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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 Manufacturer

The product is manufactured by:

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

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

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

• Unpacking instructions
• Supplement
• Routine test report
• Connection diagrams
• Dimensional drawings
• Order confirmation

1.3 Safekeeping

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

1.4 Notation conventions

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

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

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

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

1.4.1.2 Embedded warning information

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

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

1.4.1.3 Signal words and pictograms

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
</tbody>
</table>

Table 1: Signal words in warning notices
1 Introduction

Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Pictogram" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image" alt="Pictogram" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image" alt="Pictogram" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image" alt="Pictogram" /></td>
<td>Warning of danger of tipping</td>
</tr>
<tr>
<td><img src="image" alt="Pictogram" /></td>
<td>Warning of danger of crushing</td>
</tr>
</tbody>
</table>

Table 2: Pictograms used in warning notices

1.4.2 Information system

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

Important information.

1.4.3 Instruction system

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

Single-step instructions

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

Multi-step instructions
Instructions which consist of several process steps are structured as follows:
Aim of action
✓ Requirements (optional).
1. Step 1.
.DataSource Result of step (optional).
2. Step 2.
.DataSource Result of step (optional).
DataSource Result of action (optional).
2 Safety

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

▪ Read this technical file through carefully to familiarize yourself with the product.
▪ This technical file is a part of the product.
▪ Read and observe the safety instructions provided in this chapter in particular.
▪ Observe the warnings in this technical file in order to avoid function-related dangers.
▪ The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb 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 in accordance with IEC 61936-1. If used as intended and in compliance with the requirements and conditions specified in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any danger to people, property or the environment. This applies throughout service life of the product, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate use:
▪ 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 standard valid for the product and the year of issue on the nameplate.
▪ Operate the product in accordance with this technical file, the agreed-upon delivery conditions and the technical data.
▪ Ensure that all necessary work is performed by qualified personnel only.
▪ 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:
Personal protective equipment

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

- All necessary devices and personal protective equipment required for the specific task, such as a hard hat, safety footwear, etc. must be worn. Observe the section "Personal protective equipment" [► Section 2.4, Page 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.

Operation during overload

Operating the de-energized tap-changer with currents of more than twice the rated through-current \( I_r \) can lead to personal injuries and damage to the product. The de-energized tap-changer can operate with twice the rated through-current \( I_r \).

- Take appropriate measures to prevent currents of more than twice the rated through-current \( I_r \).

Working during operation

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

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

Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire. This increases the danger to life and limb.

- Do not install, operate or perform maintenance work on the product in areas where a risk of explosion is present.
Explosion protection

Impermissible tap-change operations can lead to severe explosions and fire. This poses a danger to life and limb.

▪ Never switch the de-energized tap-changer if the transformer is energized.
▪ Never actuate the drive with the hand crank if the transformer is energized.
▪ Never actuate the motor-drive via the RAISE key / LOWER key on the motor-drive unit if the transformer is energized.

Safety markings

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

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

Ambient conditions

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

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

Auxiliary materials and operating materials

Auxiliary materials and operating materials not approved by the manufacturer can lead to personal injury, damage to property and malfunctions of the product.

▪ Use MIDEL 7131 as the insulating fluid. Other insulating fluids on request.
▪ It is imperative that you consult with Maschinenfabrik Reinhausen GmbH because specific operating conditions apply to alternative insulating fluids.
▪ Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.
▪ Only use lubricants and auxiliary materials approved by the manufacturer.
▪ Contact the manufacturer.

Modifications and conversions

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

▪ Only modify the product after consultation with the manufacturer.
Spare parts
Spare parts not approved by the manufacturer may lead to physical injury, damage to the product and operational faults.

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

2.3 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 is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.
Authorized personnel

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

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

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

<table>
<thead>
<tr>
<th><strong>Special personal protective equipment for particular environments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety glasses</strong></td>
</tr>
<tr>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td><strong>Visor</strong></td>
</tr>
<tr>
<td>To protect the face from flying parts and splashing liquids or other dangerous substances.</td>
</tr>
<tr>
<td><strong>Hard hat</strong></td>
</tr>
<tr>
<td>To protect from falling and flying parts and materials.</td>
</tr>
<tr>
<td><strong>Hearing protection</strong></td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>To protect from hearing damage.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Protective gloves</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect from mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>
3 Product description

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

3.1 Scope of delivery

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

▪ De-energized tap-changer
▪ Hand wheel or snap-on ring wrench or manual drive with shielding housing or motor-drive unit with shielding housing (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" [Section 4, Page 32] 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 Design/versions

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
3 Product description

- 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 5 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 device 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 Nameplate

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

Position of nameplate

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 device

The electrical tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [▶ Section 9.24, Page 157] and 725737, 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 device

The tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [Section 9.24, Page 157] and 725737, 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.

### 3.2.5 Safety markings on the product

If the de-energized tap-changer is switched via hand wheel or snap-on ring wrench, the safety markings are located on the head of the de-energized tap-changer. If the de-energized tap-changer is switched using the TAPMOTION® ED motor-drive unit or the TAPMOTION® DD manual drive, the safety markings are located on the drive.

![Safety markings](image)

1 Safety marking
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.

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 driving or driven shaft end of the device to be connected.

Figure 3: 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 4: Drive shaft without cardan joint and without insulator (= standard version)

<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>536 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>
3.3.2.2 Drive shaft without cardan joint and with insulator

![Diagram of drive shaft without cardan joint and with insulator]

**Configuration**
- Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°)

**V 1 min**
- 706 mm

**Intermediate bearing**
- 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)

3.3.2.3 Drive shaft with cardan joints, without insulator

An axial displacement of maximum 20° to the side facing away from the transformer is permitted for the vertical drive shaft with cardan joints. An axial displacement of maximum 2° to the side facing the transformer is permitted.
3.3.2.4 Drive shaft with cardan joint and with insulator

An axial displacement of maximum 20° to the side facing away from the transformer is permitted for the vertical drive shaft with cardan joints and insulator. An axial displacement of maximum 2° to the side facing the transformer is permitted.
Figure 7: Drive shaft with cardan joint and with insulator (= special model)

<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</td>
<td>978</td>
<td>V 1 &gt; 2772</td>
</tr>
</tbody>
</table>
3.3.3 Identification plate

The identification plate is on the telescopic protective tube.

Figure 8: Position of the identification plate
4 Packaging, transport and storage

4.1 Packaging

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

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

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

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

4.1.1 Suitability

**NOTICE**

Property damage due to incorrectly stacked crates!

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

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

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

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

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

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

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

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

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

Table 3: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

⚠️ WARNING

Danger of death and damage to property!

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

- Only transport the crate when closed.
- Do not remove the securing material used in the crate during transport.
- If the product is delivered on a pallet, secure it sufficiently.
- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the hanging load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

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

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

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

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

The checks must take place after unloading when the crate or transport container can be accessed from all sides.
Visible damage  If external transport damage is found upon receipt of the shipment, proceed as follows:

▪  Immediately record the identified transport damage in the shipping documents and have this countersigned by the carrier.

▪  In the event of severe damage, total loss or high damage costs, immediately notify the manufacturer and the relevant insurance company.

▪  After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.

▪  Record the details of the damage immediately on site together with the carrier involved. This is essential for any claim for damages.

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

▪  Identify the damaged parts.

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

▪  Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.

▪  Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

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

4.3 Storage of shipments

Packaged goods dried by Maschinenfabrik Reinhausen

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

Non-dried packaged goods

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.
When selecting and setting up the storage location, ensure the following:

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

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.

If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

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

### 4.4 Unpacking shipments and checking for transportation damages

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

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

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

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 Section 9.13, Page 143 for a 400 mm contact circle diameter and page 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 Section 9.14, Page 144 for a 400 mm contact circle diameter and page 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 Section 9.17, Page 147 for a 400 mm contact circle diameter and page 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.
5 Mounting

2. Fit the stud bolts on the mounting flange.

Figure 9: Template and stud bolts for the 400 mm contact circle diameter
5.2 Installing de-energized tap-changer in a transformer (standard version)

To install the de-energized tap-changer, proceed as follows:

1. **CAUTION!** An unstably positioned de-energized tap-changer may tip, resulting in injuries or property damage. Place the de-energized tap-changer on a level surface and secure it against tipping.
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 11: 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 12: O-ring](image)

4. Remove cable ties from upper gear unit.

![Figure 13: Cable tie](image)
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 14: 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 shielding rings.

![Figure 15: 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 [Section 9.7, Page 137] and [Section 9.8, Page 138]).
8. Screw the de-energized tap-changer head to the 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 danger of malfunctions due to de-energized tap-changer connection contacts closing incorrectly.
10. Remove the set-down cylinder including the mounting material.

![Set-down cylinder](image)

**Figure 18: Set-down cylinder**

11. **NOTICE!** Secure the de-energized tap-changer to prevent it from being put under stress as a result of being turned or moved. Ensure that it can still be moved in an axial direction (see order-specific dimensional drawing and page [Section 9.19, Page 149]). 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 19: Positioning supporting structure](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contact circle diameter</td>
</tr>
<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>

**Dimensions:**
- KKD 400: 600 mm
- KKD 600: 800 mm
- KKD 850: 1100 mm
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 20: De-energized tap-changer in supporting structure](image-url)
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 [Section 5.4, Page 57]).

4. Carry out a transformer ratio test (see page [Section 5.5, Page 58]).

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.

2. Unscrew the fixing screws underneath.

Figure 23: Locking screws

Figure 24: Fixing screws
3. Lift the de-energized tap-changer head up off the de-energized tap-changer cage.

Figure 25: De-energized tap-changer head
4. Remove the set-down cylinder including the mounting material.

Figure 26: Set-down cylinder
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 bottom edge of the supporting flange and the upper edge of the mounting flange (see drawing 725975 [Section 9.9, Page 139] for a 400 mm contact circle and drawing 725976 [Section 9.10, Page 140] for a 600/850 mm contact circle).

Figure 27: 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 28: 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 29: O-ring
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.

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.
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 32: Lifting traverse

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

Figure 34: Screwing de-energized tap-changer cage to de-energized tap-changer head

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 35: 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 36: 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 danger of malfunctions due to de-energized tap-changer connection contacts closing incorrectly.

![Figure 37: Geneva wheel crank in adjustment position](image)

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

![Figure 38: Screwing de-energized tap-changer head to mounting flange](image)

16. **NOTICE!** Secure the de-energized tap-changer to prevent it from being put under stress as a result of being turned or moved. Ensure that it can still be moved in an axial direction (see order-specific dimensional drawing and page [Section 9.19, Page 149]). 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 [Section 9.31, Page 164]), 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 39: Connection contacts](image)
5.5 Carrying out transformer ratio test

Carry out a transformer ratio test before the transformer dries.

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. 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).

![Inspection window on the de-energized tap-changer head](image)

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 insulating fluid

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 the transformer with insulating fluid

Fill the transformer with MIDEL 7131 under 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 41: Locking screw
2. Open the M6 slotted head screw.

Figure 42: Slotted head screw

⚠️ The air is evacuated from the oil chamber.

1. Close the M6 slotted head screw (2 Nm of tightening torque).
2. Close the locking screw (8 Nm of tightening torque).

5.7 Connecting tap-change supervisory control, fitting drive components

5.7.1 Connecting tap-change supervisory device (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). To do so, 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.

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

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 drive shaft

Observe the following during mounting:

**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 over-length (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>
<tr>
<td>2500</td>
<td>Not permitted</td>
<td>•&lt;sup&gt;1)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Table 4: Graded standard lengths of square tubes

<sup>1)</sup> 1>&2000 only possible for vertical installation without shaft protection! Telescopic protective tubes for manual drives with vertical dimensions V1> 2462 are to be supplied with vertical intermediate bearing, as with the motor-drive unit.
5.7.3.1 Fitting a vertical drive shaft without cardan joint

Permitted axial displacement

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

Figure 46: Permitted maximum axial displacement of 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 inadvertently and cause injuries.
2. Fasten the bevel gear to the transformer.

Figure 47: Bevel gear
5 Mounting

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 48: Shortening square tube
4. Deburr cut surfaces of square tube.

Figure 49: Deburring cut surfaces
5. Slide the loosely screwed together coupling part onto square tube until stop is reached.

Figure 50: Slide coupling part onto square tube
6. Insert coupling bolt into shaft end of drive. Greasing Coupling part, Slide square tube with coupling part onto shaft end.

7. Attach square tube to drive.
8. Pivot square tube away from axis.

![Figure 53: Pivoting square tube away from axis](image)

9. When installing inner tube of telescopic protective tube, shorten on the side without slots if necessary. The minimum dimension for the overlap of 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 54: 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 non-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 55: 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. Pivot square tube back to axis.

Figure 56: 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 57: 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.
5.7.3.2 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.
To do so, proceed as follows:

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

![Figure 59: 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 60: 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 61: 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.

![Figure 62: Turning drive shaft to limit stop](image)
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.

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 65: Shortening square tube](image)

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 66: Shortening, deburring, and coating protective cover](image)

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

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

5. Mount horizontal drive shaft on bevel gear.
Figure 69: Mounting horizontal drive shaft on bevel gear


Figure 70: 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 71: Fitting protective cover

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

Figure 72: Bearing block caps
5.7.3.3 Fitting the vertical drive shaft with cardan joints

You can fit the vertical drive shaft with cardan joints onto the motor-drive unit and bevel gear.
Permitted axial displacement

An axial displacement of maximum 20° to the side facing away from the transformer is permitted for the vertical drive shaft with cardan joints. An axial displacement of maximum 2° to the side facing the transformer is permitted.

![Diagram showing permitted axial displacement](image)

**Figure 74: Permitted maximum axial displacement of vertical 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 $\alpha$ to the side facing away from the transformer is not greater than 20°.
- Ensure that the angle of deflection $\alpha$ to the side facing the transformer is not greater than 2°.
- Ensure that the angle of deflection $\alpha$ is the same on both cardan joints.
Figure 75: Angle of deflection $\alpha$
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 76: Greasing coupling bolts, coupling brackets, and shaft ends
2. Insert adapter rings into the collar of the rotating protective tube 1. Fit the two parts of pivotable protective tube together 2 and turn them towards one another 3 to set the corresponding angle.

Figure 77: Inserting adapter in pivotable protective tubes
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.
5. **NOTICE!** Attach second, longer cardan joint to the bevel gear such that the position of both cardan joint lugs is the same on the bevel gear and motor-drive unit. If this is not done, damage or malfunctions may result.

![Figure 80: Fitting second cardan joint on bevel gear](image)


![Figure 81: Securing expansion bellows with hose clip](image)
7. Provisionally connect loose shaft ends of the joints to an angle bar and align so that they are in line.

Figure 82: Connecting 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 83: Shortening square tube
5 Mounting

9. Before mounting, shorten both telescopic tubes to dimension $A/2 + 120$ mm ($A =$ dimension between both cardan joint ends) and deburr.

Figure 84: 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 85: Fitting adapters

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

Figure 86: Sliding square tube over upper cardan joint end
12. Thread upper flexible protective tube with long outlet up onto square tube from below.

Figure 87: 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.

Figure 88: Sliding on telescopic tubes
14. Slide everything up and secure with a screw clamp.

Figure 89: Secure everything with a screw clamp
15. Slide bottom flexible protective tube (also with long outlet up) onto the square tube and secure with screw clamp.

Figure 90: Sliding bottom flexible protective tube onto square tube
16. Swing in square tube and slide all the way down.

Figure 91: 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 92: Tightening lower coupling brackets
18. Fit upper coupling brackets with 3 mm axial clearance.

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.
5.7.3.4 **Fitting drive shaft with insulator**

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

Figure 95: Permitted maximum axial displacement of vertical drive shaft with insulator

5.7.3.4.1 Fitting vertical drive shaft with insulator

To fit the vertical drive shaft, 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 inadvertently and cause injuries.
2. Screw down the bevel gear for fastening on the transformer on both sides with the contact washers provided to ensure permanent grounding. Screws are not included in the scope of supply.

Figure 96: Bevel gear
3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten square tube to length of A–179 mm taking the insulator into account.

Figure 97: Shortening square tube
4. Deburr cut surfaces of square tube.

Figure 98: Deburring cut surfaces

5. Screw down double coupling part with insulator supplied and square tube. Mount insulator on the side facing the drive.

Figure 99: Screwing down square tube and insulator with double coupling part
6. Slide loosely screwed together coupling part onto insulator until stop is reached.

![Figure 100: Sliding coupling part onto insulator](image)

7. Place the supplied insulator ring on the bearing collar of the motor-drive unit.

![Figure 101: Insulating ring](image)

8. 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 102: Sliding square tube with coupling part onto shaft end](image)
9. Attach square tube to drive.

Figure 103: Attaching square tube to drive

10. Pivot square tube away from axis.

Figure 104: Pivoting square tube away from axis

11. When installing inner tube of telescopic protective tube, shorten on the side without slots if necessary. The minimum dimension for the overlap of the two protective tubes is 100 mm.
5 Mounting

Inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.

Figure 105: Deburring inner tube

<table>
<thead>
<tr>
<th>Dimension A (= distance between shaft end of drive and shaft end of bevel gear)</th>
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<th>Outer tube</th>
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<td>170 mm...190 mm</td>
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</tr>
</tbody>
</table>
12. Slide outer tube over inner tube. When doing so, make sure that the non-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 106: Sliding on telescopic protective tube
13. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Pivot square tube back to axis.

Figure 107: Fitting adapter ring and coupling bolt
14. 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 108: Mounting coupling brackets

15. 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 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.
5.7.3.5 Fitting drive shaft with insulator and cardan joint

A model with insulator and cardan joint in the vertical drive shaft is also available for insulating installation of the drive shaft.
Permitted axial displacement

An axial displacement of maximum 20° to the side facing away from the transformer is permitted for the vertical drive shaft with cardan joints and insulator. An axial displacement of maximum 2° to the side facing the transformer is permitted.

5.7.4 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.

### 5.7.5 Making the electrical connections for the motor-drive unit

Make electrical connections for the motor-drive unit as described in relevant MR operating instructions for motor-drive unit.
6 Commissioning

**WARNING**

Explosive gases in the transformer, pipe system, oil conservator and at the dehydrating breather opening can deflagrate or explode and result in severe injury or death!

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

This chapter describes how to commission the de-energized tap-changer.

6.1 Commissioning at the transformer manufacturer's site

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

6.1.1 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](image)

Figure 111: Grounding screw on the de-energized tap-changer head
2. Connect the grounding screw on the drive to the transformer tank. When using the TAPMOTION® ED motor-drive unit, it is essential that a CUPAL washer be placed between the cable shoe and connecting lug. The aluminum side of the CUPAL washer must be facing the connecting lug.

![Grounding screw on motor-drive unit](image1)

Figure 112: Grounding screw on motor-drive unit

![Grounding screw on manual drive](image2)

Figure 113: Grounding screw on manual drive
3. Connect the grounding screw on the drive to the shielding housing.

Figure 114: Ground connection on the motor-drive unit and shielding housing
6.1.2 Checking the drive

**NOTICE**

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

Damage to the on-load tap-changer / de-energized tap-changer due to actuation of the on-load tap-changer / de-energized tap-changer without insulating fluid.

- Ensure that the selector / de-energized tap changer is fully immersed in insulating fluid and that the oil compartment of the on-load tap-changer is completely filled with insulating fluid.

Prior to commissioning the transformer, check whether the drive and de-energized tap-changer are correctly coupled and that the drive is functioning correctly.

**Tests on the drive**

1. **DANGER!** Danger of explosion when tap-change operations are performed under load. Ensure that the transformer is disconnected on the high-voltage and low-voltage sides.
2. Lock transformer to prevent unintentional restart.
3. If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, perform function checks as described in the relevant MR operating instructions for the drive.

4. Starting from the adjustment position, undertake trial tap-change operations across the entire range of settings.

5. **NOTICE!** An incorrectly coupled drive will damage the de-energized tap-changer. If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, ensure that the tap position indicators of drive and de-energized tap-changer match in every operating position.

6. If necessary, repeat the transformer ratio test [► Section 5.5, Page 58].

**Dielectric tests on transformer wiring**

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

6.1.3 **High-voltage tests on the transformer**

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

- Ensure that the temperature of the insulating fluid in the transformer does not exceed 60°C during the high-voltage test.
- Ensure that all protective devices on the de-energized tap-changer are functioning correctly and are ready for use.
- 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 dielectric test of the wiring, remove all devices with a withstand voltage of < 1000 V.
- Remove leads used for testing before the high voltage test as these function as antennas.
- Wherever possible, route the measurement leads and data leads separately to the energy cables.

Contact the manufacturer if you have any questions about possible sources of danger.
6.2 Transporting transformer to the operating site

**NOTICE**

**Damage to motor-drive unit!**

Damage to the 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 downtime lasting more than 8 weeks prior to initial commissioning, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible, place a sufficient amount of desiccant in the protective housing.

If the drive must be removed in order 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 the drive to the installation site in the MR delivery packaging.
6. Fit drive [►Section 5.7.2, Page 61] and drive shaft [►Section 5.7.3, Page 62] to transformer at the installation site.

6.3 Commissioning transformer at operating site

6.3.1 Checking the drive

**NOTICE**

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

Damage to the on-load tap-changer / de-energized tap-changer due to actuation of the on-load tap-changer / de-energized tap-changer without insulating fluid.

► Ensure that the selector / de-energized tap changer is fully immersed in insulating fluid and that the oil compartment of the on-load tap-changer is completely filled with insulating fluid.
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).

- Therefore, the "Tap changer in operation" position transit contact shown in the connection diagram should be used for external monitoring, locking and control purposes instead of the position transmitter equipment.

Prior to commissioning the transformer, check whether the drive and de-energized tap-changer are correctly coupled and that the drive is functioning correctly.

Tests on the drive

1. **DANGER!** Danger of explosion when tap-change operations are performed under load. Ensure that the transformer is disconnected on the high-voltage and low-voltage sides.

2. Lock transformer to prevent unintentional restart.

3. If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, perform function checks as described in the relevant MR operating instructions for the drive.

4. Starting from the adjustment position, undertake trial tap-change operations across the entire range of settings.

5. **NOTICE!** An incorrectly coupled drive will damage the de-energized tap-changer. If the de-energized tap-changer is equipped with a manual drive or motor-drive unit, ensure that the tap position indicators of drive and de-energized tap-changer match in every operating position.

6. If necessary, repeat the transformer ratio test [Section 5.5, Page 58].

Dielectric tests on transformer wiring

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

**6.3.2 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.
7 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, remedying 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 94140 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>De-energized tap-changer not changing tap position (sluggishness, Raise keys/Lower keys not working)</td>
<td>Contact MR.</td>
</tr>
</tbody>
</table>
## 7 Fault elimination

<table>
<thead>
<tr>
<th>Error pattern</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<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 5: Fault elimination
8 Technical data

An overview of all key technical data for the de-energized tap-changer and motor-drive unit exists in the form of separate documents, which are available on request.

8.1 De-energized tap-changer properties

8.1.1 Standard version (contact circle diameter 400 / 600 mm)

<table>
<thead>
<tr>
<th>Electrical data</th>
<th>Standard designs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEETAP® DU I/DU III</strong></td>
<td>200 400 600 800 1000 1222 1202 1622 1602 2022</td>
</tr>
<tr>
<td>Number of phases</td>
<td>1/3 1/3 1/3 1/3 1/3 1/3 1/3 1/3 1/3 1/3</td>
</tr>
<tr>
<td>Max. rated through-current $I_{um}$ (A)$^1$</td>
<td>200 400 600 800 1000 1200 1200 1600 1600 2000</td>
</tr>
<tr>
<td>Rated short-time current (kA)</td>
<td>4 6 8 10 12 16 20 20 25 25</td>
</tr>
<tr>
<td>Rated duration of short-circuits (s)</td>
<td>3 3 3 3 3 3 3 3 3 3</td>
</tr>
<tr>
<td>Rated peak withstand current (kA)</td>
<td>10 15 20 25 30 40 50 50 63 63</td>
</tr>
<tr>
<td>Basic de-energized tap-changer connections</td>
<td>Linear de-energized tap-changer for neutral application $^2$</td>
</tr>
<tr>
<td></td>
<td>Linear de-energized tap-changer for delta connection</td>
</tr>
<tr>
<td></td>
<td>Single-bridging de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>Double-bridging de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>Series-parallel de-energized tap-changer $^3$</td>
</tr>
<tr>
<td></td>
<td>Star-delta de-energized tap-changer</td>
</tr>
<tr>
<td>Rated frequency (in Hz)</td>
<td>50...60</td>
</tr>
</tbody>
</table>

Table 6: Electrical data

$^1$ Max. rated through-currents over 2000 A possible, see special designs [Section 8.1.2, Page 125] and page.

$^2$ Single-phase designs for Y applications are declared as D design.

$^3$ The max. rated through-current is based on series connection.

<table>
<thead>
<tr>
<th>Mechanical data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of operating positions</td>
</tr>
<tr>
<td>Dimensions</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
8 Technical data

### Drive
Hand wheel or hexagon shaft with operating wrench
- TAPMOTION® DD manual drive
- TAPMOTION® ED motor-drive unit

### Safety devices
- Electrical locking with cam switch, operation after about 1/12 of the hand crank rotation
- Contacts: 1 normally closed and 1 normally open contact with shared change-over points
  - Switching capacity, 250 V AC, 6 A (resistive load)
  - 250 V AC, 2.5 A (cosφ = 0.4)

Table 7: Mechanical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
<th>422</th>
<th>822</th>
<th>2003</th>
<th>2403</th>
<th>3033</th>
<th>3204</th>
<th>4044</th>
<th>4005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of phases</td>
<td></td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1</td>
</tr>
<tr>
<td>Max. rated through-current $I_{\text{sm}}$ (A)</td>
<td></td>
<td>400</td>
<td>800</td>
<td>2000</td>
<td>2400</td>
<td>3000</td>
<td>3200</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>Rated short-time current (kA)</td>
<td></td>
<td>6</td>
<td>10</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>32</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>Rated duration of short-circuits (s)</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rated peak withstand current (kA)</td>
<td></td>
<td>15</td>
<td>25</td>
<td>63</td>
<td>75</td>
<td>75</td>
<td>80</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

### 8.1.2 Special types (400/600 mm contact circle diameter)

#### Electrical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Special designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic de-energized tap-changer connections</td>
<td>Linear de-energized tap-changer for neutral application ¹)</td>
</tr>
<tr>
<td></td>
<td>Linear de-energized tap-changer for delta connection</td>
</tr>
<tr>
<td></td>
<td>Single-bridging de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>Double-bridging de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>Series-parallel de-energized tap-changer ²)</td>
</tr>
<tr>
<td></td>
<td>Star-delta de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>Buck-and-boost de-energized tap-changer</td>
</tr>
<tr>
<td></td>
<td>De-energized tap-changer for special applications</td>
</tr>
</tbody>
</table>

Table 8: Electrical data

1) Single-phase designs for Y applications are declared as D design.

2) The max. rated through-current is based on series connection.

### Mechanical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Max. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of operating positions</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>See chapter &quot;Introduction&quot;, section &quot;Variant overview&quot;</td>
</tr>
</tbody>
</table>
### Table 9: Mechanical data

| Weight | 400 mm contact circle diameter: max. 220 kg  
| 600 mm contact circle diameter: max. 290 kg |
| Drive | Hand wheel or hexagon shaft with operating wrench  
TAPMOTION® DD manual drive  
TAPMOTION® ED motor-drive unit |
| Safety devices | Electrical locking with cam switch,  
operation after about 1/12 of the hand crank rotation  
Contacts: 1 normally closed and 1 normally open contact with shared change-over points  
Switching capacity AC, 250 V, 8 A |

### 8.2 Permissible ambient conditions

| Air temperature during operation | -25…+50°C |
| Temperature of the insulating fluid in operation | **Normal temperature range**  
-15…+105°C: continuous  
**Increased temperature range**  
105…130°C: max. 8 hours/day, max. 720 hours/year  
130…150°C: max. 8 hours/day, max. 240 hours/year |
| Transport temperature, storage temperature | -45…+50°C |
| Drying temperatures | See chapter "Mounting" |
| Compressive strength | De-energized tap-changer head vacuum-proof and pressure-proof up to 0.5 bar differential pressure continuous |
| Insulating fluids | Synthetic ester fluid (IEC 61099): Midel 7131  
Other insulating fluids on request |

Table 10: Permissible ambient conditions
9 Drawings
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV (10115469)
9.2 Dimensional drawing type Y, contact circle diameter 600 mm, Um 36...123 kV (10115470)

- Drive side
- Drive shaft
- Position indicator
- Monitoring contact
- Bleeding facility

Terminal
Output terminal
These screening covers are the lowest parts connected to voltage; they are on potential of related terminal

MAX RATED THROUGH-CURRENT: 200 / 400 / 600 / 800 / 1000 A

<table>
<thead>
<tr>
<th>Um in kV</th>
<th>e</th>
<th>p</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>652</td>
<td>575</td>
<td>1225</td>
</tr>
<tr>
<td>123</td>
<td>652</td>
<td>575</td>
<td>2025</td>
</tr>
</tbody>
</table>

THE CONNECTION DIAGRAM APPLICABLE TO THE ORDER IS BINDING FOR THE DESIGNATION OF THE TERMINALS AND PHASES.

DE-ENERGIZED TAP-CHANGER HEAD (TOP VIEW)

BOTTOM IS COMPRISSED OF INSULATING PARTS

THE DE-ENERGIZED TAP-CHANGER HEAD HAS TO BE FIXED ON THE BOTTOM EDGE RING (REFER TO DRAWING: 725975).

WEIGHT MAX. APPROX. 200 KG

DIMENSION DRAWINGS VALID FOR Datische IN HIGH TEMPERATURE DESIGN IN MODEL: 7131

FOR CORRESPONDING DRAWING REFER TO 1011557

THE CONNECTION DIAGRAM APPLICABLE TO THE ORDER IS BINDING FOR THE DESIGNATION OF THE TERMINALS AND PHASES.

DESIGN FOR BELL-TYPE TANK MOUNTING 725975 - AVAILABLE ON REQUEST

CAUTION:
AFTER THE DE-ENERGIZED TAP-CHANGER HAS BEEN PUT INTO SERVICE, IT MUST BE OPERATED ONLY WHEN THE TRANSFORMER HAS BEEN DISCONNECTED ON THE HIGH-VOLTAGE SIDE. THE SAFETY MEASURES MUST BE STRICTLY OBSERVED. DE-ENERGIZED ENGINERERS LIVES AND MAY CAUSE SEVERE DAMAGE TO THE DE-ENERGIZED TAP-CHANGER AND THE TRANSFORMER.
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV

(10115469)
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV (10115469)

9.3 Dimensional drawing type D, contact circle diameter 400 mm, Um 36...72.5 kV (10115471)

<table>
<thead>
<tr>
<th>Um in kV</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>352</td>
<td>275</td>
<td>1125</td>
</tr>
<tr>
<td>725</td>
<td>652</td>
<td>575</td>
<td>2025</td>
</tr>
</tbody>
</table>

DE-ENERGIZED TAP-CHANGER HEAD (TOP VIEW)

DE-ENERGIZED TAP-CHANGER HEAD (BOTTOM VIEW)

MAX RATED SINGLE-CURRENT 200 / 400 / 600 / 800 / 1000 A

DIMENSIONS IN MM

- Drive side
- Drive shaft
- Position indicator
- Monitoring contact
- Bleeding facility
- Terminal
- Output terminal

CAUTION

After the de-energized tap-changer has been put into service, it must be operated only when the transformer has been disconnected on the high-voltage side and on the low-voltage side, the safety measures must be strictly observed, disregard endangers lives and may cause severe damage to the de-energized tap-changer and the transformer.
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV (10115469)

9.4 Dimensional drawing type D, contact circle diameter 600 mm, Um 36...72.5 kV (10115472)
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV (10115469)
9.5 Dimensional drawing type ME, contact circle diameter 400 mm, Um 36...123 kV (10115473)
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV (10115469)

9.6 Dimensional drawing type ME, contact circle diameter 600 mm, Um 36...123 kV (10115474)
9.1 Dimensional drawing type Y, contact circle diameter 400 mm, Um 36...123 kV

(10115469)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

- 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
- Drive side
- Marking triangles stamped
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.8 Installation drawing for cover mounting, contact circle diameter 600 mm (725873)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.9 De-energized tap-changer head for bell-type tank, 400 mm contact circle diameter (725975)
9.10  De-energized tap-changer head for bell-type tank, 600 mm contact circle diameter (725976)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.11 Lifting traverse (72673703)
9.12 Tap-change supervisory device (10115084)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.13 Mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742006)
9.14 Customer-manufactured mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742008)
9.15 Mounting flange for de-energized tap-changer head, 600 mm contact circle diameter (742016)
9.16 Customer-manufactured mounting flange for de-energized tap-changer head, 600 mm contact circle diameter (742013)
9.17 Tracing template for de-energized tap-changer head, 400 mm contact circle diameter (742018)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.18 Tracing template for de-energized tap-changer head, 600 mm contact circle diameter (742019)
### 9.19 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**
- **Applications with UM >= 245kV without optional bottom screening ring**

**Contact Circle 600 mm**

- **Applications with UM < 245kV**
- **Applications with UM >= 245kV with optional bottom screening ring**
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

CONTACT CIRCLE 850 MM

APPLICATIONS WITH UM = 72.5KV ___________________________ 736442.

APPLICATIONS WITH UM = 170KV ___________________________ 736602.

APPLICATIONS WITH UM >= 245KV __________________________ 736603.
9.20 Fixture for de-energized tap-changer on lower cage ring (application-specific), 400 mm contact circle, Um ≤ 145 kV (735496)

**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 = +/- 6 MM MUST BE OBSERVED. ONLY NECESSARY FOR ESPECIALLY LONG DE-ENERGIZED TAP-CHANGERS ACCORDING TO THE INSTRUCTIONS ON THE DIMENSION DRAWING.
9.21 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 x = d ≤ 6 mm must be observed. Only necessary for especially long de-energized tap-changers according to the instructions on the dimension drawing.

**Support fastened to transformer core and coils. 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.T.E.**

- Drive side
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

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.
9.22 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≤ 145 kV (735497)
9.23 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≥ 245 kV (735486)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)
9.24  De-energized tap-changer head, 400 mm contact circle diameter (725735)
9.25  De-energized tap-changer head, 600 mm contact circle diameter (725737)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.26 De-energized tap-changer head with hand wheel, 400 mm contact circle diameter (725378)
9.27 De-energized tap-changer head with hand wheel, 600 mm contact circle diameter (725739)
9.28 De-energized tap-changer head with hexagon, 400 mm contact circle diameter (725740)
9.29 De-energized tap-changer head with hexagon, 600 mm contact circle diameter (725741)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.30 Take-off-terminal, 400/600 mm contact circle (725728)
9.31 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>
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.32 Manual drive TAPMOTION® DD, standard design (736530)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.33 Snap-on ring wrench with plug-on tube for de-energized tap-changer-head with hexagon (897851)
9.34 Horizontal drive shaft (limit dimensions, 725889)

**NOTE!**

H1 – H4 are minimal distances for designing the drive shaft arrangement. The dimensions of the DEETAP® DU, 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.

<table>
<thead>
<tr>
<th>CONTACT CIRCLE</th>
<th>H1</th>
<th>H1 R</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø 400</td>
<td>630</td>
<td>380</td>
<td>400</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Ø 600</td>
<td>710</td>
<td>460</td>
<td>500</td>
<td>850</td>
<td>850</td>
</tr>
<tr>
<td>Ø 850</td>
<td>710</td>
<td>460</td>
<td>500</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Intermediate bearing for H1 – H4 = 2254 mm.
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)
9.35 TAPMOTION® DD manual drive, vertical drive shaft, limit dimensions (10115056)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.36 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 trans-former! The use of any other contacts of the 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!
9.37 Manual drive TAPMOTION® DD, connection diagram (2150823)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

ATTENTION!

The dry circuit tap changer must only be operated when the transformer has been disconnected from both the high voltage and the low voltage side. The transformer must only be connected to an off-circuit tap changer without tapping. The tapping must be done with the transformer in the OFF position after switching to the OFF position. Failure to do so may cause damage to the transformer and/or the tap changer.

AFTERTAGS!

Der getrennte Saugstift darf nur in der Nennspannung eingesetzt werden. Der getrennte Saugstift darf nur angetroffen werden, wenn die Anlage vom Netz getrennt ist. Die Anlage darf nur angetroffen werden, wenn der getrennte Saugstift in der Nennspannung eingesetzt ist. Andernfalls kann es zu Schäden an der Anlage oder der getrennten Saugstift kommen.
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.38 Motor-drive unit ED-S, connection diagram (1579393)
9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

ATTENTION!

THE OFF-CIRCUIT TRANSFORMER WITH 367 V X BC CONVERTED REVERSER MOTOR AND PERIPHERAL DEVICES IS DEGRADED ON BOTH THE PRIMARY AND THE LOW-VOLTAGE SIDE.

THE TRANSFORMER MIGHT ONLY BE INSTALLED IN ACCORDANCE WITH THE INSTALLATION DIRECTIONS OF THE MANUFACTURER.

PLEASE NOTE THAT ONLY THE SUPERVISING CONTROL CIRCUIT MUST BE USED FOR THE TRANSFORMER INSTALLATION DIRECTIONS OF THE MANUFACTURER.

THE TRANSFORMER MIGHT ONLY BE INSTALLED IN ACCORDANCE WITH THE INSTALLATION DIRECTIONS OF THE MANUFACTURER.

OFF-CIRCUIT TRANSFORMER IS AN OPEN PLATFORM FOR REVERSER MOTOR AND HAMMER CRANK.

THE SUPERVISING CONTROL CIRCUIT MIGHT NOT BE CONNECTED TO THE SUPERVISING CONTROL CIRCUIT THAT LEADS TO A VOLTAGE CHANGE OF OFF-CIRCUIT TRANSFORMER AND SUPERVISING CONTROL.

DANGER TO LIFE AND HEALTH!
### 9.39 Additional drawings (10115057)

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9.7 Installation drawing for cover mounting, contact circle diameter 400 mm (725872)

9.40 Bevel gear CD 6400, dimensional drawing (892916)