of delivery.

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" [► 19] chapter.

3.2 Function description

On-load tap-changers are used to adjust the desired tap of a tap winding under load.

The on-load tap-changer is based on the high-speed resistor-type tap-changer principle and uses vacuum cells to change the tap position under load. In this process, the arc is extinguished while isolated in a vacuum cell, preventing contaminants from entering the oil.

3.3 Variants

The ECOTAP VPD is available in the following variants:

- ECOTAP VPD III 30
- ECOTAP VPD III 100

The two variants differ primarily with respect to their maximum permissible rated through-current (30 A and 100 A).

Observe further information in the "Technical data" [► 56] chapter.
3.4 Performance features

The on-load tap-changer is particularly characterized by the following properties:

- Compact dimensions
- Automatic checking of electronics and mechanics before each tap change
- Integrated lock to prevent tap changing during the inrush current impulse
- No arcing in the insulating oil
- Extended lifespan of the insulating oil

3.5 Setup/models

You can see the structure and name of the most important on-load tap-changer components in the following illustrations. Further details can be found in the dimensional drawings in the appendix.
The on-load tap-changer has 9 operating positions.
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 7: 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-
chancer/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 air-tight 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

5.1 Fastening on-load tap-changer to transformer cover

**NOTICE**

Damage to the on-load tap-changer and transformer!
The on-load tap-changer is permitted for operation only in entirely oil-filled transformers.
► Use in hermetic transformers with a gas cushion below the transformer cover is only permitted with an appropriate special design.

**NOTICE**

Damage to the on-load tap-changer and transformer!
Damage to on-load tap-changer and transformer due to electrical flashover caused by insufficient distance between motor-drive unit and high-voltage bushing!
► When positioning the opening in the transformer cover, ensure a sufficient distance from adjacent energized parts.

Mount on-load tap-changer on the transformer cover horizontally with the sealing module.
Do not paint the surface on the underside of the transformer cover, which later makes contact with the sealing module's o-ring. Only one coating of primer is permitted.

1. Make opening for sealing module and holes for fixing screws in the transformer cover. The measurements and position can be seen in the dimensional drawing in the appendix.

Figure 3: View from above of transformer cover with opening for sealing module
2. Clean sealing surfaces on sealing module and underside of transformer cover. Insert O-ring supplied in sealing module.

3. **CAUTION!** Gradually tighten screws crosswise as described below and ensure that fastening is not warped or deformed. Improper screw connection will result in damage to the on-load tap-changer.

4. Guide on-load tap-changer from below through the opening in the transformer cover.

5. Evenly tighten screws crosswise by hand. Tighten screws crosswise to a pre-tightening torque of 12 Nm.

6. Check seat of flange and seal for regularity.
7. Tighten screws crosswise to the full tightening torque of 21 Nm.

![Diagram of fastening the on-load tap-changer]

Pre-tightening torque: 12 Nm
Full tightening torque: 21 Nm

8. Tighten screws again to full tightening torque, working clockwise and tightening one screw after another until they won't tighten any further.
5.2 Connecting tap winding and on-load tap-changer take-off lead

**NOTICE**

Damage to the on-load tap-changer caused by improper mounting!

Mounting mistakes will damage the on-load tap-changer and jeopardize safe operation.

► Connect connecting leads without warping or deforming them and ensure that no forces are transferred from the connecting leads to the on-load tap-changer.

► Place at least 3 mm of paper insulation on upper connecting leads facing the transformer cover, including connection points, to ensure the dielectric strength.

► Bending the connection contacts may limit the dielectric strength in accordance with the specification in the "Technical data" [► 58] chapter and reduce the rated withstand voltages! Ensure that the dielectric strength needed for the application is still ensured after assembly.

► The diagram below shows the areas particularly critical for insulation spacing. Avoid bending the connecting pieces into these critical areas.

![Diagram of Voltage Spacing]

**Figure 6: Voltage spacing**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transformer cover</td>
</tr>
<tr>
<td>2</td>
<td>Critical area: Spacing to grounded parts</td>
</tr>
<tr>
<td>3</td>
<td>Critical area: Spacing between the phases</td>
</tr>
</tbody>
</table>
5 Mounting

**NOTICE**

**Damage to on-load tap-changer due to improperly carried out crimp connections!**

Improperly carried out crimp connections jeopardize safe operation.

- Carry out crimp connections in accordance with DIN EN 61238-1.
- The connection contacts on crimp connections may be shortened by no more than 6 cm.

**NOTICE**

**Damage to on-load tap-changer due to improperly carried out solder connections!**

Improperly carried out solder connections jeopardize safe operation.

- The connection contacts may not be shortened.
- The solder connection may only be produced on the end of the connection contacts (approx. 30 mm).
- Depending on the materials used, ensure the correct application of heat to prevent both cold solder spots and thermal damage to the on-load tap-changer.
- Ensure that sharp edges or points are not produced at the connection points. These may cause a local concentration of the field strength and therefore result in partial discharge.
- Remove flux material residue.

Taking these safety notices into consideration, you can produce the connections in accordance with the supplied connection diagram

1. by connecting the leads for the tap winding and on-load tap-changer take-off leads to the on-load tap-changer's connection contacts by means of crimping or soldering, without twisting.

![Figure 7: Tap winding connection (example)](image)
2. If the connecting pieces have to be bent, observe the aforementioned safety notices and use additional pliers to hold in place during bending so that none of the forces are transferred to the on-load tap-changer. For reasons of accessibility, we recommend starting with the bottom connections.

If you have any questions about producing the connections, please contact Maschinenfabrik Reinhausen GmbH’s Technical Service department.

5.3 Mounting motor-drive unit and control unit

You will find the description of how to mount, commission, and test the motor-drive unit and control unit in the operating instructions for the ECOTAP VPD MD&C motor-drive unit.

You have to mount and remove the motor-drive unit and control unit several times:

1. After installing the on-load tap-changer, mount motor-drive unit and control unit and start up. This includes automatic adjustment and test tap-change operations.
   
   ➞ This first partial commissioning process is needed for you to be able to check the wiring between the on-load tap-changer and transformer in accordance with the following description in the “Taking measurements” [► 28] section.

2. Before drying [► 31], remove motor-drive unit and control unit again
   
   ➞ This will prevent damage.

3. After drying and filling with oil [► 32], the transformer manufacturer undertakes complete initial commissioning of the on-load tap-changer and transformer [► 34]. This involves mounting the motor-drive unit and control unit for a second time.

4. Before undertaking the dielectric tests on the transformer wiring [► 36], you only have to remove the control unit.
   
   ➞ This will prevent damage.

5. Reconnect control unit when commissioning at operating site [► 38] and start up.

5.4 Taking measurements

**WARNING**

Electric shock from incorrect operation!

Danger of death or severe injury from electric shock!

- Only take measurements when the transformer is de-energized.
- Only perform tap-change operation with the control unit.
- Tap-change operations initiated by actuation with the emergency drive shaft are not permitted during this test.
NOTICE

Damage to on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and transformer due to improper transformer ratio test!

- Do not perform more than 100 tap-change operations without a full oil fill.
- Only switch on-load tap-changer with the help of the control unit.
- Only use emergency drive shaft to rectify faults [► 42] and never operate with a drill.

Before drying the transformer, undertake the transformer ratio test and DC resistance measurement as described below.

This requires the motor-drive unit and control unit to be correctly mounted and commissioned in accordance with the operating instructions for the ECOTAP VPD MD&C motor-drive unit. These instructions also contain further details of the trial tap-change operations required, automatic adjustment, and how to operate the control unit.

Carrying out transformer ratio test

1. Press AVR MANUAL key on control unit.

   ⇒ LED above the key lights up.

Figure 8: Activation of manual mode
2. Move on-load tap-changer into desired operating position by pressing UP/DOWN arrow keys on control unit.
   ⇒ The new operating position is displayed on the control unit.
3. Carry out the transformer ratio test in all operating positions.
   ⇒ Once the results have been checked, the transformer ratio test is complete.
Carrying out DC resistance measurement

The measurement DC current is normally restricted to 10% of the rated current of the measured transformer winding in order to prevent the winding from overheating.

Observe the maximum permitted measured currents for the on-load tap-changer during the DC resistance measurement on the transformer.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Maximum permissible measured current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer tank empty</td>
<td>Maximum 10 A DC</td>
</tr>
<tr>
<td>Transformer tank filled with insulating oil</td>
<td>Maximum 10 A DC</td>
</tr>
</tbody>
</table>

Table 8: Maximum permissible measured currents

Carry out the DC resistance measurement as follows:

1. Press AVR MANUAL key on control unit.
   - Move on-load tap-changer into desired operating position by pressing UP/DOWN arrow keys on control unit.
2. Carry out the DC resistance measurement in all operating positions.
   - Once the results have been checked, the DC resistance measurement is complete.

5.5 Drying the on-load tap-changer

**NOTICE**

Damage to the on-load tap-changer, motor-drive unit, and control unit from drying!

Incorrectly performed drying will damage components sensitive to temperature.

- Remove motor-drive unit and control unit and do not dry.
- Before drying, fit transport locking plate to protect the on-load tap-changer in accordance with the description below.
- Ensure that the temperature of the on-load tap-changer does not exceed 135 °C.

To prepare for drying, proceed as follows:

- Remove motor-drive unit and control unit as described in the "Disassembly before transformer drying" section in the operating instructions for the ECOTAP VPD MD&C motor-drive unit.
Attach and fasten transport locking plate before drying.

**Potential drying methods:**

You can dry the on-load tap-changer using one of the following methods.
- Vacuum-drying in an autoclave
- Vacuum-drying in a transformer tank
- Vapor-phase drying in an autoclave
- Vapor-phase drying in a transformer tank
- Low-frequency drying in an autoclave
- Low-frequency drying in a transformer tank

The drying time depends on the transformer.

**5.6 Filling transformer with oil**

For the oil filling of the transformer, use new mineral insulating oil for transformers as per IEC 60296 (Specification of unused mineral insulating oils for transformers and switchgear).
If approved by the transformer manufacturer, synthetic ester liquids as per IEC 61099 (Specification for unused synthetic organic esters for electrical purposes) or natural ester liquids as per IEC 62770 (Specification for unused natural esters for transformers and similar electrical equipment) can be used as alternatives.

Contact Maschinenfabrik Reinhausen GmbH if you want to use an alternative insulating liquid.

Observe the permitted temperature range of the transformer oil in the "Technical data" [► 56] chapter.

**NOTICE**

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

If a transformer is not completely filled with oil, the on-load tap-changer may be damaged!

► Before commissioning the on-load tap-changer, completely fill transformer with oil.

► If using the special design for hermetic transformers with gas cushion, be sure to observe the oil fill details on the dimensional drawings in the "Appendix" [► 61] chapter.

1. Completely fill transformer with oil.
2. Take oil sample from transformer.
3. Record temperature of oil sample just after sample is taken.
4. Determine dielectric strength and water content at a diverter switch oil temperature of $20 \degree C \pm 5 \degree C$. The dielectric strength and water content must comply with the limit values stated below:

<table>
<thead>
<tr>
<th></th>
<th>$U_d$</th>
<th>$H_2O$</th>
</tr>
</thead>
<tbody>
<tr>
<td>When commissioning the</td>
<td>$&gt; 60 \text{ kV}/2.5 \text{ mm}$</td>
<td>$&lt; 12 \text{ ppm}$</td>
</tr>
<tr>
<td>transformer for the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>first time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Limit values for mineral insulating oil (dielectric strength $U_d$ measured in accordance with IEC 60156)
6 Commissioning the on-load tap-changer at the transformer manufacturer's site

**WARNING**

Flying debris and spraying of hot oil resulting from on-load tap-changer overload!

The on-load tap-changer can switch currents of up to two times the rated through current. Higher currents occur when activating transformers (inrush current impulse) or in the event of short-circuits, for example. Higher voltages may occur from transformer overexcitation following load shedding, for example.

Danger of death or severe injury from flying debris and spraying of hot oil!

- Ensure that the on-load tap-changer is not overloaded.
- Prevent on-load tap-change operations if higher currents arise.
- Ensure that the rated step voltage is not exceeded. The rated step voltage may be briefly exceeded by up to 10 % as long as the rated through current is not exceeded.
- Ensure that the temperature limit values stated in the "Technical data" [► 56] chapter are not exceeded.

**NOTICE**

Damage to on-load tap-changer resulting from switching without oil!

Performing too many operations without a complete transformer oil fill will damage the on-load tap-changer!

- Do not perform more than 100 tap-change operations without a full oil fill.
- Only use emergency drive shaft to rectify faults [► 42] and never operate with a drill.

Before starting to test the transformer, take the following steps, which are described in detail in the operating instructions for the ECOTAP VPD MD&C motor-drive unit:

1. Mount and connect motor-drive unit and control unit.
2. Commission motor-drive unit and control unit.
3. Carry out automatic adjustment and test tap-change operations.
   ☞ You can then start the transformer tests.
6 Commissioning the on-load tap-changer at the transformer manufacturer’s site

6.1 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.
6.2 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.

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.
7 Transporting transformer to the operating site

**DANGER**

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.

**NOTICE**

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" [► 36] 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.
8 Commissioning transformer at operating site

**WARNING**

**Flying debris and spraying of hot oil resulting from on-load tap-changer overload!**

The on-load tap-changer can switch currents of up to two times the rated through current. Higher currents occur when activating transformers (inrush current impulse) or in the event of short-circuits, for example. Higher voltages may occur from transformer overexcitation following load shedding, for example.

Danger of death or severe injury from flying debris and spraying of hot oil!

- Ensure that the on-load tap-changer is not overloaded.
- Prevent on-load tap-change operations if higher currents arise.
- Ensure that the rated step voltage is not exceeded. The rated step voltage may be briefly exceeded by up to 10% as long as the rated through current is not exceeded.
- Ensure that the temperature limit values stated in the "Technical data" [► 56] chapter are not exceeded.

Before energizing the transformer, take the following steps, which are described in detail in the operating instructions for the ECOTAP VPD MD&C motor-drive unit:

1. Mount and connect motor-drive unit and control unit.
2. Commission motor-drive unit and control unit.
3. Carry out automatic adjustment and test tap-change operations.
4. Check control parameters and automatic voltage regulation.

You can then switch on the low-voltage busbar.

8.1 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.
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" [► 42] chapter.

9.1 Monitoring on-load tap-changer

Monitoring of the on-load tap-changer, motor-drive unit, and control unit is limited to occasional visual checks. For efficiency reasons these visual checks can be combined with the usual checks on the transformer.

Pay particular attention to the following:

▪ Oil leaks at transition points between sealing module and transformer cover
▪ Cable connections between control unit and motor-drive unit are in a sound condition
▪ Other damage

In the event of noticeable discrepancies, contact Maschinenfabrik Reinhausen GmbH's Technical Service department [► 42].

NOTICE

Damage to the on-load tap-changer!

Damage to the on-load tap-changer resulting from switching the on-load tap-changer at impermissible oil temperatures!

► The on-load tap-changer can be operated in the temperature range of the surrounding transformer oil of between –25 °C and +105 °C and in accordance with IEC 60214-1 up to +115 °C (during emergency transformer operation in accordance with IEC 60076-7).

► If using alternative insulating liquids, only a limited temperature range is permitted during operation. Ensure compliance with the specified temperature limit values and observe the following information.

The temperature limit values to be taken into account depending on the insulating liquid used can be found in the "Technical data" [► 57] chapter.

Ensure that the temperature limit values are not exceeded and that the "temperature blockade" is working perfectly.
9.2 Operating motor-drive unit and control unit

You will find detailed information of how to operate the motor-drive unit and control unit in the operating instructions for the ECOTAP VPD MD&C motor-drive unit.
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) [► 51]" section. Also read Software version of control unit (F6) [► 52] 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.

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Technical Service
Postfach 12 03 60
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 10: 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.
The transformer can be operated in the current operating position safely despite the red signal light. Further switching operations are blocked.
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 12: 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 13: 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" [► 46] section.
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.
2. Loosen screws and lift motor-drive unit off sealing module.

![Figure 15: Disassembling motor-drive unit](image)

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" [► 45] 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.

![Figure 16: Removing emergency drive shaft](image)
5. Attach emergency drive shaft on top of shaft of on-load tap-changer with hexagon.

![Figure 17: Attaching emergency drive shaft](image)

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

![Figure 18: 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.
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 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.

12. Evenly tighten screws crosswise by hand.

13. Tighten screws crosswise to a pre-tightening torque of 4 Nm.
14. Check seat of flange and seal for regularity.
15. Tighten screws crosswise to the full tightening torque of 7.5 Nm.

**Figure 22: Fastening motor-drive unit**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></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 [► 42].

11.1.2 Read out error memory (E)

The error memory shows you the saved error codes. Follow the "Fault elimination" [► 42] section for troubleshooting. The following error codes may appear:
### System status (error code) vs. Error description

<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>

#### Table 11: Error codes

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" [► 42] 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".

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" [► 61] 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 On-load tap-changer type designation

The designation of a particular on-load tap-changer model depends on various features, hence ensuring an unmistakable and non-interchangeable on-load tap-changer designation.

13.1.1 ECOTAP VPD on-load tap-changer type designation

<table>
<thead>
<tr>
<th>Type designation</th>
<th>ECOTAP VPD III 100 D – 36 – 09 09 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>VACUTAP VPD</td>
<td>On-load tap-changer type</td>
</tr>
<tr>
<td>III</td>
<td>Number of phases</td>
</tr>
<tr>
<td>100</td>
<td>Maximum rated through-current $I_m$ [A]</td>
</tr>
<tr>
<td>D</td>
<td>Application: Delta</td>
</tr>
<tr>
<td>36</td>
<td>Highest voltage for equipment $U_m$ [kV]</td>
</tr>
<tr>
<td>09 09 0</td>
<td>Basic connection</td>
</tr>
</tbody>
</table>

Table 12: Designation of the ECOTAP VPD on-load tap-changer

13.1.2 Number of positions and basic connection

The selector must adapt to the number of positions and tapped winding circuit.

<table>
<thead>
<tr>
<th>Designation of basic connection</th>
<th>09 09 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>09</td>
<td>Contact circle pitch of selector</td>
</tr>
<tr>
<td>09</td>
<td>Maximum number of operating positions</td>
</tr>
<tr>
<td>0</td>
<td>Number of mid-positions</td>
</tr>
</tbody>
</table>

Table 13: Designation of basic connection
## 13.2 Technical data for the on-load tapchanger

<table>
<thead>
<tr>
<th>Type</th>
<th>ECOTAP VPD III 30</th>
<th>ECOTAP VPD III 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of phases</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>At any point in the winding</td>
<td></td>
</tr>
<tr>
<td>Permitted transformer types</td>
<td>Free breathing with oil conservator</td>
<td>Entirely oil-filled sealed transformers (without gas cushion)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free breathing with air cushion only in combination with a special variant of the ECOTAP VPD (on request)</td>
</tr>
<tr>
<td>Maximum rated through current</td>
<td>30 A</td>
<td>100 A</td>
</tr>
<tr>
<td>Rated short-time current</td>
<td>600 A</td>
<td>2,000 A</td>
</tr>
<tr>
<td>Rated duration of short-circuits</td>
<td>2 s</td>
<td></td>
</tr>
<tr>
<td>Rated peak withstand current</td>
<td>1,500 A</td>
<td>5,000 A</td>
</tr>
<tr>
<td>Maximum rated step voltage</td>
<td>825 V</td>
<td>825 V</td>
</tr>
<tr>
<td>Step capacity</td>
<td>18,000 VA</td>
<td>82,500 VA</td>
</tr>
<tr>
<td>Maximum number of operating positions</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Rated insulation level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Highest voltage for equipment Um</td>
<td>36 kV</td>
<td></td>
</tr>
<tr>
<td>- Rated withstand voltages</td>
<td>See &quot;Permitted voltage stresses&quot; [► 58] section</td>
<td></td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz, 60 Hz</td>
<td></td>
</tr>
<tr>
<td>Permissible temperature range of transformer oil for on-load tap-change operations:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mineral insulating oil (IEC 60296)</td>
<td>-25°C – +105°C</td>
<td></td>
</tr>
<tr>
<td>- Synthetic ester liquid (IEC 61099)</td>
<td>on request</td>
<td></td>
</tr>
<tr>
<td>- Natural ester liquid (IEC 62770)</td>
<td>on request</td>
<td></td>
</tr>
<tr>
<td>Permissible absolute pressure during operation</td>
<td>0.7…1.4 bar</td>
<td></td>
</tr>
<tr>
<td>Vacuum-drying</td>
<td>vacuum proof</td>
<td></td>
</tr>
<tr>
<td>Maximum number of tap-change operations</td>
<td>500,000</td>
<td></td>
</tr>
</tbody>
</table>

Table 14: Technical data for the on-load tapchanger
13.3 Permitted voltage stresses

The details provided in this section only apply to use in mineral insulating oil in accordance with IEC 60296. Data for alternative insulating liquids is available on request.

This section describes the permitted voltage stresses on the tap winding and on-load tap-changer.

When selecting the on-load tap-changer, you must check that the highest stress on the selector does not exceed the related rated withstand voltages.

![Figure 23: Rated withstand voltages](image)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>between tap selector contacts of the winding of one tap position (connected or not connected)</td>
</tr>
<tr>
<td>a</td>
<td>between start and end of a tapped winding</td>
</tr>
<tr>
<td>b</td>
<td>between the tap selector contacts of various phases</td>
</tr>
<tr>
<td>b1</td>
<td>between selected contacts for different phases</td>
</tr>
<tr>
<td>b2</td>
<td>from the selected contact of one phase to non-selected contacts of other phases</td>
</tr>
<tr>
<td>b3</td>
<td>between non-selected contacts for different phases</td>
</tr>
<tr>
<td>f1</td>
<td>to ground, the following applies:</td>
</tr>
<tr>
<td>f2</td>
<td>between selected tap selector contacts and ground</td>
</tr>
<tr>
<td>f1</td>
<td>between non-selected tap selector contacts and ground</td>
</tr>
</tbody>
</table>
### Highest voltage for equipment $U_m$: 36 kV

<table>
<thead>
<tr>
<th>Insulation distance</th>
<th>Voltage waveform</th>
<th>Voltage magnitude for delta application [kV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>LI 1.2/50 µs</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>13</td>
</tr>
<tr>
<td>a1</td>
<td>LI 1.2/50 µs</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>2</td>
</tr>
<tr>
<td>b1</td>
<td>LI 1.2/50 µs</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>70</td>
</tr>
<tr>
<td>b2</td>
<td>LI 1.2/50 µs</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>80</td>
</tr>
<tr>
<td>b3</td>
<td>LI 1.2/50 µs</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>90</td>
</tr>
<tr>
<td>f1</td>
<td>LI 1.2/50 µs</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>70</td>
</tr>
<tr>
<td>f2</td>
<td>LI 1.2/50 µs</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>80</td>
</tr>
</tbody>
</table>

*Table 15: Rated insulation level*

**Key**

LI: Withstand value of full wave lightning impulse test (kV, 1.2/50 µs)

LIC: Withstand value of chopped wave lightning impulse test (kV, 1.2/50/3…6 µs)

AC: Withstand value of applied voltage test (kV, 50 Hz, 1 min)
13.4 Step capacity diagram

Figure 24: Step capacity diagram

1. ECOTAP VPD III 30: 18,000 VA
2. ECOTAP VPD III 100: 82,500 VA

$U_r$ Rated step voltage

$I_u$ Rated through-current
14 Appendix

The dimensional drawings actually provided with the on-load tap-changer apply.

14.1 Limit values for dielectric strength and water content of on-load tap-changer oil

The following table provides the limit values for dielectric strength (measured in accordance with IEC 60156) and water content (measured in accordance with IEC 60814) of the on-load tap-changer oil for the ECOTAP VPD on-load tap-changer. The values have been established on the basis of IEC 60422.

<table>
<thead>
<tr>
<th></th>
<th>$U_d$</th>
<th>$H_2O$</th>
</tr>
</thead>
<tbody>
<tr>
<td>When commissioning the transformer for the first time</td>
<td>&gt; 60 kV/2.5 mm</td>
<td>&lt; 12 ppm</td>
</tr>
<tr>
<td>During operation</td>
<td>&gt; 30 kV/2.5 mm</td>
<td>&lt; 30 ppm</td>
</tr>
</tbody>
</table>

Table 16: Limit values for on-load tap-changer oil
14.2 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-
14.3 Dimensional drawing of special design transformer with gas cushion 80 mm (10015051)
Dimensional drawing of special design transformer with gas cushion 80 mm (10015051) -2-
Dimensional drawing of special design transformer with gas cushion 80 mm
(10015051) -3-
14.4 Dimensional drawing of special design transformer with gas cushion 150 mm (10015052)

- Tap selector connection terminals
- Current take-off terminal
- Transformer cover

Dimensions and details:
- Weight: approx. 42 kg
- Displacement volume: 9 dm³
- Sealing surface on bottom side of cover must not be coated, primed only
- G6x M5, MA = 75 Nm
- Transformer cover

Diagram shows the dimensional drawing with all necessary measurements and notes.
Dimensional drawing of special design transformer with gas cushion 150 mm (10015052) -2-
Dimensional drawing of special design transformer with gas cushion 150 mm (10015052) -3-
14.5 High-voltage connection diagram, tap winding at start of main winding (4766035)
14.6 High-voltage connection diagram, tap winding in center of main winding (4766654)
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