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1 Introduction

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

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

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

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

1.1 Validity

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

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

1.2 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg, Germany
Tel.: (+49) 941/40 90-0
Fax: (+49) 941/40 90-7001
E-mail: sales@reinhausen.com

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

1.3 Completeness

This technical file is incomplete without the supporting documents.

The following documents apply:

- Unpacking instructions (included in the scope of delivery)
- Supplement (included in the scope of delivery)
- Routine test report (included in the scope of delivery)
- Connection diagrams (included in the scope of delivery)
- Dimensional drawings (included in the scope of delivery)
1 Introduction

- Technical data - General section (available on request)
- Technical data - Product-specific section (available on request)

1.4 Safekeeping

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

1.5 Notation conventions

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

1.5.1 Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Wrench size" /></td>
<td>Wrench size</td>
</tr>
<tr>
<td><img src="image" alt="Tightening torque" /></td>
<td>Tightening torque</td>
</tr>
<tr>
<td><img src="image" alt="Number and type of fastening material used" /></td>
<td>Number and type of fastening material used</td>
</tr>
<tr>
<td><img src="image" alt="Fill with oil" /></td>
<td>Fill with oil</td>
</tr>
<tr>
<td><img src="image" alt="Cut open, cut through" /></td>
<td>Cut open, cut through</td>
</tr>
<tr>
<td><img src="image" alt="Clean" /></td>
<td>Clean</td>
</tr>
<tr>
<td><img src="image" alt="Visual inspection" /></td>
<td>Visual inspection</td>
</tr>
<tr>
<td><img src="image" alt="Use your hand" /></td>
<td>Use your hand</td>
</tr>
<tr>
<td><img src="image" alt="Adapter ring" /></td>
<td>Adapter ring</td>
</tr>
<tr>
<td><img src="image" alt="Apply a coat of paint" /></td>
<td>Apply a coat of paint</td>
</tr>
<tr>
<td><img src="image" alt="Use a file" /></td>
<td>Use a file</td>
</tr>
</tbody>
</table>
1.5.2 Hazard communication system

Warnings in this technical file are displayed as follows.

1.5.2.1 Warning relating to section

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

WARNING

Type and source of danger

Consequences

► Action

► Action
1.5.2.2 Embedded warning information

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

⚠️ DANGER! Instruction for avoiding a dangerous situation.

1.5.2.3 Signal words and pictograms

The following signal words are used:

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

Table 2: Signal words in warning notices

Pictograms warn of dangers:

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

Table 3: Pictograms used in warning notices
1.5.3 Information system

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

Important information.
2 Safety

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

- Read this technical file through carefully to familiarize yourself with the product.
- This technical file is part of the product.
- Read and observe the safety instructions provided in this chapter in particular.
- Observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb of the user or impairment of the product and other material assets may occur during use due to function-related dangers.

2.1 Appropriate use

The product is a de-energized tap-changer which is used to set the voltage of oil-immersed transformers. The product is designed solely for use in electrical energy systems and facilities. If used as intended and in compliance with the requirements and conditions specified in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any danger to people, property or the environment. This applies throughout the product’s entire life, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate use:

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

2.2 Fundamental safety instructions

To prevent accidents, disruptions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:
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" [► 14].
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents.

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

Working during operation

You must only operate the product when it is in a sound operational condition. Otherwise it poses a danger to life and limb.

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

Explosion protection

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

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

Safety markings

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

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

Ambient conditions

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

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

Auxiliary materials and operating materials

Auxiliary materials and operating materials not approved by Maschinenfabrik Reinhausen GmbH could damage the product.

- Only use lubricants and auxiliary materials approved by the manufacturer.
- Contact Maschinenfabrik Reinhausen GmbH.

Modifications and conversions

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

- Only modify product following consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may cause physical injury and damage the product.

- Only use spare parts approved by the manufacturer.
- Contact Maschinenfabrik Reinhausen GmbH.

2.3 Personnel qualification

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

Electrically skilled person

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

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

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

Operator

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

Technical Service

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

Authorized personnel

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

2.4 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged protective equipment.
- Follow information about personal protective equipment provided in the work area.

<table>
<thead>
<tr>
<th>Always wear</th>
<th>Protective clothing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protective clothing</td>
</tr>
<tr>
<td></td>
<td>Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.</td>
</tr>
</tbody>
</table>
### Always wear

**Safety shoes**
To protect against falling heavy objects and slipping on slippery surfaces.

---

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

### Wear the following in special environments

**Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.**

<table>
<thead>
<tr>
<th>Wear the following in special environments</th>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety glasses</td>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td>Visor</td>
<td>To protect the face from flying parts and splashing liquids or other dangerous substances.</td>
</tr>
<tr>
<td>Hard hat</td>
<td>To protect from falling and flying parts and materials.</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>To protect from hearing damage.</td>
</tr>
<tr>
<td>Protective gloves</td>
<td>For protection from mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>

---

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

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

3.1 Scope of delivery

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

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

Note the following information:

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

You will find more information in the "Packaging, transport, and storage" chapter.

3.2 De-energized tap-changer

3.2.1 Function description

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

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

3.2.2 Setup/models

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

▪ Linear de-energized tap-changer
▪ Single-bridging de-energized tap-changer
▪ Double-bridging de-energized tap-changer
▪ Series-parallel de-energized tap-changer
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 17 operating positions.
The design of the de-energized tap-changer and the designation of its main parts are shown in the installation drawings in the appendix.

Figure 1: DEETAP® DU

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

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

Position of name plate

3.2.4 Protective devices

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

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

The device is equipped with the following safety devices.

3.2.4.1.1 Mechanical locking

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

3.2.4.1.2 Electrical tripping and locking option

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

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

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

### 3.2.4.2 TAPMOTION® DD manual drive

The device is equipped with the following safety devices.

#### 3.2.4.2.1 Mechanical locking

Locking provided via a padlock on the manual drive.

#### 3.2.4.2.2 Tap-change supervisory control

The electrical tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [► 63] and 725737 [► 64], functional principle on the basis of connection diagram 2150823).

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

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

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

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

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

The transformer circuit breakers must be tripped automatically if

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

Reclosure of the transformer circuit breakers must be possible only if

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

3.2.4.3 TAPMOTION® ED motor-drive unit

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

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

3.2.4.3.2 Tap-change supervisory control

The tap-change supervisory control is installed in a housing on the de-energized tap-changer head (dimensional drawings 725735 [► 63] and 725737 [► 64], 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.
3 Product description

The motor protective switch in the motor-drive unit interrupts the motor circuit and the control circuit if a change in position is attempted electrically with the circuit breaker engaged.

The circuit breaker for the transformer is tripped if:

- Micro-switch S90 (de-energized tap-changer head) of the tap-change supervisory control opens, i.e. the selector switch shaft of the de-energized tap-changer is turned.
- Non-directional cam-operated contact (motor-drive unit) S117 opens, i.e. the motor-drive unit is not in a defined position.

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

- Micro-switch S90 (de-energized tap-changer head) of the tap-change supervisory control is closed, i.e. the de-energized tap-changer is in a defined operating position.
- Non-directional cam-operated contact (motor-drive unit) S117 is closed, i.e. the motor-drive unit is in a defined position.
- Micro-switch S80 (de-energized tap-changer head) of the tap-change supervisory control and directional cam switch S156 match, i.e. de-energized tap-changer and motor-drive unit are in the same operating position.

3.3 Drive shaft

3.3.1 Function description

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

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

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

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

Figure 2: Components of the drive shaft

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bevel gear</td>
</tr>
<tr>
<td>2</td>
<td>Hose clip</td>
</tr>
<tr>
<td>3</td>
<td>Telescopic protective tube</td>
</tr>
<tr>
<td>4</td>
<td>Coupling bracket</td>
</tr>
<tr>
<td>5</td>
<td>Square tube</td>
</tr>
<tr>
<td>6</td>
<td>Coupling bolt</td>
</tr>
<tr>
<td>7</td>
<td>Adapter ring</td>
</tr>
<tr>
<td>8</td>
<td>Protective cover</td>
</tr>
<tr>
<td>9</td>
<td>Hose clip</td>
</tr>
</tbody>
</table>
### 3.3.2.1 Drive shaft without cardan joint and without insulator

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

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

<table>
<thead>
<tr>
<th>Configuration</th>
<th>V 1 min</th>
<th>Intermediate bearing</th>
</tr>
</thead>
<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

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

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

![Diagram](image)

Figure 5: Drive shaft with cardan joint and without 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 (maximum permissible axial offset alpha = 20°)</td>
<td>798</td>
<td>V 1 &gt; 2564</td>
</tr>
</tbody>
</table>

3.3.2.4 Drive shaft with cardan joint and with insulator

![Diagram](image)

Figure 6: 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 (maximum permissible axial offset alpha = 20°)</td>
<td>978</td>
<td>V 1 &gt; 2772</td>
</tr>
</tbody>
</table>
4 Commissioning transformer at operating site

4.1 Checking motor-drive unit

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

⚠️ WARNING

Danger of death or severe injury!

Danger of death or severe injury due to incorrect operation!

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

⚠️ NOTICE

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

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

► Always keep protective housing of the motor-drive unit tightly closed.

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

⚠️ NOTICE

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

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

► Only circuits stated in the chapter Technical data for position transmitter equipment may be connected to the position transmitter module connections.

► The switchover point of the position transmitter equipment in the motor-drive unit is not the same as the switchover point of the diverter switch operation. This depends on the type of diverter switch. This fact should be noted when project planning the locking circuits between the motor-drive unit and external equipment (e.g. transformer circuit breaker).

► For external monitoring, locking, and control purposes, it is not therefore the position transmitter equipment but the "Tap changer in operation" position transit contact shown in the connection diagram that should be used.
4 Commissioning transformer at operating site

4.2 Performing trial tap-change operations

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

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

4.3 Commissioning transformer

Proceed as follows to commission the transformer:

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

The following sections describe how to operate the de-energized tap-changer and monitor the de-energized tap-changer and drive.

5.1 Temperature range

When using a vegetable oil as insulating fluid, the permissible temperature range for operation of the DEETAP® DU/COMTAP® ARS is limited. Please observe the relevant information in the specific order documents and on the indicator plate on the drive.

You can operate the DEETAP® DU/COMTAP® ARS in the rated load range at oil temperatures of -25 °C to +105 °C and in accordance with IEC 60214-1 up to +115 °C (during emergency transformer operation in accordance with IEC 60076-7). Contact Maschinenfabrik Reinhausen GmbH if this temperature range is not sufficient for the requirements of your application.

5.2 Carrying out tap-change operation

Before you undertake a tap-change operation, you need to switch off and lock the transformer to prevent it switching back on.

Proceed as follows:

1. **DANGER!** Switch off transformer on high and low-voltage side. Failure to do so may result in severe injuries and property damage.
2. Lock transformer to prevent unintentional restart.
3. Make sure everything is de-energized.
4. Visibly connect all transformer terminals to ground (grounding leads, grounding disconnectors) and short circuit them.
5. Cover or cordon off adjacent energized parts.

Once you have switched off and locked the transformer, you can perform tap-change operations.

5.3 Monitoring during operation

Monitoring the de-energized tap-changer and drive is limited to occasional visual inspections of the de-energized tap-changer head and drive. For efficiency reasons these visual checks can be combined with the usual checks on the transformer.

Pay particular attention to the following:

- No oil leaks at the de-energized tap-changer head sealing points
- Gaskets of the drive’s protective housing
- Correct functioning of the installed electrical heater in the protective housing of the motor-drive unit
The insulating oils in the transformer are to be monitored by the operator in accordance with the appropriate rules and regulations.
6 Maintenance

6.1 Safety precautions

**WARNING**

Danger of death and severe injury!

An energized transformer and energized de-energized tap-changer components could cause death or serious injuries during maintenance work!

► Adherence to the following safety precautions is mandatory.

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

6.2 Maintenance

De-energized tap-changers which are installed in network transformers and are operated only rarely do not require maintenance at regular intervals, because mechanical operation of the de-energized tap-changer does not involve any significant contact wear.

If, after several years of service in one position, an de-energized tap-changer is to be operated in another position, several switching operations must first be performed into the desired position as well as the respective adjacent positions in order to remove possible tarnish on the contacts. Experience shows that up to 25 tap-change operations on each contact are necessary for this purpose. We recommend checking the efficiency of this action using a resistance measurement.

De-energized tap-changers which operate in furnace transformers and which therefore undergo a large number of tap-change operations per year, however, must receive maintenance at the latest after every 100,000 tap-change operations. This measure includes checks of the fixed connection contacts, the movable main switching contacts, the drive shafts with bevel gear, the drive, and the tap-change supervisory control of the de-energized tap-changer.

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

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

Re-commissioning after maintenance

Proceed as follows to re-commission the transformer after maintenance:

1. Ensure that the de-energized tap-changer and drive are correctly centered (see page).

2. **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.

3. Carry out a transformer ratio test (see page) and fill transformer with oil (see page).

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>
</tbody>
</table>
## 7 Fault elimination

<table>
<thead>
<tr>
<th>Error pattern</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-energized tap-changer not changing tap position (sluggishness, Raise keys/Lower keys not working)</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>No change in voltage on transformer despite change in position on motor-drive unit</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>Tap position indicator on motor-drive unit and de-energized tap-changer different</td>
<td>Contact MR.</td>
</tr>
<tr>
<td>Noises on drive shaft or motor-drive unit when changing tap position</td>
<td>Ensure proper mounting of the drive shaft in accordance with its operating instructions. Check that hose clips and protective covers are seated correctly. Contact MR in the event of noise from the motor-drive unit.</td>
</tr>
<tr>
<td>Warning or tripping of Buchholz relay on transformer</td>
<td>Notify manufacturer of transformer.</td>
</tr>
<tr>
<td>Deviation from desired value when measuring winding resistance of transformer</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
<tr>
<td>Deviation from desired value during dissolved gas analysis (transformer oil)</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
<tr>
<td>Deviation from desired value during transformer ratio test</td>
<td>Contact manufacturer of transformer and, if necessary, MR and provide measured values.</td>
</tr>
</tbody>
</table>

Table 6: Fault elimination
8 Drawings

8.1 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 SHAFT (G)
- GENEVA WHEEL CRANK
- OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL OR HEXAGON
- PAWLOK
- HAND WHEEL
- HEXAGON, SPANNER WIDTH 46
- INSULATING BAR EASE
- TERMINAL CONTACTS OR CONNECTING CONTACTS
- BOTTOM IS COMPOSED OF INSULATING PARTS
- DRIVE SIDE
- MARKING TRIANGLES STAMPED
8.2 Installation drawing for cover mounting, contact circle diameter 600 mm (725873)
8.3 Installation drawing for cover mounting, contact circle diameter 850 mm (736601)

- MOUNTING FLANGE OF TRANSFORMER COVER
- FIXING SCREW M 12
- TRANSFORMER COVER
- OFF-CIRCUIT TAP-CHANGER HEAD WITH GEAR UNIT
- BLEEDING FACILITY FOR OFF-CIRCUIT TAP-CHANGER HEAD
- POSITION INDICATOR
- MONITORING CONTACT
- LIFTING LUGS
- EARTH CONNECTION M 10
- UPPER GEAR UNIT WITH DRIVE SHAFT
- GENEVA WHEEL CRANK
- OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL OR HEXAGON
- PABLOCK
- HAND WHEEL
- HEXAGON, SPANNER WIDTH 46
- INSULATING BAR CAGE
- TERMINAL CONTACTS OR CONNECTING CONTACTS
- BOTTOM IS COMPOSED OF INSULATING PARTS
- SCREENING RING
- DRIVE SIDE
- MARKING TRIANGLES STAMPED
8.4 De-energized tap-changer head for bell-type tank, 400 mm contact circle diameter (725975)
8.5 De-energized tap-changer head for bell-type tank, 600 mm contact circle diameter (725976)
8.6 De-energized tap-changer head for bell-type tank, 850 mm contact circle diameter (733023)
8.7 Position of the supporter (737272)

After measurement:

SUPPORTER POSITION = A + B + C + D - E - 75° mm
8.8 Tap-change supervisory device (726977)
8.9 Mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742006)
8.10 Customer-manufactured mounting flange for de-energized tap-changer head, 400 mm contact circle diameter (742008)
8.11 Mounting flange for de-energized tap-changer head, 600/850 mm contact circle diameter (742016)
8.12 Customer-manufactured mounting flange for de-energized tap-changer head, 600/850 mm contact circle diameter (742013)
8.13 Tracing template for de-energized tap-changer head, 400 mm contact circle diameter (742018)
8.14 Tracing template for de-energized tap-changer head, 600/850 mm contact circle diameter (742019)
8.15 Additional drawings for bottom cage ring (725935)

**FIXING OF THE DEETAP® DU ON THE BOTTOM CAGE RING**

**CONTACT CIRCLE 400 MM**

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

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

**CONTACT CIRCLE 600 MM**

APPLICATIONS WITH UM < 245KV  
735497:

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

APPLICATIONS WITH UM = 72,5KV ___________ 736442:

APPLICATIONS WITH UM = 170KV ___________ 736602:

APPLICATIONS WITH UM >= 245KV ___________ 736603:
8.16 Fixture for de-energized tap-changer on lower cage ring (application-specific), 400 mm contact circle, Um ≤ 170 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.

- Bottom is composed of insulating parts.
- De-energized tap-changer manufactured according to dimension drawing of individual order.
- Support fastened to transformer core and coils. Insulation to match applied operating and test voltages.
- View Z bottom cage rings.
- The holes on diameter 180 mm can also be used to fix the gaskets.

- Drive side
8.17 Fixture for de-energized tap-changer on lower cage ring (application-specific), 400 mm contact circle, Um ≥ 245 kV (735494)

WARNING
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. 6 MM MUST BE OBSERVED. ONLY NECESSARY FOR ESPECIALLY LONG DE-ENERGIZED TAP-CHANGERS ACCORDING TO THE INSTRUCTIONS ON THE DIMENSION DRAWING.

Support fixed to transformer core and coils Insulation to match applicable operating and test voltages.

The holes on diameter 300 mm can also be used to fix the DE.T.C

THE CAGE RING
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.
8.18 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≤ 170 kV (735497)

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 OBTAINED. ONLY NECESSARY FOR ESPECIALLY LONG DE-ENERGIZED TAP-CHANGERS ACCORDING TO THE INSTRUCTIONS ON THE DIMENSION DRAWING.

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

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

VIEW Z
BOTTOM CAGE RING

BOTTOM IS COMPOSED OF INSULATING PARTS

- DRIVE SIDE
8.19 Fixture for de-energized tap-changer on lower cage ring (application-specific), 600 mm contact circle, Um ≥ 245 kV (735486)

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 = 4x – 6 mm MUST BE OBSERVED ONLY NECESSARY FOR ESPECIALLY LONG DE-ENERGIZED TAP-CHANGERS ACCORDING TO THE INSTRUCTIONS ON THE DIMENSION DRAWING.

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

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

BOTTOM IS COMPOSED OF INSULATING PARTS

VIEW Z
BOTTOM CAGE RING

A

15

X

Z

A–A

51

15

11

- DRIVE SIDE
SUGGESTION FOR ADDITIONAL FIXING

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

FOR APPLICATIONS UIm = 362 kV
X = 130 MM
8.20 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, Um = 72.5 kV (736442)
8.21 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, Um = 170 kV (736602)
SUGGESTION FOR ADDITIONAL ATTACHMENT

---

Diagram showing a circular component with dimensions and annotations for additional attachment points.
8.22 Fixture for de-energized tap-changer on lower cage ring (application-specific), 850 mm contact circle, $U_m \geq 245$ kV (736603)
SUGGESTION FOR ADDITIONAL ATTACHMENT
8.23 De-energized tap-changer head, 400 mm contact circle diameter (725735)
8.24 De-energized tap-changer head, 600/850 mm contact circle diameter (725737)
8.25 De-energized tap-changer head with hand wheel, 400 mm contact circle diameter (725738)
8.26 De-energized tap-changer head with hand wheel, 600/850 mm contact circle diameter (725739)
8.27 De-energized tap-changer head with hexagon, 400 mm contact circle diameter (725740)
8.28 De-energized tap-changer head with hexagon, 600/850 mm contact circle diameter (725741)
8.29 Connection contact, 400/600 mm contact circle, connection contact 850 mm (Y, D, BB, 725730)
8.30 Connection-contact, 850 mm contact circle (ME, MD, SP, YD, 734095)
8.31 Take-off-terminal, 400/600/850 mm contact circle (725728)
8.32 Bridges for parallel connection (726215)

ALL OFFERED CONNECTING POINTS MUST BE USED!

<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>
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</table>
8.33 DEETAP® DU, snap-on ring wrench with plug-on tube for de-energized tap-changer-head with hexagon (897851)
8.34 Horizontal drive shaft (limit dimensions, 725889)

NOTE!

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

<table>
<thead>
<tr>
<th>CONTACT CIRCLE</th>
<th>H1 L</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.
UPPER GEAR UNIT
DRIVE SHAFT RIGHT

SWIVEL RANGE 180°

POSITION-INDICATION DISK
NOT COVERED BY
DRIVE-SHAFT!

SWIVEL RANGE 130°
UPPER GEAR UNIT
DRIVE SHAFT LEFT

POSITION-INDICATION DISK
NOT COVERED BY DRIVE-SHAFT!

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

1. UNIT WITHOUT CARBON SHAFT, WITHOUT INSULATOR STANDARD DESIGN

<table>
<thead>
<tr>
<th>MANUAL DRIVE</th>
<th>V 1 mm</th>
<th>INTERMEDIATE BEARING NECESSARY IF</th>
<th>SUPPORTING BEARING NECESSARY IF</th>
<th>WITH PROTECTIVE TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>t03</td>
<td>106</td>
<td>V 1 + 5012</td>
<td>V 1 + 432</td>
<td>V 1 - 2472</td>
</tr>
</tbody>
</table>

2. UNIT WITHOUT CARBON SHAFT, WITH INSULATOR SPECIAL DESIGN

<table>
<thead>
<tr>
<th>MANUAL DRIVE</th>
<th>V 1 mm</th>
<th>INTERMEDIATE BEARING NECESSARY IF</th>
<th>SUPPORTING BEARING NECESSARY IF</th>
<th>WITH PROTECTIVE TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>t03</td>
<td>106</td>
<td>V 1 + 5012</td>
<td>V 1 + 432</td>
<td>V 1 - 2472</td>
</tr>
</tbody>
</table>

3. UNIT WITH CARBON SHAFT, WITHOUT INSULATOR SPECIAL DESIGN

<table>
<thead>
<tr>
<th>MANUAL DRIVE</th>
<th>V 1 mm</th>
<th>INTERMEDIATE BEARING NECESSARY IF</th>
<th>WITH PROTECTIVE TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>t90</td>
<td>194</td>
<td>V 1 + 194</td>
<td>V 1 - 254</td>
</tr>
</tbody>
</table>

4. UNIT WITH CARBON SHAFT, WITH INSULATOR SPECIAL DESIGN

<table>
<thead>
<tr>
<th>MANUAL DRIVE</th>
<th>V 1 mm</th>
<th>INTERMEDIATE BEARING NECESSARY IF</th>
<th>WITH PROTECTIVE TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>t90</td>
<td>194</td>
<td>V 1 + 194</td>
<td>V 1 - 254</td>
</tr>
</tbody>
</table>
### 8.36 Additional drawings (725723)

**Installation drawings:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
</tr>
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<tbody>
<tr>
<td>CONTACT CIRCLE - HEAD 400</td>
<td>725872:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 600</td>
<td>725873:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 850</td>
<td>736601:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD - HEAD 400</td>
<td>725735:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD - HEAD 600</td>
<td>725737:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL - HEAD 400</td>
<td>725738:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HAND WHEEL - HEAD 600</td>
<td>725739:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HEXAGON - HEAD 400</td>
<td>725740:</td>
</tr>
<tr>
<td>OFF-CIRCUIT TAP-CHANGER HEAD WITH HEXAGON - HEAD 600</td>
<td>725741:</td>
</tr>
<tr>
<td>SLIP-ON RING WRENCH WITH EXTENSION TUBE FOR OFF-CIRCUIT</td>
<td>897851:</td>
</tr>
<tr>
<td>TAP-CHANGER HEAD WITH HEXAGON</td>
<td></td>
</tr>
</tbody>
</table>

**Off-Circuit Tap-Changer for Bell-Type Tank:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTACT CIRCLE - HEAD 400</td>
<td>725975:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 600</td>
<td>725976:</td>
</tr>
<tr>
<td>CONTACT CIRCLE - HEAD 850</td>
<td>733023:</td>
</tr>
<tr>
<td>TERMINALS 1000A CONTACT CIRCLE 400 / 600 / 850 (Y, D, BB)</td>
<td>725730:</td>
</tr>
<tr>
<td>TERMINALS 1000A CONTACT CIRCLE 850 (ME, MD, SP, YD)</td>
<td>734095:</td>
</tr>
<tr>
<td>OUTPUT TERMINALS 1000A / 6-PITCH, 12-PITCH AND 18-PITCH</td>
<td>725728:</td>
</tr>
<tr>
<td>HORIZONTAL DRIVE SHAFT</td>
<td>725889:</td>
</tr>
</tbody>
</table>

**Additional Attachment for \( U_m \leq 245 \text{ kV} \) Contact Circle 400:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \leq 245 \text{ kV} ) CONTACT CIRCLE 400</td>
<td>735496:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \geq 245 \text{ kV} ) CONTACT CIRCLE 400</td>
<td>735494:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \leq 245 \text{ kV} ) CONTACT CIRCLE 600</td>
<td>735497:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \geq 245 \text{ kV} ) CONTACT CIRCLE 600</td>
<td>735486:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \geq 72.5 \text{ kV} ) CONTACT CIRCLE 850</td>
<td>736442:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \geq 170 \text{ kV} ) CONTACT CIRCLE 850</td>
<td>736602:</td>
</tr>
<tr>
<td>ADDITIONAL ATTACHMENT FOR ( U_m \geq 245 \text{ kV} ) CONTACT CIRCLE 850</td>
<td>736603:</td>
</tr>
</tbody>
</table>

**Manual Drive TapMotion DD**

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
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</thead>
<tbody>
<tr>
<td>VERTICAL DRIVE SHAFT TAPMOTION® DD</td>
<td>736530:</td>
</tr>
<tr>
<td>HANDVEEL / HEXAGON SHAFT, TRIPPING-/INTERLOCKING CIRCUIT</td>
<td>737695:</td>
</tr>
</tbody>
</table>

**Connection Diagram:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Drawing Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>HANDEL / HEXAGON SHAFT, TRIPPING-/INTERLOCKING CIRCUIT CONNECTION DIAGRAM</td>
<td>1531579:</td>
</tr>
<tr>
<td>MANUAL DRIVE TAPMOTION® DD WITH SUPERVISORY CONTROL CONNECTION DIAGRAM</td>
<td>2150823:</td>
</tr>
</tbody>
</table>
8.37 Hand wheel drive/hexagon, tripping/locking circuit, connection diagram (1531579)

CONTACT DIAGRAM

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<tr>
<th>POSITION</th>
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<th>4</th>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NO</td>
</tr>
</tbody>
</table>

EXAMPLE: OFF-CIRCUIT TAP CHANGER 17 SERVICE POSITIONS

ATTENTION !!

THE OFF-CIRCUIT TAP-CHANGER MUST ONLY BE OPERATED WHEN THE TRANSFORMER HAS BEEN DISCONNECTED ON BOTH, THE HIGH-VOLTAGE AND THE LOW-VOLTAGE SIDE.
THE TRANSFORMER MUST ONLY BE RECONNECTED, WHEN OFF-CIRCUIT TAP-CHANGER AND MOTOR DRIVE ARE IN THE SAME OPERATING POSITION. PLEASE NOTE THAT ONLY THE SUPERVISORY CONTROL CIRCUIT MUST BE USED FOR THE TRIPPING OF THE TRANSFORMER CIRCUIT BREAKER RESPECTIVELY FOR INTERLOCKING TO PREVENT ITS RECLOSURE IN CASE THE OFF-CIRCUIT TAP CHANGER IS IN AN UNDEFINED POSITION. THE USE OF ANY OTHER OFF-CIRCUIT TAP CHANGER OR 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 !
8.38 Manual drive TAPMOTION® DD, connection diagram (2150823)
8.39 Motor-drive unit ED-S, connection diagram (1579393)
ATTENTION:

THE OFF-CIRCUIT TOP COVER MUST ONLY BE OPENED BY QUALIFIED PERSONNEL WITH THE APPROPRIATE PERSONAL PROTECTIVE AND THE LOCAL MAIN NAME.

THE TRANSFORMER MUST ONLY BE RECONUILD BY QUALIFIED PERSONNEL. DO NOT USE ANY POWER SOURCE.

PLEASE NOTE THAT ONLY THE SUPERVISORY CONTROL CIRCUIT BOARD IS USED FOR THE OPENING OF THE TRANSFORMER CIRCUIT BOARD. THE SUPERVISORY CONTROL CIRCUIT BOARD MUST NOT BE DISMANTLED OR DISMANTLED IN ANY WAY DURING THE INSTALLATION.

THE DISCONNECT OF ANY OTHER CONTACTORS OF THE MOTOR CIRCUIT IS PERMITTED. FOR DISMANTLED CIRCUIT, CONTACTORS MUST BE DISMANTLED AND TRANSFORMER MUST BE DISMANTLED.

DANGER TO LIFE AND HEALTH!
8.40 Lifting traverse (72673703)
8.41 Bevel gear CD 6400, dimensional drawing (892916)

Der Drehsinne wird bei Bestellung festgelegt. / THE DIRECTION OF ROTATION IS DEFINED DURING ORIERING.
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