On-Load Tap-Changer
ECOTAP® VPD®

Operating Instructions
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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.

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

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

1.1 Manufacturer

The product is manufactured by:

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

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

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

- Operating instructions for the associated ECOTAP® VPD® MD&C motor-drive unit with control unit.
- 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.

1.3 Safekeeping

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

1.4 Notation conventions

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

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

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

Type of danger!
Source of the danger and outcome.
► Action
► Action

1.4.1.2 Embedded warning information

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

DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words and pictograms

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Definition</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 minor or moderate injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
</tbody>
</table>

Table 1: Signal words in warning notices
Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Definition</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>
<tr>
<td><img src="image" alt="Warning of danger of crushing" /></td>
<td>Warning of danger of crushing</td>
</tr>
</tbody>
</table>

Table 2: Pictograms used in warning notices

1.4.2 Information system

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

Important information.

1.4.3 Instruction system

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

Single-step instructions

Instructions which consist of only a single process step are structured as follows:
Aim of action
✓ Requirements (optional).
► Step 1 of 1.
☞ Result of step (optional).
☞ Result of action (optional).

Multi-step instructions
Instructions which consist of several process steps are structured as follows:

Aim of action
✓ Requirements (optional).
1. Step 1.
   ☞ Result of step (optional).
2. Step 2.
   ☞ Result of step (optional).
   ☞ Result of action (optional).

1.4.4 Typographic conventions
The following typographic conventions are used in this technical file:

<table>
<thead>
<tr>
<th>Typographic convention</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPPERCASE</td>
<td>Operating controls, keys</td>
<td>AVR MANUAL</td>
</tr>
<tr>
<td>Bold</td>
<td>Displays/menus</td>
<td>P21</td>
</tr>
<tr>
<td>Italic</td>
<td>System messages/LED displays</td>
<td>ERROR LED</td>
</tr>
</tbody>
</table>
[► Page number]. Cross reference [► 41].

Table 3: Typographic conventions
2 Safety

This 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.
▪ This technical file is a part of the product.
▪ Read and observe the safety instructions provided in this chapter in particular.
▪ Observe the warnings in this technical file in order to avoid function-related dangers.
▪ The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets may arise in the event of improper use.

2.1 Appropriate use

The product is an on-load tap-changer and adjusts the transmission ratio of transformers without interrupting the load flow. The product is designed solely for use in electrical energy systems and facilities. 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 danger to people, property or the environment. This applies throughout service life of the product, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate use:

▪ Only use the ECOTAP® VPD® on-load tap-changer in systems set up in accordance with IEC 61936-1.
▪ You will find the standard valid for the product and the year of issue on the nameplate.
▪ Only operate the product in accordance with this technical file and the agreed delivery conditions and technical data.
▪ 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. In such cases, ensure that the minimum oil fill level stated on the dimensional drawing supplied is observed.
▪ Operation with alternative insulating fluids is possible in accordance with the specification in the Technical data [Section 11, Page 64]. In such cases, you must ensure compliance with the limited temperature ranges by means of temperature blocking.
▪ Only operate the 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.
• Ensure that all necessary work is performed by qualified personnel only.
• Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file.

**Permitted electrical operating conditions**

In addition to the design data in accordance with the order confirmation, observe the following limits for the through-current and the step voltage:

In the standard version, the on-load tap-changer is designed for sinusoidal 50/60 Hz AC current with a curve form symmetrical to the zero axis and can switch twice the rated through-current $I_r$ at its rated step voltage $U_{ir}$.

Exceeding the rated step voltage $U_{ir}$ for a short period by up to 10% is permitted if the rated through-current $I_r$ is not exceeded.

### 2.2 Inappropriate use

Use is considered inappropriate if the product is used in a way other than as described in the "Appropriate use" section. In addition, observe the following:

**Prohibited electrical operating conditions**

All operating conditions that do not comply with the design data in accordance with the order confirmation are prohibited.

Prohibited operating conditions may arise due to short circuits as well as due to inrush current impulses when energizing transformers or other electrical machines. This applies to the affected transformer itself just as it does to transformers electrically connected in parallel or serially or other electrical machines.

Higher voltages may occur due to transformer overexcitation following load shedding, for example.

Operations outside of the permitted operating conditions can lead to injury to persons and damage to the product.
• Prevent any such operations outside of the permitted operating conditions by taking suitable measures.

### 2.3 Fundamental Safety Instructions

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:
Personal protective equipment
Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This increases the danger to life and limb.

- All necessary devices and personal protective equipment required for the specific task, such as a hard hat, safety footwear, etc. must be worn. Observe the section "Personal protective equipment" [Section 2.5, Page 14].
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

Work area
Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Working during operation
The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Working with current transformers
Dangerous high voltages may occur when a current transformer is operated with an open secondary circuit. This can lead to injuries and property damage.

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

Explosion protection
Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire.

- Do not install or operate the product in areas where a risk of explosion is present.
2 Safety

Safety markings
Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

▪ Observe all safety markings on the product.
▪ Make sure all safety markings on the product remain intact and legible.
▪ Replace safety markings that are damaged or missing.

Ambient conditions
To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

▪ Observe the specified operating conditions and requirements for the installation location.

Modifications and conversions
Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

▪ Only modify the product after consultation with the manufacturer.

Spare parts
Spare parts not approved by the manufacturer may lead to physical injury, damage to the product and operational faults.

▪ Only use spare parts approved by the manufacturer.
▪ Contact the manufacturer.

2.4 Personnel qualification
The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

Electrically skilled person
The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

▪ Can identify potential dangers independently and is able to avoid them.
▪ Is able to perform work on electrical systems.
▪ Is specially trained for the working environment in which (s)he works.
▪ Must satisfy the requirements of the applicable statutory regulations for accident prevention.
Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.5 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.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.
Personal protective equipment to be worn at all times

<table>
<thead>
<tr>
<th>Protective clothing</th>
<th>Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety shoes</td>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
</tbody>
</table>

Special personal protective equipment for particular environments

<table>
<thead>
<tr>
<th>Safety glasses</th>
<th>To protect the eyes from flying parts and splashing liquids.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visor</td>
<td>To protect the face from flying parts and splashing liquids or other dangerous substances.</td>
</tr>
<tr>
<td>Hard hat</td>
<td>To protect from falling and flying parts and materials.</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>To protect from hearing damage.</td>
</tr>
<tr>
<td>Protective gloves</td>
<td>To protect from mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>
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
- Nameplate (label)
- Technical files

Attach the on-load tap-changer nameplate to the corresponding motor-drive unit. The position can be found in the section "Design/versions" [Section 3.4, Page 17].

The crimp sleeves 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" [Section 4, Page 24] 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 as a 3-phase or 1-phase version.

<table>
<thead>
<tr>
<th>Type</th>
<th>ECOTAP® VPD® III</th>
<th>ECOTAP® VPD® I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum rated through-current</td>
<td>30 A</td>
<td>30 A</td>
</tr>
<tr>
<td>( I_{m} )</td>
<td>100 A</td>
<td>100 A</td>
</tr>
<tr>
<td>Highest voltage for equipment</td>
<td>36 kV</td>
<td>36 kV</td>
</tr>
<tr>
<td>( U_{m} )</td>
<td>40.5 kV</td>
<td></td>
</tr>
<tr>
<td>Optional change-over selector</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 4: ECOTAP® VPD® versions

In the 1-phase version, the connection contacts are arranged on the left or right side, depending on the order. Figures illustrating this can be found in the section "ECOTAP® VPD® I without change-over selector" [► Section 3.4.3, Page 21].

For the correct connection, observe the order-specific connection diagram supplied.

More important information can be found in the "Technical data" [► Section 11, Page 64] chapter.

3.4 Setup/models

The design and designation of the most important on-load tap-changer components are shown in the following illustrations. Further details can be found in the dimensional drawings in the appendix.
3.4.1 ECOTAP® VPD® III without change-over selector

The on-load tap-changer without change-over selector has 9 operating positions.

![Figure 1: Front view of the ECOTAP® VPD® without change-over selector](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor-drive unit</td>
</tr>
<tr>
<td>2</td>
<td>Nameplate</td>
</tr>
<tr>
<td>3</td>
<td>Sealing module</td>
</tr>
<tr>
<td>4</td>
<td>Connection contact</td>
</tr>
<tr>
<td>5</td>
<td>O-ring gasket</td>
</tr>
</tbody>
</table>
3 Product description

Figure 2: Rear view of the ECOTAP® VPD® without change-over selector

1 Diverter switch assembly with transition resistor and vacuum interrupter
2 Selector assembly
3.4.2 ECOTAP® VPD® III with change-over selector

The on-load tap-changer with change-over selector has 17 operating positions.

Figure 3: Front view of the ECOTAP® VPD® with change-over selector

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor-drive unit</td>
</tr>
<tr>
<td>2</td>
<td>Nameplate</td>
</tr>
<tr>
<td>3</td>
<td>Sealing module</td>
</tr>
<tr>
<td>4</td>
<td>Connection contact</td>
</tr>
<tr>
<td>5</td>
<td>O-ring gasket</td>
</tr>
</tbody>
</table>
3.4.3 ECOTAP® VPD® I without change-over selector

The 1-phase on-load tap-changer is only available without a change-over selector and has 9 operating positions.
1-phase on-load tap-changer with connection contacts on the left

Figure 5: Front view, ECOTAP® VPD® I, connection contacts on left

1. Sealing module
2. Motor-drive unit
3. O-ring gasket
4. Connection contact

Figure 6: Rear view, ECOTAP® VPD® I, connection contacts on left

1. Selector assembly
2. Diverter switch assembly with transition resistor and vacuum interrupter
3. Nameplate
1-phase on-load tap-changer with connection contacts on the right

Figure 7: Front view, ECOTAP® VPD® I, connection contacts on right

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor-drive unit</td>
</tr>
<tr>
<td>2</td>
<td>Nameplate</td>
</tr>
<tr>
<td>3</td>
<td>Sealing module</td>
</tr>
<tr>
<td>4</td>
<td>Connection contact</td>
</tr>
<tr>
<td>5</td>
<td>O-ring gasket</td>
</tr>
</tbody>
</table>

Figure 8: Rear view, ECOTAP® VPD® I, connection contacts on right

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diverter switch assembly with transition resistor and vacuum interrupter</td>
</tr>
<tr>
<td>2</td>
<td>Selector assembly</td>
</tr>
</tbody>
</table>
4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with sealed packaging and sometimes in a dry state, depending on requirements.

Sealed packaging surrounds the packaged goods with plastic foil on all sides.

Products that have also been dried are identified by a yellow label on the sealed packaging. In the dry state, delivery is also possible in a transport container.

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.

► The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.

► General rule: Do not stack crates above a height of 1.5 m.

► For other crates: Only stack up to 2 equally sized crates on top of one another.

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

The packaged goods are packed in a sturdy 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.

Sealed packaging surrounds the packaged goods with plastic foil on all sides. The packaged goods are protected from humidity using a desiccant. The plastic foil was bonded after the desiccant 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.

![Symbols for packaging](image)

Table 5: Shipping pictograms

<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>

4.2 Transportation, receipt and handling of shipments

**WARNING**

Danger of death and damage to property!

Danger of death and damage to property due to tipping or falling load.

- Only transport the crate when closed.
- Do not remove the securing material used in the crate during transport.
- If the product is delivered on a pallet, secure it sufficiently.
- Only trained and authorized 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, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

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

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

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

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

If external transport damage is found upon receipt of the shipment, proceed as follows:

▪ Immediately record the identified transport damage 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 manufacturer 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 on site together with the carrier involved. This is essential for any claim for damages.

▪ Photograh 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!** If the product is delivered in sealed packaging, inspect this immediately. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either re-dry the dried packaged goods as per the operating instructions, or contact the manufacturer to agree on how to proceed. Failure to do so may result in damage to the packaged goods.

▪ Identify 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.
4 Packaging, transport and storage

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 a 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!**

Damage to on-load tap-changer and transformer due to electrical flashover caused by insufficient distance from the motor-drive unit!

► When positioning the opening in the transformer, ensure a sufficient distance from adjacent energized parts.

Mount the on-load tap-changer horizontally with the sealing module on the transformer cover.

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 found in the dimensional drawing in the appendix.
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 without warping or deforming. 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 with a pre-tightening torque of 9 Nm.
6. Check seat of flange and seal for regularity.
7. Tighten screws crosswise with the full tightening torque of 16 Nm.
8. Tighten screws again with full tightening torque, working clockwise and tightening one screw after another as far as each screw will go.

5.1.1 Attaching the ECOTAP® VPD® III

**NOTICE**

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

The on-load tap-changer may only be operated in transformers that are completely filled with insulating fluid. Non-compliance may result in voltage flashovers that cause serious damage to the on-load tap-changer and transformer.

► Use in hermetic transformers with a gas cushion below the transformer cover is only permitted with an appropriate special design.
Mount the on-load tap-changer horizontally with the sealing module on the transformer cover.

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 found in the dimensional drawing in the appendix.

Figure 9: Top view 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 without warping or deforming. 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 with a pre-tightening torque of 9 Nm.

6. Check seat of flange and seal for regularity.
7. Tighten screws crosswise with the full tightening torque of 16 Nm.

8. Tighten screws again with full tightening torque, working clockwise and tightening one screw after another as far as each screw will go.
5.1.2 Attaching the ECOTAP® VPD® I

**NOTICE**

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

The on-load tap-changer must be fully immersed in insulating fluid. Energized parts of the on-load tap-changer coming into contact with air may result in voltage flashovers that cause serious damage to the on-load tap-changer and transformer.

- Use in hermetic transformers with a gas cushion is only permitted if there is sufficient distance between the gas cushion and the on-load tap-changer and connection contacts.
- The distance to the gas cushion must ensure that the on-load tap-changer is fully immersed in insulating fluid in every operating situation.

Mount the on-load tap-changer vertically with the sealing module on the transformer side wall.

Do not paint the inner surface of the transformer side wall which will later make contact with the sealing module o-ring. Only one coating of primer is permitted.

1. Make an opening for the sealing module and holes for the fixing screws on the transformer side wall. The measurements and position can be found in the dimensional drawing in the appendix.

![Figure 12: View of the transformer side wall with opening for sealing module](image-url)
2. Clean the sealing surfaces on the sealing module and the transformer side wall. Insert O-ring supplied in sealing module.

![Figure 13: O-ring gasket](image)

3. **CAUTION!** Gradually tighten screws crosswise as described below without warping or deforming. Improper screw connection will result in damage to the on-load tap-changer.

4. Lead the on-load tap-changer sideways from the inside through the opening in the transformer side wall.

5. Evenly tighten screws crosswise by hand. Tighten screws crosswise with a pre-tightening torque of 9 Nm.

6. Check seat of flange and seal for regularity.
7. Tighten screws crosswise with the full tightening torque of 16 Nm.

<table>
<thead>
<tr>
<th>Pre-tightening torque</th>
<th>Full tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Nm</td>
<td>16 Nm</td>
</tr>
</tbody>
</table>

8. Tighten screws again with full tightening torque, working clockwise and tightening one screw after another as far as each screw will go.
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 the connecting leads – including connection points – that face the transformer cover or the transformer side wall to ensure the dielectric strength.

► Bending the connection contacts may limit the dielectric strength in accordance with the specification in the "Technical data" [Section 11.4, Page 69] 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 connection contacts into these critical areas.

**ECOTAP® VPD® III on-load tap-changer without change-over selector**

![Diagram of ECOTAP® VPD® III on-load tap-changer without change-over selector]

Figure 15: Insulation spacing for ECOTAP® VPD® III without change-over selector

<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>
ECOTAP® VPD® III on-load tap-changer with change-over selector

Figure 16: Insulation spacing for ECOTAP® VPD® III with change-over selector

<table>
<thead>
<tr>
<th></th>
<th>Description</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>
ECOTAP® VPD® I on-load tap-changer without change-over selector

Figure 17: Insulation spacing for ECOTAP® VPD® I without change-over selector

1 Transformer side wall
2 Supporting bar
3 Critical area: Spacing to grounded parts

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 establish the connections in accordance with the supplied order-specified connection diagram. This connection diagram also contains the exact assignment of the individual connecting pieces of the on-load tap-changer.

1. To do so, connect 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 18: Tap winding connection (example for ECOTAP® VPD® III)*
5 Mounting

2. If the connection contacts 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

As preparation, you must ensure that the on-load tap-changer is in a defined operating position.

1. **DANGER!** Check the operating position before the transformer is commissioned or ensure that the transformer is disconnected from all voltage sources and secured against reconnection. Failure to do so can lead to death or serious injuries.
2. Remove transport locking plate and store safely. To avoid contamination and mechanical damage, do not leave the sealing module open for long periods of time.

![Figure 20: Removing the transport locking plate](image)

3. When mounting for the first time: remove label with warning.

![Figure 21: Removing the label](image)
4. Check the position of the on-load tap-changer: The current operating position is displayed by the control wheel.

![Figure 22: Checking operating position (exemplary illustration)](image)

5. Check additionally the position of the shaft of the on-load tap-changer: If the previous on-load tap-change operation has been finished correctly, the arrow on the cam disk 1 is pointing to the arrow in the cover 2.

![Figure 23: Position of the shaft of the on-load tap-changer](image)

If the shaft of the on-load tap-changer is in this position, the on-load tap-changer is in a defined operating position. If this is not the case, correct the position as described below.

6. **NOTICE!** Only use the emergency drive shaft installed in the sealing module. Failure to do so can result in damage to the on-load tap-changer.
7. Pull the emergency drive shaft out of the bracket in the sealing module.

Figure 24: Removing emergency drive shaft

8. Plug the emergency drive shaft with feather key into the shaft of the on-load tap-changer.

Figure 25: Attaching emergency drive shaft

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

Figure 26: Emergency drive shaft actuation
10. **NOTICE!** Using the emergency drive shaft, turn for every tap-change operation in one direction until one revolution has been completed and the arrow on the cam disk (1) is again pointing to the arrow in the cover (2). Otherwise the tap-change operation is not completed correctly, which may result in damage to the on-load tap-changer and transformer.

![Figure 27: Position of the shaft of the on-load tap-changer](image)

The current operating position is displayed by the control wheel.

![Figure 28: Checking operating position (exemplary illustration)](image)

11. Pull the emergency drive shaft out of the shaft of the on-load tap-changer and plug it back into the bracket.

![Figure 29: Plugging the emergency drive shaft back in](image)

12. Close the sealing module with the transport locking plate if the motor-drive unit is not to be mounted immediately.
You have to mount and remove the motor-drive unit and control unit several times:

1. After installing the on-load tap-changer, mount the motor-drive unit and control unit and start them up, including automatic adjustment and trial 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" [►Section 5.4, Page 44] section.

2. Before "Drying the on-load tap-changer" [►Section 5.5, Page 46], remove the motor-drive unit and control unit again to avoid damage.

3. Drying and filling with oil [►Section 5.6, Page 48] is followed by the step "Commissioning the on-load tap-changer at the transformer manufacturer's site" [►Section 6.1, Page 49]. This involves mounting the motor-drive unit and control unit for a second time.

4. Before performing the "dielectric tests on the transformer wiring [►Section 6.1.1.2, Page 51]", disconnect the connection cable to the motor-drive unit on the control unit to avoid damage.

5. Before "Commissioning the transformer at the operating site" [►Section 6.3, Page 54], reconnect and commission the 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.

### 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 [►Section 8, Page 58] 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 \( \text{AVR Manual} \) on the control unit to activate manual mode.
   \( \Rightarrow \) LED above the key lights up.

![Figure 30: Activating manual mode](image)

2. Press \( \text{AVR Manual} \) or \( \text{Avr Manual} \) until the desired operating position is reached.
   \( \Rightarrow \) The new operating position is displayed on the control unit.

3. Carry out the transformer ratio test in all operating positions.
   \( \Rightarrow \) Once the results have been checked, the transformer ratio test is complete.
Check the transformer configuration in accordance with the supplied connection diagrams if the tap-change operation is not in the desired direction. The behavior of the control unit (lowest voltage at smallest or largest position) can be adjusted accordingly via parameterization. To do so, follow the description in the ECOTAP® VPD® MD&C motor-drive unit operating instructions, section "Inverting travel commands".

### Carrying out DC resistance measurement

The measured 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 6: Maximum permissible measured currents

Carry out the DC resistance measurement as follows:

1. Press “MAN” on the control unit to activate manual mode.
   - LED above the key lights up.
2. Press ▲ or ▼ until the desired operating position is reached.
   - The new operating position is displayed on the control unit.
3. 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 section "Dis-assembly before transformer drying" in the operating instructions for the ECOTAP® VPD® MD&C motor-drive unit.

1. Clean sealing surfaces on sealing module and transport locking plate and check that o-ring is in the correct position.

2. Attach and fasten transport locking plate before drying.

![Figure 31: Fastening transport locking plate](image)

**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 the transformer tank
- Vapor-phase drying in an autoclave
- Vapor-phase drying in the 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 fluid.

Observe the permitted temperature range of the transformer oil in the "Technical data" [Section 11.2, Page 65] 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 of the 3-phase on-load tap-changer for hermetic transformers with gas cushion, be sure to observe the oil fill details on the supplied dimensional drawing.

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 an oil temperature of 20°C ± 5°C. The dielectric strength and water content must comply with the limit values stated below:

<table>
<thead>
<tr>
<th>U_d (MV/mm)</th>
<th>H_2O (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 60 kV/2.5 mm</td>
<td>&lt; 12 ppm</td>
</tr>
</tbody>
</table>

Table 7: Limit values for mineral insulating oil (dielectric strength U_d measured in accordance with IEC 60156)
6 Commissioning

This chapter describes how to commission the device. Commissioning is broken down into the following sections:

- Commissioning at the transformer manufacturer's site
- Transporting transformer to the operating site
- Commissioning at the operating site

6.1 Commissioning the on-load tap-changer at the transformer manufacturer's site

**WARNING**

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

The on-load tap-changer can switch currents of up to twice 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 due to transformer overexcitation following load shedding, for example.

Danger of death or severe injury due to flying parts 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 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 [► Section 8, Page 58] 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® 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 trial tap-change operations.

► You can then start the transformer tests. Observe the description below.
6.1.1 Tests on the transformer

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

6.1.1.1 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.

### 6.1.1.2 Dielectric tests on transformer wiring

The motor-drive unit and control unit are subjected to dielectric tests before delivery. Another dielectric test is not necessary. If you would like to perform a dielectric test on the transformer wiring, observe the following information.

**Damage to the control unit.**

Damage to the control unit due to impermissibly high voltages during the dielectric test on the transformer wiring.

► Disconnect the connection cable to the motor-drive unit on the control unit prior to performing a dielectric test on the transformer wiring.

To disconnect the control unit, proceed as follows:

1. **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. Otherwise, there is a risk of fatal injury due to electrical voltage during the following work.

  - The LED can remain lit for up to 30 minutes after disconnection of the voltage supply. This indicates that the energy accumulator is still charged. This does not represent a hazard during mounting or removing the control unit.

2. Remove plug connector from terminal X1 on the control unit.
3. Remove plug connector from terminal X2 on the control unit.
4. Remove plug connector from terminal X4 on the control unit.

5. Wind up connection cable and fix on motor-drive unit.

You can then perform the dielectric test.

6.1.2 Resetting automatic adjustment

Reset the automatic adjustment prior to transporting the transformer to the installation site. This ensures that automatic adjustment is carried out again during commissioning at the installation site.

To reset the automatic adjustment, proceed as follows:

- The AVR MANUAL operating mode is active.

1. Press \[ \text{MENU} \]

2. Press \[ \rightarrow + \] for longer than 5 seconds.

\[ \Rightarrow \text{****} \]

3. Press \[ \rightarrow \] until code 3 is displayed.

\[ \Rightarrow \text{***} \]
4. Press \( \text{Janum} \) to confirm the selection.

\( \Rightarrow \) The LED  \( \Delta \) lights up and the error code E4.1 is displayed.

### 6.2 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" [Section 6.1.1.2, Page 51] 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.
6.3 Commissioning transformer at operating site

**WARNING**

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

The on-load tap-changer can switch currents of up to twice 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 due to transformer overexcitation following load shedding, for example.

Danger of death or severe injury due to flying parts 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 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 trial tap-change operations.
4. Check control parameters and automatic voltage regulation.
5. When operating with alternative insulating fluids, activate temperature blocking

6.3.1 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 trial 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.
7 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 the EXTERNAL CONTROL operating mode, the commands of the PRO CONTROL control unit (available separately) are executed. In this case, manual operation using the LOWER and RAISE keys is not possible. This operating mode can be used only in connection with this Maschinenfabrik Reinhausen GmbH control unit. Always observe the safety instructions and detailed description in the corresponding operating instructions.

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" [► Section 8, Page 58] chapter.

7.1 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 [► Section 8, Page 58].
7.2 Operating motor-drive unit and control unit

You will find detailed information on how to operate the motor-drive unit and control unit in the operating instructions for the ECOTAP® VPD® MD&C motor-drive unit.

You will also find the description for actuating the motor-drive unit in emergency operation there. Emergency operation is to be understood as the failure of the motor-drive unit’s voltage supply when there is an urgent need to perform an on-load tap-change operation.
8 Fault elimination

In the event of an operating failure, check the voltage supply of the motor-drive unit and the display on the control unit.

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

Corrective measures for control unit error messages and faults in the automatic voltage regulation can be found in the operating instructions of the ECOTAP® VPD® MD&C motor-drive unit.

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.

Please have the following data to hand:
- Serial number (nameplate)
- Control unit software version (see corresponding operating instructions)

Contact address

Maschinenfabrik Reinhausen GmbH
Technical Service

Postfach 12 03 60
D93025 Regensburg
Germany

Tel.: +49 94140 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com
9 Maintenance

**DANGER**

Electric shock!

Working on the transformer when the transformer is energized can lead to death or serious injuries.

- Switch off transformer on high and low-voltage side.
- Lock transformer to prevent unintentional restart.
- Ensure that everything is de-energized.
- Visibly connect all transformer terminals to ground (grounding leads, grounding disconnectors) and short circuit them.
- Cover or cordon off adjacent energized parts.

**DANGER**

Electric shock!

Working on the on-load tap-changer when components are energized can lead to death or serious injuries.

- De-energize all auxiliary circuits, such as the tap-change supervisory device, pressure relief device, pressure monitoring device.
- Ensure that everything is de-energized.

**WARNING**

Danger of explosion!

Explosive gases in the oil compartment of the on-load tap-changer, transformer, pipework system, oil conservator and at the dehydrating breather opening can deflagrate or explode and result in severe injury or death!

- Ensure that there are no ignition sources such as naked flame, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the transformer's immediate surroundings and that none occur.
- Do not operate any electrical devices (e.g. risk of sparks from impact wrench).
- Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

9.1 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:

9.1.1 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 [☞ Section 8, Page 58].
If a problem occurs with the control unit and you want to contact Maschinenfabrik Reinhausen GmbH, first read out the software version.

9.1.2 Read out software version (F6)

To read out the software version, proceed as follows:

1. The AVR MANUAL operating mode is active.
2. Press \( \text{FUNCTION} \) until the desired function is displayed.
3. Press \( \text{PARAMETER} \) to confirm the selection.
4. The control unit’s software version is displayed.
5. Press \( \text{FUNCTION} \) to exit the display.
6. Press \( \text{PARAMETER} \) to leave the parameterization menu.

9.1.3 Reading remaining life (F2)

The control unit's integrated energy accumulator is continually monitored. With the function "Read remaining life", you can request the current status (as a percentage). If the remaining life is 0%, the function of the energy accumulator is no longer guaranteed.

If the remaining life is less than 5(%), contact Maschinenfabrik Reinhausen GmbH's Technical Service department.
For functional reasons, the remaining life drops more quickly at the beginning of the product life cycle and levels out as the operating time increases. The typical progression of the remaining life is shown below:

![Graph showing the typical progression of the remaining life.](image)

Figure 33: Typical progression of the remaining life

To start the remaining life query, proceed as follows:

1. Press \[ \text{MENU} \] until the desired function is displayed.
   - Press \[ \text{AVR MANUAL} \] to confirm the selection.
   - The remaining life is displayed as a percentage value.
2. Press \[ \text{AVR MANUAL} \] to exit the display.
3. Press \[ \text{AVR MANUAL} \] to leave the parameterization menu.

### 9.1.4 LED function test (F3)

You can use this function to test the function of all LEDs and the display on the front of the control unit. To do so, proceed as follows:

1. Press \[ \text{MENU} \] until the desired function is displayed.
   - Press \[ \text{AVR MANUAL} \] to confirm the selection.
   - All display elements on the front of the control unit light up.
2. Press \[ \text{AVR MANUAL} \] to exit the display.
4. Press **MENU** to leave the parameterization menu.

### 9.1.5 Checking the temperature blocking

If you operate the on-load tap-changer with alternative insulating fluids, you must check the function of the temperature blocking. To do so, proceed as follows:

- Check the function of the temperature sensor in accordance with the manufacturer's details.
- The △ LED is not lit; if this is not the case, resolve the cause of the error.
- Remove the plug at terminal X3 to simulate a blocking signal.
  - Blocking is active and the LED △ is lit.

### 9.1.6 Oil quality

1. Check the quality of the transformer oil at regular intervals.
2. Determine dielectric strength and water content at an oil temperature of 20°C ± 5°C.
3. The dielectric strength and water content must comply with the limit values specified in the section “Technical data”.
  - If these limit values are not complied with, change the oil.

### 9.2 Maintenance

The ECOTAP® VPD® on-load tap-changer and the ECOTAP® VPD® MD&C motor-drive unit do not require maintenance.

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

### 9.3 Care

You can clean the device's housing with a dry cloth.
10 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.
11 Technical data

11.1 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.

11.1.1 ECOTAP® VPD on-load tap-changer designation

<table>
<thead>
<tr>
<th>Type designation</th>
<th>ECOTAP® VPD III 100 D – 36 – 09 09 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECOTAP® 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_{\text{rm}} ) [A]</td>
</tr>
<tr>
<td>D</td>
<td>Application: Delta</td>
</tr>
<tr>
<td>36</td>
<td>Highest voltage for equipment ( U_{\text{m}} ) [kV]</td>
</tr>
<tr>
<td>09 09 0</td>
<td>Basic connection</td>
</tr>
</tbody>
</table>

Table 8: Designation of the ECOTAP® VPD® on-load tap-changer

11.1.2 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 9: Designation of basic connection
# 11.2 Technical data for the on-load tap-changer

<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>Free breathing with air cushion only in combination with a special variant of the ECOTAP VPD (on request)</td>
<td></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>Without change-over selector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Maximum rated step voltage</td>
<td>825 V</td>
<td>825 V</td>
</tr>
<tr>
<td>▪ Step capacity</td>
<td>24,750 VA</td>
<td>82,500 VA</td>
</tr>
<tr>
<td>With change-over selector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Maximum rated step voltage</td>
<td>550 V</td>
<td>550 V</td>
</tr>
<tr>
<td>▪ Step capacity</td>
<td>16,500 VA</td>
<td>55,000 VA</td>
</tr>
<tr>
<td>Maximum number of operating positions</td>
<td>9 / 17</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 / 40.5 kV</td>
<td></td>
</tr>
<tr>
<td>▪ Rated withstand voltages</td>
<td>See section &quot;Permitted voltage stresses&quot; [ Section 11.4, Page 69 ]</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 fluid (IEC 61099)</td>
<td>On request</td>
<td></td>
</tr>
<tr>
<td>▪ Natural ester fluid (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>Optional 0.7…2.0 bar</td>
</tr>
<tr>
<td>▪ At a reduced service life of 250,000 switching operations and 25 years:</td>
<td></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>
<tr>
<td>Resistance to corrosion</td>
<td>Unpainted, optional CX</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: ECOTAP® VPD III technical data
## Technical data

**Table 11: ECOTAP® VPD I technical data**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECOTAP® VPD I 30</th>
<th>ECOTAP® VPD I 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of phases</td>
<td>1</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</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>24,750 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 section &quot;Permitted voltage stresses&quot; [► Section 11.4, Page 69]</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 fluid (IEC 61099)</td>
<td>On request</td>
<td></td>
</tr>
<tr>
<td>- Natural ester fluid (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>- At a reduced service life of 250,000 switching operations and 25 years:</td>
<td>Optional 0.7…2.0 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>
<tr>
<td>Resistance to corrosion</td>
<td>Unpainted, optional CX</td>
<td></td>
</tr>
</tbody>
</table>
11.3 Step capacity diagrams

Step capacity diagram for ECOTAP® VPD® without change-over selector

![Step capacity diagram](image)

Figure 34: Step capacity diagram for ECOTAP® VPD® without change-over selector

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ECOTAP® VPD III 30 without change-over selector: 24,750 VA</td>
</tr>
<tr>
<td>2</td>
<td>ECOTAP® VPD III 100 without change-over selector: 82,500 VA</td>
</tr>
</tbody>
</table>

- **U_r**  Rated step voltage
- **I_r**  Rated through-current
Figure 35: Step capacity diagram for ECOTAP® VPD® with change-over selector

1. ECOTAP® VPD III 30 with change-over selector: 16,500 VA
2. ECOTAP® VPD III 100 with change-over selector: 55,000 VA

- $U_r$: Rated step voltage
- $I_r$: Rated through-current
11.4 Permitted voltage stresses

The specifications in this section only apply to use in mineral insulating oil in accordance with IEC 60296. Data for alternative insulating fluids 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 stresses on the selector do not exceed the related rated withstand voltages.

<table>
<thead>
<tr>
<th>Definition of insulation distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
</tr>
<tr>
<td>a1</td>
</tr>
<tr>
<td>2a1</td>
</tr>
<tr>
<td>b</td>
</tr>
<tr>
<td>b1</td>
</tr>
<tr>
<td>b2</td>
</tr>
<tr>
<td>b3</td>
</tr>
<tr>
<td>f</td>
</tr>
<tr>
<td>f1</td>
</tr>
<tr>
<td>f2</td>
</tr>
<tr>
<td>Additionally for coarse tap selector connection in (+) position of the change-over selector:</td>
</tr>
<tr>
<td>c1</td>
</tr>
<tr>
<td>c2</td>
</tr>
</tbody>
</table>

Table 12: Definition of insulation distances
Insulation distances for ECOTAP® VPD III without change-over selector

Figure 36: ECOTAP® VPD III without change-over selector

Insulation distances for ECOTAP® VPD I

Figure 37: ECOTAP® VPD I
Insulation distances for ECOTAP® VPD III with reversing change-over selector

Figure 38: ECOTAP® VPD III with reversing change-over selector
Insulation distances for ECOTAP® VPD III with coarse tap connection

Figure 39: ECOTAP® VPD III with coarse tap connection

Abbreviations for the rated insulation level:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LI</td>
<td>Full wave lightning impulse (kV, 1.2/50 μs)</td>
</tr>
<tr>
<td>LIC</td>
<td>Chopped wave lightning impulse (kV, 1.2/50/3 μs)</td>
</tr>
<tr>
<td>AC</td>
<td>Applied voltage (kV, 50 Hz, 1 min)</td>
</tr>
</tbody>
</table>

Table 13: Abbreviations for the rated insulation level:
## Rated insulation level (voltage magnitudes for delta applications in kV)

<table>
<thead>
<tr>
<th>Insulation distance</th>
<th>Voltage waveform</th>
<th>Without change-over selector</th>
<th>Without change-over selector</th>
<th>With change-over selector</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>LI 1.2/50 µs</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>105</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>a1</td>
<td>LI 1.2/50 µs</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>b1&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>LI 1.2/50 µs</td>
<td>200</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>220</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>70</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>b2&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>LI 1.2/50 µs</td>
<td>230</td>
<td>305</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>250</td>
<td>335</td>
<td>335</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>85</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>b3&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>LI 1.2/50 µs</td>
<td>250</td>
<td>330</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>275</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>100</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>f1</td>
<td>LI 1.2/50 µs</td>
<td>200</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>220</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>70</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>f2</td>
<td>LI 1.2/50 µs</td>
<td>230</td>
<td>305</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>250</td>
<td>335</td>
<td>335</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>85</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>c1</td>
<td>LI 1.2/50 µs</td>
<td>-</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>-</td>
<td>-</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>-</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>c2</td>
<td>LI 1.2/50 µs</td>
<td>-</td>
<td>-</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>LIC 1.2/50/3…6 µs</td>
<td>-</td>
<td>-</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td>AC 50 Hz, 1 min</td>
<td>-</td>
<td>-</td>
<td>120</td>
</tr>
</tbody>
</table>

Table 14: Rated insulation level (voltage magnitudes for delta applications in kV)

<sup>1)</sup> "b" distances not relevant for ECOTAP® VPD I
11.5 Tapped winding potential connection

During its switching operation the tap winding is briefly electrically isolated from the main winding by the reversing change-over selector or coarse change-over selector. It then adopts a potential resulting from the voltages of the adjacent windings and coupling capacities for these windings or earthed parts.

This potential shift of the tap winding produces corresponding voltages between the deactivating change-over selector contacts because one contact is always connected to the tap winding and the other contact is always connected to the main winding. This voltage is known as the recovery voltage $U_W$.

When separating the change-over selector contacts, a capacitive current has to be interrupted. This current depends on the aforementioned coupling capacities of the tap winding. This current is known as the breaking current $I_S$.

The recovery voltage $U_W$ and breaking current $I_S$ may result in impermissible signs of discharge on the change-over selector. The permissible recovery voltage $U_W$ and breaking current $I_S$ ranges are listed below.

**Maximum permissible values for recovery voltage $U_W$ and breaking current $I_S$**

![Graph showing permissible ranges for recovery voltage $U_W$ and breaking current $I_S$.](image-url)

Figure 40: Recovery voltage $U_W$ and breaking current $I_S$
11.6 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 based on 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 15: Limit values for on-load tap-changer oil
12 Drawings

12.1 Information on the drawings in the appendix

The drawings listed in this section are examples. The delivered product may deviate from these examples.

The drawings that you receive with the order confirmation are definitive.

12.2 Dimensional drawings
TAP-CHANGER CONNECTION CONTACTS
MATERIAL: CU-ETP-R250

8x M8
MA = 16 Nm

PLACE AT LEAST 3 MM OF PAPER INSULATION ON UPPER CONNECTING LEADS FACING THE TRANSFORMER COVER, INCLUDING CONNECTION POINTS, TO ENSURE THE DIELECTRIC STRENGTH

DRILLING TEMPLATE:
TRANSFORMER COVER PROVIDED BY CUSTOMER (TOP VIEW)

SIDE OF TAP-CHANGER CONNECTION CONTACTS
SAME POTENTIAL AS TRANSFORMER COVER

AREA WITH PARTS AT HIGH VOLTAGE POTENTIAL

THES COMPONENTS ARE MADE OF NON CONDUCTIVE MATERIALS

71.5 cm

35 cm

152 cm

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TAP-CHANGER ECOTAP® VPD®
40,5 KV, AS SHOWN FOR 17 OPERATING POSITIONS

WEIGHT: APPROX 34,7 KG
DISPLACEMENT VOLUME: 10 DM³

SEALING SURFACE ON BOTTOM SIDE OF COVER MUST NOT BE PAINTED, PRIMER ONLY
PLACE AT LEAST 3 MM OF PAPER INSULATION ON
UPPER CONNECTING LEADS FACING THE TRANSFORMER
COVER, INCLUDING CONNECTION POINTS, TO ENSURE
THE DIELECTRIC STRENGTH

TAP-CHANGER CONNECTION CONTACTS
MATERIAL: CU-ETP-R250
8x M8
MA = 16 Nm

146
124,5
8x MB

103
100
90,5

PLACE AT LEAST 3 MM OF PAPER INSULATION ON
UPPER CONNECTING LEADS FACING THE TRANSFORMER
COVER, INCLUDING CONNECTION POINTS, TO ENSURE
THE DIELECTRIC STRENGTH

TAP-CHANGER CONNECTION CONTACTS
MATERIAL: CU-ETP-R250
8x M8
MA = 16 Nm

146
124,5
8x MB

103
100
90,5

131 ±0,3
300 ±0,3
163 ±0,2
81,5 ±0,2
5,5 ±0,1
162 ±0,2
84,5 ±0,2
84,5 ±0,2
324 ±0,3
R 36 ±0,3

DRILLING TEMPLATE:
TRANSFORMER COVER
PROVIDED BY CUSTOMER
(TOP VIEW)

SIDE OF TAP-CHANGER
CONNECTION CONTACTS

205
190
365
300 ±0,3
R 36 ±0,3
R 5,5 ±0,1
8x φ9

TAP-CHANGER ECOTAP® VPD®
40,5 KV, AS SHOWN FOR 17 OPERATING POSITIONS
DIMENSION DRAWING
TAP-CHANGER ECOTAP® VPD®

40.5 KV, AS SHOWN FOR 17 OPERATING POSITIONS

THESE COMPONENTS ARE MADE OF NON CONDUCTIVE MATERIALS

AREA WITH PARTS AT HIGH VOLTAGE POTENTIAL

SAME POTENTIAL AS TRANSFORMER COVER

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TAP-CHANGER CONNECTION CONTACTS
MATERIAL: CU-ETP-R250

DRILLING TEMPLATE: TRANSFORMER WALL PROVIDED BY CUSTOMER (OUTSIDE)

SIDE OF TAP-CHANGER CONNECTION CONTACTS

TOP SIDE

1-PHASE, 36 kV, AS SHOWN FOR 9 OPERATING POSITIONS LEFT

DIMENSION DRAWING

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These components are made of non-conductive materials. The same potential as the transformer wall.

Area with parts at high voltage potential.
TAP-CHANGER ECOTAP® VPD®
1-PHASE, 36 kV, AS SHOWN FOR 9 OPERATING POSITIONS RIGHT

DIMENSION DRAWING

WEIGHT: APPROX 15.5 KG
DISPLACEMENT VOLUME: 2.8 DM³

SEALING SURFACE ON INSIDE OF TRANSFORMER WALL MUST NOT BE PAINTED, PRIMER ONLY

GROUNDING BOLT M8

7x M6
MA = 6 Nm

8x M8
MA = 16 Nm

1:3
TAP-CHANGER ECOTAP® VPD®
1-PHASE, 36 kV, AS SHOWN FOR 9 OPERATING POSITIONS RIGHT

SAME POTENTIAL AS TRANSFORMER WALL

THESE COMPONENTS ARE MADE OF NON CONDUCTIVE MATERIALS

AREA WITH PARTS AT HIGH VOLTAGE POTENTIAL

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12.3 High-voltage connection diagrams
Fuer diese technische Unterlage behalten wir uns gemaess DIN 34 Abschnitt 2.1 und 2.2 alle Rechte vor.

STANDARD

VERIFIED

EXEC.

DATE

ORIGIN.

REPL.BY

SH.

REPL.

LANGUAGE:

PROJECT:

DE

EN

1198x624

STUFEN / STEPS

TW_1_U

1

2

3

4

5

6

7

8

9

A

TS_1_U

WÄHLER_U

TAP SELECTOR_U

TS_2_V

WÄHLER_V

TAP SELECTOR_V

TS_3_W

WÄHLER_W

TAP SELECTOR_W

TW_0_U

TRAFO WICKLUNG_U

TRANSFORMER WINDING_U

TW_1_U

STUFENWICKLUNG_U

V

ANSCHLUSS TRAFO

CONNECTION TRANSFORMER

W

ANSCHLUSS TRAFO

CONNECTION TRANSFORMER

U

ANSCHLUSS TRAFO

CONNECTION TRANSFORMER

BETRIEBSSTELLUNGEN

SERVICE POSITIONS

VERSCHIEDENE SPANNUNGEN

DIFFERENT VOLTAGES

JUSTIERSTELLUNG

ADJUSTMENT POSITION

BETRIEBSSTELLUNG

SERVICE POSITION

BEZEICHNUNG DER WÄHLERKONTAKTE

DESIGNATION OF TAP SELECTOR CONTACTS

BEZEICHNUNG DER STELLUNGEN

DESIGNATION OF POSITIONS

REGELBEREICH (kV)

REGULATION RANGE (kV)
Vor diesem technischen Unterlagen behalten wir uns gemäß DIN 34 Abschnitt 2.1 und 2.2 alle Rechte vor.