On-Load Tap-Changer
VACUTAP® VM-Ex

Operating Instructions
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1 Introduction

This technical file contains detailed descriptions for monitoring during operation, troubleshooting, and maintenance.

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

Information about installation can be found in the installation and commissioning instructions.

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

1.1 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

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

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

1.2 Subject to change without notice

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

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

1.3 Completeness

This technical file is incomplete without the supporting documents.

The following documents apply:

- Unpacking instructions (included in the scope of delivery)
- Supplement (included in the scope of delivery)
- Routine test report (included in the scope of delivery)
- Connection diagrams (included in the scope of delivery)
- Dimensional drawings (included in the scope of delivery)
- Technical data - General section (available on request)
- Technical data - Product-specific section (available on request)
1.4 Safekeeping

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

1.5 Notation conventions

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

1.5.1 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>
<tr>
<td><img src="image" alt="Use a file" /></td>
<td>Use a file</td>
</tr>
<tr>
<td><img src="image" alt="Grease" /></td>
<td>Grease</td>
</tr>
</tbody>
</table>
1 Introduction

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coupling bolt</td>
</tr>
<tr>
<td></td>
<td>Use a ruler</td>
</tr>
<tr>
<td></td>
<td>Use a saw</td>
</tr>
<tr>
<td></td>
<td>Hose clip</td>
</tr>
<tr>
<td></td>
<td>Wire eyelet, safety wire</td>
</tr>
<tr>
<td></td>
<td>Use a screwdriver</td>
</tr>
<tr>
<td></td>
<td>Apply adhesive</td>
</tr>
<tr>
<td></td>
<td>Lock tab</td>
</tr>
</tbody>
</table>

Table 1: Symbols

1.5.2 Hazard communication system

Warnings in this technical file are displayed as follows.

1.5.2.1 Warning relating to section

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

⚠️ WARNING

Type and source of danger

Consequences

► Action
► Action

1.5.2.2 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:
1 Introduction

DANGER! Instruction for avoiding a dangerous situation.

1.5.2.3 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="image1" alt="Warning of a danger point" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image2" alt="Warning of dangerous electrical voltage" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image3" alt="Warning of combustible substances" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image4" alt="Warning of danger of tipping" /></td>
<td>Warning of danger of tipping</td>
</tr>
</tbody>
</table>

Table 3: Pictograms used in warning notices

1.5.3 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.
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 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 of the user or impairment of the product and other material assets may occur during use due to function-related dangers.

2.1 Appropriate use

The product is an on-load tap-changer and keeps the output voltage of a transformer constant. 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 across the entire service life of the product, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate use:

- Use the product only with the transformer specified in the order.
- The serial numbers of on-load tap-changers and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay, etc.) must match if the on-load tap-changers and on-load tap-changer accessories are supplied as a set for one order.
- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this technical file, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in delivery for the intended purpose and in accordance with the specifications of this technical file.
- The on-load tap-changer is not intended to be used with an oil filter unit.
- The measures described in this technical file must be taken in order to comply with explosion protection requirements.
2.2 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" [► 21].
▪ 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

You must only operate the product when it is 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 maintenance work and maintenance intervals described in this technical file.

Explosion protection

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

▪ Do not install the product in potentially explosive areas.

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.
2 Safety

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.

Auxiliary materials and operating materials
Auxiliary materials and operating materials not approved by Maschinenfabrik Reinhausen GmbH could damage the product.
- Only use lubricants and auxiliary materials approved by the manufacturer.
- Contact Maschinenfabrik Reinhausen GmbH.

Modifications and conversions
Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.
- Only modify product following consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts
Spare parts not approved by Maschinenfabrik Reinhausen GmbH may cause physical injury and damage the product.
- Only use spare parts approved by the manufacturer.
- Contact Maschinenfabrik Reinhausen GmbH.

2.3 Standards and regulations
The standards and regulations which apply to the explosion-protected product are described in the following chapters.

2.3.1 Application range of the on-load tap-changer
The on-load tap-changer is certified for Ex II 3G Ex nAC IIC T3 Gc. Refer to the following overview for the resulting application range.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Ex]</td>
<td>II</td>
<td>3G</td>
<td>Ex</td>
<td>nAC</td>
<td>IIC</td>
<td>T3</td>
<td>Gc</td>
</tr>
</tbody>
</table>

Table 4: Example of the application range

<table>
<thead>
<tr>
<th>Number</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sign for explosion protection</td>
</tr>
<tr>
<td>2</td>
<td>Equipment group</td>
</tr>
<tr>
<td>3</td>
<td>Equipment category</td>
</tr>
<tr>
<td>Number</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>4</td>
<td>Ex: Symbol for explosion-protected equipment</td>
</tr>
<tr>
<td>5</td>
<td>Ignition protection type</td>
</tr>
<tr>
<td>6</td>
<td>Explosion group</td>
</tr>
<tr>
<td>7</td>
<td>Temperature class</td>
</tr>
<tr>
<td>8</td>
<td>EPL (Equipment Protection Level)</td>
</tr>
</tbody>
</table>

**Equipment groups (number 2)**

<table>
<thead>
<tr>
<th>I</th>
<th>Equipment in this category is intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by firedamp and/or combustible dust.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Equipment in this category is intended for use in other areas in which explosive atmospheres may be present.</td>
</tr>
</tbody>
</table>

Table 5: Equipment groups

**Equipment category / zone classification (number 3)**

<table>
<thead>
<tr>
<th>Designation for gases</th>
<th>Designation for dusts</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G (0)</td>
<td>1D (20)</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapors or mists or by air/dust mixtures are present continuously, for long periods or frequently.</td>
</tr>
<tr>
<td>2G (1)</td>
<td>2D (21)</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by gases, vapors, mists or air/dust mixtures occur occasionally.</td>
</tr>
<tr>
<td>3G (2)</td>
<td>3D (22)</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air/dust mixtures are unlikely to occur or, if they do occur, are likely to do so only infrequently and for a short period only.</td>
</tr>
</tbody>
</table>

Table 6: Equipment category / zone classification

**Ignition protection types (number 5)**

<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>Pressure-proof enclosure</td>
</tr>
<tr>
<td>e</td>
<td>Increased safety</td>
</tr>
<tr>
<td>l</td>
<td>Intrinsic safety (ia, ib)</td>
</tr>
<tr>
<td>m</td>
<td>Encapsulation</td>
</tr>
<tr>
<td>o</td>
<td>Oil immersion</td>
</tr>
<tr>
<td>p</td>
<td>Pressurized apparatus</td>
</tr>
</tbody>
</table>
Table 7: Ignition protection types

**Explosion group (number 6)**

<table>
<thead>
<tr>
<th>EN/IEC</th>
<th>Gases, vapors (examples)</th>
<th>Min. ignition energy (mJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIA</td>
<td>Ammonia</td>
<td>-</td>
</tr>
<tr>
<td>IIA</td>
<td>Acetic acid, acetone, benzene, diesel, ethane, ether, fuel oil, hexane, methane, petrol, petroleum, propane</td>
<td>0.18</td>
</tr>
<tr>
<td>IIB</td>
<td>Ethylene, isoprene, town gas</td>
<td>0.06</td>
</tr>
<tr>
<td>IIC</td>
<td>Acetylene, carbon disulfide, hydrogen</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 8: Explosion groups

**Temperature classes (number 7)**

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>Maximum equipment surface temperature</th>
<th>Ignition temperature of the flammable substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>450 °C</td>
<td>&gt; 450 °C</td>
</tr>
<tr>
<td>T2</td>
<td>300 °C</td>
<td>&gt; 300 °C &lt; 450 °C</td>
</tr>
<tr>
<td>T3</td>
<td>200 °C</td>
<td>&gt; 200 °C &lt; 300 °C</td>
</tr>
<tr>
<td>T4</td>
<td>135 °C</td>
<td>&gt; 135 °C &lt; 200 °C</td>
</tr>
<tr>
<td>T5</td>
<td>100 °C</td>
<td>&gt; 100 °C &lt; 135 °C</td>
</tr>
<tr>
<td>T6</td>
<td>85 °C</td>
<td>&gt; 85 °C &lt; 100 °C</td>
</tr>
</tbody>
</table>

Table 9: Temperature classes

**Equipment protection level (EPL) (number 8)**

The EPL indicates the level of protection defined for a device based on the level of probability of ignition and taking account of the differences between potentially explosive gas atmospheres, potentially explosive dust atmospheres, and potentially explosive atmospheres in mine workings affected by firedamp.
2.3.2 Standards and regulations

The following standards and regulations apply to explosion-proof on-load tap-changers:

- EN 60079-0: Equipment – General requirements
- EN 60079-15: Equipment protection by type of protection "n"
- Additional requirements apply to vacuum interrupters, as these are hermetically sealed devices that generate arcs, sparks or hot surfaces.
- Additional requirements apply to the diverter switch oil compartment, as this is a sealed or encapsulated device that generates arcs, sparks or hot surfaces.

2.4 Measures for ensuring compliance with explosion protection requirements

2.4.1 Measures taken by the manufacturer

Maschinenfabrik Reinhausen has taken the following measures for ensuring compliance with explosion protection requirements. You do not need to take any special measures in this regard.

2.4.1.1 Quality of the insulating oil in the on-load tap-changer

The quality of the insulating oil required by IEC 60296 and the quality of the synthetic esters required by IEC 61099 in the oil compartment of the on-load tap-changer is ensured by using vacuum cells in transition resistors.

2.4.1.2 Monitoring the oil temperature in the diverter switch oil compartment

A temperature sensor is provided in the on-load tap-changer head cover for monitoring the oil temperature in the diverter switch oil compartment. The corresponding temperature monitoring relay is in the TAPMOTION® ED-Ex.

Temperature monitoring prevents further switching of the on-load tap-changer when the maximum permitted temperature is reached. This maximum permitted temperature is factory-configured for each specific order for all on-load tap-changer types (maximum 130 °C) and secured against accidental incorrect adjustment.

2.4.2 Measures to be taken by the transformer manufacturer/operator

The following measures for ensuring compliance with explosion protection requirements must be taken by the transformer manufacturer/operator.
2.4.2.1 Prescribed protective and drive components

Operate the on-load tap-changer only in conjunction with the following components:

- Ex protective relay
- Ex motor-drive unit
- Ex drive shaft
2.4.2.2 Setting up the on-load tap-changer oil system

Operate the on-load tap-changer only with a suitable oil system. This diverter switch oil system consists of the diverter switch oil compartment, protective relay, and oil conservator of the on-load tap-changer. It ensures that enough insulating oil is present in the diverter switch oil compartment at all times.

Figure 1: On-load tap-changer oil system

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diverter switch oil compartment</td>
</tr>
<tr>
<td>2</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td>3</td>
<td>Protective relay</td>
</tr>
<tr>
<td>4</td>
<td>Level indicator</td>
</tr>
<tr>
<td>5</td>
<td>Signaling contacts</td>
</tr>
<tr>
<td>6</td>
<td>Oil conservator</td>
</tr>
<tr>
<td>7</td>
<td>Dehydrating breather</td>
</tr>
</tbody>
</table>

2.4.2.3 Oil conservator to be used

The oil conservator of the on-load tap-changer ensures that sufficient insulating oil is present in the on-load tap-changer oil system at all times during operation.

Therefore, operate the on-load tap-changer only with a oil conservator that fulfills the following requirements:
2.4.2.3.1 Dehydrating breather

The oil conservator must be equipped with a dehydrating breather in accordance with VDE 0532-216-5. The dehydrating breather prevents water, impurities, insects etc. from entering the insulating oil.

2.4.2.3.2 Level indicator

The oil conservator must have a level indicator from which the minimum oil quantity required and the maximum quantity permitted, as well as the current oil level, can be read.

2.4.2.3.3 Level monitoring

The oil level in the oil conservator must be monitored at all times during operation. Therefore, loop the signaling contact for falling below the minimum oil level in the on-load tap-changer's oil conservator to the tripping circuit of the circuit breaker so that the circuit breaker will immediately de-energize the transformer when the oil level in the oil conservator falls below this minimum.

2.4.2.3.4 Insulating oil to be used

When filling the diverter switch oil compartment and its oil conservator, use only new mineral insulating oil for transformers in accordance with IEC 60296 (Specification for unused mineral insulating oils for transformers and switchgear) or synthetic ester in accordance with IEC 61099 (Specifications for unused synthetic organic esters for electrical purposes).

2.4.2.3.5 Checking the quality of the insulating oil in the Ex transformer

During the tap changes, polarity sparks (low energy) may occur at the tap selector of the on-load tap-changer in the transformer tank. In this regard, observe Section 5.1.6 and 5.1.7 in the on-load tap-changer standard IEC 60214.

Therefore, check the quality and dielectric strength of the insulating oil in the transformer tank on a regular basis and comply with the service intervals for the oil change.
2.4.2.4 Corrosion protection measures

Because further installation steps are required before operation of the on-load tap-changer, sufficient corrosion protection cannot be provided at certain interfaces to the transformer when the device leaves the factory.

Figure 2: On-load tap-changer head

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sealing surface on piping connection flange</td>
</tr>
<tr>
<td>2</td>
<td>Air-vent valve</td>
</tr>
<tr>
<td>3</td>
<td>Contact surface on on-load tap-changer head</td>
</tr>
<tr>
<td>4</td>
<td>Through-holes</td>
</tr>
</tbody>
</table>

The sealing surfaces on the piping connection flange are zinc-plated ex factory. The through-holes are zinc-plated and partially painted.

The contact surface of the on-load tap-changer head is primed ex factory. The through-holes are primed and partially painted.

The transformer manufacturer is responsible for the design of the mating surfaces on the transformer and piping and that of the screw connections needed for these attachments.

1. Provide suitable sealing to prevent electrolytes from entering sealing surfaces and holes.
2. Design screws, washers, nuts etc. in A4 in accordance with ISO 3506-1/ISO 3506-2 standard.
3. If the painted surfaces are damaged, note repair instructions. These can be requested from Maschinenfabrik Reinhausen GmbH's Technical Service department.

2.5 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 will be 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.

2.6 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.
▪ 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>
</tr>
</thead>
<tbody>
<tr>
<td>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.</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>

Special personal protective equipment for particular environments

<table>
<thead>
<tr>
<th>Safety glasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visor</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect the face from flying parts and splashing liquids or other dangerous substances.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hard hat</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect from falling and flying parts and materials.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hearing protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect from hearing damage.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protective gloves</th>
</tr>
</thead>
<tbody>
<tr>
<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 usually delivered as follows:

- Oil compartment with on-load tap-changer head and built-in diverter switch insert
- Selector
- Motor-drive unit
- Drive shaft with coupling parts and bevel gear
- Protective device
- Technical files

Please refer to the delivery slip for full details of scope of delivery.

Single-phase on-load tap-changers are also available as an on-load tap-changer set with a common motor-drive unit.

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" chapter.

3.2 On-load tap-changer

3.2.1 Function description

On-load tap-changers are used to adjust the transmission ratio of transformers without interrupting the load flow. Fluctuations in voltage occurring in the power transmission grid, for example, can therefore be compensated for. For this purpose, on-load tap-changers are fitted in transformers and connected to the active part of the transformer.
3 Product description

A motor-drive unit, which receives a control impulse (e.g. from a voltage regulator), changes the on-load tap-changer's operating position, which adapts the transmission ratio of the transformer to the respective operating requirements.

![Figure 3: System overview of on-load tap-changer Transformer](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transformer tank</td>
</tr>
<tr>
<td>2</td>
<td>Motor-drive unit</td>
</tr>
<tr>
<td>3</td>
<td>Vertical drive shaft</td>
</tr>
<tr>
<td>4</td>
<td>Bevel gear</td>
</tr>
<tr>
<td>5</td>
<td>Horizontal drive shaft</td>
</tr>
<tr>
<td>6</td>
<td>Upper gear unit</td>
</tr>
<tr>
<td>7</td>
<td>On-load tap-changer</td>
</tr>
<tr>
<td>8</td>
<td>RS protective relay</td>
</tr>
<tr>
<td>9</td>
<td>Oil conservator</td>
</tr>
<tr>
<td>10</td>
<td>Active part of the transformer</td>
</tr>
</tbody>
</table>

3.2.2 Setup/models

The on-load tap-changer consists of the on-load tap-changer head, oil compartment with built-in diverter switch insert and the selector mounted below (also available with change-over selector on request).

The design and designation of the most important on-load tap-changer components are shown in the installation drawings in the appendix.
For the number of maximum operating positions of the on-load tap-changer, refer to the technical data.

**Figure 4: VACUTAP® VM**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On-load tap-changer head</td>
</tr>
<tr>
<td>2</td>
<td>Oil compartment</td>
</tr>
<tr>
<td>3</td>
<td>Selector</td>
</tr>
<tr>
<td>4</td>
<td>Change-over selector</td>
</tr>
</tbody>
</table>
3.2.2.1 Pipe connections

The on-load tap-changer head features 4 pipe connections for different purposes.
Depending on the order, some or all of these pipe connections are fitted with pipe bends ex factory. All pipe bends without terminal box for the tap-change supervisory control can be freely swiveled once the pressure ring is loosened.

**Pipe connection Q**

Pipe connection Q is sealed off with a blank cover and, depending on the on-load tap-changer type, is intended for the bushing of the tap-change supervisory device supplied as an option.

The functions of the R and Q pipe connections can be interchanged.

**Pipe connection S**

The pipe bend on pipe connection S features a vent screw and can be connected to a pipe that ends with a drain valve on the side of the transformer tank at operating height. If the on-load tap-changer is fitted with an oil suction pipe, the on-load tap-changer can be completely emptied via pipe connection S.

**Pipe connection R**

Pipe connection R is provided for attachment of the protective relay and connection of the on-load tap-changer oil conservator and can be interchanged with pipe connection Q.

**Pipe connection E2**

The pipe connection E2 is sealed off with a blank cover. It leads into the oil tank of the transformer, directly under the on-load tap-changer head and can be connected to a collective pipe for the Buchholz relay, if necessary. This pipe connection serves a further purpose, namely to equalize the pressure.
between the transformer tank and oil compartment of the on-load tap-changer, which is necessary for drying, oil filling and transportation of the transformer.

### 3.2.3 Nameplate and serial number

The nameplate with the serial number is on the on-load tap-changer head cover.

![Figure 7: Position of nameplate](image7.png)

The serial number can also be found on the selector.

![Figure 8: Serial number](image8.png)
3.3 Drive shaft

3.3.1 Function description

The drive shaft is the mechanical connection between drive and on-load tap-changer head.

The bevel gear changes the direction from vertical to horizontal (see drawing 892916).

Accordingly, the vertical drive shaft has to be mounted between drive and bevel gear and the horizontal drive shaft between bevel gear and on-load tap-changer or de-energized tap-changer.

The explosion-proof drive shaft consists of a square tube with insulator and is coupled by two coupling brackets and one coupling bolt at both ends to the drive or driven shaft end of the device to be connected.

Figure 9: Explosion-proof drive shaft with insulator
3.3.2 Design/Model

The design of the explosion-proof drive shaft is described in this section.

![Diagram of the explosion-proof drive shaft with labeled components.]

**Figure 10: Components of the explosion-proof drive shaft**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bevel gear</td>
</tr>
<tr>
<td>2</td>
<td>Hose clip</td>
</tr>
<tr>
<td>3</td>
<td>Screws</td>
</tr>
<tr>
<td>4</td>
<td>Telescopic protective tube</td>
</tr>
<tr>
<td>5</td>
<td>Coupling bracket</td>
</tr>
<tr>
<td>6</td>
<td>Insulator</td>
</tr>
<tr>
<td>7</td>
<td>Double coupling bracket</td>
</tr>
<tr>
<td>8</td>
<td>Square tube</td>
</tr>
<tr>
<td>9</td>
<td>Pin</td>
</tr>
<tr>
<td>10</td>
<td>Adapter ring</td>
</tr>
<tr>
<td>11</td>
<td>Protective cover</td>
</tr>
<tr>
<td>12</td>
<td>Hose clip</td>
</tr>
</tbody>
</table>
3 Product description

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min</th>
<th>Intermediate bearing</th>
</tr>
</thead>
</table>
### 3.3.3 Identification plate

The identification plate is on the telescopic protective tube.

![Identification plate](image)

**Figure 11: Position of the identification plate**

### 3.4 Protective relay

#### 3.4.1 Function description

The protective relay is used to protect the on-load tap-changer and the transformer when a malfunction occurs in the diverter switch oil compartment or selector switch oil compartment. It is tripped when the specified speed of oil flow from the on-load tap-changer head to the oil conservator is exceeded due to a fault. The flowing oil actuates the flap valve which tips over into position OFF. The contact in the dry-reed magnetic switch is thereby actuated, the circuit breakers are tripped, and the transformer is de-energized.
3 Product description

The protective relay is part of an on-load tap-changer filled with insulating liquid and its properties conform to the applicable valid version of IEC publication 60214-1.

Diverter switch operations at rated switching capacity or at permissible overload will not cause the protective relay to trip.

The protective relay responds to oil flow, not to gas accumulated in the protective relay. It is not necessary to bleed the protective relay when filling the transformer with oil. Gas accumulation in the protective relay is normal.

3.4.2 Setup/versions

Front view

![Front view diagram](image1)

1. Inspection window
2. Pressure equalization element

Rear view

![Rear view diagram](image2)

1. Ground connection
2. Nameplate

Figure 12: RS 2001-Ex

Figure 13: RS 2001-Ex
### 3.4.3 Name plate

The name plate for the explosion-protected protective relay is on the rear of the product.
4 Commissioning the transformer at the 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 1.5 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 are not exceeded.

Before energizing the transformer, check that the motor-drive unit and protective relay are functioning correctly and fill the on-load tap-changer oil compartment with new mineral insulating oil. Proceed as follows:

4.1 Checking motor-drive unit

Before commissioning the transformer, repeat the function tests on the motor-drive unit as described in MR operating instructions for motor-drive unit.

**WARNING**

Danger of death or severe injury!

Danger of death or severe injury due to incorrect operation!

► Under no circumstances is the transformer to be commissioned if the functions specified in the section "Tests on motor-drive unit" are not satisfied.

**NOTICE**

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

Damage to on-load tap-changer and motor-drive unit due to condensate in protective housing of motor-drive unit!

► Always keep protective housing of the motor-drive unit tightly closed.
► In the event of downtimes prior to initial commissioning of more than 8 weeks or operation interruptions of more than 2 weeks, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible (e.g. during transportation), place a sufficient amount of dehydrating agent in the protective housing.
Damage to the on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and motor-drive unit due to incorrect use of position transmitter equipment!

- Only circuits stated in the chapter Technical data for position transmitter equipment may be connected to the position transmitter module connections.
- The switchover point of the position transmitter equipment in the motor-drive unit is not the same as the switchover point of the diverter switch operation. This depends on the type of diverter switch. This fact should be noted when project planning the locking circuits between the motor-drive unit and external equipment (e.g. transformer circuit breaker).
- For external monitoring, locking, and control purposes, it is not therefore the position transmitter equipment but the "Tap changer in operation" position transit contact shown in the connection diagram that should be used.

### 4.2 Checking protective relay


- Check that the protective relay is functioning correctly before commissioning the transformer:
  1. Ground the transformer on the high-voltage and low-voltage sides. Ensure that the working ground connection on the transformer is not removed during testing.
  2. Ensure that transformer remains de-energized during testing.
  3. Deactivate the automatic fire extinguishing device.
  4. Open terminal box of protective relay.
  5. Press OFF test button.
  6. Leave the transformer's danger zone.
  7. Ensure that the transformer's circuit breaker cannot be closed.
     - Passive protection test
  8. Press IN SERVICE test button.
  9. Leave the transformer's danger zone.
  10. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
  11. Press OFF test button.
  12. Ensure that the transformer's circuit breaker is open.
     - Active protection test.
  13. Press IN SERVICE test button to reset the protective relay.
4 Commissioning the transformer at the operating site

4.2.2 Checking protective relay (RS 2004)

✓ Check that the protective relay is functioning correctly before commissioning the transformer:

1. Ensure that the flap valve is in the IN SERVICE position.
2. Leave the transformer's danger zone.
3. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
4. Press OFF test button.
5. Ensure that the transformer's circuit breaker is open.
   ⊳ Active protection test

4.3 Filling the oil compartment of the on-load tap-changer with oil

**WARNING**

Danger of death or severe injury!

Danger of death or severe injury from explosive gases under the on-load tap-changer head cover, in the pipework system, in the oil conservator or 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.

**NOTICE**

Damage to the on-load tap-changer/de-energized tap-changer!

Damage to the on-load tap-changer/de-energized tap-changer by actuating the on-load tap-changer/de-energized tap-changer without oil!

- Make sure that the selector/de-energized tap changer is fully immersed in transformer oil and that the oil compartment of the on-load tap-changer is completely filled with oil.

- The on-load tap-changer/de-energized tap-changer can be operated in the following temperature range:
  - when surrounded by transformer oil: –25 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
  - with synthetic esters in accordance with IEC 61099: –15 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
1. Establish a connecting lead between pipe connection E2 and one of the pipe connections R, S or Q to ensure equal pressure during evacuation in the oil compartment and transformer.

![Connecting lead between E2 and Q.](image)

Figure 16: Connecting lead between E2 and Q.

2. Fill on-load tap-changer with new mineral insulating oil for transformers in accordance with IEC 60296 using one of the two free pipe connections of the on-load tap-changer head.

![Pipe connection S and R](image)

Figure 17: Pipe connection S and R

3. Take oil sample from oil compartment.
4. Record temperature of oil sample just after sample is taken.
5. Determine dielectric strength and water content at a diverter switch oil temperature of 20 °C ± 5 °C. The dielectric strength and water content must comply with the limit values specified in the technical data [► 55].

### 4.4 Bleeding on-load tap-changer head and suction pipe

Before first commissioning, the on-load tap-changer head and the suction pipe on pipe connection S must be bled.

#### 4.4.1 Bleeding on-load tap-changer head

1. Open all forward and return valves in the pipe system.
2. Remove screw cap on air-vent valve E1 on the on-load tap-changer head cover.

![Figure 18: Screw cap](image)

3. Use screwdriver to lift valve tappet on air-vent valve E1 and bleed on-load tap-changer head.

![Figure 19: Valve tappet](image)

4. Seal air-vent valve E1 with screw cap (tightening torque 10 Nm).
4.4.2 Bleeding suction pipe on pipe connection S

1. Remove screw cap from pipe connection S.

2. **NOTICE!** Open vent screw and bleed suction pipe. Make sure the suction pipe is fully vented. The insulation capability of the on-load tap-changer to ground will otherwise be significantly impaired.

3. Close vent screw.

4. Seal vent screw with screw cap.

4.5 Performing trial tap-change operations

Before you energize the transformer, you must carry out trial tap-change operations to check the mechanical function of on-load tap-changer and motor-drive unit. Proceed as follows:

**NOTICE**

Damage to the on-load tap-changer/de-energized tap-changer!

Damage to the on-load tap-changer/de-energized tap-changer by actuating the on-load tap-changer/de-energized tap-changer without oil!

- Make sure that the selector/de-energized tap changer is fully immersed in transformer oil and that the oil compartment of the on-load tap-changer is completely filled with oil.

- The on-load tap-changer/de-energized tap-changer can be operated in the following temperature range:
  - when surrounded by transformer oil: –25 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
  - with synthetic esters in accordance with IEC 61099: –15 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
4 Commissioning the transformer at the operating site

1. **NOTICE!** Undertake tap-change operation tests across entire range of settings. Make sure that in each operating position the tap position indicators of motor-drive unit and on-load tap-changer (inspection window in the on-load tap-changer head) read the same position. An incorrectly coupled motor-drive unit will damage the on-load tap-changer.

2. Check, in both end positions, the function of the electrical and mechanical end stop (see MR operating instructions for motor-drive unit).

### 4.6 Commissioning the transformer

1. Loop the signaling contact for falling below the minimum oil level in the on-load tap-changer's oil conservator into the tripping circuit of the circuit breaker.

2. Loop protective relay and additional protective devices into circuit breaker's tripping circuit.

3. Ensure that all stop-cocks between on-load tap-changer and oil conservator of the on-load tap-changer are open.

4. **NOTICE!** Switch on transformer. Once the transformer has been switched on, ensure that the inrush current impulse has fully subsided before undertaking an on-load tap-change 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.

   After the transformer has been switched on and the inrush current impulse has subsided, on-load tap-changer tap-change operations can be performed both under no load and load conditions.

During all function checks and tests when commissioning, in addition to the safety instructions in Chapter 2, also note the safety notice provided in the chapter Electrical high voltage tests on the transformer.
5 Operation

The following sections describe the circumstances under which you are permitted to operate the motor-drive unit using the hand crank and how to monitor the on-load tap-changer and motor-drive unit. How to check the quality of the insulating oils is also explained.

5.1 Actuating motor-drive unit with hand crank

**WARNING**

**Danger of explosion!**

Unauthorized operation of the motor-drive unit with the hand crank may result in death or serious injury.

- Only ever open the motor-drive unit when it is de-energized and wait at least 30 minutes after the voltage supply has failed or the motor-drive unit has been switched off before you open it.
- Never operate the motor-drive unit electrically or with the hand crank before the transformer has been disconnected if you think there may be a fault in the transformer or on-load tap-changer/de-energized tap-changer.
- Never use the hand crank to complete a tap-change operation that has begun electrically, but has not been ended completely.
- If the hand crank is difficult to move, you must stop using it.
- When operating the motor-drive unit with the hand crank, never reverse the direction of rotation.
- If there is any doubt about the on-load tap-changer/de-energized tap-changer being in proper working condition or about the cause of a fault in the motor-drive unit, contact the Technical Service department of Maschinenfabrik Reinhausen GmbH immediately.
- To operate the motor-drive unit manually, only use the hand crank mounted in the motor-drive unit.

For information about fault rectification, refer to the "Troubleshooting" chapter.

**Normal operation**

During normal operation, there is no need to operate the unit with the hand crank. The hand crank is mainly required during installation or for tests in the transformer plant.

Use of the hand crank for operating the motor-drive unit is permitted if the transformer is disconnected, e.g., for maintenance tasks, if there is no detectable fault on the transformer or on-load tap-changer/de-energized tap-changer and the previous tap-change operation has been ended correctly.
Emergency operation exception

An operation is considered an emergency operation if a tap-change operation is absolutely necessary when a transformer is energized, despite a fault in the motor-drive unit. In this case, be sure to observe the warnings listed above.

Operating the motor-drive unit with the hand crank

To carry out a tap-change operation with the hand crank, proceed as follows:

1. Ensure that the protective gas supply has been switched off.
2. Open the door of the protective housing for the motor-drive unit.
3. Switch off motor protective switch Q1 (position 0).
4. Insert the hand crank mounted in the motor-drive unit into the hand crank aperture in the upper cover plate.
   - The built-in hand crank interlock switch interrupts the motor circuit at two poles. The control circuit will not be interrupted.
5. Turn in one direction with the hand crank until the pointer has fully circled the tap-change indicator once and is again in the mid-position of the area marked in gray on the tap-change indicator. Otherwise the tap-change operation is not completed correctly, which may result in damage to the on-load tap-changer and transformer.
   - The tap-change operation is complete.
6. Take off the hand crank and return to the mounting bracket.
7. Switch on motor protective switch Q1 (position I).
8. Close the door of the protective housing for the motor-drive unit.

Monitoring the on-load tap-changer and motor-drive unit

5.2 Monitoring the on-load tap-changer and motor-drive unit

Danger of death or severe injury!

Danger of death or severe injury from explosive gases under the on-load tap-changer head cover, in the pipework system, in the oil conservator or 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.
5 Operation

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/de-energized tap-changer can be operated in the following temperature range:
  - when surrounded by transformer oil: –25 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
  - with synthetic esters in accordance with IEC 61099: –15 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7

NOTICE

Damage to the on-load tap-changer!

Damage to the on-load tap-changer!

► Make sure that the signaling contact which indicates that the oil has fallen below the minimum oil level in the on-load tap-changer’s oil conservator has been looped into the tripping circuit of the circuit breaker and that the circuit breaker will immediately de-energize the transformer when the oil falls below this minimum oil level in the oil conservator.

► Make sure that the protective relay and additional protective devices have been looped into the tripping circuit of the circuit breaker and that the circuit breaker will immediately de-energize the transformer when the protective relay or additional protective devices are tripped.

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

Pay particular attention to the following:

▪ Oil impermeability at the sealing points of the on-load tap-changer head, protective relay, and connected pipes
▪ Gaskets of protective housing of motor-drive unit
▪ Correct functioning of installed electrical heater in protective housing of motor-drive unit
▪ Correct function of protective relay [► 36]
▪ Perfect condition of the silica gel breather for the on-load tap-changer oil conservator

5.3 Checking the quality of insulating oils

The insulating oils in the transformer, including the on-load tap-changer, are to be monitored by the operator following the appropriate rules and regulations.
Check the oil quality of the on-load tap-changer oil at regular intervals:

- For on-load tap-changers used on the neutral point of windings (class 1 in accordance with IEC 60214-1): **every 7 years**
- For on-load tap-changers used at points other than the neutral point of windings (class 2 in accordance with IEC 60214-1): **every 2 years**

To do so, proceed as follows:

1. Take oil sample from oil compartment.
2. Record temperature of oil sample just after sample is taken.
3. Determine dielectric strength and water content at a diverter switch oil temperature of 20 °C ± 5 °C. The dielectric strength and water content must comply with the limit values provided in the technical data.
6 Fault elimination

**WARNING**

**Danger of explosion!**

Danger of death from explosive gases under the on-load tap-changer head cover!

- Ensure that there are no open flames, hot surfaces or sparks (for example caused by static charging) in the immediate surroundings and that none arise.
- De-energize all auxiliary circuits (for example tap-change supervisory device) before removing the on-load tap-changer head cover.
- Do not operate any electrical devices during the work (for example risk of sparks caused by impact wrench).
- Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

**NOTICE**

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

Tripping of the protective relay or other protective devices can indicate damage on the on-load tap-changer and transformer! The transformer must not be energized without first undertaking checks!

- Check on-load tap-changer and transformer when protective relay or other protective devices have been tripped.
- Do not use the equipment again until you are sure there is no damage to the on-load tap-changer or transformer.

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

For more information, please consult the operating instructions for the RS-Ex protective relay or the relevant protective device.

In the event of faults on the on-load tap-changer and motor-drive unit, which cannot be easily corrected on site, or if the RS-Ex protective relay or additional protective devices have been tripped, please inform your authorized MR representative, the transformer manufacturer or contact us directly at:

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: +49 94140 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

<table>
<thead>
<tr>
<th>Fault description</th>
<th>Action</th>
</tr>
</thead>
</table>
| Tripping of protective relay (for example RS-Ex) | See [► 48]
|                                  | Also contact MR.  |
### Fault description

<table>
<thead>
<tr>
<th>Fault description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation of tap-change supervisory device</td>
<td>The motor-drive unit can no longer be electrically actuated once the tap-change supervisory device has been activated. Manual operation of the motor-drive unit via the hand crank when the transformer is switched on is prohibited. On-load tap-changer and transformer must be checked. Depending on the cause of tripping, take measurements/carry out checks on the transformer. Contact MR to check the on-load tap-changer.</td>
</tr>
<tr>
<td>Activation of rupture disk in on-load tap-changer head cover</td>
<td>On-load tap-changer and transformer must be checked. Depending on the cause of tripping, take measurements/carry out checks on the transformer. Contact MR to check the on-load tap-changer.</td>
</tr>
<tr>
<td>Tripping of motor protective switch in motor-drive unit</td>
<td>See chapter &quot;Fault elimination&quot; in the operating instructions of the TAPMOTION® ED-Ex motor-drive unit.</td>
</tr>
<tr>
<td>Tripping of signaling contact that indicates that the oil has fallen below the minimum oil level in the on-load tap-changer oil conservator</td>
<td>Check pipework system (pipes etc.) and on-load tap-changer head for leaks. Check oil level and oil quality of diverter switch oil in accordance with operating instructions for on-load tap-changer. If the oil falls below the limit values, also contact MR.</td>
</tr>
<tr>
<td>On-load tap-changer not changing tap position (sluggishness, Raise keys/Lower keys not working, no audible diverter switch action)</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>No change in voltage on transformer despite change in position on motor-drive unit</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>Tap position indicator on motor-drive unit and on-load tap-changer different</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>Noises on drive shaft or motor-drive unit when changing tap position</td>
<td>Ensure proper mounting of the drive shaft in accordance with its operating instructions. Check that hose clips and protective covers are seated correctly. Contact MR in the event of noise from the motor-drive unit.</td>
</tr>
<tr>
<td>Red message on monitoring unit</td>
<td>If possible read out database and send to MR along with error code.</td>
</tr>
<tr>
<td>Warning or tripping of Buchholz relay on transformer</td>
<td>Notify manufacturer of transformer.</td>
</tr>
<tr>
<td>Deviation from desired value when measuring winding resistance of transformer</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
<tr>
<td>Deviation from desired value during dissolved gas analysis (transformer oil)</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
<tr>
<td>Deviation from desired value during transformer ratio test</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
</tbody>
</table>
Fault description | Action
--- | ---
Deviation from limit value for diverter switch oil values | Carry out oil change, check oil conservator breather of on-load tap-changer.

Table 10: Fault elimination

6.1 Tripping of the protective relay and re-commissioning the transformer

**WARNING**

Danger of death or severe injury!

Danger of death or severe injury from explosive gases in the protective relay, which accumulate during on-load tap-changer operation!

- Wait 15 minutes after switching off the transformer before you begin further work on the protective relay so that the gases have a chance to volatize.
- 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.
- De-energize all auxiliary circuits before starting the work.
- Do not operate any electrical devices during the work (for example risk of sparks caused by impact wrench).

**WARNING**

Risk of severe injury or death!

Risk of severe injury or death if on-load tap-changer and transformer are insufficiently tested!

- Be sure to contact Maschinenfabrik Reinhausen to check on-load tap-changer and transformer after the protective relay has been tripped.
- Only use the equipment again when you are sure there is no damage to the on-load tap-changer or transformer.

When the circuit breakers have been tripped by the protective relay, proceed as follows:

1. Establish time of tripping.
2. Determine operating position of on-load tap-changer.
3. As a precaution, block the motor-drive unit by tripping the motor protective switch to prevent the on-load tap-changer from being actuated by remote control.
4. Check the on-load tap-changer head cover. If oil is leaking, shut the oil conservator stop valve immediately.
5. Check whether the flap valve of the protective relay is in the OFF or IN SERVICE position.
6.1.1 Flap valve in IN SERVICE position

If the flap valve is in the IN SERVICE position, there may be a fault in the tripping circuit. Check the tripping circuit in this case. If you are not able to clarify why the protective relay tripped, be sure to contact Maschinenfabrik Reinhausen to check the on-load tap-changer.

6.1.2 Flap valve in OFF position

If the flap valve is in the OFF position, proceed as follows:

1. Ensure that the transformer is not started up under any circumstances.
2. Contact and inform Maschinenfabrik Reinhausen of the following:
   - Serial number of protective relay and on-load tap-changer
   - What was the load of the transformer at the instant of tripping?
   - Was the on-load tap-changer moved immediately before or during tripping?
   - Did any other protective devices of the transformer respond at the instant of tripping?
   - Were switching operations in the network being carried out at the instant of tripping?
   - Were overvoltages registered at the instant of tripping?
3. Take further action in agreement with Maschinenfabrik Reinhausen.

6.1.3 Re-commissioning the transformer

Once the reason for the protective relay tripping has been established and remedied, you can re-commission the transformer:

1. Ensure that the flap valve is in the IN SERVICE position.
2. Commission the transformer.
7 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.

7.1 Inspection

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

Check the following:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>annually</td>
<td>Check the drive shaft's lubrication points for sufficient lubrication. You will find the lubrication points in the installation description (see page).</td>
</tr>
<tr>
<td>annually</td>
<td>Check upper gear unit and bevel gear for seal integrity and damage.</td>
</tr>
<tr>
<td>annually</td>
<td>Check air-vent valve on on-load tap-changer head cover for seal integrity.</td>
</tr>
<tr>
<td>annually</td>
<td>Check door seal, cable bushings, and ventilation of protective housing of motor-drive unit.</td>
</tr>
</tbody>
</table>
7 Inspection and maintenance

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>annually</td>
<td>Check coating of on-load tap-changer head, attachments, and accessories.</td>
</tr>
<tr>
<td>annually</td>
<td>Check sealing points of on-load tap-changer head, protective relay, and connected pipes.</td>
</tr>
<tr>
<td>annually</td>
<td>Check correct functioning of the installed electrical heater in the protective housing of the motor-drive unit.</td>
</tr>
<tr>
<td>annually</td>
<td>Check correct function of protective relay [► 36].</td>
</tr>
<tr>
<td>annually</td>
<td>Check perfect condition of the silica gel breather for the on-load tap-changer oil conservator.</td>
</tr>
</tbody>
</table>

Table 11: Inspection plan

7.2 Maintenance

The scope and execution of maintenance are determined by the maintenance manual for the corresponding on-load tap-changer (available on request). If the appropriate preparations are made, proper maintenance can be carried out within one day per on-load tap-changer column.

Technical Service

We strongly recommend having maintenance carried out by our Technical Service department. If this route is taken, in addition to the correct performance of all work, certain components will be upgraded to the latest state of technology and manufacturing status.

If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained by MR or are otherwise suitably qualified to carry out the work. In such cases, we would ask you to forward to us a report on the maintenance performed so we can update our maintenance files. For inquiries about spare parts, please provide the serial number (see name plate on on-load tap-changer and motor-drive unit) and the number of tap-change operations.

7.2.1 Maintenance intervals

**Maintenance intervals without MR monitoring system**

**WARNING**

**Danger of death or severe injury from failure to observe the maintenance intervals!**

If pending maintenance work is not carried out immediately, this may lead to death or serious injury as a result of a progressive short circuit, for example.

► Adherence to the following maintenance intervals is mandatory.

If you are operating the on-load tap-changer without an MR monitoring system, the following maintenance intervals shall apply.
### 7 Inspection and maintenance

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>after 150,000 switching operations (motor-drive unit counter reading)</td>
<td>Maintenance of the on-load tap-changer</td>
</tr>
<tr>
<td>after 1.2 million switching operations (motor-drive unit counter reading)</td>
<td>Selector maintenance</td>
</tr>
<tr>
<td>after 1.2 million switching operations (motor-drive unit counter reading)</td>
<td>Replacement of diverter switch insert</td>
</tr>
</tbody>
</table>

Table 12: Maintenance plan without MR monitoring system

A label on the inside of the door of the TAPMOTION® ED motor-drive unit also specifies the relevant maintenance interval.

![Figure 21: Label showing maintenance intervals](image)

#### Maintenance intervals with MR monitoring system

**WARNING**

Danger of death or severe injury from failure to observe the maintenance intervals!

If pending maintenance work is not carried out immediately, this may lead to death or serious injury as a result of a progressive short circuit, for example.

- Perform maintenance on the on-load tap-changer as soon as the MR monitoring system outputs a maintenance notification.
In the event of failure or shutdown of the MR monitoring system, observe the maintenance intervals as specified in the maintenance plan without the MR monitoring system.

If you are operating the on-load tap-changer with an MR monitoring system, the maintenance intervals displayed by the MR monitoring system shall apply. More information can be found in the operating instructions for the MR monitoring system.

### 7.2.2 Oil change

**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/de-energized tap-changer can be operated in the following temperature range:
  - when surrounded by transformer oil: –25 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7
  - with synthetic esters in accordance with IEC 61099: –15 °C…+105 °C and up to +115 °C as per IEC 60214-1 during emergency transformer operation in accordance with IEC 60076-7

When filling the oil compartment and its oil conservator, use only new mineral insulating oil for transformers in accordance with IEC 60296 (Specification for unused mineral insulating oils for transformers and switchgear).

**Performing oil change**

Carry out the oil change in accordance with the maintenance manual for the corresponding on-load tap-changer (available on request).

**Determining the dielectric strength and water content**

The dielectric strength and water content of the diverter switch oil must be determined after filling with oil. Proceed as follows:

1. Take oil sample from oil compartment.
2. Record temperature of oil sample just after sample is taken.

Determine dielectric strength and water content at a diverter switch oil temperature of 20 °C ± 5 °C. The dielectric strength and water content must comply with the limit values provided in the technical data (see page).
8 Technical data

An overview of all key technical data for the on-load tap-changer and motor-drive unit exists in the form of separate documents, which are available on request.
8.1 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 VACUTAP® on-load tap-changers. 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>$&gt; 60 \text{kV}/2.5 \text{mm}$</td>
<td>$&lt; 12 \text{ppm}$</td>
</tr>
<tr>
<td>During operation</td>
<td>$&gt; 30 \text{kV}/2.5 \text{mm}$</td>
<td>$&lt; 30 \text{ppm}$</td>
</tr>
<tr>
<td>After maintenance</td>
<td>$&gt; 50 \text{kV}/2.5 \text{mm}$</td>
<td>$&lt; 15 \text{ppm}$</td>
</tr>
</tbody>
</table>

Table 13: Limit values for on-load tap-changer oil
## 8.2 Technical data for protective relay

### General technical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Outdoor model</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP 54</td>
</tr>
<tr>
<td>Relay actuation</td>
<td>Flap valve with aperture</td>
</tr>
<tr>
<td>Vibration immunity</td>
<td>up to max. 3 g</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 3.5 kg</td>
</tr>
<tr>
<td>Oil flow speed of available types when tripping</td>
<td>0.65 ± 0.15 m/s, 1.20 ± 0.20 m/s, 3.00 ± 0.40 m/s, 4.80 ± 0.60 m/s</td>
</tr>
</tbody>
</table>

Table 14: General technical data

### Tripping switch

The protective relay can be supplied with two independent dry-reed magnetic switches. These can be designed as normally open (NO) or normally closed (NC) contacts (see dimensional drawing supplied).

### Additional electrical data for the dry-reed magnetic switches

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum admissible voltage</td>
<td>24 V</td>
</tr>
<tr>
<td>Minimum switching capacity AC/DC</td>
<td>1.2 VA/1.2 W</td>
</tr>
<tr>
<td>Power frequency withstand voltage test (insulation against ground potential)</td>
<td>Between all voltage-carrying connections and the grounded parts: at least 2500 V, 50 Hz, test duration 1 minute</td>
</tr>
</tbody>
</table>

Table 15: Additional electrical data for the dry-reed magnetic switches

### Electrical data for connecting to an inherently safe circuit

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum input voltage $U_i$</td>
<td>60 V</td>
</tr>
<tr>
<td>Maximum input current $I_i$</td>
<td>2 A</td>
</tr>
<tr>
<td>Minimum switched current at 24 V</td>
<td>50 mA</td>
</tr>
<tr>
<td>Maximum inner capacity $C_i$</td>
<td>negligible</td>
</tr>
<tr>
<td>Maximum inner inductivity $L_i$</td>
<td>negligible</td>
</tr>
</tbody>
</table>

Table 16: Connection to an inherently safe circuit

### Electrical data for connecting to a non-inherently safe circuit

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage UC</td>
<td>250 V</td>
</tr>
<tr>
<td>Rated current level</td>
<td>2 A</td>
</tr>
<tr>
<td>Maximum AC switching capacity</td>
<td>200 VA</td>
</tr>
</tbody>
</table>


8.2 Technical data for protective relay

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum DC switching capacity</td>
<td>130 W</td>
</tr>
<tr>
<td>Minimum switched current at 24 V</td>
<td>50 mA</td>
</tr>
<tr>
<td>Minimum switched current at 250 V</td>
<td>4.8 mA</td>
</tr>
</tbody>
</table>

Table 17: Connection to a non-inherently safe circuit

**Thermal data**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature $T_a$</td>
<td>$-25^\circ C$…$+50^\circ C$</td>
</tr>
<tr>
<td>Oil temperature</td>
<td>$&lt; 130^\circ C$</td>
</tr>
</tbody>
</table>

Table 18: Thermal data

8.2.1 Protective relay with several dry-reed magnetic switches

The protective relay can be supplied with several independent dry-reed magnetic switches. These can be designed as normally open (NO) or normally closed (NC) contacts and are electrically isolated (see dimensional drawing supplied).

Electrical data for normally open (NO) and normally closed (NC) dry-reed magnetic switch
9 Drawings

9.1 VACUTAP® VM, installation drawing (746230)
VACUTAP® VM - installation drawing of centrical drive (746230) –2–

11 Mounting flange on transformer cover
12 Fixing bolt M10
13 On-load tap-changer head gasket
14 Remove-position indicator before withdrawal of diverter switch
15 Inspection window
16 Bushing shaft for position indicator
17 Through hole (13 mm ØA)
21 On-load tap-changer head
22 Cover bolt
23 Cover gasket
24 On-load tap-changer head cover
25 Contact gear shaft with drive shaft 25a
26 Pipe connection 1 for protective relay
31 Diverter switch oil compartment
32 Oil compartment base with tip selector support screw 32a
33 Covering ring with 1704 C, 264 Kt, 500 Kt only
34 Oil compartment cover with insulating material
35 Connection terminal (MV 35/500/50, neutral point MV 35/500/50-65, on-load tap-changer live-off feed)
36 Connecting wire to on-load tap-changer live-off feed (MV 35/500/50, neutral point MV 35/500/50-65, on-load tap-changer live-off feed) only with MV 162/625-2500
37 Connection lead (only with MV 633/633)
38 Section pipe
39 Covering ring (only with 123 kV)
41 Tap selector insulating plate
42 Tap selector gear
43 One-way selector
44 Change-over selector
45 Tap selector contacts (see corresponding dimension drawing)
46 Change-over selector connection terminal “X” and “Y” –
47 Change-over selector connection terminal “+” and “-” –
48 Tap selector connecting lead
51 Diverter switch insert
52 Supporting cylinder
53 Base plate
54 Fixing bolt
55 Lifting up through hole (5 mm ØA)
56 Transition reaction
9.2 VACUTAP® VM 300, installation drawing (765192)

- Mounting flange on transformer cover (only if needed)
- M10 fixing screw
- Oil-lead tap-changer head/gasket
- Fillwipe indicator
- Inspection glass
- Drive shaft for position indicator
- Through holes (dia. 17)
- Oil-lead tap-changer head
- Cover screw
- Cover gasket
- Oil-lead tap-changer head cover
- Upper gear unit with drive shaft (25z)
- Pipe connection 9 for protective relay
- Pipe connection 11 for auxiliary gasket
- Pipe connection Q for oil return (with oil filter only)
- Bleeder valve of oil-lead tap-changer head cover
- Bleeder device for transformer oil compartment
- Bleeder screw for suction pipe
- On-load switch oil compartment
- Oil compartment floor with tap selector suspension
- Oil compartment connection contact
- On-load tap-changer terminal (for MR3600 expansion point terminal)
- Suction pipe
- Screening rings (only when \( I_{ nominal} = 170 \) kV and 245 kV)
- Screening rings (only when \( I_{ nominal} = 123 \) kV)

Drive side of the tap selector
### 9.3 VACUTAP® VM, installation position of selector connection contacts (890477)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Through-Hole Vertical" /></td>
<td><img src="image2" alt="Through-Hole Horizontal" /></td>
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<table>
<thead>
<tr>
<th>Model</th>
<th>Contacts Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>M III 350 / 500 / 600Y</td>
<td>- 0</td>
</tr>
<tr>
<td>VM III 350 / 500 / 650Y</td>
<td>- 0</td>
</tr>
<tr>
<td>M II 352 / 502 / 602</td>
<td>- 0</td>
</tr>
<tr>
<td>VM II 352 / 502 / 652</td>
<td>- 0</td>
</tr>
<tr>
<td>M I 351 / 501 / 601</td>
<td>- 0</td>
</tr>
<tr>
<td>VM I 351 / 501 / 651</td>
<td>- 0</td>
</tr>
<tr>
<td>M III 350 / 500 / 600Y</td>
<td>- W</td>
</tr>
<tr>
<td>VM III 350 / 500 / 650Y</td>
<td>- W</td>
</tr>
<tr>
<td>M II 352 / 502 / 602</td>
<td>- W</td>
</tr>
<tr>
<td>VM II 352 / 502 / 652</td>
<td>- W</td>
</tr>
<tr>
<td>M I 351 / 501 / 601</td>
<td>- W</td>
</tr>
<tr>
<td>VM I 351 / 501 / 651</td>
<td>- W</td>
</tr>
<tr>
<td>M III 350 / 500 / 600Y</td>
<td>- G</td>
</tr>
<tr>
<td>VM III 350 / 500 / 650Y</td>
<td>- G</td>
</tr>
<tr>
<td>M II 352 / 502 / 602</td>
<td>- G</td>
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<tr>
<td>VM II 352 / 502 / 652</td>
<td>- G</td>
</tr>
<tr>
<td>M I 351 / 501 / 601</td>
<td>- G</td>
</tr>
<tr>
<td>VM I 351 / 501 / 651</td>
<td>- G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Contact Positions" /></td>
<td><img src="image4" alt="Contact Positions" /></td>
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<table>
<thead>
<tr>
<th>Model</th>
<th>Contacts Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>M I 802</td>
<td>- 0</td>
</tr>
<tr>
<td>VM I 802</td>
<td>- 0</td>
</tr>
<tr>
<td>VM I 1002</td>
<td>- 0</td>
</tr>
<tr>
<td>M I 1203 / 1503</td>
<td>- 0</td>
</tr>
<tr>
<td>VM I 1203 / 1503</td>
<td>- 0</td>
</tr>
<tr>
<td>M I 802</td>
<td>- W</td>
</tr>
<tr>
<td>VM I 802</td>
<td>- W</td>
</tr>
<tr>
<td>VM I 1002</td>
<td>- W</td>
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<tr>
<td>M I 1203 / 1503</td>
<td>- W</td>
</tr>
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<td>- W</td>
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<tr>
<td>M I 802</td>
<td>- G</td>
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<tr>
<td>VM I 802</td>
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<tr>
<td>VM I 1002</td>
<td>- G</td>
</tr>
<tr>
<td>M I 1203 / 1503</td>
<td>- G</td>
</tr>
<tr>
<td>VM I 1203 / 1503</td>
<td>- G</td>
</tr>
</tbody>
</table>
9.4 Special design for bell-type tank installation for Um up to 300 kV (896762)
9.5 On-load tap-changer head (893899)
9.6 On-load tap-changer head with tap-change supervisory control (894109)

E1 = BLEEDING FACILITY FOR ON-LOAD TAP-CHANGER HEAD
E2 = BLEEDING FACILITY FOR SPACE UNDER THE ON-LOAD TAP-CHANGER HEAD OUTSIDE THE TAP-CHANGER OIL COMPARTMENT (OPTIONALLY WITH SAME PIPE CONNECTION AS Q, S, R OR BLEEDER SCREW)
Q = CONNECTION FOR OIL RETURN PIPE - ONLY FOR OIL FILTER 1 - CONNECTIONS ORIENTABLE THROUGH 100°
Q1 = CONNECTION FOR TAP CHANGE SUPERVISORY CONTROL, IF OIL RETURN PIPE OR OIL FILTER SYSTEM IS INSTALLED AT Q - CONNECTIONS ORIENTABLE THROUGH 100°
S = CONNECTION FOR SUCTION PIPE - CONNECTIONS ORIENTABLE THROUGH 360°
R = CONNECTION FOR PROTECTIVE RELAY 1 - EXCHANGEABLE WITH CONNECTION Q1 - CONNECTIONS ORIENTABLE THROUGH 360°
T = THERMOMETER DAS (OPTIONALLY)
SR = INSPECTION WINDOW, RIGHT
SL = INSPECTION WINDOW, LEFT

SCALE 1:25

M = DRIVE SIDE OF THE TAP SELECTOR
9.7 Pipe connection Q with tap-change supervisory control (766161)

PIECE CONNECTION WITH TAP-CHANGE SUPERVISORY CONTROL BUSHING WITHOUT OIL FILTER UNIT

NOTICE!
THE VENT SCREW (2) OF THE MOUNTED HOUSING (1) HAS TO BE ON THE TOP

ON-LOAD TAP-CHANGER HEAD

A 11
REPRESENTED WITHOUT COVER

M20x15 CLAMPING RANGE FOR CONNECTION CABLE
EXTERNAL DIAMETER 7 - 13 mm

CONNECTION TERMINALS FOR TAP-CHANGE SUPERVISORY CONTROL
WIRING SEE CONNECTION DIAGRAM OF THE MOTOR-DRIVE UNIT
FUNCTION DIAGRAM FOR TAP-CHANGE SUPERVISORY CONTROL SEE MOTOR-DRIVE CONNECTION DIAGRAM

RATED CONTINUOUS CURRENT: 2A
RATED VOLTAGE: DC (50Hz): 24V, 250V
DIELECTRIC STRENGTH: 1500V / 50Hz / 1 Min.
DIELECTRIC TEST OF ALL VOLTAGE CARRYING TERMINALS TO GROUND: 2000V AC, 50Hz, TEST-DURATION 1 Min.
9.8 Tracing template for on-load tap-changer head (890183)
9.9 Socket wrench for kerosene drain plug (890182)

<table>
<thead>
<tr>
<th>SOCKET WRENCH</th>
<th>ITEM NO. 014820: L = 1350 mm</th>
<th>ITEM NO. 017660: L = 1860 mm</th>
</tr>
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<tbody>
<tr>
<td>TO BE USED FOR ON-LOAD TAP-CHANGERS</td>
<td>TYPE M (EXCEPT M Δ)</td>
<td>TYPE M III 350 Δ / 600Δ</td>
</tr>
<tr>
<td></td>
<td>TYPE MS</td>
<td>TYPE T</td>
</tr>
<tr>
<td></td>
<td>TYPE VM®</td>
<td>TYPE R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TYPE RM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TYPE G</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TYPE VR®</td>
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</table>
9.10 Screw tools for installation and maintenance (890478)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>NO.</th>
<th>DESIGNATION</th>
<th>FIG.</th>
<th>DIN</th>
<th>WRENCH SIZE</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>DOUBLE-ENDED OPEN-JAW WRENCH</td>
<td>A</td>
<td>895</td>
<td>8 x 10</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>RING &amp; OPEN-JAW WRENCH</td>
<td>C</td>
<td>3113</td>
<td>10</td>
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<tr>
<td>3</td>
<td>1</td>
<td>DOUBLE-ENDED OPEN-JAW WRENCH</td>
<td>A</td>
<td>895</td>
<td>13 x 17</td>
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<tr>
<td>4</td>
<td>1</td>
<td>DOUBLE-ENDED SOCKET WRENCH</td>
<td>B</td>
<td>896</td>
<td>13 x 17</td>
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<tr>
<td>5</td>
<td>1</td>
<td>DOUBLE-ENDED OPEN-JAW WRENCH</td>
<td>A</td>
<td>895</td>
<td>17 x 19</td>
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<tr>
<td>6</td>
<td>1</td>
<td>DOUBLE-ENDED OPEN-JAW WRENCH</td>
<td>A</td>
<td>895</td>
<td>22 x 24</td>
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<tr>
<td>7</td>
<td>1</td>
<td>HEXAGON SOCKET SCREW KEY</td>
<td>D</td>
<td>911</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>HEXAGON SOCKET SCREW KEY</td>
<td>D</td>
<td>911</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>HEXAGON SOCKET SCREW KEY</td>
<td>D</td>
<td>911</td>
<td>8</td>
</tr>
</tbody>
</table>

ADDITIONAL DRAWING: 890479
SPECIAL TOOLS FOR THE INSPECTION
9.11 Bevel gear CD 6400, dimensional drawing (892916)

Der Drehricht wird bei Bestellung festgelegt. If the direction of rotation is defined during ordering.
# Glossary

## Dielectric strength
Material-specific property of isolators [kV/2.5 mm]: maximum electrical field strength without a breakdown (arc)

## IEC
The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.

## IP
Ingress protection

## MR
Maschinenfabrik Reinhausen GmbH

## NC
Normally Closed contact

## NO
Normally Open contact
MR worldwide

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