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1 Introduction

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

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

Information about operation can be found in the operating instructions.

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

1.1 Validity

The document supplied with the product is always the valid version. This technical file is configured for the specific order and applies to the following products, the serial numbers of which can be found on the delivery documents:

- De-energized tap-changer DEETAP® DU
- Drive shaft

1.2 Manufacturer

The product is manufactured by:

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

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

1.3 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="wrench.png" alt="Symbol" /></td>
<td>Wrench size</td>
</tr>
<tr>
<td><img src="torque.png" alt="Symbol" /></td>
<td>Tightening torque</td>
</tr>
<tr>
<td><img src="bolts.png" alt="Symbol" /></td>
<td>Number and type of fastening material used</td>
</tr>
<tr>
<td><img src="oil.png" alt="Symbol" /></td>
<td>Fill with oil</td>
</tr>
<tr>
<td><img src="cut.png" alt="Symbol" /></td>
<td>Cut open, cut through</td>
</tr>
<tr>
<td><img src="clean.png" alt="Symbol" /></td>
<td>Clean</td>
</tr>
<tr>
<td><img src="inspection.png" alt="Symbol" /></td>
<td>Visual inspection</td>
</tr>
<tr>
<td><img src="hand.png" alt="Symbol" /></td>
<td>Use your hand</td>
</tr>
<tr>
<td><img src="adapter.png" alt="Symbol" /></td>
<td>Adapter ring</td>
</tr>
<tr>
<td><img src="paint.png" alt="Symbol" /></td>
<td>Apply a coat of paint</td>
</tr>
<tr>
<td><img src="file.png" alt="Symbol" /></td>
<td>Use a file</td>
</tr>
<tr>
<td><img src="grease.png" alt="Symbol" /></td>
<td>Grease</td>
</tr>
</tbody>
</table>
1 Introduction

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

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:
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.png" alt="Pictogram" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image2.png" alt="Pictogram" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image3.png" alt="Pictogram" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image4.png" alt="Pictogram" /></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:
1 Introduction

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 a de-energized tap-changer which is used to set the voltage of oil-immersed transformers. 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 the product's entire life, 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 de-energized tap-changer and de-energized tap-changer accessories drive, drive shaft, bevel gear, protective relay etc.) must match if de-energized tap-changer and de-energized tap-changer accessories are supplied as a set for one order.
▪ You will find the applicable standard for the product and the year of issue on the nameplate.
▪ Operate the product only in accordance with this technical file, the agreed delivery conditions and technical data.
▪ Ensure that all necessary work is performed only by qualified personnel.
▪ Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file.

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:
2 Safety

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" [► 15].
▪ 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 or operate the product in areas where a risk of explosion is present.

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 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.

2.4 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 protective equipment.
- Follow information about personal protective equipment provided in the work area.

<table>
<thead>
<tr>
<th>Always wear</th>
<th>Protective clothing</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Protective clothing" /></td>
<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>
## 2 Safety

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

Table 4: Personal protective equipment to be worn at all times

<table>
<thead>
<tr>
<th>Wear the following in special environments</th>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety glasses</td>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td>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>For protection from mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>

Table 5: Personal protective equipment to be worn in special environments
3 Product description

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

3.1 Scope of delivery

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

- De-energized tap-changer
- Hand wheel or snap-on ring wrench or manual drive or motor-drive unit (depending on the order)
- Drive shaft with coupling parts and bevel gear (omitted for model with hand wheel/snap-on ring wrench)
- Technical files

Note the following information:

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

You will find more information in the "Packaging, transport, and storage" [► 29] chapter.

3.2 De-energized tap-changer

3.2.1 Function description

De-energized tap-changers are used for setting the voltage of oil-immersed transformers. In contrast to on-load tap-changers, the required winding taps must be set with the transformer switched off on the high-voltage and low-voltage side.

The de-energized tap-changer is changed over from one operating position to the next by rotating an insulating drive shaft. The de-energized tap-changer is actuated using the TAPMOTION® DD manual drive, the TAPMOTION® ED motor-drive unit, a hand wheel or an operating wrench.

3.2.2 Setup/models

The DEETAP® DU de-energized tap-changer can be supplied in the following designs:

- Linear de-energized tap-changer
- Single-bridging de-energized tap-changer
- Double-bridging de-energized tap-changer
- Series-parallel de-energized tap-changer
• Star-delta de-energized tap-changer
• Buck-and-boost de-energized tap-changer
• De-energized tap-changer for special applications

The de-energized tap-changer is produced following a modular principle where maximum rated through-currents of 200 A, 400 A, 600 A, 800 A, and 1000 A are possible per contact plane.

The de-energized tap-changer can be supplied with a maximum of 17 operating positions.
The design of the de-energized tap-changer and the designation of its main parts are shown in the installation drawings in the appendix.

Figure 1: DEETAP® DU

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tap-change supervisory control with inspection window for tap position indicator</td>
</tr>
<tr>
<td>2</td>
<td>De-energized tap-changer head</td>
</tr>
<tr>
<td>3</td>
<td>Upper gear unit</td>
</tr>
<tr>
<td>4</td>
<td>Connection contact</td>
</tr>
<tr>
<td>5</td>
<td>De-energized tap-changer cage</td>
</tr>
</tbody>
</table>
3.2.3 Name plate

The name plate is on the de-energized tap-changer head.

Position of name plate

3.2.4 Protective devices

To prevent the equipment from being actuated unintentionally or by unauthorized persons, the de-energized tap-changer and/or drive are provided with the following protective devices:

3.2.4.1 De-energized tap-changer with hand wheel/operating wrench on the de-energized tap-changer head

The device is equipped with the following safety devices.

3.2.4.1.1 Mechanical locking

The de-energized tap-changer can only be operated after removing the padlock. The hand wheel is removable; it can be locked using a padlock.

3.2.4.1.2 Electrical tripping and locking option

Electrically tripping and locking the transformer circuit breakers using the built-in cam switch (see functional principle on the basis of connection diagram 1531579).

The tripping circuit of the transformer circuit breakers is regarded as a closed circuit below. The specified connection diagrams are only examples. The wiring of the tripping and locking device must be laid out in accordance with the binding connection diagram based on the specific order.
Ensure that the transformer is off before a separation of the de-energized tap-changer contacts takes place when activating the hand wheel/operating wrench.

- The tripping and locking device on the de-energized tap-changer head contains two mechanically activated micro-switches S80 and S90.
- S90 is operated after each tap change of the de-energized tap-changer, i.e. it returns to its original position after the de-energized tap-changer has been operated by one tap change.
- The tripping and locking device is designed in accordance with the closed circuit current principle, i.e. a voltage drop will cause a circuit breaker to be tripped. For safety reasons, the monitoring current circuit should therefore be powered by an uninterruptible power supply.
- The transformer circuit breakers must trip automatically if micro-switch S90 of the tripping and locking device opens, i.e. the de-energized tap-changer switching shaft is rotated.
- It must be possible to switch on the transformer circuit breakers only if micro-switch S90 of the tripping and locking device is closed, i.e. the de-energized tap-changer is in a defined operating position.

3.2.4.2 TAPMOTION® DD manual drive

The device is equipped with the following safety devices.

3.2.4.2.1 Mechanical locking

Locking provided via a padlock on the manual drive.

3.2.4.2.2 Tap-change supervisory control

The electrical tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [► 165] and 725737 [► 166], functional principle on the basis of connection diagram 2150823).

The tripping circuit of the transformer circuit breakers is regarded as a closed circuit below. The specified connection diagrams are only examples. The wiring of the tripping and locking device must be laid out in accordance with the binding connection diagram based on the specific order.

The tap-change supervisory control fulfills several functions in connection with the drive:
- Automatically tripping the connected transformer circuit breakers when the de-energized tap-changer is operated.
- Preventing the circuit breaker from being reenergized as long as the de-energized tap-changer or drive are not in a defined operating position.
- Monitoring the drive shaft between the de-energized tap-changer and drive.
When the drive is operated, the disconnection of the transformer must be triggered by the built-in cam switches S80, S90, S48, and S156 before the de-energized tap-changer contacts open. The transformer must be energized only if the de-energized tap-changer and drive are in the same operating position.

With a TAPMOTION® DD manual drive, the cam switch can be connected electrically once the terminal box on the bottom of the drive protective housing has been removed (see TAPMOTION® DD operating instructions).

- The tap-change supervisory control at the de-energized tap-changer head includes two mechanically operated micro-switches, S80 and S90.
- S90 is operated after each tap change of the de-energized tap-changer, i.e. it returns to its original position after the de-energized tap-changer has been operated by one tap change.
- S80 is operated in every operating position, i.e. it changes switching states after the de-energized tap-changer changes from one operating position to the next. It returns to its original position after a second subsequent operating position has been reached.
- The TAPMOTION® DD manual drive contains a micro-switch, S48, which is non-directional and mechanically activated, and a cam-operated directional switch, S156, which is mechanically activated.
- The tap-change supervisory control is designed in accordance with the closed-circuit current principle, i.e. a voltage drop will trip a circuit breaker. For safety reasons, the monitoring current circuit should therefore be powered by an uninterruptible power supply.

The transformer circuit breakers must be tripped automatically if

- Micro-switch S90 of the tap-change supervisory control opens, i.e. the de-energized tap-changer switching shaft is turned.
- Micro-switch S48 of the drive opens, i.e. the drive is operated.
- The position of micro-switch S80 of the tap-change supervisory control does not match the position of micro-switch S156 of the drive, i.e. the drive is operated and the drive shaft between the drive and de-energized tap-changer is uncoupled.

Reclosure of the transformer circuit breakers must be possible only if

- Micro-switch S90 of the tap-change supervisory control is closed, i.e. the de-energized tap-changer is in a defined operating position.
- Micro-switch S48 of the drive is closed, i.e. the drive is in a defined operating position.
- The position of micro-switch S80 of the tap-change supervisory control matches the position of micro-switch S156 of the drive, i.e. de-energized tap-changer and drive are in the same operating position.

3.2.4.3 TAPMOTION® ED motor-drive unit

The device is equipped with the following safety devices.
3.2.4.3.1 Mechanical locking

A mechanical locking device such as a padlock can be used or a cylinder lock can be installed.

3.2.4.3.2 Tap-change supervisory control

The tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [► 165] and 725737 [► 166], functional principle on the basis of connection diagram 1579393).

The tap-change supervisory control fulfills several functions in connection with the drive:

▪ Automatically tripping the connected transformer circuit breakers when the de-energized tap-changer is operated.
▪ Preventing the circuit breaker from being reenergized as long as the de-energized tap-changer or drive are not in a defined operating position.
▪ Monitoring the drive shaft between the de-energized tap-changer and drive.
▪ The tap-change supervisory control at the de-energized tap-changer head includes two mechanically operated micro-switches, S80 and S90.
▪ S90 is operated after each tap change of the de-energized tap-changer, i.e. it returns to its original position after the de-energized tap-changer has been operated by one tap change.
▪ S80 is operated in every operating position, i.e. it changes switching states after the de-energized tap-changer changes from one operating position to the next. It returns to its original position after a second subsequent operating position has been reached.

The following are also provided in the motor-drive unit (functional principle on the basis of connection diagram 1570451, sheet 1 and sheet 2):

▪ 1 mechanical, non-directional cam switch S117 (is activated between the tap-change indicator sections 2-31)
▪ 1 mechanical, cam-operated directional switch S156 (changes the state for each change in position)
▪ The supply voltage for the control circuit of the motor-drive unit is led over potential-free contacts of the transformer circuit breaker which are closed when the circuit-breaker is off.

The tap-change supervisory control is designed in accordance with the closed-circuit current principle, i.e. a power failure will trip a circuit breaker. For safety reasons, the monitoring current circuit should therefore be powered by an uninterruptible power supply.

The motor-drive unit can thus only be operated electrically if the transformer circuit breaker is switched off.
The motor protective switch in the motor-drive unit interrupts the motor circuit and the control circuit if a change in position is attempted electrically with the circuit breaker engaged.

The circuit breaker for the transformer is tripped if:

▪ Micro-switch S90 (de-energized tap-changer head) of the tap-change supervisory control opens, i.e. the selector switch shaft of the de-energized tap-changer is turned.

▪ Non-directional cam-operated contact (motor-drive unit) S117 opens, i.e. the motor-drive unit is not in a defined position.

Switching on the transformer circuit breaker must only be possible if:

▪ Micro-switch S90 (de-energized tap-changer head) of the tap-change supervisory control is closed, i.e. the de-energized tap-changer is in a defined operating position.

▪ Non-directional cam-operated contact (motor-drive unit) S117 is closed, i.e. the motor-drive unit is in a defined position.

▪ Micro-switch S80 (de-energized tap-changer head) of the tap-change supervisory control and directional cam switch S156 match, i.e. de-energized tap-changer and motor-drive unit are in the same operating position.

### 3.3 Drive shaft

#### 3.3.1 Function description

The drive shaft is the mechanical connection between motor-drive and on-load tap-changer head / de-energized 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.
3.3.2 Design/versions

The drive shaft consists of a square tube and is coupled at each end by two coupling brackets and one coupling bolt to the drive / driven shaft end of the device to be connected.

![Diagram of drive shaft components]

Figure 2: Components of the 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>Telescopic protective tube</td>
</tr>
<tr>
<td>4</td>
<td>Coupling bracket</td>
</tr>
<tr>
<td>5</td>
<td>Square tube</td>
</tr>
<tr>
<td>6</td>
<td>Coupling bolt</td>
</tr>
<tr>
<td>7</td>
<td>Adapter ring</td>
</tr>
<tr>
<td>8</td>
<td>Protective cover</td>
</tr>
<tr>
<td>9</td>
<td>Hose clip</td>
</tr>
</tbody>
</table>
3.3.2.1 Drive shaft without cardan joint and without insulator

Figure 3: Drive shaft without cardan joint and without insulator (= normal model)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min</th>
<th>Intermediate bearing</th>
</tr>
</thead>
</table>
| Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°) | 536 mm | When the maximum value of 2472 mm is exceeded, it is necessary to use an intermediate bearing.  
V 1 ≤ 2472 mm (without intermediate bearing)  
V 1 > 2472 mm (with intermediate bearing) |
3.3.2.2 Drive shaft without cardan joint and with insulator

Figure 4: Drive shaft without cardan joint and with insulator (= special model)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min</th>
<th>Intermediate bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°)</td>
<td>706 mm</td>
<td>When the maximum value of 2472 mm is exceeded, it is necessary to use an intermediate bearing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V 1 ≤ 2472 mm (without intermediate bearing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V 1 &gt; 2472 mm (with intermediate bearing)</td>
</tr>
</tbody>
</table>
3.3.2.3 Drive shaft with cardan joint and without insulator

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min [mm]</th>
<th>Intermediate bearing for [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle of hand crank – middle of bevel gear (maximum permissible axial offset alpha = 20°)</td>
<td>798</td>
<td>V 1 &gt; 2564</td>
</tr>
</tbody>
</table>

Figure 5: Drive shaft with cardan joint and without insulator (= special model)

3.3.2.4 Drive shaft with cardan joint and with insulator

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min [mm]</th>
<th>Intermediate bearing for [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle of hand crank – middle of bevel gear (maximum permissible axial offset alpha = 20°)</td>
<td>978</td>
<td>V 1 &gt; 2772</td>
</tr>
</tbody>
</table>

Figure 6: Drive shaft with cardan joint and with insulator (= special model)
4 Packaging, transport and storage

4.1 Packaging

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

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

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

4.1.1 Suitability

**NOTICE**

Property damage due to incorrectly stacked crates!
Stacking the crates incorrectly can lead to damage to the packaged goods!

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

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

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

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

4.1.2 Markings

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

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

Table 6: Shipping pictograms
4.2 Transportation, receipt and handling of shipments

**WARNING**

Danger of death and damage to property!

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

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

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

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

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

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

**Visible damage**

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

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

**NOTICE!** Be absolutely sure to also check the sealed packaging. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either dry the dried packaged goods again as per the operating instructions for the relevant on-load tap-
4 Packaging, transport and storage

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

- Name the damaged parts.

Hidden damage When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:
- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

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

4.3 Storage of shipments

Packaged goods dried by Maschinenfabrik Reinhausen

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

Non-dried packaged goods

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

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

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

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

### 4.4 Unpacking shipments and checking for transportation damages

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

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

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

This chapter describes how to install the de-energized tap-changer in a transformer and how to dry it.

5.1 Preparatory work

Perform the work stated below before installing the de-energized tap-changer in the transformer.

5.1.1 Fitting mounting flange on transformer cover

An optionally available mounting flange is required to install the de-energized tap-changer head onto the transformer cover (see page [► 146] for a 400 mm contact circle diameter and page [► 148] for a 600/850 mm contact circle diameter).

Alternatively you can produce your own mounting flange as shown in the corresponding drawings in the appendix (see page [► 147] for a 400 mm contact circle diameter and page [► 149] for a 600/850 mm contact circle diameter).

When installing the de-energized tap-changer into a transformer with bell-type tank design, the mounting flange produced by the customer may also have a square profile. Please note that the overall height of the mounting flange + transformer wall thickness must be < 50 mm.

► Fit the mounting flange onto the transformer cover.

5.1.2 Fitting stud bolts on mounting flange

To attach the stud bolts to the mounting flange, use a tracing template, which can be provided upon request free of charge for the initial installation of the de-energized tap-changer (see page [► 150] for a 400 mm contact circle diameter and page [► 151] for a 600/850 mm contact circle diameter). The stud bolts and mounting flange are not included in delivery but can be ordered as an option.

1. Place the tracing template on the mounting flange and use the four markings for alignment.
2. Fit the stud bolts on the mounting flange.

Figure 7: Template and stud bolts for the 400 mm contact circle diameter
5.2 Installing de-energized tap-changer in a transformer (standard design)

Depending on the de-energized tap-changer design, you can fit the de-energized tap-changer in the transformer in 3 different ways.

These 3 forms of installation are described below.

Installing the de-energized tap-changer without disconnecting the de-energized tap-changer head and de-energized tap-changer cage

- 400/600 mm contact circle diameter, Um ≤ 300 kV

Installing the de-energized tap-changer by disconnecting the de-energized tap-changer head and de-energized tap-changer cage without supporting flange

- Contact circle diameter: 400/600 mm, Um ≥ 362 kV, optionally also for Um ≤ 300 kV
- Contact circle diameter: 850 mm
Installing the de-energized tap-changer by disconnecting the de-energized tap-changer head and de-energized tap-changer cage with optional supporting flange

- Contact circle diameter: 400/600 mm, Um ≥ 362 kV, optionally also for Um ≤ 300 kV
- Contact circle diameter: 850 mm

5.2.1 Installing the de-energized tap-changer without disconnecting the de-energized tap-changer head and de-energized tap-changer cage

For de-energized tap-changers with a 400 mm and 600 mm contact circle diameter up to a 300 kV voltage range, you can lower the de-energized tap-changer through the opening in the mounting flange without disconnecting the de-energized tap-changer head from the de-energized tap-changer cage.

Proceed as follows to install the de-energized tap-changer:

1. **WARNING!** Place the de-energized tap-changer on a level surface and secure it against tipping. An unstably positioned de-energized tap-changer may tip, resulting in serious injuries!
2. Clean the sealing surfaces and sealing groove on the bottom of the de-energized tap-changer head and the sealing surfaces on top of the mounting flange.

Figure 9: Sealing surfaces
3. Insert the provided O-ring into the sealing groove on the bottom of the de-energized tap-changer head and ensure that it is not twisted.

Figure 10: O-ring

4. Remove cable ties from upper gear unit.

Figure 11: Cable tie
5. Turn the Geneva wheel crank of the step-by-step gear inwards by 90° starting from the adjustment position (delivery position). The hand crank is not included in delivery.

Figure 12: Geneva wheel crank
6. **NOTICE!** Lift the de-energized tap-changer over the mounting flange and carefully lower it into the mounting flange opening. Take care not to damage the connection contacts and screening rings.

![Figure 13: Lowering the de-energized tap-changer](image)

7. Check that the mounting position of the de-energized tap-changer is correct. Note the markings on the de-energized tap-changer head relating to the drive side (see page [► 138] and [► 139]).
8. Screw the de-energized tap-changer head to the mounting flange.

Figure 14: Screwing de-energized tap-changer to mounting flange

9. **NOTICE!** Turn the Geneva wheel crank of the step-by-step gear back by 90° into the adjustment position. Otherwise there is a risk of malfunctions from de-energized tap-changer connection contacts closing incorrectly.

Figure 15: Geneva wheel crank in adjustment position
10. Remove the set-down cylinder including the mounting material.

11. **NOTICE!** Secure a very long de-energized tap-changer to prevent it twisting as a result of being turned and slid. Ensure that it can still be slid in an axial direction (see order-specific dimensional drawing and page [► 152]). Failure to do so may result in damage to the de-energized tap-changer.
5.2.2 Installing the de-energized tap-changer by disconnecting the de-energized tap-changer head and de-energized tap-changer cage without supporting flange

For de-energized tap-changers with a 400 mm and 600 mm contact circle diameter at a voltage range of 362 kV or higher ($U_{m}$≤300 kV as an option) and de-energized tap-changers with a 850 mm contact circle diameter, you first must remove the de-energized tap-changer head from the de-energized tap-changer cage to install the de-energized tap-changer since the contact circle diameter of the de-energized tap-changer is bigger than the inner diameter of the mounting flange. Next position the de-energized tap-changer head on the mounting flange, lift the de-energized tap-changer cage from below onto the de-energized tap-changer head and then secure the de-energized tap-changer cage on the de-energized tap-changer head.

Proceed as follows to install the de-energized tap-changer:

5.2.2.1 Required tools

Ensure that the following tools are available before starting to install the de-energized tap-changer.

- Lifting traverse
- Transformer oil

5.2.2.2 Removing the de-energized tap-changer head

1. **WARNING!** Place the de-energized tap-changer on a level surface and secure it against tipping. An unstably positioned de-energized tap-changer may tip, resulting in serious injuries!

2. Unscrew the locking screws on the de-energized tap-changer head.
3. Unscrew the fixing bolts underneath.

Figure 18: Fixing bolts
5 Mounting

4. Lift the de-energized tap-changer head up off the de-energized tap-changer cage.

Figure 19: De-energized tap-changer head
5.2.2.3 Positioning the de-energized tap-changer head on the transformer cover

1. Clean the sealing surfaces and sealing groove on the bottom of the de-energized tap-changer head and the sealing surfaces on top of the mounting flange.

2. Insert the provided O-ring into the sealing groove on the bottom of the de-energized tap-changer head and ensure that it is not twisted.
3. Use transformer oil to lubricate the coupling in the de-energized tap-changer cage and the Geneva wheel in the de-energized tap-changer head.

![Figure 22: Coupling and Geneva wheel](image)

4. Align the de-energized tap-changer cage based on the later mounting position.

5. **CAUTION!** Lift the de-energized tap-changer cage from below onto the transformer cover. There must be 65 to 80 mm of clearance between the cage ring and the upper edge of the mounting flange. Only use the set-down cylinder for lifting and never the circumferential
screening ring (if present). Secure the de-energized tap-changer against tipping and falling. Failure to do so may result in personal injury or property damage.

Figure 23: Lifting de-energized tap-changer cage

6. Remove cable ties from upper gear unit.

Figure 24: Cable tie
5 Mounting

7. Turn the Geneva wheel crank of the step-by-step gear inwards by 90° starting from the adjustment position (delivery position). The hand crank is not included in delivery.

Figure 25: Geneva wheel crank
8. Position de-energized tap-changer head on mounting flange so that the 5 mounting points on the de-energized tap-changer head and de-energized tap-changer cage match. Ensure that the Geneva wheel's shaft engages in the insulating drive shaft when the de-energized tap-changer cage is lifted.

Figure 26: De-energized tap-changer head
5.2.2.4 Connecting the de-energized tap-changer cage with de-energized tap-changer head

1. Align the de-energized tap-changer cage so that the 5 mounting points on the de-energized tap-changer cage and the de-energized tap-changer head match.

2. Install the lifting traverse.
3. Lift the de-energized tap-changer cage with the lifting traverse until there is a visible gap of about 5 mm between the de-energized tap-changer head and the mounting flange.

![Figure 29: Lifting de-energized tap-changer cage](image1)

4. Start by screwing the de-energized tap-changer cage to the de-energized tap-changer head using 3 fixing screws.

![Figure 30: Screwing de-energized tap-changer cage to de-energized tap-changer head](image2)

5. Lower the de-energized tap-changer onto the mounting flange and remove the lifting traverse.
6. Screw the de-energized tap-changer cage to the de-energized tap-changer head using the 2 remaining fixing screws.

Figure 31: Screwing de-energized tap-changer cage to de-energized tap-changer head

7. Clean the sealing surfaces of the locking screws; install the locking screws.

Figure 32: Locking screws
8. **NOTICE!** Turn the Geneva wheel crank of the step-by-step gear back by 90° into the adjustment position. Otherwise there is a risk of malfunctions from de-energized tap-changer connection contacts closing incorrectly.

![Figure 33: Geneva wheel crank in adjustment position](image)

9. Screw the de-energized tap-changer head to the mounting flange.

![Figure 34: Screwing de-energized tap-changer head to mounting flange](image)
10. Remove the set-down cylinder including the mounting material.

![Figure 35: Set-down cylinder](image)

11. **NOTICE!** Secure a very long de-energized tap-changer to prevent it twisting as a result of being turned and slid. Ensure that it can still be slid in an axial direction (see order-specific dimensional drawing and page [► 152]). Failure to do so may result in damage to the de-energized tap-changer.
5.2.3 Installing the de-energized tap-changer by disconnecting the de-energized tap-changer head and de-energized tap-changer cage with optional supporting flange

For de-energized tap-changers with a 400 mm and 600 mm contact circle diameter at a voltage range of 362 kV or higher (Um≤300 kV as an option) and de-energized tap-changers with a 850 mm contact circle diameter, you first must remove the de-energized tap-changer head from the de-energized tap-changer cage to install the de-energized tap-changer since the contact circle diameter of the de-energized tap-changer is bigger than the inner diameter of the mounting flange. Then position the de-energized tap-changer head on the mounting flange and temporarily position the de-energized tap-changer cage in a supporting structure. Next lift the de-energized tap-changer cage from below onto the de-energized tap-changer head and secure the de-energized tap-changer cage on the de-energized tap-changer head.

Proceed as follows to install the de-energized tap-changer:

5.2.3.1 Required tools

Ensure that the following tools are available before starting to install the de-energized tap-changer.

- Lifting traverse
- Transformer oil
- Spacers

5.2.3.2 Removing the de-energized tap-changer head

1. **WARNING!** Place the de-energized tap-changer on a level surface and secure it against tipping. An unstably positioned de-energized tap-changer may tip, resulting in serious injuries!
2. Unscrew the locking screws on the de-energized tap-changer head.

Figure 36: Locking screws

3. Unscrew the fixing bolts underneath.

Figure 37: Fixing bolts
4. Lift the de-energized tap-changer head up off the de-energized tap-changer cage.

Figure 38: De-energized tap-changer head
5.2.3.3 Positioning the de-energized tap-changer head on the transformer cover

1. Clean the sealing surfaces and sealing groove on the bottom of the de-energized tap-changer head and the sealing surfaces on top of the mounting flange.

![Figure 39: Cleaning the sealing surfaces](image)

2. Insert the oil-resistant gasket provided into the sealing groove on the bottom of the de-energized tap-changer head and ensure that it is not twisted.

![Figure 40: O-ring](image)
3. Use transformer oil to lubricate the coupling in the de-energized tap-changer cage and the Geneva wheel in the de-energized tap-changer head.

![Figure 41: Coupling and Geneva wheel](image1)

4. Suspend the de-energized tap-changer cage in a temporary supporting structure and align it based on the de-energized tap-changer's subsequent mounting position.

![Figure 42: De-energized tap-changer cage in supporting structure](image2)
5. **CAUTION!** Lift the de-energized tap-changer cage from below onto the transformer cover. Use spacers to configure a distance of about 75 mm between the bottom edge of the supporting flange and the upper edge of the mounting flange. Only use the supporting flange or set-down cylinder for lifting and never the circumferential screening ring (if present). Secure the de-energized tap-changer against tipping and falling. Failure to do so may result in personal injury or property damage.

![Figure 43: Lifting de-energized tap-changer cage](image)

6. Remove cable ties from upper gear unit.

![Figure 44: Cable tie](image)
7. Turn the Geneva wheel crank of the step-by-step gear inwards by 90° starting from the adjustment position (delivery position). The hand crank is not included in delivery.

Figure 45: Geneva wheel crank
8. Position de-energized tap-changer head on mounting flange so that the 5 mounting points on the de-energized tap-changer head and de-energized tap-changer cage match. Ensure that the Geneva wheel's shaft engages in the insulating drive shaft when the de-energized tap-changer cage is lifted.

Figure 46: De-energized tap-changer head
5.2.3.4 Connecting the de-energized tap-changer cage with de-energized tap-changer head

1. Align the de-energized tap-changer cage so that the 5 mounting points on the de-energized tap-changer cage and the de-energized tap-changer head match.

Figure 47: Aligning de-energized tap-changer cage
2. Install the lifting traverse.

Figure 48: Lifting traverse

3. Lift the de-energized tap-changer cage with the lifting traverse until there is a visible gap of about 5 mm between the de-energized tap-changer head and the mounting flange.

Figure 49: Lifting de-energized tap-changer cage
4. Start by screwing the de-energized tap-changer cage to the de-energized tap-changer head using 3 fixing screws.

![Figure 50: Fixing screws](image)

5. Remove the spacers.

![Figure 51: Removing the spacers](image)

6. Lower the de-energized tap-changer onto the mounting flange and remove the lifting traverse.
7. Screw the de-energized tap-changer cage to the de-energized tap-changer head using the 2 remaining fixing screws.

Figure 52: Screwing de-energized tap-changer cage to de-energized tap-changer head

8. Clean the sealing surfaces of the locking screws; install the locking screws.

Figure 53: Locking screws
9. **NOTICE!** Turn the Geneva wheel crank of the step-by-step gear back by 90° into the adjustment position. Otherwise there is a risk of malfunctions from de-energized tap-changer connection contacts closing incorrectly.

![Geneva wheel crank in adjustment position](image1)

**Figure 54: Geneva wheel crank in adjustment position**

10. Screw the de-energized tap-changer head to the mounting flange.

![Screwing de-energized tap-changer head to mounting flange](image2)

**Figure 55: Screwing de-energized tap-changer head to mounting flange**
11. Remove the set-down cylinder including the mounting material.

![Figure 56: Set-down cylinder](image)

12. **NOTICE!** Secure a very long de-energized tap-changer to prevent it twisting as a result of being turned and slid. Ensure that it can still be slid in an axial direction (see order-specific dimensional drawing and page [► 152]). Failure to do so may result in damage to the de-energized tap-changer.
5.3 Installing de-energized tap-changer in transformer (bell-type tank design)

If the de-energized tap-changer is being installed in a bell-type tank transformer, you must first lift the de-energized tap-changer into a supporting structure (fork) and make the electrical connections to the active part of the transformer. Next, remove the de-energized tap-changer head from the de-energized tap-changer cage, set up the bell-type tank, and then screw the de-energized tap-changer cage to the de-energized tap-changer head.

Proceed as follows:

5.3.1 Required tools

Ensure that the following tools are available before starting to install the de-energized tap-changer.

- Lifting traverse
- Transformer oil
- Spacers

5.3.2 Positioning the supporting structure

1. When positioning the supporting structure, ensure the correct vertical and horizontal position of the supporting structure in the transformer that will be fully fitted later on.

2. Position supporting structure as shown below taking account of the actual transformer dimensions.

![Figure 57: Positioning supporting structure](image)

<table>
<thead>
<tr>
<th>1</th>
<th>Contact circle diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Supporting structure</td>
</tr>
<tr>
<td>3</td>
<td>Supporting flange</td>
</tr>
<tr>
<td>4</td>
<td>Transformer cover</td>
</tr>
<tr>
<td>5</td>
<td>De-energized tap-changer head</td>
</tr>
<tr>
<td>6</td>
<td>Spacer</td>
</tr>
</tbody>
</table>
### 5.3.3 Suspending de-energized tap-changer in supporting structure

1. **NOTICE!** Using spacers, insert the de-energized tap-changer into the supporting structure vertically so that the de-energized tap-changer reaches its final installation height and only has to be raised a maximum of 5 to 20 mm after fitting the bell-type tank. If this is not done, once the tap winding is connected tension may occur which will damage the de-energized tap-changer and transformer. In addition, there is a risk of malfunctions from de-energized tap-changer contacts closing incorrectly.

![Figure 58: De-energized tap-changer in supporting structure](image)
2. Temporarily fasten the de-energized tap-changer to the supporting structure. The supporting flange has through holes for this purpose.

3. Connecting de-energized tap-changer to tap winding (see page [► 82]).

4. Carry out a transformer ratio test (see page [► 83]).

5. Remove temporary fasteners and spacers.
5.3.4 Removing the de-energized tap-changer head

1. Unscrew the locking screws on the de-energized tap-changer head.

![Figure 61: Locking screws](image1)

2. Unscrew the fixing screws underneath.

![Figure 62: Fixing screws](image2)
3. Lift the de-energized tap-changer head up off the de-energized tap-changer cage.

Figure 63: De-energized tap-changer head
4. Remove the set-down cylinder including the mounting material.

5.3.5 Installing a bell-type tank and connecting the de-energized tap-changer cage to the de-energized tap-changer head

1. Lift the bell-type tank over the active part of the transformer and thus over the de-energized tap-changer cage. Depending on the height adjustment, 65 to 80 mm of clearance must be present between the bot-
tom edge of the supporting flange and the upper edge of the mounting flange (see drawing 725975 [► 141] for a 400 mm contact circle and drawing 725976 [► 142] for a 600/850 mm contact circle).

Figure 65: Bell-type tank

2. Clean the sealing surfaces and sealing groove on the bottom of the de-energized tap-changer head and the sealing surfaces on top of the mounting flange.

Figure 66: Sealing surfaces
3. Insert the oil-resistant gasket provided into the sealing groove on the bottom of the de-energized tap-changer head and ensure that it is not twisted.

![Figure 67: O-ring](image)

4. Use transformer oil to lubricate the coupling in the de-energized tap-changer cage and the Geneva wheel in the de-energized tap-changer head.

![Figure 68: Lubricating coupling and Geneva wheel](image)

5. Remove cable ties from upper gear unit.
6. Turn the Geneva wheel crank of the step-by-step gear inwards by 90° starting from the adjustment position (delivery position). The hand crank is not included in delivery.

![Figure 69: Installation position](image)

7. Position de-energized tap-changer head on mounting flange so that the 5 mounting points on the de-energized tap-changer head and de-energized tap-changer cage match. Ensure that the Geneva wheel's shaft engages in the insulating drive shaft when the de-energized tap-changer cage is lifted.

8. Install the lifting traverse.

![Figure 70: Lifting traverse](image)
9. Lift the de-energized tap-changer cage with the lifting traverse until there is a visible gap of about 5 mm between the de-energized tap-changer head and the mounting flange.

![Figure 71: Lifting de-energized tap-changer cage](image)

10. Start by screwing the de-energized tap-changer cage to the de-energized tap-changer head using 3 fixing screws.

![Figure 72: Screwing de-energized tap-changer cage to de-energized tap-changer head](image)

11. Lower the de-energized tap-changer onto the mounting flange and remove the lifting traverse.
12. Screw the de-energized tap-changer cage to the de-energized tap-changer head using the 2 remaining fixing screws.

Figure 73: Screwing de-energized tap-changer cage to de-energized tap-changer head

13. Clean the sealing surfaces of the locking screws; install the locking screws.

Figure 74: Locking screws
14. **NOTICE!** Turn the Geneva wheel crank of the step-by-step gear back by 90° into the adjustment position. Otherwise there is a risk of malfunctions from de-energized tap-changer connection contacts closing incorrectly.

![Figure 75: Geneva wheel crank in adjustment position](image)

15. Screw the de-energized tap-changer head to the mounting flange.

![Figure 76: Screwing de-energized tap-changer head to mounting flange](image)

16. **NOTICE!** Secure a very long de-energized tap-changer to prevent it twisting as a result of being turned and slid. Ensure that it can still be slid in an axial direction (see order-specific dimensional drawing and page [► 152]). Failure to do so may result in damage to the de-energized tap-changer.
5.4 Connecting the de-energized tap-changer to the tap winding

**NOTICE**

**Damage to the de-energized tap-changer from improperly connecting the de-energized tap-changer to the tap winding!**

Incorrectly installed leads can exert mechanical tension on the connection contacts, resulting in changes in the position of the connection contacts and impairment of correct contacting.

► Connect the leads in such a manner that you can lift the de-energized tap-changer to its final installation height even after setting up the bell-type tank without causing any tension on the connection contacts in this position.

► Lay out the ends of the connections as an expansion loop if necessary.

► Install and secure the leads so that the application of force to the de-energized tap-changer is kept to a minimum during all operating, testing and malfunction conditions (e.g. short circuit).

► If parallel bridges are fitted on the de-energized tap-changer (see page [► 174]), connect leads to all connection holes provided.

► Establish and secure the connections with care.

► Use fixing screws (12 mm diameter, not included in delivery) to connect the de-energized tap-changer to the tap winding in accordance with the connection diagram included in the delivery. Screening caps for the fixing screws can be delivered optionally.

![Figure 77: Connection contacts](image)
5.5 Carrying out transformer ratio test

Carry out a transformer ratio test before the transformer is dried.

If the de-energized tap-changer is equipped with a TAPMOTION® DD manual drive or TAPMOTION® ED motor-drive unit, you have to use a short tube (25 mm nominal width) with a coupling bolt inserted (12 mm diameter) and a hand wheel or crank to operate the drive shaft of the upper gear unit.

1. **NOTICE!** Wet all of the de-energized tap-changer contacts with mineral insulating oil for transformers before the transformer ratio test. Failure to do so may result in damage to the de-energized tap-changer.

2. Now move de-energized tap-changer into the desired operating position.

3. **NOTICE!** Carry out the transformer ratio test in all operating positions. Always check the operating position reached through the inspection window on the de-energized tap-changer head. Never move de-energized tap-changer beyond the limit positions (see supplied connection diagram).

4. Once the transformer ratio test is complete, return de-energized tap-changer to its adjustment position (see supplied connection diagram).

5.6 Drying the de-energized tap-changer, filling the transformer with oil

A prerequisite for the dielectric values assured by MR for the de-energized tap-changer is a minimum drying procedure (vacuum drying or vapor-phase drying) performed following the instructions below.

5.6.1 Checking adjustment position

The de-energized tap-changer must be in the adjustment position before it is dried.

1. Check that the de-energized tap-changer is in the adjustment position. The adjustment position is indicated in the de-energized tap-changer connection diagram included in delivery.
2. Move the de-energized tap-changer into the adjustment position by turning the drive shaft for the upper gear unit if necessary. Make sure that the movable contacts close symmetrically on the stationary contacts while doing so.

5.6.2 Vacuum-drying the de-energized tap-changer

Pre-drying
► Pre-dry the de-energized tap-changer in circulating air at a max. temperature of 135 °C for a period of 8 hours.

Drying
► Dry the de-energized tap-changer at a maximum temperature of 135 °C for at least 3 hours, residual pressure of approx. 10^-3 bar.

5.6.3 Drying the de-energized tap-changer with kerosene

The temperature at the de-energized tap-changer must not exceed 135 °C.

The duration of the drying process is the same as that of the transformer. However, it must be at least 8 hours.

5.6.4 Filling transformer with oil

Fill the transformer with new insulating oil for transformers (fill under a vacuum). In this regard, we would like to point out that the insulating oils used in transformers must comply with the relevant standards, especially with respect to dielectric strength and water content (e.g. IEC 60296).

This requires the air to be evacuated from the oil chamber in the de-energized tap-changer head.

1. Open locking screw on de-energized tap-changer head.

Figure 79: Locking screw

2. Open the M6 slotted head screw.
5 Mounting

5.7 Connecting tap-change supervisory control, fitting drive components

5.7.1 Connecting tap-change supervisory control (if installed)

Connect the tap-change supervisory control fitted in a housing on the de-energized tap-changer head to the corresponding terminals for the drive via a connecting lead (see connection diagram for the associated drive). Proceed as follows:

1. Ensure that the drive and de-energized tap-changer are in the adjustment position. The adjustment position is indicated in the de-energized tap-changer connection diagram included in delivery.

2. Loosen the hexagonal socket screws on the terminal box cover of the tap-change supervisory control and remove the terminal box cover.
3. Connect the monitoring contacts to the corresponding drive terminals using a connecting lead in accordance with the connection diagram of the relevant drive.

![Figure 82: Tap-change supervisory control terminals](image)

4. Mount the terminal box cover. Ensure that the seal points are clean.

![Figure 83: Tap-change supervisory control cover](image)

### 5.7.2 Fitting the drive

- Install the drive in accordance with the associated MR "TAPMOTION® DD" or "TAPMOTION® ED" operating instructions.

### 5.7.3 Fitting bevel gear

The stamped serial number of the bevel gear must match the serial number of the de-energized tap-changer.

The horizontal drive shaft must be flush with the shaft end of the upper gear unit and the bevel gear.

- Attach bevel gear [188] to support on the transformer cover with 2 bolts (through-holes 18 mm in diameter).

The information provided above applies analogously to special design bevel gears and angle gears, as well as to intermediate bearings of the vertical or horizontal drive shaft. Refer to the information about the drive shaft in this technical file for more information.
5.7.4 Fitting drive shaft

Observe the following during mounting:

**NOTICE**

**Damage to drive and on-load tap-changer or de-energized tap-changer!**

Trouble-free operation of the drive and the on-load tap-changer or de-energized tap-changer cannot be guaranteed.

- The shaft ends to be connected must be exactly aligned.

**Permitted axial displacement for the drive shaft without cardan joint**

Minor axial displacement of the vertical and horizontal drive shafts is permitted as long as it does not exceed 35 mm per 1000 mm square tube length (that corresponds to 2°).

![Figure 84: Permitted maximum axial displacement of vertical drive shaft](image-url)
Resistance to corrosion of components

The square tubes, coupling brackets, coupling bolts, screws, and locking washers are corrosion-resistant. We therefore recommend not applying the same external coating to these parts as to the transformer tank.

Cutting square tubes, telescopic protective tubes, and protective cover

The square tubes, the telescopic protective tube and the protective cover are supplied in overlengths (graded standard lengths). You must cut these parts to the required size before mounting on the transformer. In rare cases, you also have to cut the inner tube of the telescopic protective tube to the desired length. The maximum permitted total drive shaft length of the drive - last column = 15 m.

<table>
<thead>
<tr>
<th>Standard lengths</th>
<th>Motor-drive unit</th>
<th>Manual drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>600</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>900</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>1300</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>1700</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>2000</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>
5 Mounting

<table>
<thead>
<tr>
<th>Standard lengths</th>
<th>Motor-drive unit</th>
<th>Manual drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500</td>
<td>Not permitted</td>
<td>• (^1)</td>
</tr>
</tbody>
</table>

Table 7: Graded standard lengths of square tubes

\(^1\) \(l > 2000\) only possible for vertical installation without shaft protection! Telescopic protective tubes for manual drives with vertical dimensions \(V1 > 2462\) should be delivered vertically, similar to the motor-drive unit with intermediate bearing.

5.7.4.1 Fitting horizontal drive shaft

Aligning upper gear unit on the de-energized tap-changer head

In order to correctly install the horizontal drive shaft, under certain circumstances you may have to first align the upper gear unit such that the horizontal drive shaft is flush with the shaft end of the upper gear unit.

Proceed as follows:

1. Loosen screws and turn pressure ring segments to one side.

![Figure 86: Pressure ring segments](image)
2. **NOTICE!** Align gear unit such that the horizontal drive shaft is flush with the drive shaft of the gear unit. While aligning the gear unit, turn the unit's drive shaft such that its output shaft retains its original position. Failure to do so may result in damage to the de-energized tap-changer and transformer when starting up.

![Figure 87: Aligning gear unit](image)

3. Swivel pressure ring segments back towards gear unit and tighten screws. Ensure that the spring washer is between the screw head and pressure ring segment and that the pressure ring segments are firmly in contact with the gear unit housing.

![Figure 88: Securing pressure ring segments](image)
Putting de-energized tap-changer into adjustment position

Put the de-energized tap-changer in its adjustment position before you start the centering process.

1. Manually turn the drive shaft of the upper gear unit until it becomes difficult to move.

2. Repeat the process in the other direction. Count the required revolutions.
3. Turn the drive shaft of the upper gear unit back in the opposite direction by half of the number of revolutions counted.

Figure 91: Turning back drive shaft

⇒ The adjustment position has been reached.

**Fitting horizontal drive shaft**

To fit the horizontal drive shaft, proceed as follows.

1. Calculate dimension A between shaft end of upper gear unit and shaft end of bevel gear and shorten square tube to length A – 9 mm.

Figure 92: Shortening square tube
2. Calculate inside width B between housings of upper gear unit and bevel gear. Shorten the protective cover to B – 2 mm and deburr the cuts. Protect protective cover against corrosion with a coat of paint.

Figure 93: Shorten, deburr, and coat protective cover

3. Slide loosely screwed together coupling part onto square tube until stop is reached.

Figure 94: Sliding coupling part onto square tube
4. Grease coupling bolt. Fit coupling bolt onto bevel gear and slide square tube with coupling part over it.

![Figure 95: Attaching coupling part to bevel gear](image)

5. Mount horizontal drive shaft on bevel gear.

![Figure 96: Mounting horizontal drive shaft on bevel gear](image)

Figure 97: Mounting horizontal drive shaft on upper gear unit
7. Now attach shortened protective cover to housing lugs on the on-load tap-changer head and bevel gear. Secure each end of protective cover with a hose clip.

Figure 98: Fitting protective cover

8. If using a bearing block or angle gear, attach caps to the protective cover.

Figure 99: Bearing block caps
5 Mounting

**5.7.4.2 Fitting a vertical drive shaft without cardan joint**

To fit the vertical drive shaft to the drive, proceed as follows:

1. **CAUTION!** Switch off motor protective switch Q1 in the motor-drive unit (position O). If this is not done, the motor-drive unit may be started by accident and thereby cause injuries.

2. Fasten the bevel gear to the transformer.

---

**Figure 100: Angle gear caps**

**Figure 101: Bevel gear**
3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten square tube to length of A – 9 mm.

Figure 102: Shortening square tube
4. Deburr cut surfaces of square tube.

Figure 103: Deburring cut surfaces
5. Slide the loosely screwed together coupling part onto square tube until stop is reached.

Figure 104: Slide coupling part onto square tube
5 Mounting

6. Insert coupling bolt into shaft end of drive. Grease coupling part, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32). Slide square tube with coupling part onto shaft end.

Figure 105: Slide square tube with coupling part onto shaft end

7. Secure square tube onto drive.

Figure 106: Secure square tube onto drive
8. Pivoting square tube.

Figure 107: Pivoting square tube

9. When installing inner tube of telescopic protective tube, if necessary shorten on side without slits. The minimum dimension for overlapping the two protective tubes is 100 mm.

Inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.
Figure 108: Deburring inner tube

<table>
<thead>
<tr>
<th>Dimension A (= distance between shaft end of drive and shaft end of bevel gear)</th>
<th>Inner tube</th>
<th>Outer tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>170 mm...190 mm</td>
<td>Shorten to 200 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>191 mm...1130 mm</td>
<td>Dimension A + 20 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>1131 mm...1598 mm</td>
<td>= 700 mm</td>
<td>= 1150 mm</td>
</tr>
<tr>
<td>1599 mm...2009 mm</td>
<td>= 1150 mm</td>
<td>= 1150 mm</td>
</tr>
</tbody>
</table>
10. Slide outer tube over inner tube. When doing so, make sure that the un-slotted side of the inner tube is facing upwards. Slide telescopic protective tube onto square tube. Then slide hose clips over telescopic protective tube.

Figure 109: Sliding on telescopic protective tube
11. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Swing square tube in.

Figure 110: Fitting adapter ring and coupling bolt
12. Grease coupling brackets, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32) and secure square tube with coupling brackets on the bevel gear. Set a unilateral axial clearance of 3 mm between coupling bolt and upper coupling piece.

Figure 111: Mounting coupling brackets
13. Attach bottom protective tube (inner tube) with a hose clip to bearing collar of drive 1. Then slide upper protective tube (outer tube) over adapter ring on bevel gear 2. Secure upper protective tube to bottom protective tube with hose clip both at top end and at the connection point 3.

Figure 112: Mounting protective tube

5.7.4.3 Fitting drive shaft with cardan joints

Installation of the drive shaft with cardan joints is mainly designed as a vertical drive shaft between motor-drive unit and bevel gear.

Technically, a horizontal design is also possible. However, if using a horizontal design please note that the protective cover supplied must be adapted accordingly and a cardan joint with an inner hub diameter of 25 mm must be used if you want to use the cardan joint on the upper gear unit.
Permitted axial displacement

An axial displacement of 20° is permitted for the vertical and horizontal drive shaft with cardan joints.

Figure 113: Permitted maximum axial displacement of vertical drive shaft with cardan joints
Figure 114: Permitted maximum axial displacement of horizontal drive shaft with cardan joints

**NOTICE**

Damage to property!

Improper mounting of the cardan joint may result in damage or malfunctions!

- Ensure that the folding cardan joint does not damage the expansion bellows during mounting.
- Ensure that the angle of deflection $\alpha$ is no greater than 20°.
- Ensure that the angle of deflection $\alpha$ is the same on both cardan joints.
Figure 115: Angle of deflection $\alpha$

- Correct: $\alpha = \alpha$
- Incorrect: $\alpha \neq \beta$
To fit the drive shaft with cardan joints, proceed as follows:

1. Grease coupling bolts, coupling brackets, and shaft ends, e.g. ISOFLEX TOPAS L 32.

Figure 116: Greasing coupling bolts, coupling brackets, and shaft ends
2. Insert adapter rings into the collar of the rotating protective tube. Place both parts of pivotable protective tube inside one another and turn towards one another to set the corresponding angle.

![Figure 117: Inserting adapter in pivotable protective tubes](image)

3. When supplied, the cardan joints are fitted with coupling bolts. To mount on the shaft end, the following steps must be taken: Remove hose clip. Slide up expansion bellows. Remove coupling bolt.
Slide cardan joint over device’s output shaft. Push in coupling bolt. Slide expansion bellows over this. Secure expansion bellows with hose clip.

4. Connect shorter cardan joint supplied to shaft end of motor-drive unit with coupling bolt.

Figure 118: Mounting cardan joints

Figure 119: Attach cardan joint on shaft end of motor-drive unit
5. **NOTICE!** Attach second, longer cardan joint to the bevel gear such that the position of both cardan joint lugs matches on the bevel gear and motor-drive unit. If this is not done, damage or malfunction may result.

Figure 120: Fit second cardan joint on bevel gear


Figure 121: Secure expansion bellows with hose clip
7. Provisionally connect loose shaft ends of the joints to an angle bar and align so that they are flush.

Figure 122: Connect shaft ends with angle bar
8. Determine dimension A between the shaft ends. Cut square tube to LR = A + 106 mm (LR = length of square tube). Deburr cut surfaces of square tube.

Figure 123: Shortening square tube
9. Before mounting, shorten both telescopic tubes to dimension \( A/2 + 120 \text{ mm} \) \((A = \text{dimension between both cardan joint ends})\) and de-burr.

Figure 124: Shortening telescopic tubes
10. Fit one adapter ring to bearing collar of motor-drive unit and fit other adapter ring to bearing collar of bevel gear.

Figure 125: Fitting adapters

11. Slide previously shortened and deburred square tube over upper cardan joint end until stop is reached.

Figure 126: Sliding square tube over upper cardan joint end
12. Thread upper flexible protective tube with long outlet up onto square tube from below.

Figure 127: Sliding flexible protective tube over square tube
13. Slide inner tube into outer tube such that the slotted sides of the outer and inner tube are both facing down. Thread the hose clips.
14. Slide everything up and secure with a screw clamp.

Figure 129: Secure everything with a screw clamp
15. Slide bottom flexible protective tube (also with long outlet up) on to the square tube and secure with screw clamp.
16. Swing in square tube and slide all the way down.

Figure 131: Swinging square tube in
17. Tighten bottom coupling brackets. Shaft end and coupling part must be securely connected such that no axial clearance remains between the coupling bolt and coupling bracket.

Figure 132: Tightening lower coupling brackets
18. Fit upper coupling brackets with 3 mm axial clearance.

Figure 133: Fitting upper coupling brackets

19. Working from top to bottom, mount the individual parts of the shaft protection. Set angle position between both parts of pivotable protective tube and fix with available hose clip. Secure both upper and lower protective tubes with a hose clip at both ends. Secure the two telescopic protective tubes to one another using a hose clip.

The plastic adapters must be at the respective end of the pivotable protective tube. Only slide telescopic protective tube into upper and lower pivotable protective tubes by the width of the adapter before tightening the hose clips.
5.7.4.4 **Fitting drive shaft with insulator**

A model with insulator in the vertical drive shaft is available for insulating installation of the drive shaft.

Figure 134: Secure telescopic protective tube and flexible protective tubes with hose clips
Permitted axial displacement

Minor axial displacement of the vertical drive shaft with insulator is permitted as long as it does not exceed 35 mm per 1000 mm square tube length (that corresponds to 2°).

![Permitted maximum axial displacement of vertical drive shaft with insulator](image)

5.7.5 Centering de-energized tap-changer and drive

It is absolutely necessary that the de-energized tap-changer action is accomplished before the drive stops.

This is ensured by setting the time of de-energized tap-changer action at a distinct interval before the end of the drive action. In the case of a motor-drive unit, the shaded section of the tap-change indicator is used as a reference when adjusting. When using a manual drive, its lock-in action is the reference point.

Depending on the type of manual drive, one switching operation of the de-energized tap-changer corresponds to a specific number of revolutions of the hand crank or one revolution of a tap-change indicator in a motor-drive unit. This tap-change indicator is divided into tap-change indicator sections, each of which corresponds to one hand crank revolution.

The number of hand crank revolutions between the de-energized tap-changer switching operation to the end of the drive operation must be the same in both rotation directions (adjustment position).
Proceed as follows to center the de-energized tap-changer and drive:

1. **NOTICE!** Wet all of the de-energized tap-changer contacts with insulating oil for transformers. Failure to do so may result in damage to the de-energized tap-changer.

2. For all adjustment activities, make sure the tap position indicators on the drive and de-energized tap-changer are identical.

3. Ensure that the drive and de-energized tap-changer are in the adjustment position. The adjustment position is indicated in the de-energized tap-changer connection diagram included in delivery.

4. **NOTICE!** Turn the hand crank in only one direction until the digit of the inspection window in the de-energized tap-changer head comes to a stop. Using a drill can result in damage to the de-energized tap-changer. Never move de-energized tap-changer beyond the limit positions (see supplied connection diagram).

5. Count the necessary number of hand crank revolutions until the lock in the manual drive engages or the number of tap-change indicator sections until the pointer reaches the center mark of the tap-change indicator.

6. Repeat this procedure in the opposite direction.

7. If there is a difference in the number of hand crank revolutions or tap-change indicator sections counted in both directions, remove the drive shafts and adjust the motor-drive unit or manual drive in relation to the de-energized tap-changer by half the difference of the number of sections or hand crank revolutions counted.

8. Finally check the symmetrical coupling in both directions.

Do not uncouple the de-energized tap-changer once it has been successfully connected to the drive. Otherwise all of the setup steps listed in this chapter must be repeated.

### 5.7.6 Installing electrics for motor-drive unit

Install electrics for motor-drive unit as described in relevant MR operating instructions for motor-drive unit.
6 Commissioning at the transformer manufacturer's site

Perform the work and tests stated below before commissioning the de-energized tap-changer and transformer.

6.1 Grounding the de-energized tap-changer

1. Connect the grounding screw on the de-energized tap-changer head to the transformer cover.

![Grounding screw on the de-energized tap-changer head](image1)

Figure 136: Grounding screw on the de-energized tap-changer head

2. Connect the grounding screw of the motor-drive protective housing to the transformer tank.

![Grounding screw on motor-drive unit](image2)

Figure 137: Grounding screw on motor-drive unit
3. Connect the grounding screw of the manual drive protective housing to the transformer tank.

![Figure 138: Grounding screw on manual drive](image)

### 6.2 Performing tests on motor-drive unit

**Function tests**
- Perform function checks as described in relevant MR operating instructions for motor-drive unit.

**Dielectric tests on transformer wiring**
- Note information relating to dielectric tests on transformer wiring in relevant MR operating instructions for motor-drive unit.

### 6.3 Performing trial tap-change operations

Before energizing the transformer, test change operations must be carried out to check the mechanical function of the de-energized tap-changer.

1. **DANGER!** Switch off transformer on high and low-voltage side. Failure to do so may result in severe injuries and property damage.
2. Lock transformer to prevent unintentional restart.
3. Starting from the adjustment position, undertake tap change operation tests across the entire range of settings.
4. If necessary, repeat the transformer ratio test [► 83].
5. **NOTICE!** If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, check that the tap position indicators of drive and de-energized tap-changer match in every operating position. A drive that is connected incorrectly will damage the de-energized tap-changer.
6 Commissioning at the transformer manufacturer’s site

6.4 High-voltage tests on the transformer

**DANGER**

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, at the dehydrating breather opening, and from flying parts and hot oil splashing!

► 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 oil compartment of the on-load tap-changer is completely filled with oil.
► Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.
► Ensure that all protective devices for the on-load tap-changer are 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.

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.

Note the following points **before** undertaking high voltage tests on the transformer:

- Ensure that the ground connections on the motor-drive protective housing and protective housing fastening are free of paint.
- Only perform high voltage test if motor-drive unit door is closed.
- Disconnect external connections to electronic components in the motor-drive unit to prevent damage from overvoltage.
- When connecting the motor-drive unit's supply voltage, only use the cable bushings in the protective housing base intended for lead insertion.
- Guide all ground connecting leads to one central connection point (establishment of suitable reference earth).
- Disconnect all electronic components before the high voltage test. Before a wiring dielectric test, remove all devices with a withstand voltage of < 1,000 V.
- Remove leads used for testing before the high voltage test as these function as antennas.
- Wherever possible, route the measurement and data leads separately from the energy cables.
Contact the manufacturer if you have any questions about possible sources of danger.
7 Transporting transformer to the operating site

If you have to remove the drive to transport the transformer, proceed as follows:

1. Ensure that the drive and de-energized tap-changer are in the adjustment position.
2. Remove the drive.
3. Do not actuate drive while de-energized tap-changer is not coupled and do not turn output shaft.
4. Do not actuate a de-energized tap-changer which is not coupled and do not turn its drive shaft.
5. Transport drive to installation site in the MR delivery packaging.
6. Fit drive and drive shaft to transformer at the operating site (see [► 86] and [► 87]).
8 Commissioning transformer at operating site

8.1 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.

NOTICE

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.
8 Commissioning transformer at operating site

8.2 Performing trial tap-change operations

Before energizing the transformer, test change operations must be carried out to check the mechanical function of the de-energized tap-changer.

1. **DANGER!** Switch off transformer on high and low-voltage side. Failure to do so may result in severe injuries and property damage.
2. Lock transformer to prevent unintentional restart.
3. Starting from the adjustment position, undertake tap change operation tests across the entire range of settings.
4. If necessary, repeat the transformer ratio test [► 83].
5. **NOTICE!** If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, check that the tap position indicators of drive and de-energized tap-changer match in every operating position. A drive that is connected incorrectly will damage the de-energized tap-changer.

8.3 Commissioning transformer

Proceed as follows to commission the transformer:

1. **DANGER!** Ensure that the transformer is switched off on the high-voltage and low-voltage sides. Failure to do so will result in danger of death and damage to property when commissioning the transformer.
2. Connect the drive to the tripping circuit of the transformer's circuit breaker.
3. **DANGER!** Ensure that de-energized tap-changer and drive are in the same operating position. Check that all safety measures are effective. Failure to do so will result in danger of death and damage to property when commissioning the transformer.
4. Commission the transformer.
9 Fault elimination

**WARNING**

Danger of death or severe injury!

Danger of death or severe injury from explosive gases under the de-energized 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 occur.
- De-energize all auxiliary circuits (such as the tap-change supervisory control) before removing the de-energized 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 de-energized tap-changer and transformer!

Tripping of a protective device can indicate damage on the de-energized tap-changer and transformer! The transformer must not be energized without being inspected first!

- Check the de-energized tap-changer and transformer when a protective device has been tripped.
- Do not use the equipment again until you are sure there is no damage to the de-energized tap-changer and transformer.

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

In the event of faults on the de-energized tap-changer, and motor-drive unit, which cannot be easily corrected on site, or if a protective device has 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: +49 941 40 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

<table>
<thead>
<tr>
<th>Error pattern</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation of tap-change supervisory device</td>
<td>Contact MR.</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 motor-drive unit</td>
</tr>
<tr>
<td>Error pattern</td>
<td>Action</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>De-energized tap-changer not changing tap position (sluggishness, Raise keys/Lower keys not working)</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 de-energized 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>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>

Table 8: Fault elimination
10.1 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)
10.2 Installation drawing for cover mounting, contact circle diameter 600 mm (725873)
10.3 Installation drawing for cover mounting, contact circle diameter 850 mm (736601)

- Mounting Flange of Transformer Cover
- Fixing Screw M 12
- Transformer Cover
- Off-Circuit Tap-Changer Head with Gear Unit
- Bleeding Facility for Off-Circuit Tap-Changer Head
- Position Indicator
- Monitoring Contact
- Lifting Lugs
- Earth Connection M 10
- Upper Gear Unit with Drive Shaft
- Geneva Wheel Crank
- Off-Circuit Tap-Changer Head with Hand Wheel or Hexagon
- Padlock
- Hand Wheel
- Hexagon, Spanner Width 46
- Insulating Bar Cage
- Terminal Contacts or Connecting Contacts
- Bottom Is Composed of Insulating Parts
- Screening Ring
- Drive Side
- Marking Triangles Stamped
10.4 De-energized tap-changer head for bell-type tank, 400 mm contact circle diameter (725975)
10.5 De-energized tap-changer head for bell-type tank, 600 mm contact circle diameter (725976)
10.6 De-energized tap-changer head for bell-type tank, 850 mm contact circle diameter (733023)
10.7 Position of the supporter (737272)

Position of the supporter (737272)

After measurement:

SUPPORTER POSITION = A + B + C + D - E - 75° mm

Diagram showing the position of the supporter with dimensions and annotations.
10.8 Tap-change supervisory device (726977)
10.9 Mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742006)
10.10 Customer-manufactured mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742008)
10.11 Mounting flange for de-energized tap-changer head, 600/850 mm contact circle diameter (742016)
10.12 Customer-manufactured mounting flange for de-energized tap-changer head, 600/850 mm contact circle diameter (742013)
10.13 Tracing template for de-energized tap-changer head, 400 mm contact circle diameter (742018)
10.14 Tracing template for de-energized tap-changer head, 600/850 mm contact circle diameter (742019)
10.15  Additional drawings for bottom cage ring (725935)

FIXING OF THE DEETAP® DU ON THE BOTTOM CAGE RING

CONTACT CIRCLE 400 MM

APPLICATIONS WITH UM < 245KV
AND >= 245KV WITHOUT OPTIONAL BOTTOM SCREENING RING ________ 735496:

APPLICATIONS WITH UM >= 245KV
WITH OPTIONAL BOTTOM SCREENING RING ______________________ 735494:

CONTACT CIRCLE 600 MM

APPLICATIONS WITH UM < 245KV _____________________________ 735497:

APPLICATIONS WITH UM >= 245KV ___________________________ 735486:
CONTACT CIRCLE 850 MM

APPLICATIONS WITH UM = 72,5KV ________________________ 736442:

APPLICATIONS WITH UM = 170KV ________________________ 736602:

APPLICATIONS WITH UM >= 245KV ________________________ 736603:
10.16 Fixture for de-energized tap-changer on lower cage ring (application-specific), 400 mm contact circle, Um ≤ 170 kV (735496)
10.17 Fixture for de-energized tap-changer on lower cage ring (application-specific), 400 mm contact circle, Um ≥ 245 kV (735494)

CAUTION
THE TRANSFORMER MANUFACTURER
MUST FIX THE DE-ENERGIZED TAP-CHANGER
BY MEANS OF AN INSULATING SUPPORT AND
PROVIDE THE DE-ENERGIZED TAP-CHANGER
WITH CENTERING AND TORSIONAL PROTECTION.
WHEREBY A THERMAL LENGTH L = øt + 6 mm
MUST BE OBSERVED. ONLY NECESSARY FOR
ESPECIALLY LONG DE-ENERGIZED TAP-CHANGERS
ACCORDING TO THE INSTRUCTIONS ON
THE DIMENSION DRAWING.

DE-ENERGIZED TAP-CHANGER
MANUFACTURED ACCORDING
TO DIMENSION DRAWING
OF INDIVIDUAL ORDER

SUPPORT FASTENED TO
TRANSFORMER CORE.
INSULATION TO MATCH
APPLICABLE OPERATING AND
TEST VOLTAGES.

VIEW Z
BOTTOM CAGE RING

THE HOLES ON DIAMETER 300 mm
CAN ALSO BE USED TO FIX THE DE-ETC.

10 Drawings
Maschinenfabrik Reinhausen GmbH 2016
SUGGESTION FOR ADDITIONAL FIXING

FOR APPLICATIONS 245 KV / 300 KV
X = 90 MM

FOR APPLICATIONS Um >= 362 KV
X = 130 MM

SUPPORT FASTENED TO
TRANSFORMER CORE AND COILS,
INSULATION TO MATCH
APPLICABLE OPERATING AND
TEST VOLTAGES.
10.18 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≤ 170 kV (735497)
10.19 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≥ 245 kV (735486)
SUGGESTION FOR ADDITIONAL FIXING

FOR APPLICATIONS Un = 245 kV / 380kV
X = 90 MM

FOR APPLICATIONS Un = 362 kV
X = 130 MM

Dimensions:
- B-B:
  - \( \Phi 500 \)
  - 15\(^\circ\) and 5\(^\circ\) angles

- C-C:
  - 30 and 141 MM

- B:
  - 15\(^\circ\) angle

10 Drawings
Maschinenfabrik Reinhausen GmbH 2016
10.20 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, Um = 72.5 kV (736442)
10.21 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, Um = 170 kV (736602)
SUGGESTION FOR ADDITIONAL ATTACHMENT

10 Drawings
10.22 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, Um ≥ 245 kV (736603)
10.23 De-energized tap-changer head, 400 mm contact circle diameter (725735)
10.24 De-energized tap-changer head, 600/850 mm contact circle diameter (725737)
10.25 De-energized tap-changer head with hand wheel, 400 mm contact circle diameter (725738)
10.26 De-energized tap-changer head with hand wheel, 600/850 mm contact circle diameter (725739)
10.27 De-energized tap-changer head with hexagon, 400 mm contact circle diameter (725740)
10.28  De-energized tap-changer head with hexagon, 600/850 mm contact circle diameter (725741)
10.29 Connection contact, 400/600 mm contact circle, connection contact 850 mm (Y, D, BB, 725730)
10.30 Connection-contact, 850 mm contact circle (ME, MD, SP, YD, 734095)
10.31  Take-off-terminal, 400/600/850 mm contact circle (725728)
10.32 Bridges for parallel connection (726215)

<table>
<thead>
<tr>
<th>CONTACT CIRCLE PITCH</th>
<th>MAX. Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>435</td>
</tr>
<tr>
<td>12</td>
<td>635</td>
</tr>
<tr>
<td>18</td>
<td>885</td>
</tr>
</tbody>
</table>

ALL OFFERED CONNECTING POINTS MUST BE USED!
10.33 DEETAP® DU, snap-on ring wrench with plug-on tube for de-energized tap-changer-head with hexagon (897851)
10.34 Horizontal drive shaft (limit dimensions, 725889)

NOTE!

H1 - H4 are minimal distances for designing the drive shaft arrangement. The dimensions of the DEETAP® oil, which are necessary for designing the transformer tank, have to be taken from the dimension drawing or additional drawings (725723). The insulating distance between the contacts has to be taken into account.

CONTACT CIRCLE  H1  L  H1  R  H2  H3  H4
Φ 400  630  380  400  700  700
Φ 600  710  460  500  850  850
Φ 850  710  460  500  1000  1000

Intermediate bearing for H1 - H4 = 2254 mm.
UPPER GEAR UNIT
DRIVE SHAFT RIGHT

SWIVEL RANGE 180°

POSITION-INDICATION DISK
NOT COVERED BY
DRIVE-SHAFT!

SWIVEL RANGE 130°
UPPER GEAR UNIT
DRIVE SHAFT LEFT

POSITION-INDICATION DISK
NOT COVERED BY
DRIVE-SHAFT!

SWIVEL RANGE 310°
10.35 TAPMOTION® DD manual drive, vertical drive shaft, limit dimensions (737695)

### 1. Unit without carbon shaft, without insulator standard design

<table>
<thead>
<tr>
<th>Manual Drive</th>
<th>Without Protective Tube</th>
<th>With Protective Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø3</td>
<td>V1 1 mm</td>
<td>V1 + 5932</td>
</tr>
<tr>
<td></td>
<td>Intermediate bearing necessary if</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supporting bearing necessary if</td>
<td></td>
</tr>
<tr>
<td>Ø3</td>
<td>V1 + 6324</td>
<td>V1 + 2472</td>
</tr>
</tbody>
</table>

### 2. Unit without carbon shaft, with insulator special design

<table>
<thead>
<tr>
<th>Manual Drive</th>
<th>Without Protective Tube</th>
<th>With Protective Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø3</td>
<td>V1 1 mm</td>
<td>V1 + 5932</td>
</tr>
<tr>
<td></td>
<td>Intermediate bearing necessary if</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supporting bearing necessary if</td>
<td></td>
</tr>
<tr>
<td>Ø3</td>
<td>V1 + 6324</td>
<td>V1 + 2472</td>
</tr>
</tbody>
</table>

### 3. Unit with carbon shaft, without insulator special design

The dimensions apply for a 25° angle only.

<table>
<thead>
<tr>
<th>Manual Drive</th>
<th>Without Protective Tube</th>
<th>With Protective Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø3</td>
<td>V1 1 mm</td>
<td>V1 + 2034</td>
</tr>
</tbody>
</table>

### 4. Unit with carbon shaft, with insulator special design

The dimensions apply for a 25° angle only.

<table>
<thead>
<tr>
<th>Manual Drive</th>
<th>Without Protective Tube</th>
<th>With Protective Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø3</td>
<td>V1 1 mm</td>
<td>V1 + 2342</td>
</tr>
</tbody>
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Maschinenfabrik Reinhausen GmbH 2016

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4434202/01 EN  DEETAP® DU  179
## 10.36 Additional drawings (725723)

### INSTALLATION DRAWINGS:

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
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<tbody>
<tr>
<td>CONTACT CIRCLE - HEAD 400</td>
<td>725872:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 600</td>
<td>725873:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 850</td>
<td>736601:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD - HEAD 400</td>
<td>725735:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD - HEAD 600</td>
<td>725737:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL - HEAD 400</td>
<td>725738:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL - HEAD 600</td>
<td>725739:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HEXAGON - HEAD 400</td>
<td>725740:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HEXAGON - HEAD 600</td>
<td>725741:</td>
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<tr>
<td>SLIP-ON RING WRENCH WITH EXTENSION TUBE FOR OFF-CIRCUIT</td>
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<tr>
<td>TAP-CHANGER HEAD WITH HEXAGON</td>
<td>897851:</td>
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<tr>
<td>OFF-CIRCUIT TAP-CHANGER FOR BELL-TYPE TANK:</td>
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<tr>
<td>CONTACT CIRCLE - HEAD 400</td>
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<tr>
<td>CONTACT CIRCLE - HEAD 600</td>
<td>725976:</td>
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<tr>
<td>CONTACT CIRCLE - HEAD 850</td>
<td>733023:</td>
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<tr>
<td>TERMINALS 1000A CONTACT CIRCLE 400 / 600 / 850 (Y, D, BBI)</td>
<td>725730:</td>
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<tr>
<td>TERMINALS 1000A CONTACT CIRCLE 850 (ME, MD, SP, YD)</td>
<td>734095:</td>
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<tr>
<td>OUTPUT TERMINALS 1000A / 6-PITCH, 12-PITCH AND 18-PITCH</td>
<td>725728:</td>
</tr>
<tr>
<td>HORIZONTAL DRIVE SHAFT</td>
<td>725889:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR $U_m \leq 245$ kV CONTACT CIRCLE 400</td>
<td>735496:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR $U_m \geq 245$ kV CONTACT CIRCLE 400</td>
<td>735494:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR $U_m \leq 245$ kV CONTACT CIRCLE 600</td>
<td>735497:</td>
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<tr>
<td>ADDITIONAL ATTACHMENT FOR $U_m \geq 245$ kV CONTACT CIRCLE 600</td>
<td>735498:</td>
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<tr>
<td>ADDITIONAL ATTACHMENT FOR $U_m = 72.5$ kV CONTACT CIRCLE 850</td>
<td>736442:</td>
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<td>ADDITIONAL ATTACHMENT FOR $U_m = 170$ kV CONTACT CIRCLE 850</td>
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<td>MANUAL DRIVE TAPMOTION DD</td>
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<tr>
<td>VERTICAL DRIVE SHAFT TAPMOTION® DD</td>
<td>737695:</td>
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<tr>
<td>HANDWHEEL / HEXAGON SHAFT, TRIPPING-/INTERLOCKING CIRCUIT</td>
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<tr>
<td>CONNECTION DIAGRAM</td>
<td>1531579:</td>
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<td>MANUAL DRIVE TAPMOTION® DD WITH SUPERVISORY CONTROL</td>
<td></td>
</tr>
<tr>
<td>CONNECTION DIAGRAM</td>
<td>2150823:</td>
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</tbody>
</table>
10.37 Hand wheel drive/hexagon, tripping/locking circuit, connection diagram (1531579)

**ATTENTION!!**

The off-circuit tap changer must only be operated when the transformer has been disconnected on both, the high-voltage and the low-voltage side. The transformer must only be reconnected, when off-circuit tap changer and motor drive are in the same operating position. Please note that only the supervisory control circuit must be used for the tripping of the transformer circuit breaker respectively for interlocking to prevent its reclosure in case the off circuit tap changer is in an undefined position. The use of any other circuit breaker motor drive unit instead of the supervisory control circuit may lead to a severe damage of off circuit tap changer and transformer and danger to life and health!
10.38  Manual drive TAPMOTION® DD, connection diagram
(2150823)
10.39 Motor-drive unit ED-S, connection diagram (1579393)
10.40 Lifting traverse (72673703)
Der Drehricht wird bei Bestellung festgelegt. / THE DIRECTION OF ROTATION IS DEFINED DURING ORDERING.
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