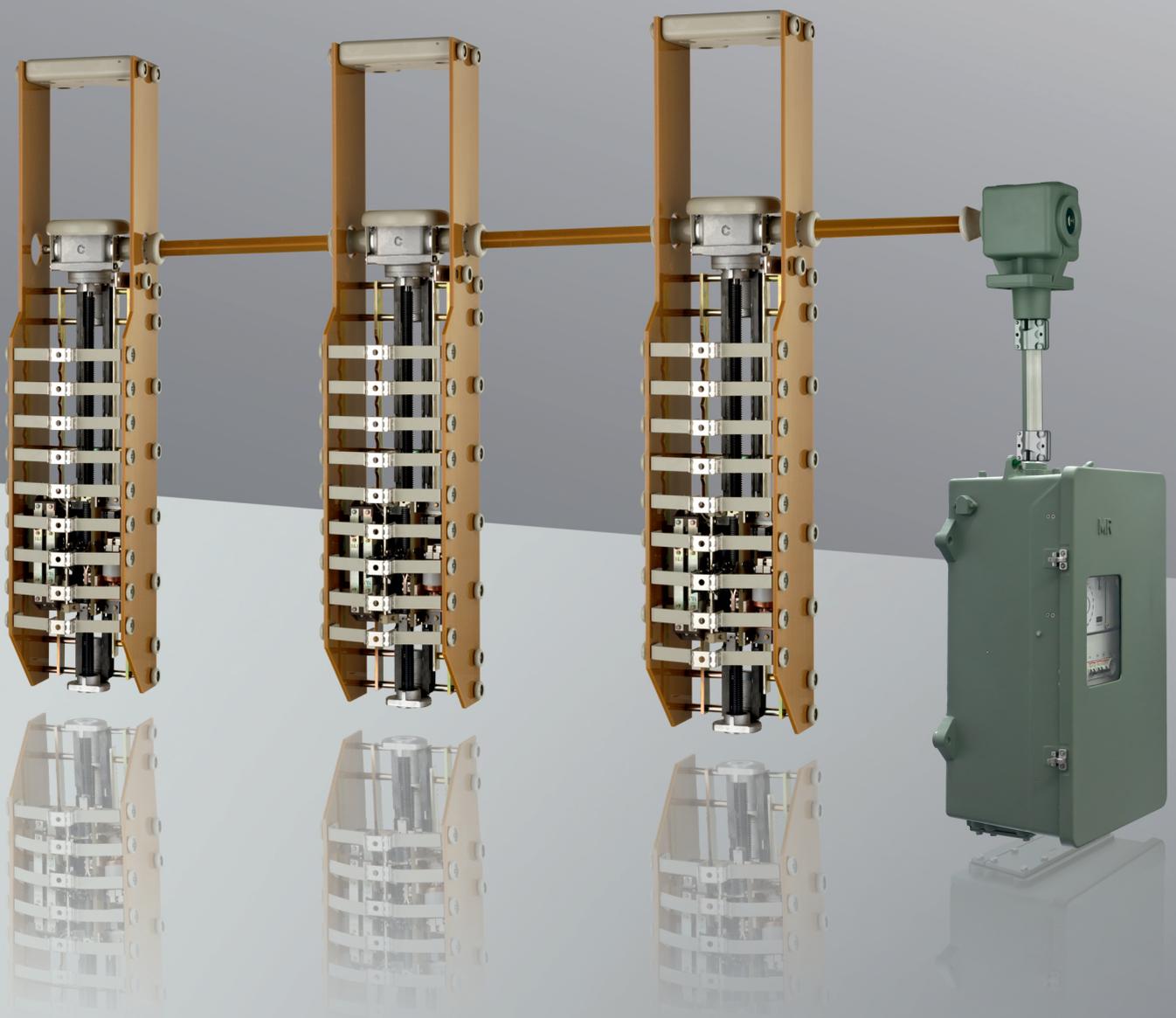




# On-load tap-changer VACUTAP<sup>®</sup> VT<sup>®</sup>

Installation and commissioning instructions

4349319/03 EN



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The product may have been altered since this document was published.

We reserve the right to change the technical data, design and scope of supply.

Generally the information provided and agreements made when processing the individual quotations and orders are binding.

The original operating instructions were written in German.



## Table of contents

<b>1</b>	<b>Introduction.....</b>	<b>5</b>
1.1	Manufacturer.....	5
1.2	Completeness.....	5
1.3	Safekeeping.....	5
1.4	Notation conventions.....	5
1.4.1	Hazard communication system.....	5
1.4.2	Information system.....	7
1.4.3	Instruction system.....	7
<b>2</b>	<b>Safety.....</b>	<b>9</b>
2.1	Appropriate use.....	9
2.2	Inappropriate use.....	10
2.3	Fundamental safety instructions.....	10
2.4	Personal protective equipment.....	12
2.5	Personnel qualification.....	13
<b>3</b>	<b>Product description.....</b>	<b>14</b>
3.1	Scope of delivery.....	14
3.2	On-load tap-changer.....	14
3.2.1	Function description.....	14
3.2.2	Design.....	15
3.2.3	Name plate.....	17
3.3	Drive shaft.....	18
3.3.1	Function description.....	18
3.3.2	Design/versions.....	19
<b>4</b>	<b>Packaging, transport and storage.....</b>	<b>20</b>
4.1	Packaging.....	20
4.1.1	Suitability.....	20
4.1.2	Markings.....	21
4.2	Transportation, receipt and handling of shipments.....	22
4.3	Storage of shipments.....	23
4.4	Unpacking shipments and checking for transportation damages.....	24
<b>5</b>	<b>Mounting.....</b>	<b>25</b>
5.1	Installing on-load tap-changer in transformer.....	25



5.2 Connecting the tap winding and on-load tap-changer take-off lead ..... 26

5.3 Fitting drive components..... 26

5.3.1 Fitting motor-drive unit ..... 26

5.3.2 Fitting drive shaft..... 27

5.4 Carrying out the transformer ratio test ..... 43

5.5 Measuring DC resistance on transformer ..... 43

**6 Commissioning..... 44**

6.1 Commissioning the on-load tap-changer at the transformer manufacturer's site ..... 44

6.1.1 Performing trial tap-change operations ..... 44

6.1.2 Grounding the on-load tap-changer ..... 44

6.1.3 High-voltage tests on the transformer ..... 45

6.2 Transporting transformer to the operating site..... 47

6.3 Commissioning transformer at operating site ..... 47

6.3.1 Performing trial tap-change operations ..... 47

6.3.2 Commissioning the transformer ..... 47

**7 Fault elimination ..... 48**

**8 Technical data..... 49**

8.1 On-load tap-changer properties ..... 49

8.2 Permissible ambient conditions ..... 49

**9 Drawings ..... 50**

9.1 VACUTAP® VT I 500, installation drawing (898312) ..... 50

9.2 VACUTAP® VT I 500, dimensional drawing (897979) ..... 51

9.3 VACUTAP® VT I 500, switching sequence (899507)..... 52

9.4 VACUTAP® VT I 500, fitting variants (897377)..... 53

9.5 VACUTAP® VT I 500, adjustment plan (898613)..... 54

9.6 VACUTAP® VT I 500, determining insulating shaft length (897975) ..... 55

9.7 TAPMOTION® ED with CD 6400, limit dimension of vertical drive shaft (898598)..... 56

9.8 Bevel gear CD 6400, dimensional drawing (892916) ..... 57

**List of key words ..... 58**



# 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  
Tel.: (+49) 9 41/40 90-0  
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

### 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:

Signal word	Definition
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

Pictograms warn of dangers:

Pictogram	Definition
	Warning of a danger point
	Warning of dangerous electrical voltage
	Warning of combustible substances
	Warning of danger of tipping
	Warning of danger of crushing

Table 2: Pictograms used in warning notices

### 1.4.2 Information system

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



Important information.

### 1.4.3 Instruction system

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

#### Single-step instructions

Instructions which consist of only a single process step are structured as follows:



Aim of action

- ✓ Requirements (optional).
- ▶ Step 1 of 1.
  - ⇒ Result of step (optional).
- ⇒ Result of action (optional).

**Multi-step instructions**

Instructions which consist of several process steps are structured as follows:

Aim of action

- ✓ Requirements (optional).
- 1. Step 1.
  - ⇒ Result of step (optional).
- 2. Step 2.
  - ⇒ Result of step (optional).
- ⇒ Result of action (optional).



## 2 Safety

- Read this technical file through 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.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

### 2.1 Appropriate use

The product is an on-load tap-changer and adjusts the transmission ratio of transformers without interrupting the load flow. The product is designed solely for use in electrical energy systems and facilities. If used as intended and in compliance with the requirements and conditions specified in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any danger to people, property or the environment. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered appropriate use:

- Use the product only with the transformer/motor-drive unit specified in the order.
- The serial numbers of on-load tap-changer and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay, etc.) must match if the on-load tap-changer and on-load tap-changer accessories are supplied as a set for one order.
- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this provided technical file, the agreed delivery conditions and technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical file.
- For this on-load tap-changer, indoor installation in accordance with environmental class E0 in accordance with IEC 60076-11:2004 is mandatory. Fire class F0 in accordance with IEC 60076-11:2004 is satisfied.
- Take suitable measures to ensure that no condensation forms on the on-load tap-changer and that the on-load tap-changer is not susceptible to dew condensation or icing. The on-load tap-changer has no protective housing.



### Permitted electrical operating conditions

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

In the standard version, the on-load tap-changer is designed for sinusoidal 50/60 Hz alternating current with a curve form symmetrical to the zero axis and can switch 2 times the rated through-current  $I_r$  at its rated step voltage  $U_{ir}$ .

Exceeding the rated step voltage  $U_{ir}$  by up to 10% for a short period is permitted as long as the rated step capacity  $P_{SIN}$  permissible for this step voltage is not exceeded.

## 2.2 Inappropriate use

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

### Prohibited electrical operating conditions

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

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

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

Operations outside of the permitted operating conditions can lead to injury to persons and damage to the product.

- Prevent any such operations outside of the permitted operating conditions by taking suitable measures.

## 2.3 Fundamental safety instructions

To prevent accidents, malfunctions 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 poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

### **Work area**

Untidy and poorly lit work areas can lead to accidents.

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

### **Working during operation**

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

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

### **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.

### **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.

- 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 Maschinenfabrik Reinhausen GmbH.

### Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

## 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.

<b>Protective clothing</b>	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.
<b>Safety shoes</b>	To protect against falling heavy objects and slipping on slippery surfaces.
<b>Safety glasses</b>	To protect the eyes from flying parts and splashing liquids.
<b>Visor</b>	To protect the face from flying parts and splashing liquids or other dangerous substances.
<b>Hard hat</b>	To protect against falling and flying parts and materials.
<b>Hearing protection</b>	To protect against hearing damage.
<b>Protective gloves</b>	To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment



## 2.5 Personnel qualification

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

### Electrically skilled person

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

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

### Electrically trained persons

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

### Operator

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

### Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work 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.



## 3 Product description

### 3.1 Scope of delivery

The product is delivered as follows:

- On-load tap-changer
- Motor-drive unit
- Drive shaft with coupling parts and bevel gear
- 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 20] chapter.

### 3.2 On-load tap-changer

#### 3.2.1 Function description

On-load tap-changers are used to adjust the transmission ratio of transformers without interrupting the load flow. This makes it possible to compensate for aspects such as fluctuations in voltage occurring in the power transmission grid. For this purpose, on-load tap-changers are fitted in transformers and connected to the active part of the transformer.

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

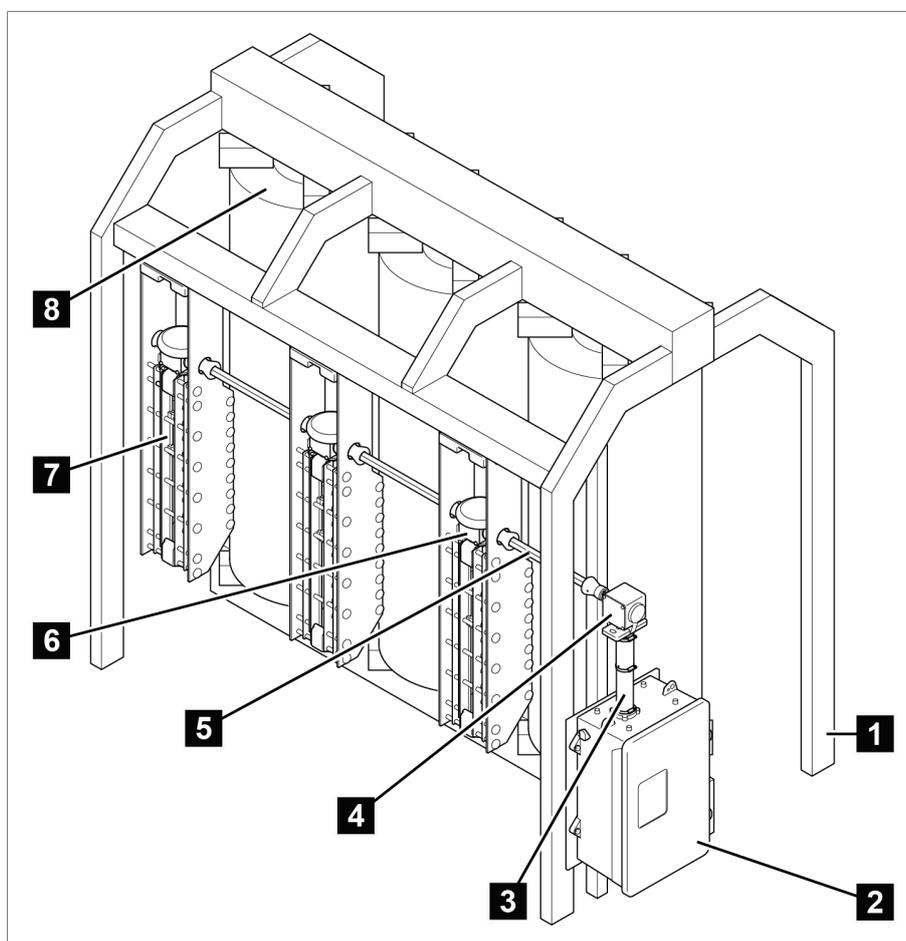


Figure 1: Overview of a 3-phase system

1 Transformer tank	5 Insulating shaft (horizontal drive shaft)
2 Motor-drive unit	6 Bevel gear of on-load tap-changer
3 Square tube (vertical drive shaft)	7 On-load tap-changer
4 Bevel gear of motor-drive unit	8 Active part

### 3.2.2 Design

The following drawing shows the main components of the on-load tap-changer.

You will find a detailed drawing of the on-load tap-changer in the "Drawings [► Section 9, Page 50]" section.

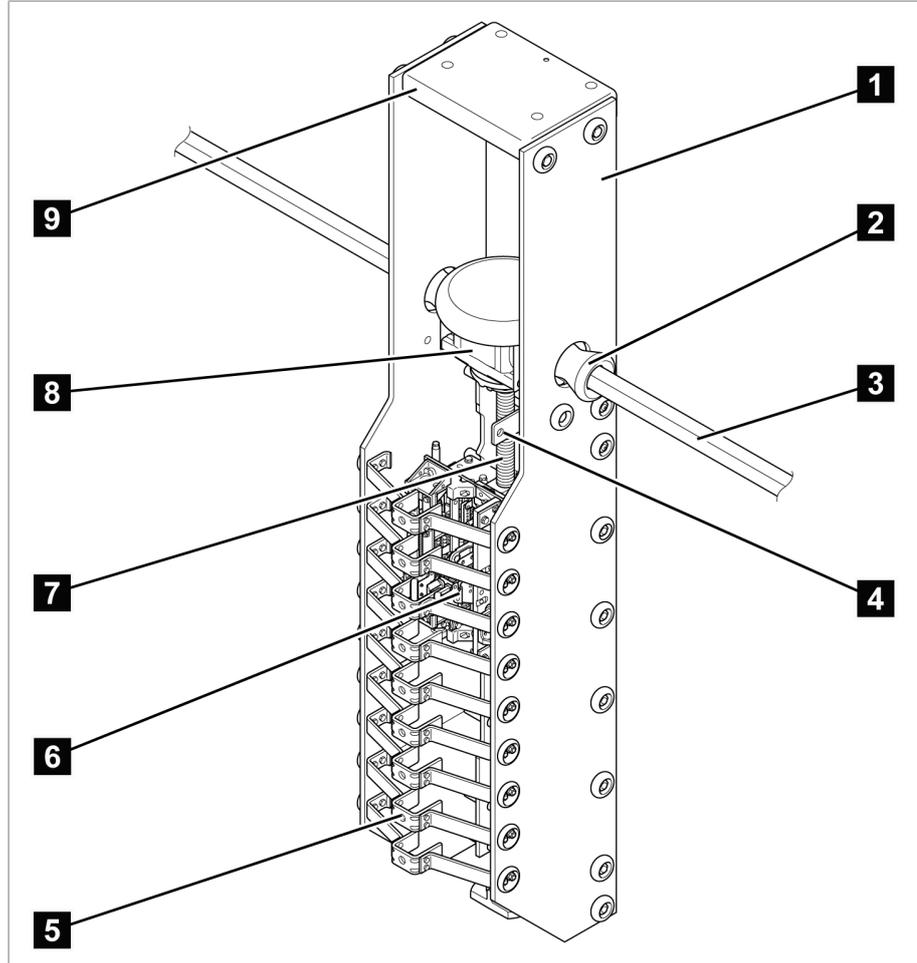


Figure 2: Design

1 Insulating plate	6 Switching element
2 Screening sleeve	7 Threaded spindle
3 Insulating shaft	8 Bevel gear
4 Take-off contact	9 Mounting bridge
5 Connection contact	

### 3.2.3 Name plate

The name plate is located on the bevel gear's mounting arm:

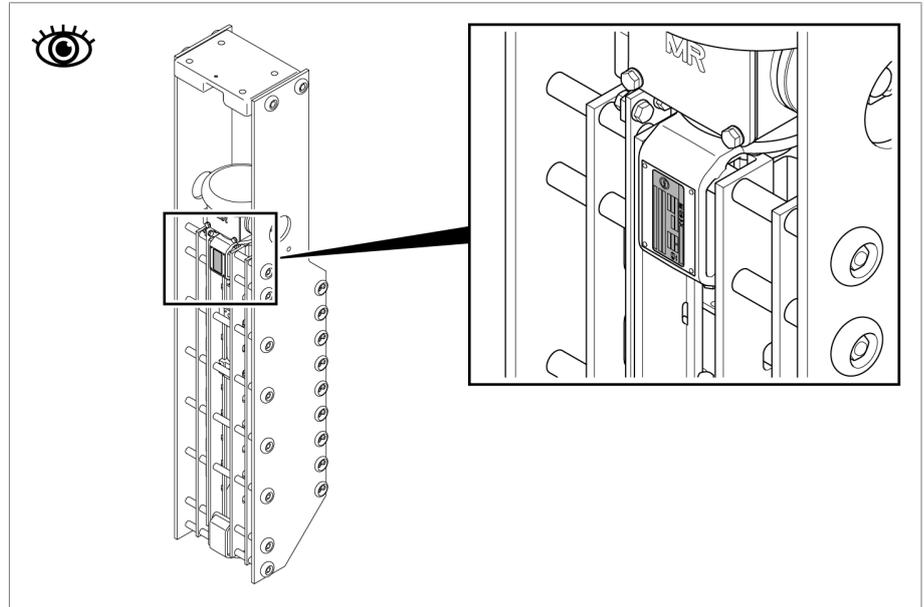


Figure 3: Name plate



### **3.3 Drive shaft**

#### **3.3.1 Function description**

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

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/coupling sleeves and one coupling bolt to the driving or driven shaft end of the device to be connected.

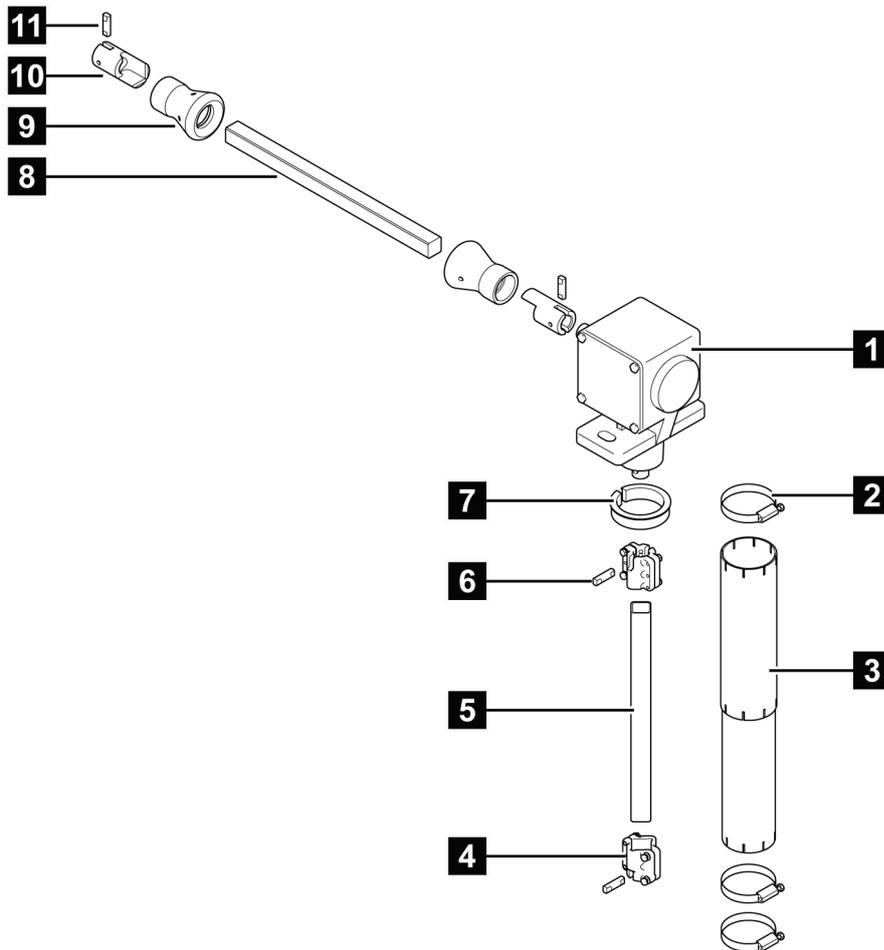


Figure 4: Components of the drive shaft

1 Bevel gear	2 Hose clip
3 Telescopic protective tube	4 Coupling bracket
5 Square tube	6 Coupling bolt
7 Adapter ring	8 Insulating shaft (square tube)
9 Screening sleeve	10 Coupling sleeve
11 Coupling bolt	



## 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.

---

				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

---

Table 4: Shipping pictograms

## 4.2 Transportation, receipt and handling of shipments

### ▲ WARNING



#### Danger of death or severe injury!

Danger of death or serious injuries 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 suspended 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!** Damage to packaged goods due to damaged sealed packaging. If the product is delivered in sealed packaging, check the sealed packaging 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.

- 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 fluid until used if the packaged goods were not supplied in insulating fluid.

#### **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!** Damage to packaged goods due to ineffectively sealed packaging. Transport the packaged crate to the place where the packaged goods are to be installed. Do not open the sealed packaging until just before installation.
- **▲ WARNING!** Serious injuries and damage to the packaged goods due to the packaged goods tipping out. Place the packaged goods in an upright crate and protect it from tipping out.
- Unpack the packaged goods and check the condition.
- Check the completeness of the accessories kit using the delivery slip.

## 5 Mounting

### ▲ WARNING



#### Risk of crushing!

During an on-load tap-changer switching operation, the switching element – which is freely accessible – moves. Reaching into the switching element during a tap-change operation can result in serious injuries.

- ▶ Keep at a safe distance of at least 1 m during tap-change operations.
- ▶ Do not reach into the switching element during tap-change operations.
- ▶ Do not switch the on-load tap-changer when working on the on-load tap-changer.

### 5.1 Installing on-load tap-changer in transformer

- ▶ **NOTICE!** Damage to the on-load tap-changer due to partial discharges or flashovers. Mount the on-load tap-changer on the transformer vertically (maximum 2° deviation from the vertical) and with the mounting bridge at top. Maintain a minimum distance of 100 mm between the selector connection contacts and transformer winding. Ensure that there is sufficient safety clearance between the bottom bearing of the on-load tap-changer and grounded parts of the transformer and transformer tank bottom.

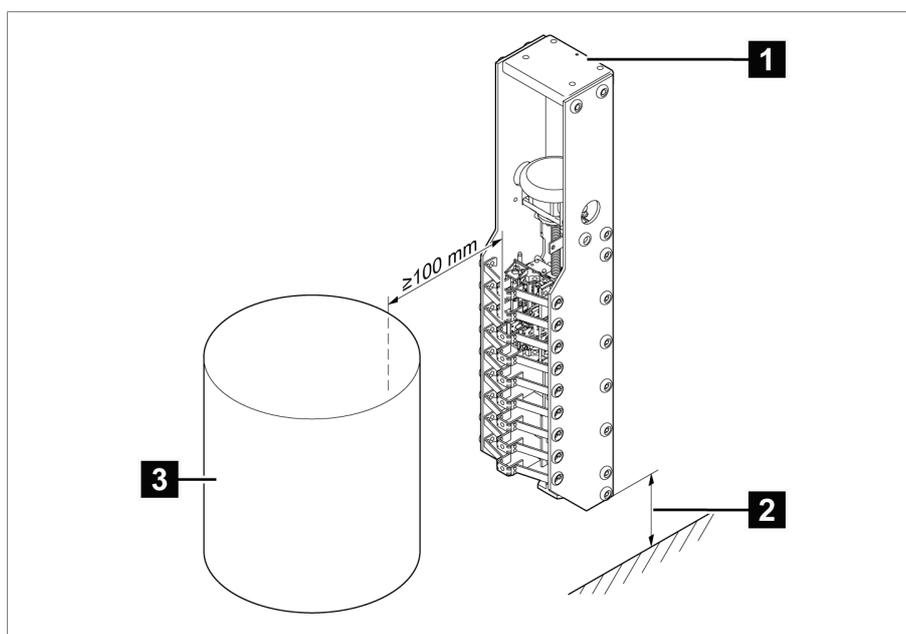


Figure 5: Installing on-load tap-changer

1 Mounting bridge

2 Spacing to transformer tank bottom

3 Active part of the transformer with transformer winding



## 5.2 Connecting the tap winding and on-load tap-changer take-off lead

### NOTICE

#### Damage to the on-load tap-changer!

Connecting leads which place mechanical strain on the on-load tap-changer will damage the on-load tap-changer!

- ▶ Establish and secure connections with care.
- ▶ Do not twist connection contacts.
- ▶ Connect connecting leads without warping or deforming.
- ▶ If necessary use an expansion loop for connecting leads.

The designations of the on-load tap-changer's connection contacts are shown in the connection diagram. The connection contacts are provided with horizontal through-holes with a diameter of 13.5 mm for M10 bolts.

- ▶ Connect tap-winding connecting lead and in accordance with the connection diagram included with the delivery.

## 5.3 Fitting drive components

### 5.3.1 Fitting motor-drive unit

- ▶ Fit motor-drive unit to transformer as described in relevant MR operating instructions for motor-drive unit.

### 5.3.2 Fitting drive shaft

#### 5.3.2.1 Fitting a vertical drive shaft without cardan joint

##### Permitted axial displacement

Minor axial displacements of the vertical drive shaft are permitted as long as they do not exceed 35 mm per 1000 mm of square tube length (this corresponds to 2°).

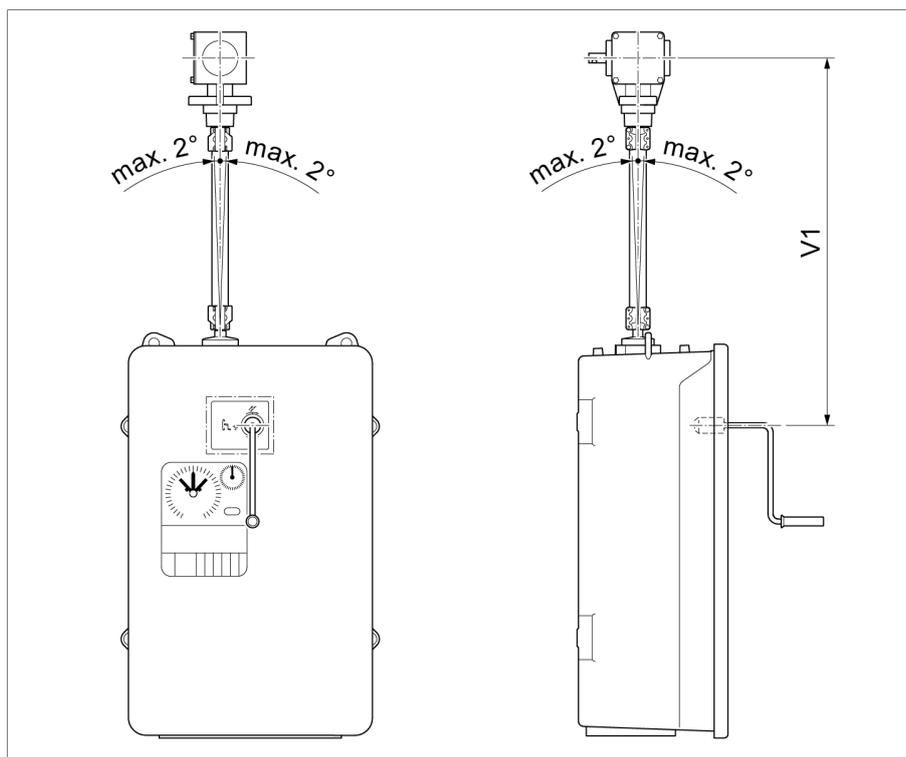


Figure 6: Permitted maximum axial displacement of vertical drive shaft without cardan joint

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.

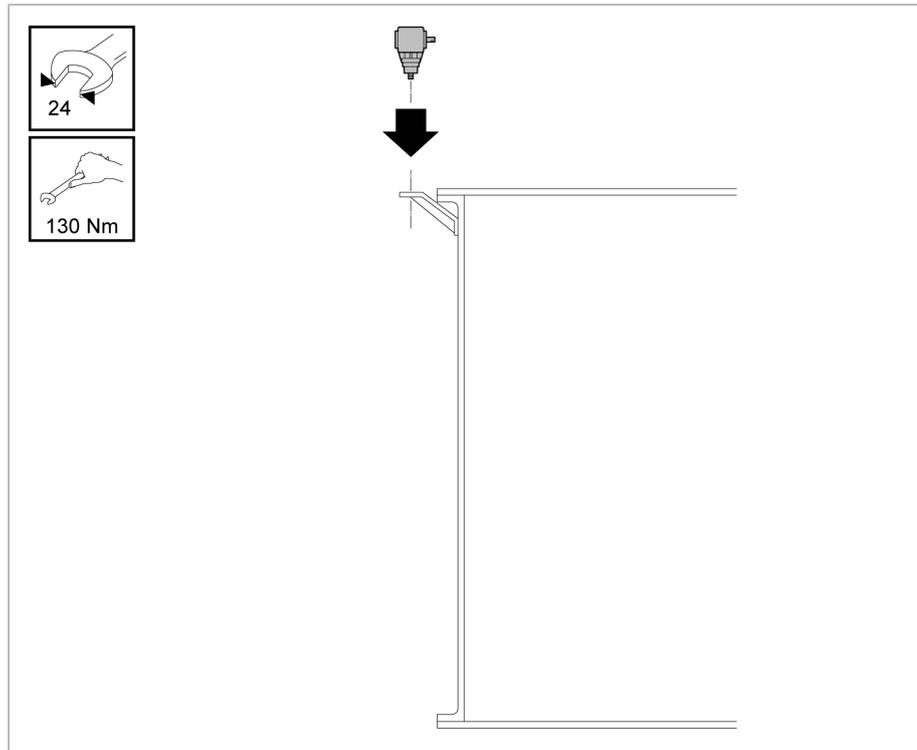


Figure 7: Bevel gear

3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten square tube to length of A-9 mm.

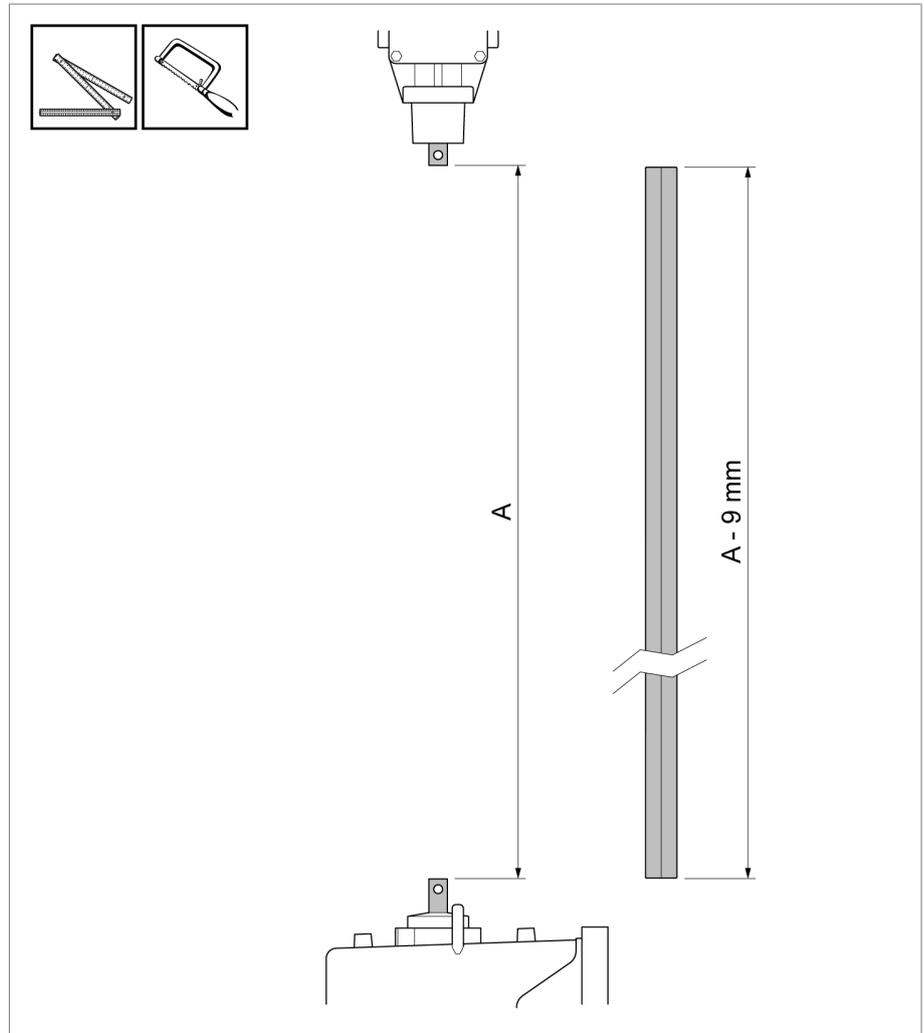


Figure 8: Shortening square tube

4. Deburr cut surfaces of square tube.

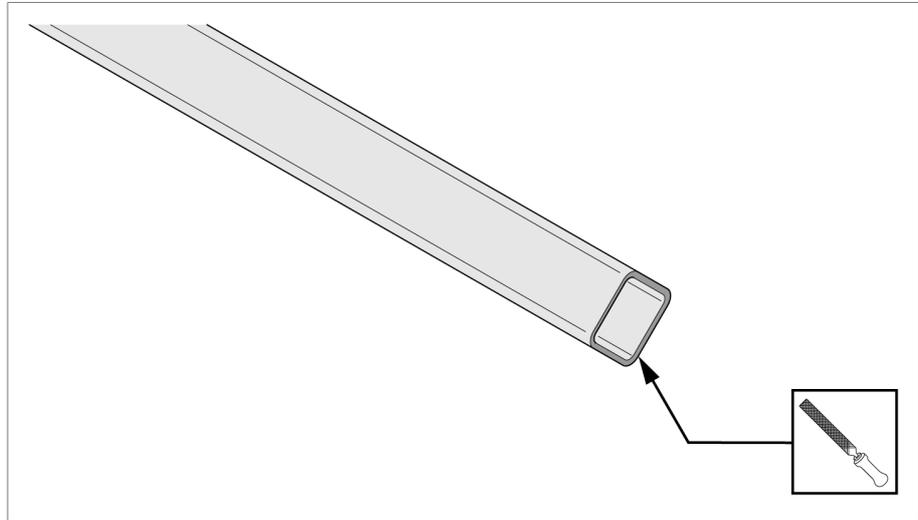


Figure 9: Deburring cut surfaces

5. Slide the loosely screwed-together coupling part onto square tube until stop is reached.

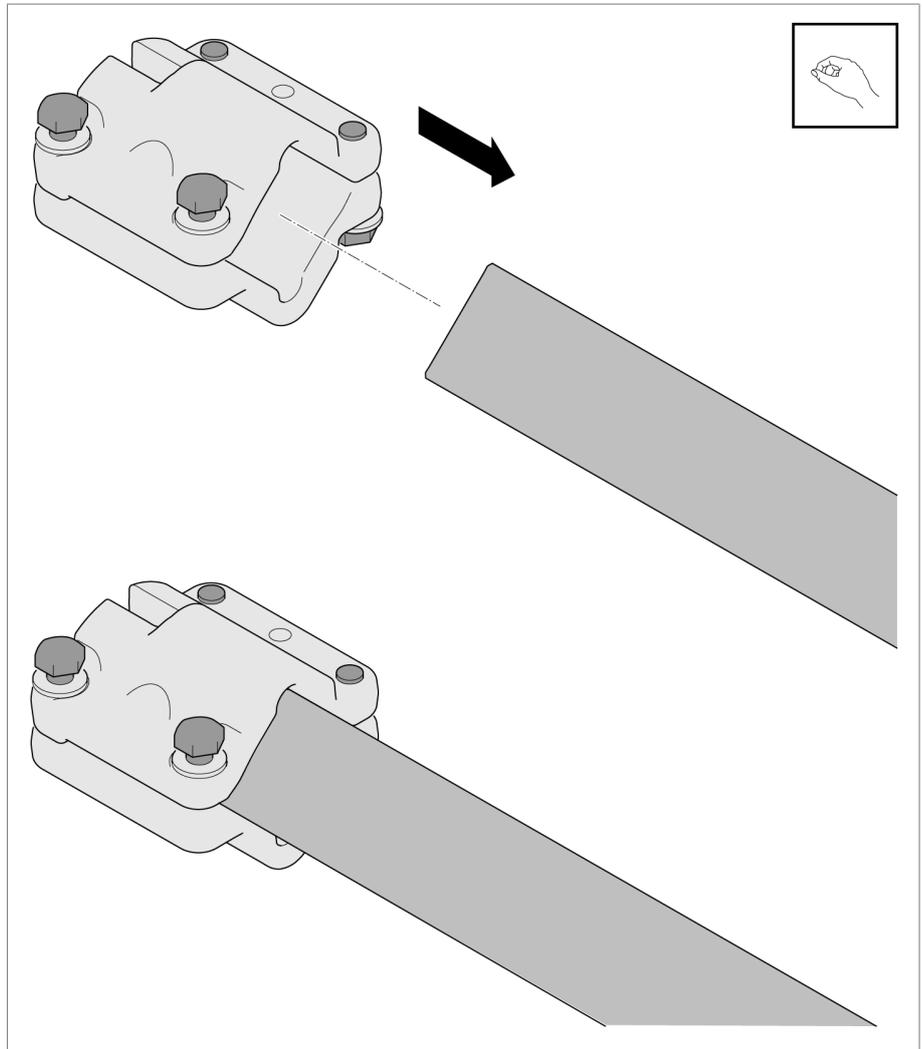


Figure 10: Slide coupling part onto square tube

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

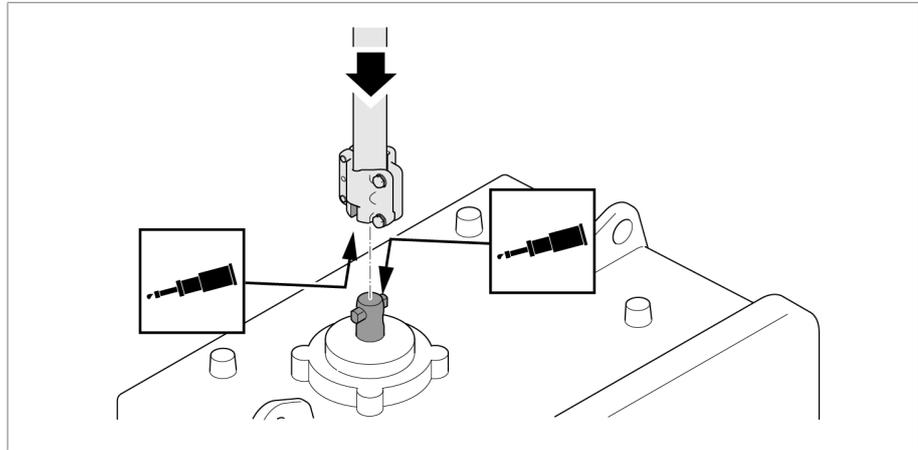


Figure 11: Sliding square tube with coupling part onto shaft end

7. Attach square tube to drive.

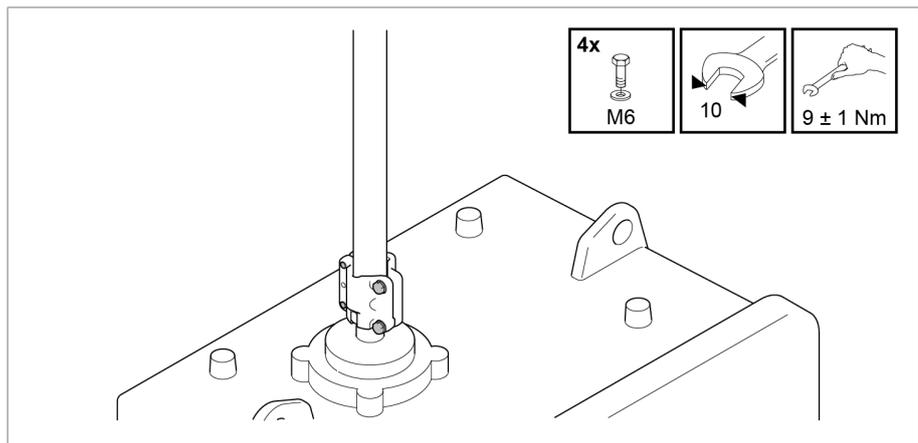


Figure 12: Attaching square tube to drive

8. Pivot square tube away from axis.

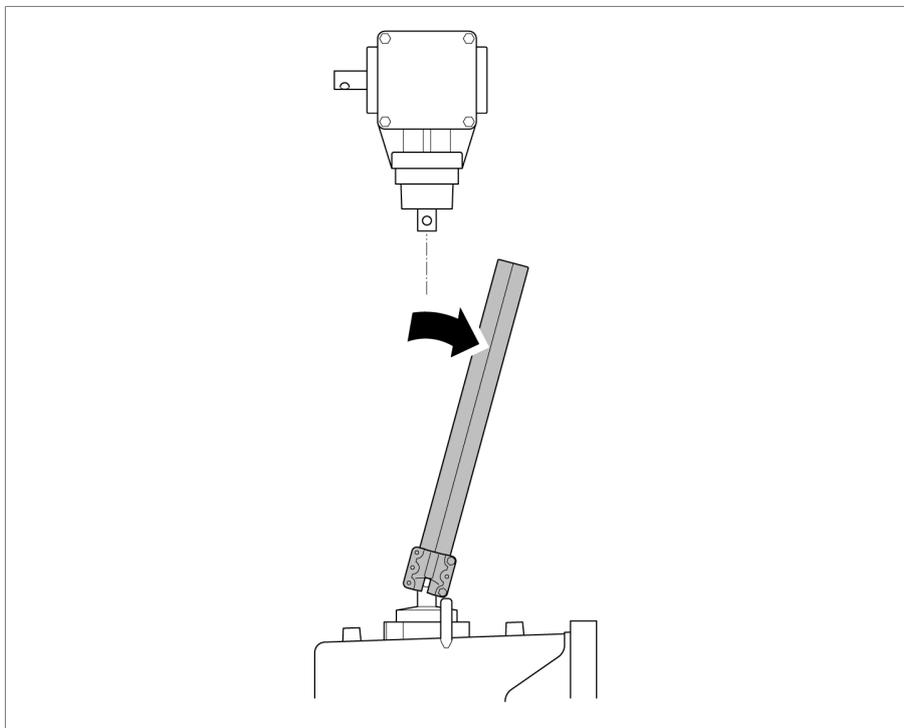


Figure 13: Pivoting square tube away from axis

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



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

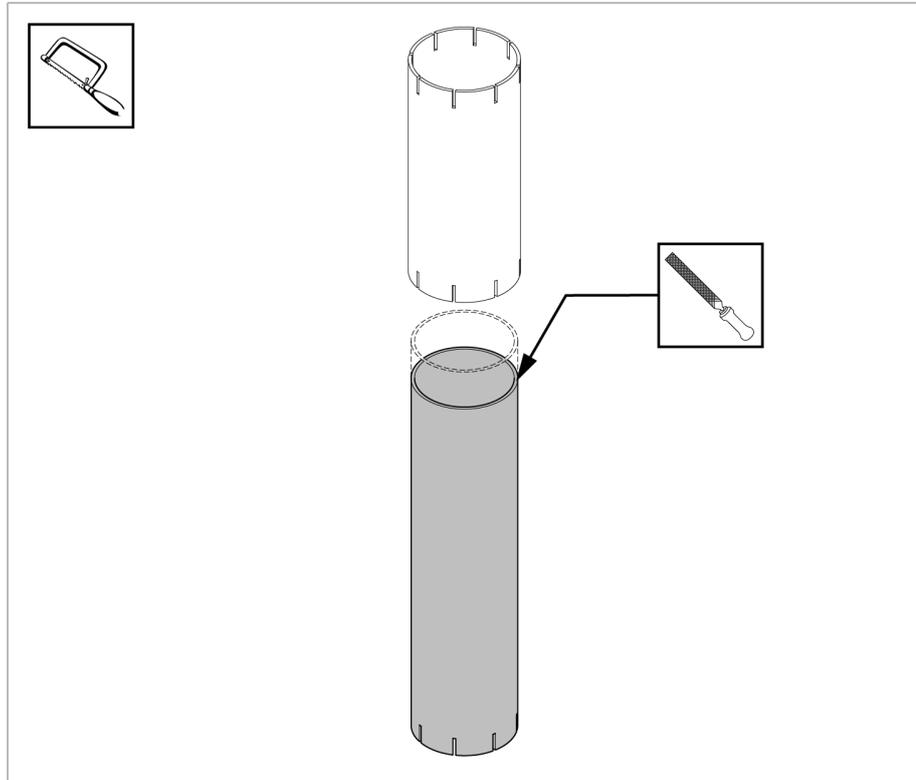


Figure 14: Deburring inner tube

Dimension A (= distance between shaft end of drive and shaft end of bevel gear)	Inner tube	Outer tube
170 mm...190 mm	Shorten to 200 mm	= 200 mm
191 mm...1,130 mm	Dimension A + 20 mm	= 200 mm
1,131 mm...1,598 mm	= 700 mm	= 1,150 mm
1,599 mm...2,009 mm	= 1,150 mm	= 1,150 mm

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.

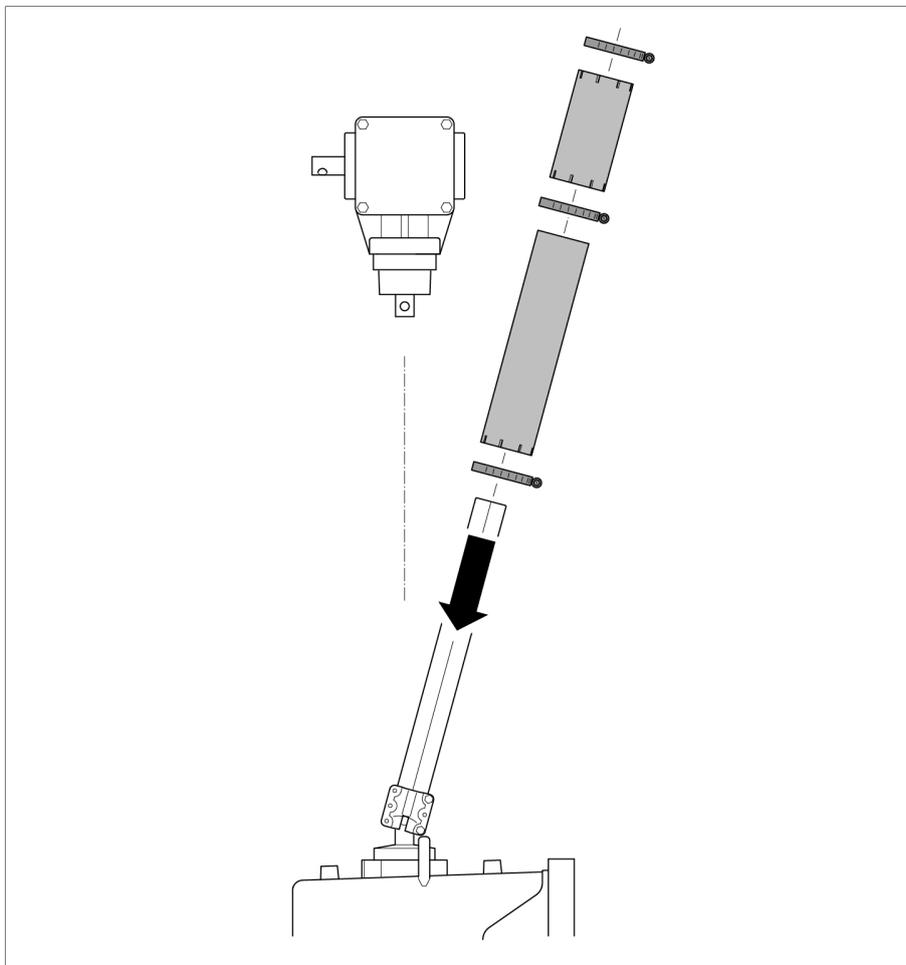


Figure 15: Sliding on telescopic protective tube

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.

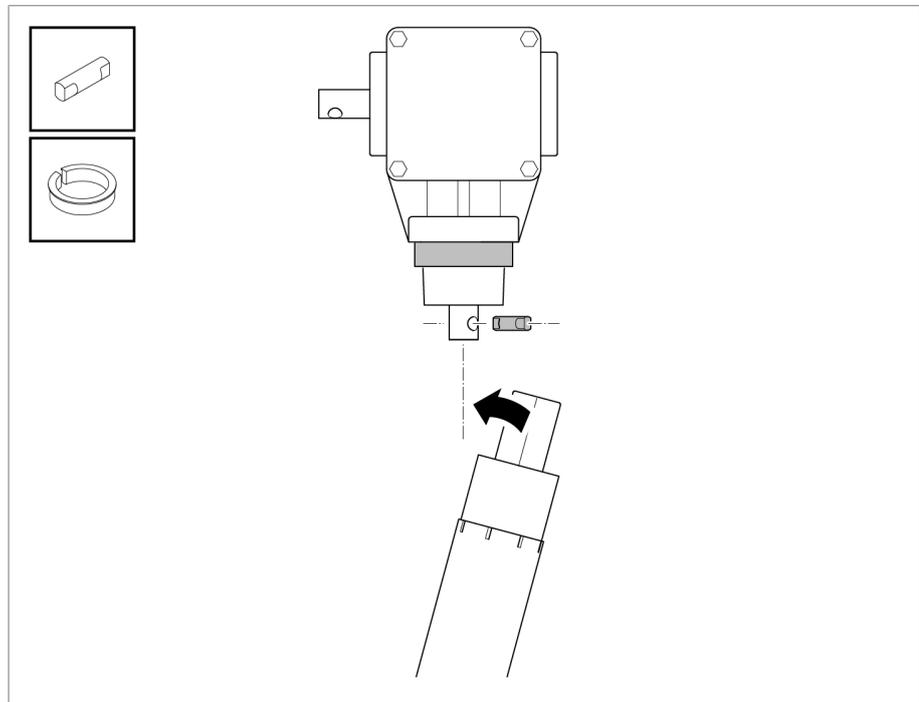


Figure 16: Fitting adapter ring and coupling bolt

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 the coupling bolt and upper coupling piece.

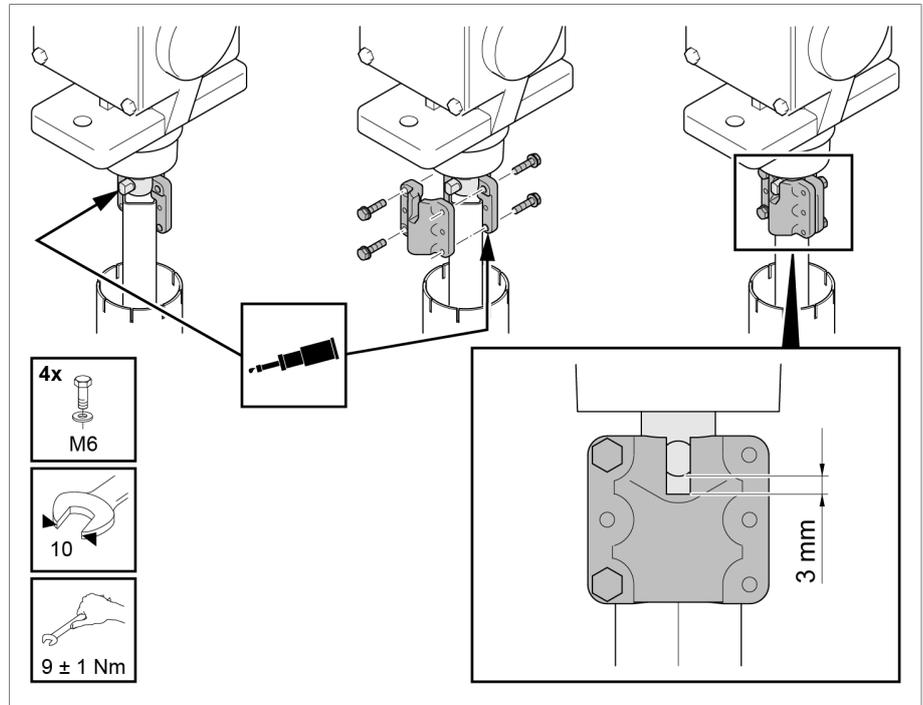


Figure 17: Mounting coupling brackets

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

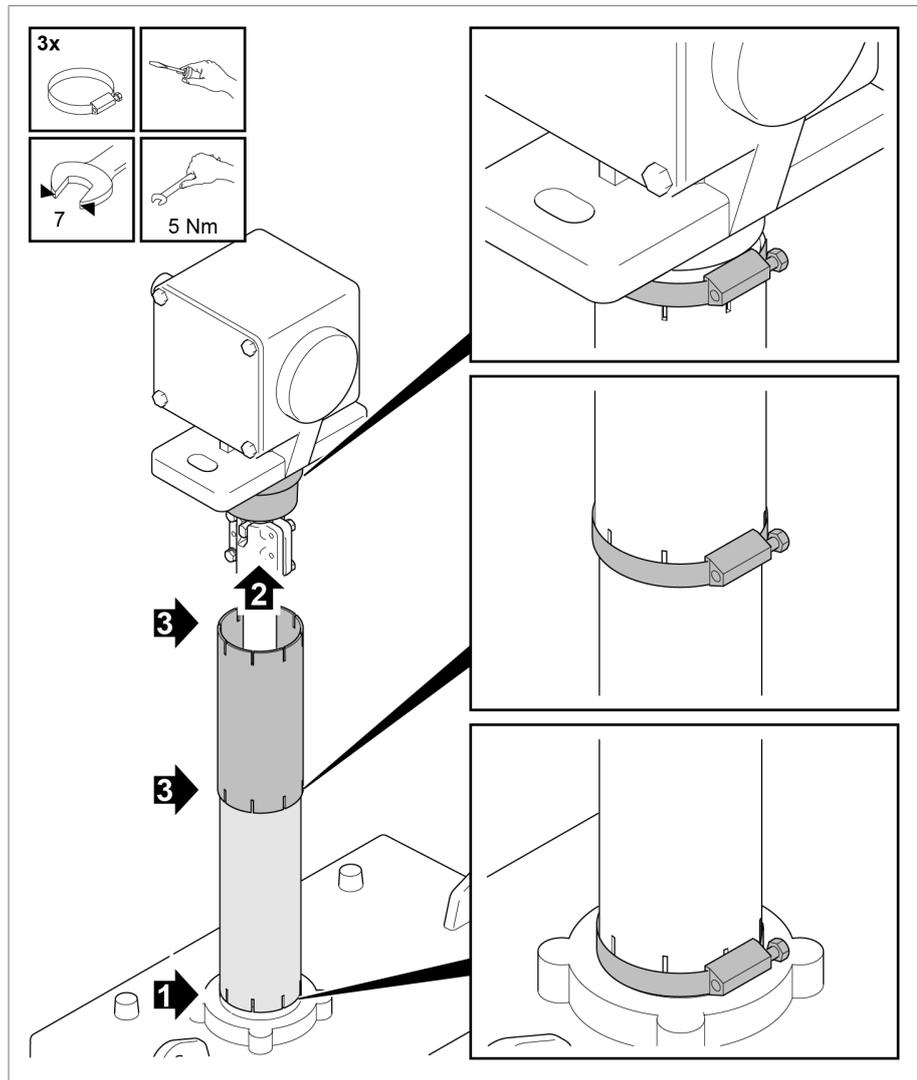


Figure 18: Mounting protective tube

### 5.3.2.2 Fitting insulating shaft (horizontal drive shaft)



When installing 3 on-load tap-changers, note the corresponding insulation spacing [► Section 9.4, Page 53] between the on-load tap-changers.



If you are using 3 on-load tap-changers in the transformer, start with step 2.

1. Determine dimension C between shaft end of on-load tap-changer's bevel gear and motor-drive unit's bevel gear. Shorten insulating shaft to length of C – 53 mm.

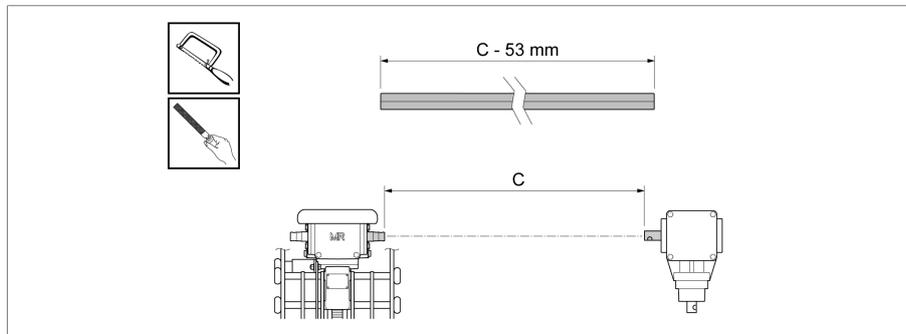


Figure 19: Shortening insulating shafts

2. With a variant comprising 3 on-load tap-changers: Measure dimensions D and E between the shaft ends of the bevel gears on all on-load tap-changers. Shorten insulating shafts to length D - 53 mm and length E - 53 mm.

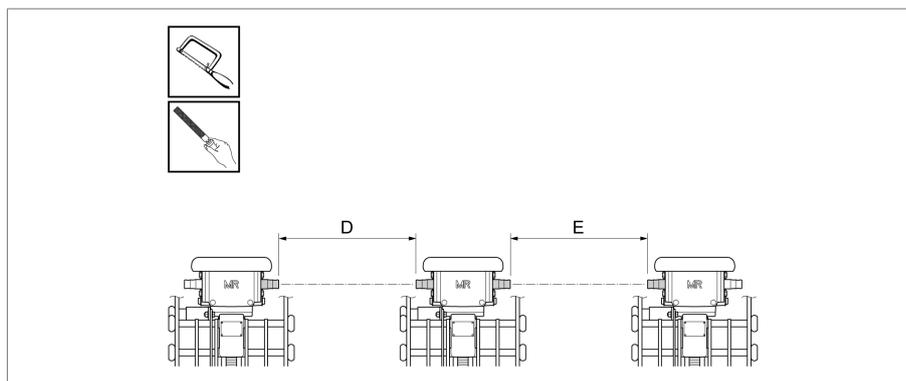


Figure 20: Shortening insulating shafts

3. Deburr cut surfaces of shortened insulating shaft.

4. Grease coupling bolts on both shaft ends and insert. Push coupling sleeves in over coupling bolts.

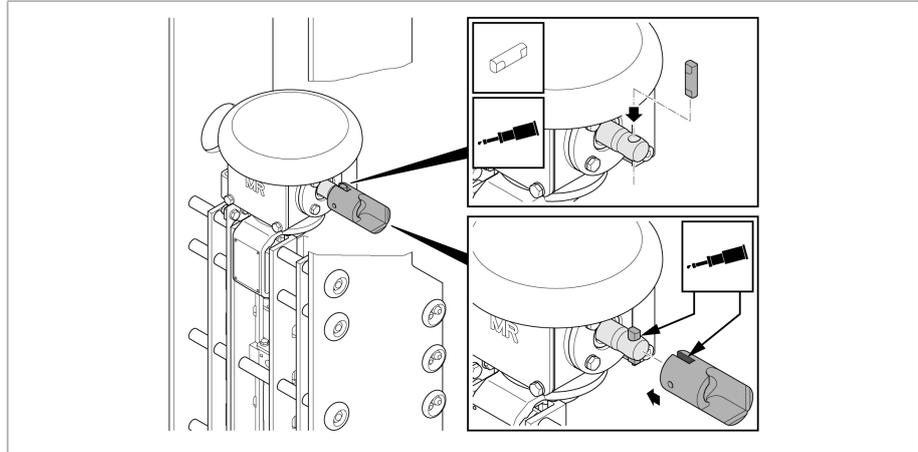


Figure 21: Greasing coupling bolt

5. Slide 2 screening sleeves onto insulating shafts.

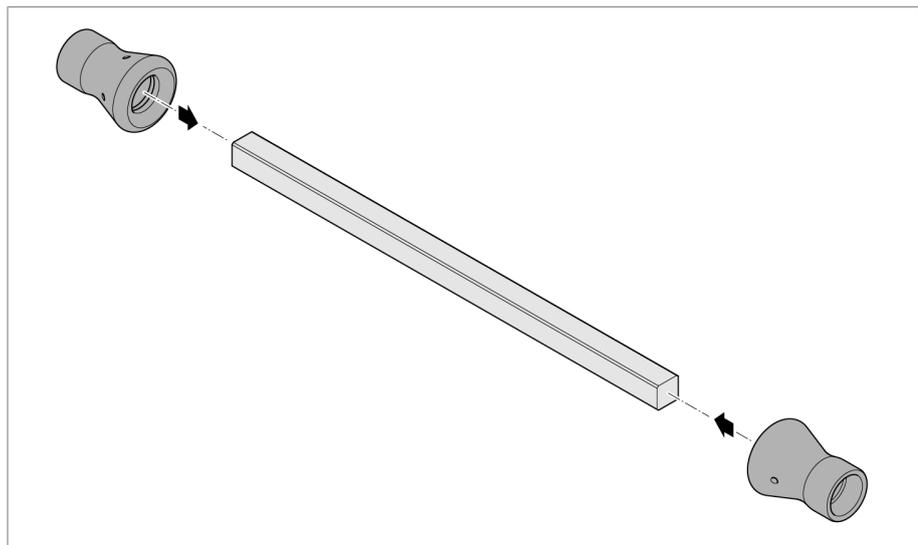


Figure 22: Sliding screening sleeves onto insulating shafts

6. Insert insulating shafts into the two coupling sleeves with an axial clearance on one side of 3 mm.

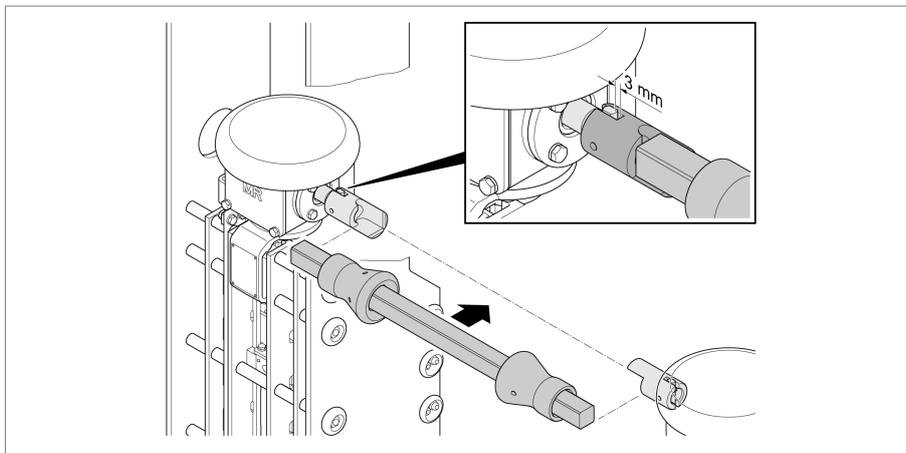


Figure 23: Inserting insulating shaft into coupling sleeves

7. Slide screening sleeves over coupling sleeve as far as they will go.

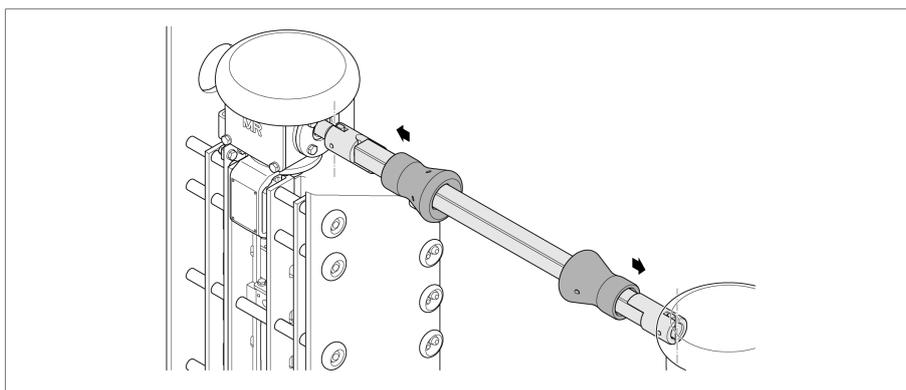


Figure 24: Sliding screening sleeves over coupling sleeves

8. Secure each coupling sleeve with a clamping piece.

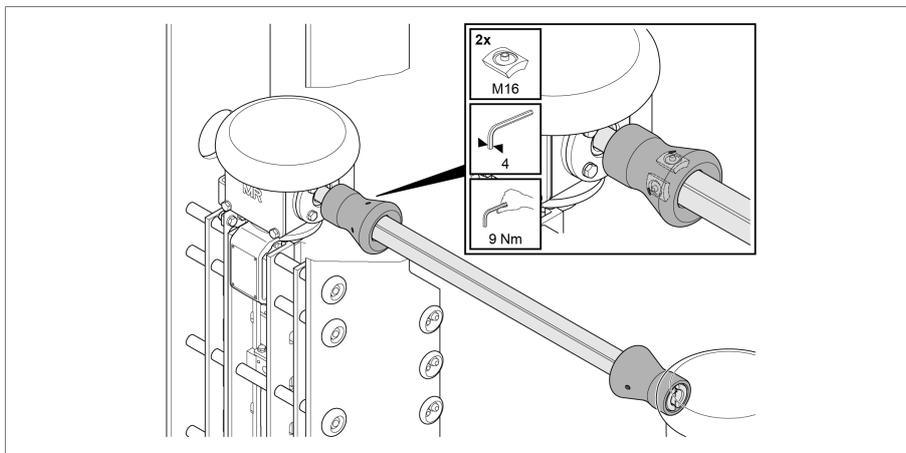


Figure 25: Securing coupling sleeves



9. Repeat steps 2 to 9 to connect the other on-load tap-changers with one another.
10. Center motor-drive unit and on-load tap-changer in accordance with operating instructions for motor-drive unit.



## 5.4 Carrying out the transformer ratio test

### NOTICE

#### Damage to the on-load tap-changer!

Damage to the on-load tap-changer due to transformer ratio test being incorrectly performed.

- ▶ Use the supplied hand crank of the motor-drive unit to actuate the on-load tap-changer's drive shaft.
  - ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
  - ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft parts.
1. Switch the on-load tap-changer to the desired operating position by performing 33 hand crank revolutions on the motor-drive unit.
    - ⇒ The switching action of the on-load tap-changer can be heard clearly.
  2. **NOTICE!** An incomplete tap-change operation may damage the on-load tap-changer. Once the on-load tap-changer has been switched, perform another 3 to 4 hand crank revolutions in the same direction to correctly end the tap-change operation.
  3. Perform the transformer ratio test.
  4. **NOTICE!** Damage to the on-load tap-changer due to time interval between successive tap-change operations being too short. Repeat the transformer ratio test in all operating positions. Wait at least 60 seconds between the individual tap-change operations.
  5. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram).

## 5.5 Measuring DC resistance on transformer

Note the measurement scenarios listed below and the associated maximum measured currents when measuring DC resistance on the transformer.



The measured DC current is normally restricted to 10% of the rated current of the measured transformer winding in order to prevent the winding from overheating.

Take DC resistance measurement in various on-load tap-changer operating positions of measured current as described below: You can take the DC resistance measurement with or without interruption of measured current during the change of operating position:

- Without interruption in measured current: Maximum 10 A DC
- With interruption: Maximum 50 A DC
  - When changing operating position, the measured current must be 0 A

## 6 Commissioning

### ▲ WARNING



#### Danger of explosion!

Overloading the on-load tap-changer can lead to explosion.

- ▶ Ensure that the on-load tap-changer is not overloaded.
- ▶ Ensure use of the on-load tap-changer in accordance with section "Appropriate use".
- ▶ Prevent operations outside of the permitted operating conditions by taking suitable measures.

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

Perform the following work and functional checks before commissioning the transformer.

#### 6.1.1 Performing trial tap-change operations

Before energizing the transformer, trial tap-change operations must be carried out to check the mechanical functions of on-load tap-changer and motor-drive unit.

1. **NOTICE!** Damage to the on-load tap-changer due to time interval between successive tap-change operations being too short. Manually undertake trial tap-change operations (33 hand crank revolutions on motor-drive unit) across entire tapping range. Wait at least 60 seconds between the individual tap-change operations.
2. **NOTICE!** An incorrectly coupled motor-drive unit will lead to damage to the on-load tap-changer. Ensure that in each operating position the tap position indicator of the motor-drive unit matches the contact designation on the on-load tap-changer.
3. In both end positions, check the function of the electrical and mechanical end stop in accordance with the motor-drive unit operating instructions.

#### 6.1.2 Grounding the on-load tap-changer

- ▶ **NOTICE!** Damage to the on-load tap-changer due to partial discharges or flashovers. Connect the grounding screw on the mounting bridge to the support on the transformer cover using a grounding electrode conductor. Ensure that the grounding electrode conductor **1** does not protrude into the grounding insulation distance.

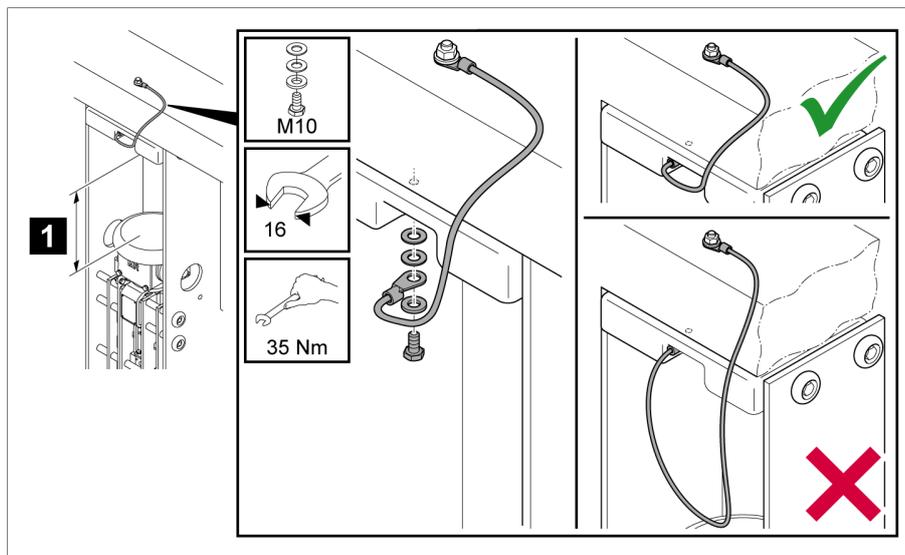


Figure 26: Grounding the on-load tap-changer

### 6.1.3 High-voltage tests on the transformer

#### ▲ WARNING



#### Danger of death or severe injury!

Danger of death or severe injury if high voltage tests are not carried out correctly on transformer.

- ▶ Ensure that all the on-load tap-changer's safety equipment is ready for use.
  - ▶ Use suitable personal protective equipment/clothing.
  - ▶ Keep away from the danger area during the transformer test.
  - ▶ Observe applicable fire protection regulations.
  - ▶ Make sure that only trained technicians perform work on the transformer.
- 
- 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, because 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

If the drive must be removed in order to transport the transformer, proceed as follows:

1. Ensure that the drive and the on-load tap-changer are in the adjustment position.
2. Remove the drive.
3. Do not actuate the drive while the on-load tap-changer is uncoupled and do not turn the output shaft.
4. Do not actuate an on-load tap-changer which is uncoupled and do not turn its drive shaft.
5. Transport the drive to the installation site in the MR delivery packaging.
6. Fit drive [► Section 5.3.1, Page 26] and drive shaft to transformer at the installation site.

## 6.3 Commissioning transformer at operating site

Check that the motor-drive unit functions correctly before energizing the transformer.

### 6.3.1 Performing trial tap-change operations

Before energizing the transformer, trial tap-change operations must be carried out to check the mechanical functions of on-load tap-changer and motor-drive unit.

1. **NOTICE!** Damage to the on-load tap-changer due to time interval between successive tap-change operations being too short. Manually undertake trial tap-change operations (33 hand crank revolutions on motor-drive unit) across entire tapping range. Wait at least 60 seconds between the individual tap-change operations.
2. **NOTICE!** An incorrectly coupled motor-drive unit will lead to damage to the on-load tap-changer. Ensure that in each operating position the tap position indicator of the motor-drive unit matches the contact designation on the on-load tap-changer.
3. In both end positions, check the function of the electrical and mechanical end stop in accordance with the motor-drive unit operating instructions.

### 6.3.2 Commissioning the transformer

1. Switch on transformer.
2. **NOTICE!** Inrush current impulses can be significantly greater than the transformer rated current and may lead to current paths with asymmetrical or non-sinusoidal curve shapes and, as a result, overload the on-load tap-changer during the diverter switch operation. Only perform tap-change operations - whether under no load or under load conditions - once the inrush current impulse has subsided.



## 7 Fault elimination

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

For more serious problems with the on-load tap-changer and motor-drive unit, which cannot be easily corrected on site, please inform your authorized MR representative, the transformer manufacturer or contact us directly at

Maschinenfabrik Reinhausen GmbH  
Technischer 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](mailto:service@reinhausen.com)  
Internet: [www.reinhausen.com](http://www.reinhausen.com)

Error pattern	Action
Tripping of motor protective switch in motor-drive unit	Request "Information sheet on motor protective switch tripping" from MR, complete and return to MR.
On-load tap-changer not changing tap position (sluggishness, Raise keys/Lower keys not working, diverter switch action not audible)	Contact MR.
No change in voltage on transformer despite change in position on motor-drive unit	Contact MR.
Tap position indicator on motor-drive unit and on-load tap-changer different	Contact MR.
Noises on drive shaft or motor-drive unit when changing tap position	Check that the drive shaft is attached correctly as described in the "Attaching drive components" [► Section 5.3, Page 26] section. Check that hose clips and protective covers are seated correctly. Contact MR in the event of noise from the motor-drive unit.
Red message on monitoring unit	If possible read out database and send to MR along with error code.
Deviation from desired value when measuring winding resistance of transformer	Contact manufacturer of transformer and, if necessary, MR and provide measured values.
Deviation from desired value during transformer ratio test	Contact manufacturer of transformer and, if necessary, MR and provide measured values.

Table 5: Fault elimination



## 8 Technical data

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

### 8.1 On-load tap-changer properties

#### Electrical data for VACUTAP® VT I 500

On-load tap-changer	VT I 500
Max. rated through-current $I_{um}$ [A]	500
Rated short-time current [kA]	5
Rated duration of short-circuits [s]	3
Rated peak withstand current [kA]	12.5
Max. rated step voltage $U_{im}$ [V] <sup>1)</sup>	900
Step capacity $P_{stN}$ [kVA]	250
Rated frequency [Hz]	50...60

Table 6: Electrical data for VACUTAP® VT I 500

#### Mechanical data for VACUTAP® VT I 500

Number of operating positions	Max. 9, change-over selector not available
Dimensions	See dimensional drawings
Weight [kg]	Approx. 70

Table 7: Mechanical data for VACUTAP® VT I 500

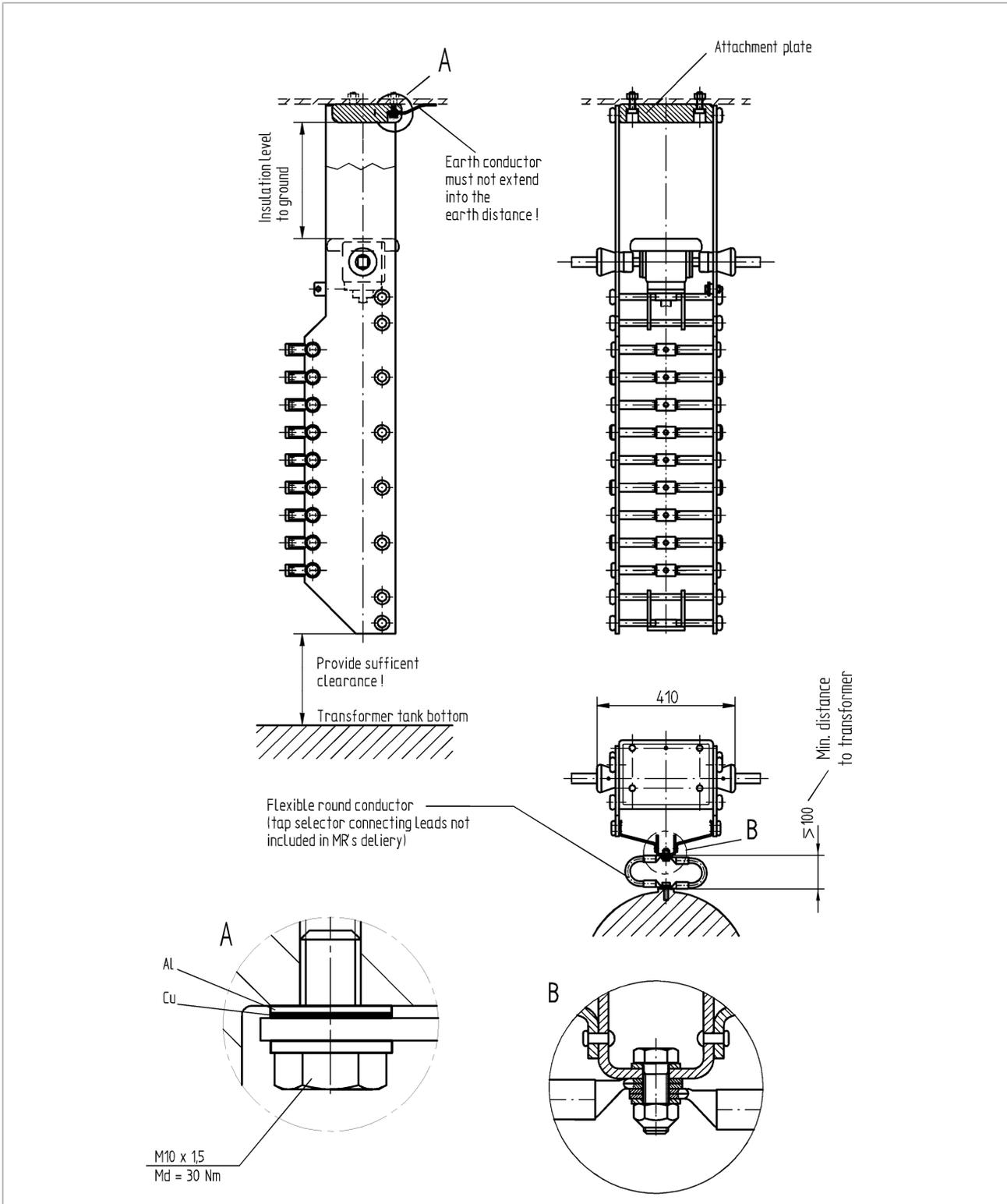
### 8.2 Permissible ambient conditions

Air temperature during operation	-25°C...+65°C
Transport temperature, storage temperature	-40°C...+65°C
Installation height above sea level	See technical data TD 61 – General Section

Table 8: Permissible ambient conditions

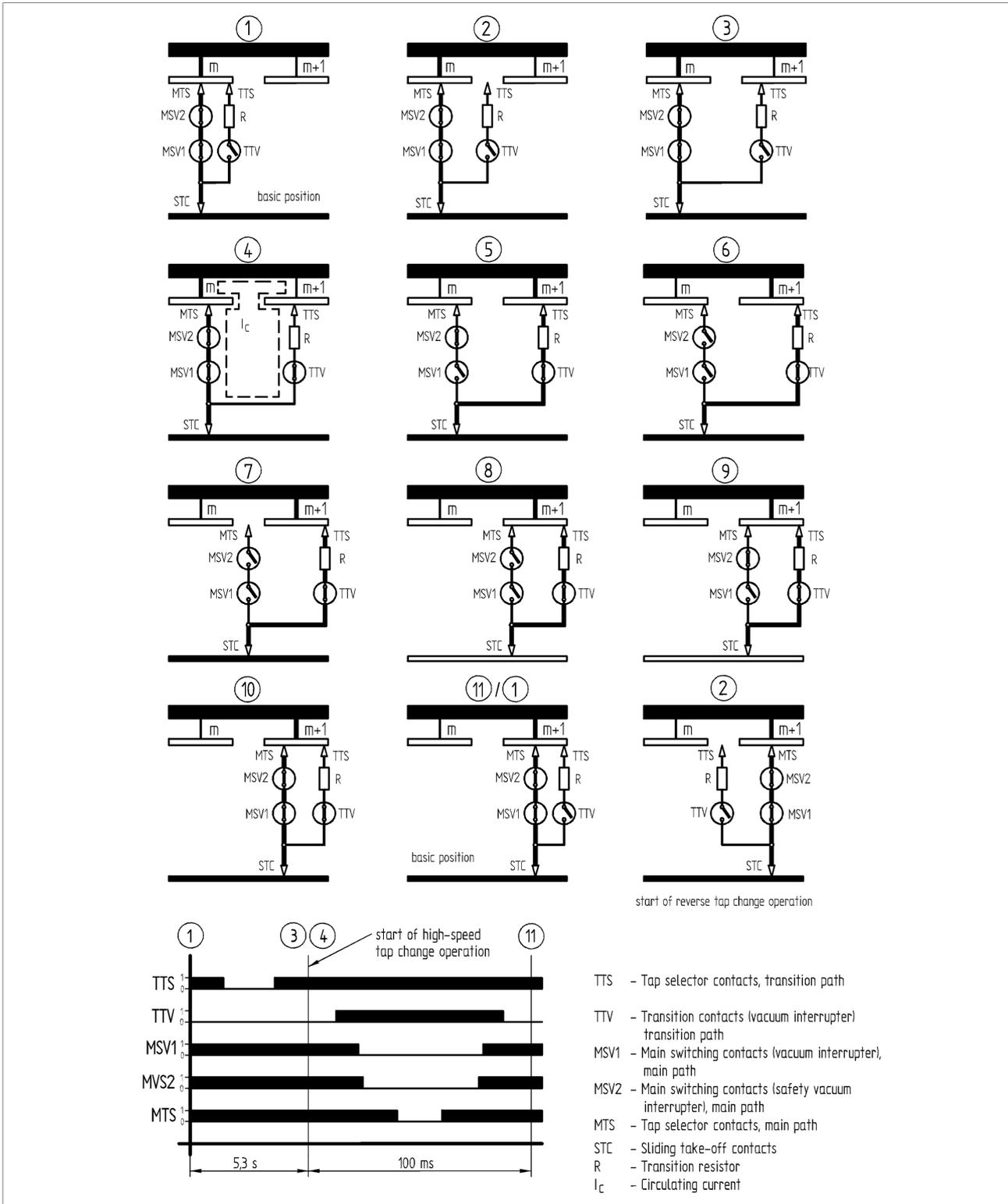
## 9 Drawings

### 9.1 VACUTAP® VT I 500, installation drawing (898312)

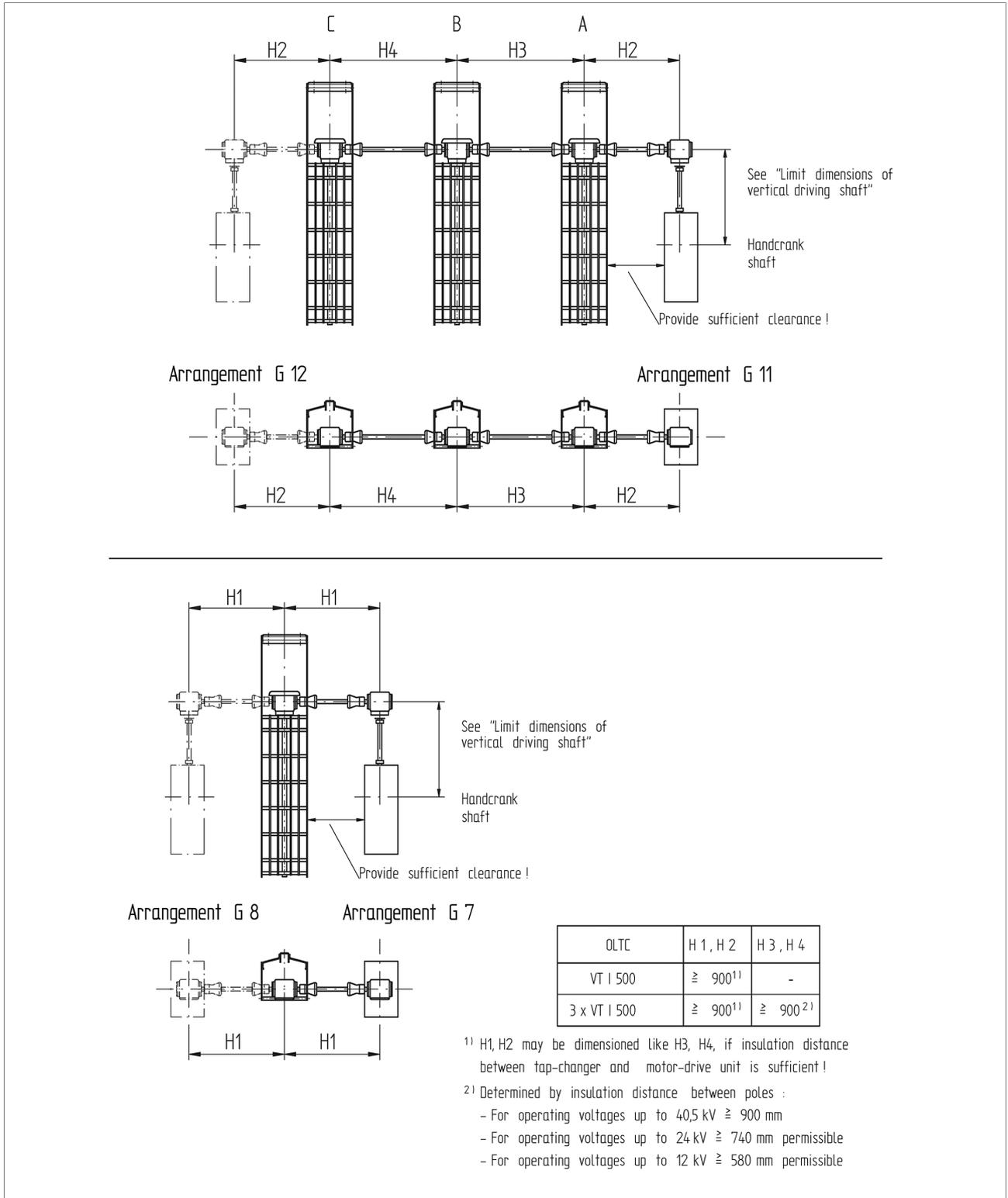




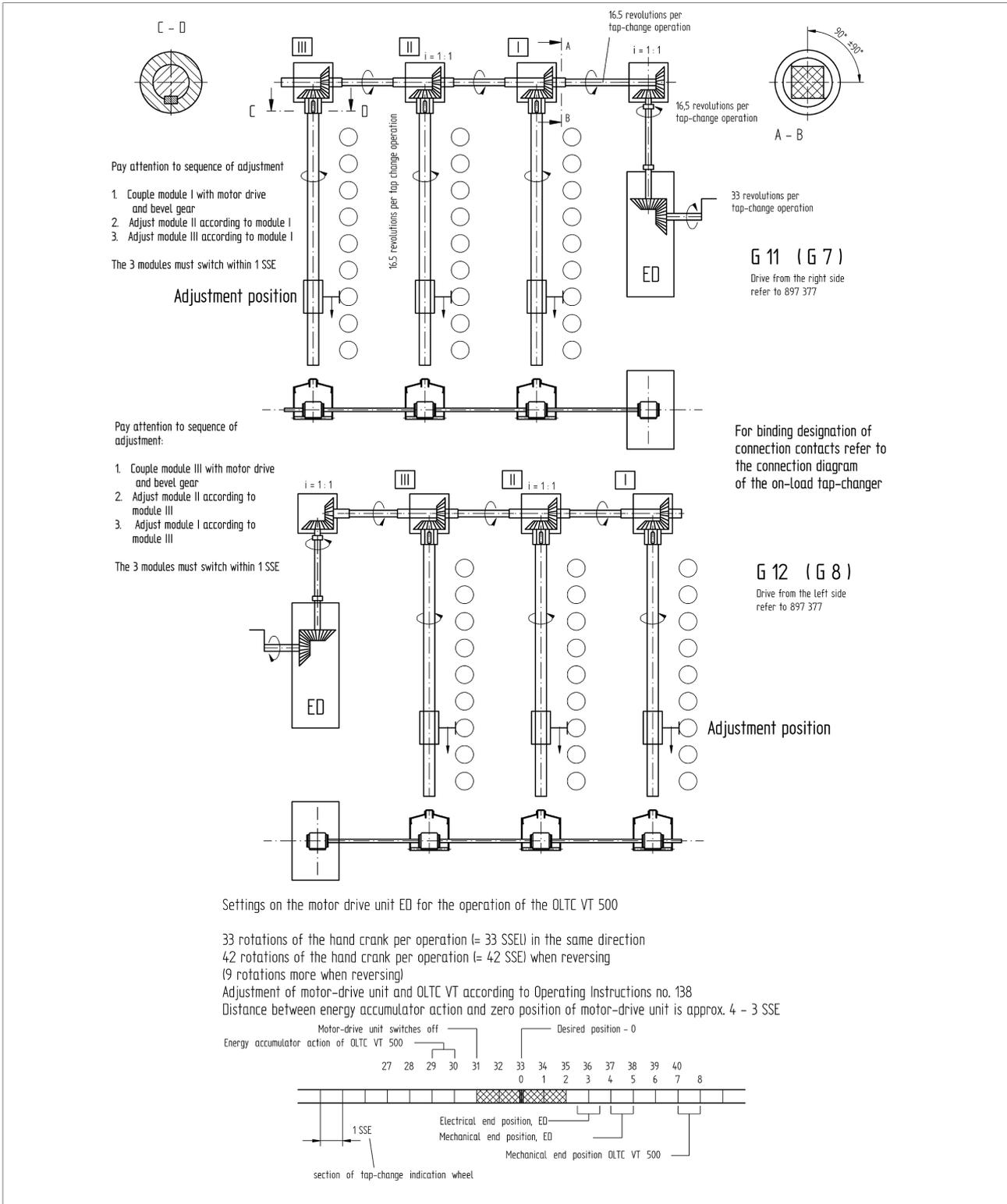
### 9.3 VACUTAP® VT I 500, switching sequence (899507)



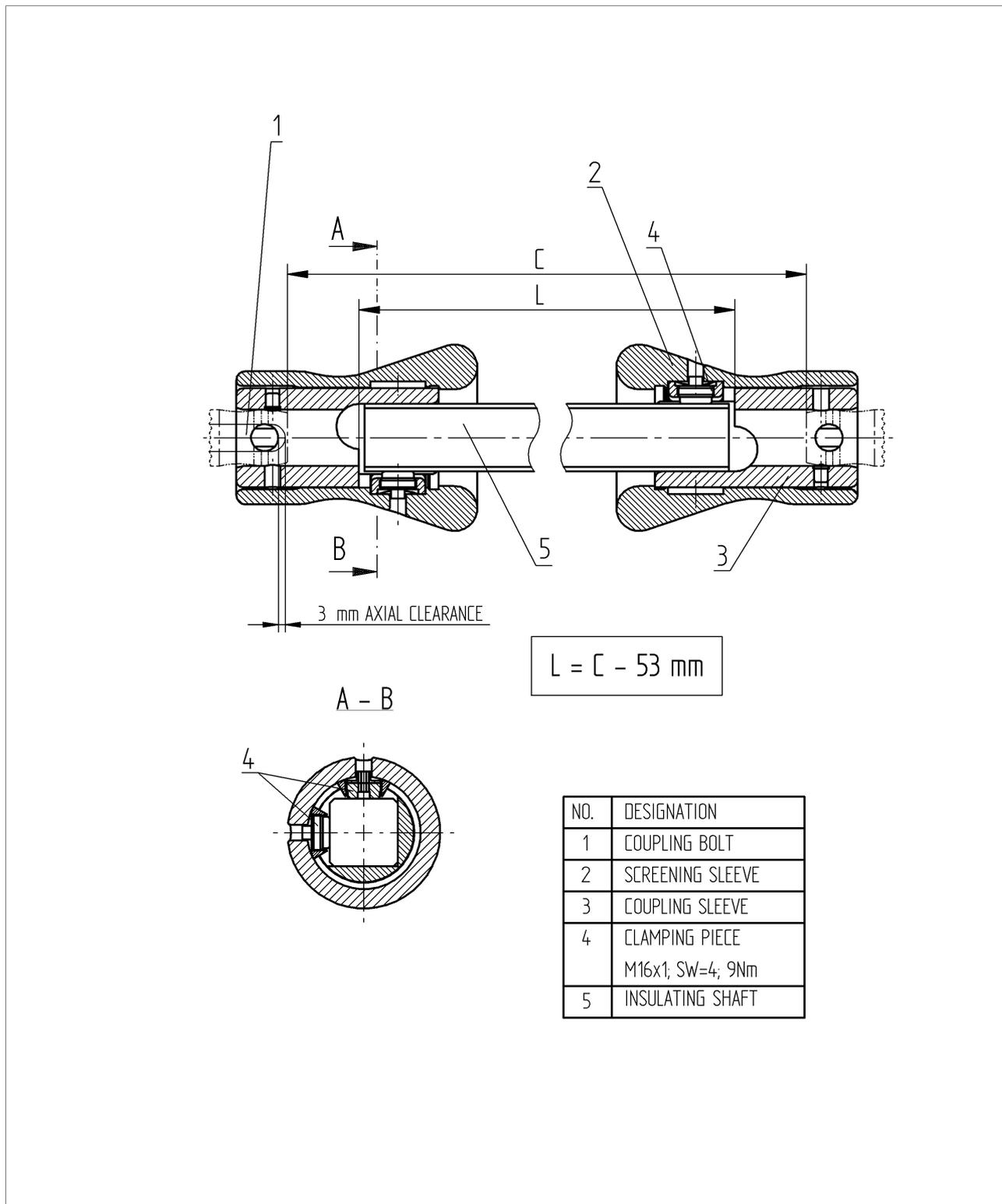
### 9.4 VACUTAP® VT I 500, fitting variants (897377)



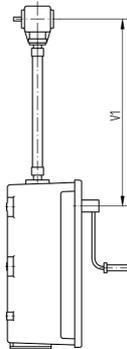
### 9.5 VACUTAP® VT I 500, adjustment plan (898613)



**9.6 VACUTAP® VT I 500, determining insulating shaft length (897975)**

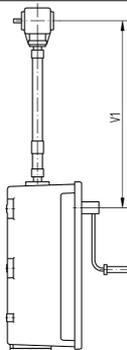


### 9.7 TAPMOTION® ED with CD 6400, limit dimension of vertical drive shaft (898598)



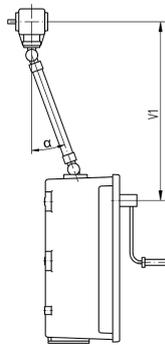
1. UNIT WITHOUT CARDAN SHAFT WITHOUT INSULATOR (  $\alpha_{max} = 2^\circ$  )  
( = STANDARD DESIGN )

CONFIGURATION	V 1 min [ mm ]	INTERMEDIATE BEARING NECESSARY IF [ mm ]
BEVEL GEAR	536	V 1 > 2472



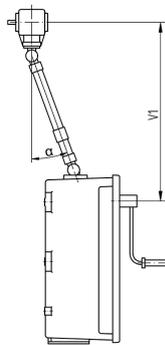
2. UNIT WITHOUT CARDAN SHAFT WITH INSULATOR (  $\alpha_{max} = 2^\circ$  )  
( = SPECIAL DESIGN )

CONFIGURATION	V 1 min [ mm ]	INTERMEDIATE BEARING NECESSARY IF [ mm ]
BEVEL GEAR	706	V 1 > 2472



3. UNIT WITH CARDAN SHAFT WITHOUT INSULATOR (  $\alpha_{max} = 20^\circ$  )  
( = SPECIAL DESIGN )

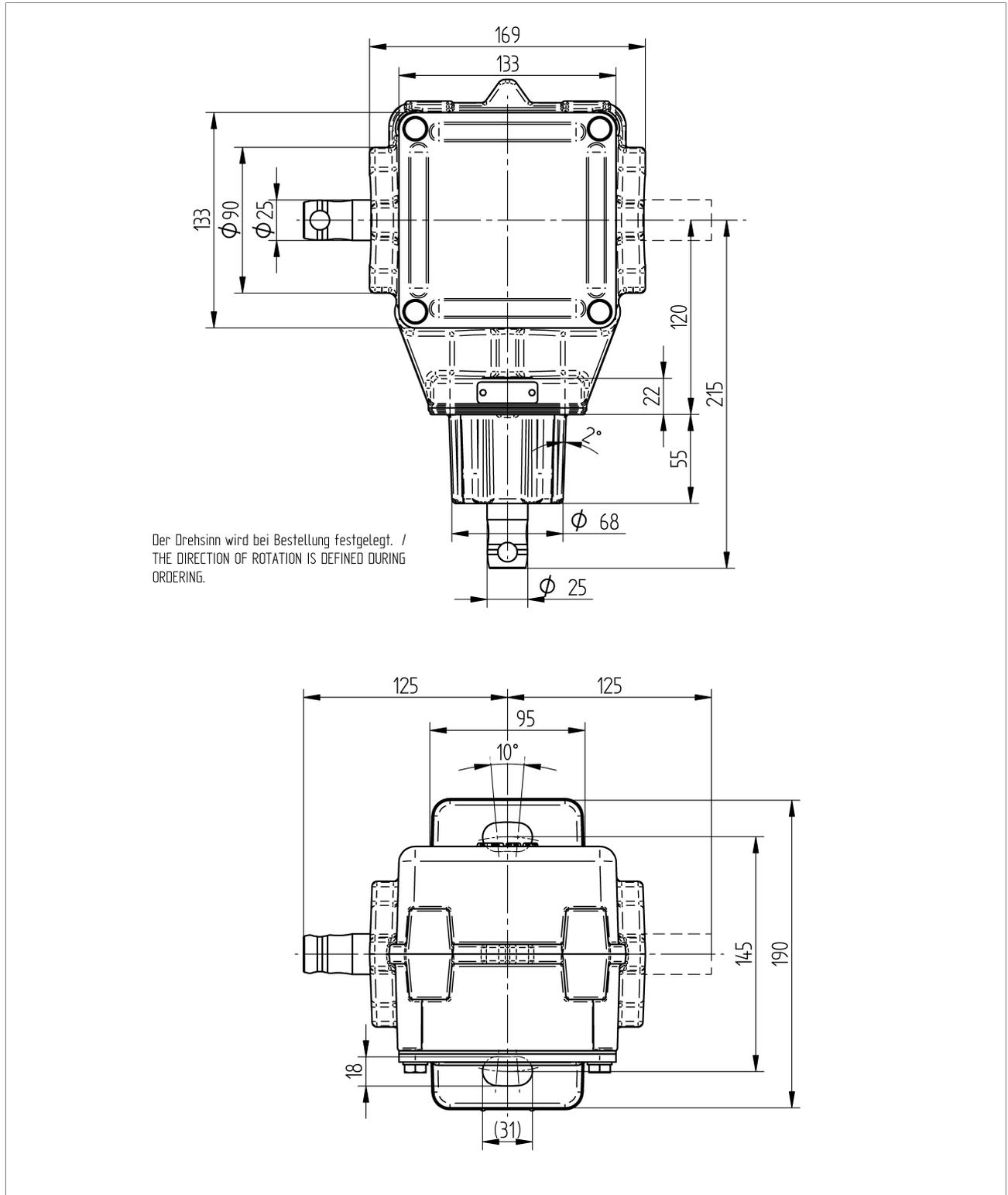
CONFIGURATION	V 1 min [ mm ]	INTERMEDIATE BEARING NECESSARY IF [ mm ]
BEVEL GEAR	798	V 1 > 2564



4. UNIT WITH CARDAN SHAFT WITH INSULATOR (  $\alpha_{max} = 20^\circ$  )  
( = SPECIAL DESIGN )

CONFIGURATION	V 1 min [ mm ]	INTERMEDIATE BEARING NECESSARY IF [ mm ]
BEVEL GEAR	978	V 1 > 2772

9.8 Bevel gear CD 6400, dimensional drawing (892916)





## List of key words

### D

DC resistance measurement 43

### F

Faults 48

### G

Grounding 44  
Grounding electrode conductor 44  
Grounding insulation distance 44

### O

on-load tap-changer take-off lead  
26

### T

Trial tap-change operation 44, 47



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- 10/21 - Maschinenfabrik Reinhausen GmbH 2021

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