Drive Shaft

Operating Instructions

042/08 EN
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1 Introduction

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

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

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

1.1 Validity

This technical file applies to the following types of drive shaft:

- Drive shaft
- Drive shaft with insulator
- Drive shaft with cardan joints

1.2 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8
93059 Regensburg, Germany

Tel.: (+49) 9 41/40 90-0
Fax: (+49) 9 41/40 90-7001
E-mail: sales@reinhausen.com

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

1.3 Subject to change without notice

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

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

1.4 Completeness

This technical file is incomplete without the supporting documentation.

1.5 Supporting documents

The following documents also apply in addition to this technical file:

- Supplements
• Dimensional drawing

Also observe generally valid legislation, standards, guidelines and specifications on accident prevention and environmental protection in the respective country of use.

1.6 Safekeeping

This technical file and all supporting documents must be kept ready at hand and accessible for future use at all times.

1.7 Notation conventions

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

1.7.1 Symbols used

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</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 materials used" /></td>
<td>Number and type of fastening materials 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>
</tbody>
</table>
1 Introduction

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="File symbol" /></td>
<td>Use a file</td>
</tr>
<tr>
<td><img src="image" alt="Grease symbol" /></td>
<td>Grease</td>
</tr>
<tr>
<td><img src="image" alt="Coupling bolt symbol" /></td>
<td>Coupling bolt</td>
</tr>
<tr>
<td><img src="image" alt="Ruler symbol" /></td>
<td>Use a ruler</td>
</tr>
<tr>
<td><img src="image" alt="Saw symbol" /></td>
<td>Use a saw</td>
</tr>
<tr>
<td><img src="image" alt="Hose clip symbol" /></td>
<td>Hose clip</td>
</tr>
</tbody>
</table>

Table 1: Symbols used

1.7.2 Hazard communication system

Warnings in this technical file use the following format:

![WARNING](image)

**Type and source of danger**

Consequences

► Action

► Action

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DANGER</strong></td>
<td>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td><strong>WARNING</strong></td>
<td>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td><strong>CAUTION</strong></td>
<td>Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</td>
</tr>
<tr>
<td><strong>NOTICE</strong></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>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Pictogram" /></td>
<td>Warning of a danger point</td>
</tr>
<tr>
<td><img src="image2.png" alt="Pictogram" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image3.png" alt="Pictogram" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image4.png" alt="Pictogram" /></td>
<td>Warning of danger of tipping</td>
</tr>
</tbody>
</table>

Table 3: Pictograms used in warning notices

1.7.3 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

2.1 General safety information

The 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.
- Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use

The product and associated equipment and special tools supplied with it comply with the relevant legislation, regulations and standards, particularly health and safety requirements, applicable at the time of delivery.

If used as intended and in compliance with the specified requirements and conditions 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 hazards to people, property or the environment. This applies throughout the product’s entire life, from delivery through installation and operation to disassembly and disposal.

The operational quality assurance system ensures a consistently high quality standard, particularly in regard to the observance of health and safety requirements.

The following is considered appropriate use

- The product must be operated in accordance with this technical file and the agreed delivery conditions and technical data
- The equipment and special tools supplied must be used solely for the intended purpose and in accordance with the specifications of this technical file
- The product must be used only with the transformer specified in the order

2.3 Inappropriate use

Use is considered to be inappropriate if the product is used other than as described in the Appropriate use section.

Maschinenfabrik Reinhausen does not accept liability for damage resulting from unauthorized or inappropriate changes to the product. Inappropriate changes to the product without consultation with Maschinenfabrik Reinhausen can lead to personal injury, damage to property and operational disruption.
2.4 Personnel qualification

The product is designed solely for use in electrical energy systems and facilities operated by appropriately trained staff. This staff comprises people who are familiar with the installation, assembly, commissioning and operation of such products.

2.5 Operator’s duty of care

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:

▪ All warning and hazard notices are complied with.
▪ Personnel are instructed regularly in all relevant aspects of operational safety, the operating instructions and particularly the safety instructions contained therein.
▪ Regulations and operating instructions for safe working as well as the relevant instructions for staff procedures in the case of accidents and fires are kept on hand at all times and are displayed in the workplace where applicable.
▪ The product is only used when in a sound operational condition and safety equipment in particular is checked regularly for operational reliability.
▪ Only replacement parts, lubricants and auxiliary materials which are authorized by the manufacturer are used.
▪ The specified operating conditions and requirements of the installation location are complied with.
▪ All necessary devices and personal protective equipment for the specific activity are made available.
▪ The prescribed maintenance intervals and the relevant regulations are complied with.
▪ Installation, electrical connection and commissioning of the product may only be carried out by qualified and trained personnel in accordance with this technical file.
▪ The operator must ensure appropriate use of the product.

2.6 Personal protective equipment

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

▪ Always wear the personal protective equipment required for the job at hand.
▪ Follow information about personal protective equipment provided in the work area.
### 2 Safety

Always wear

<table>
<thead>
<tr>
<th>Protective clothing</th>
<th>Close-fitting work clothing with a low breaking strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts. Do not wear any rings, necklaces or other jewelry.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety shoes</td>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Wear the following in special environments</th>
<th>Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety glasses</td>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td>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>
</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 Function description of drive shaft

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

The bevel gear changes the direction from vertical to horizontal (see drawing 892916 [► 47]).

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 off-circuit tap-changer.

3.2 Performance features of drive shaft

The product is particularly characterized by the following properties:

▪ Resistance to corrosion

3.3 Scope of delivery

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

▪ Drive shaft
▪ Bevel gear
▪ Operating instructions
▪ Supplements
▪ Dimensional drawing

Please note the following:

▪ 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.

3.4 Setup/models of drive shaft

The drive shaft consists of a square tube and is coupled by two coupling brackets and one coupling bolt at both ends to the drive / driven shaft end of the device to be connected.
3.4.1 Model without cardan shaft, without insulator (= normal model)

![Diagram of normal 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 2°)</td>
<td>526</td>
<td>V 1 &gt; 2462</td>
</tr>
</tbody>
</table>

3.4.2 Model without cardan shaft, with insulator (= special model)

![Diagram of 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 2°)</td>
<td>697</td>
<td>V 1 &gt; 2462</td>
</tr>
</tbody>
</table>
3.4.3 Model with cardan shaft, without insulator (= special model)

Figure 3: Model with cardan shaft, 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>790</td>
<td>V 1 &gt; 2556</td>
</tr>
</tbody>
</table>

3.4.4 Model with cardan shaft, with insulator (= special model)

Figure 4: Model with cardan shaft, 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>975</td>
<td>V 1 &gt; 2556</td>
</tr>
</tbody>
</table>
4 Packaging, transport and storage

4.1 Packaging

4.1.1 Purpose

The packaging is designed to protect the packaged goods during transport, loading and unloading as well as periods of storage in such a way that no (detrimental) changes occur. The packaging must protect the goods against permitted transport stresses such as vibration, knocks and moisture (rain, snow, condensation).

The packaging also prevents the packaged goods from moving impermissibly within the packaging. The packaged goods must be prepared for shipment before actually being packed so that the goods can be transported safely, economically and in accordance with regulations.

4.1.2 Suitability

The packaging is suitable for

- all common types of transportation
- stackability - 1000 kg/m² top surface

The packaged goods are packed in a stable wooden crate. This crate ensures that the shipment is secure when in the intended transportation position and that none of its parts touch the loading surface of the means of transport or touch the ground after unloading.

The packaged goods are stabilized inside the crate to prevent impermissible changes in position.

4.1.3 Markings

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>⌀</td>
<td>Protect against moisture</td>
</tr>
<tr>
<td>↑↑</td>
<td>Top</td>
</tr>
<tr>
<td>🍷</td>
<td>Fragile</td>
</tr>
</tbody>
</table>

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

#### WARNING

**Danger of death or severe injury!**

- Danger due to tipping or falling load!
  - Only trained and appointed persons may select the sling gear and secure the load.
  - Do not walk under the hanging load.
  - Use means of transport and lifting gear with a carrying capacity of > 500 kg.

#### NOTICE

**Damage to packaged goods!**

- Damage due to tipping or falling load!
  - Only trained and appointed persons may select the sling gear and secure the load.
  - Use means of transport and lifting gear with a carrying capacity of > 500 kg.

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

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

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

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

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

#### Visible damage

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

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately together with the carrier involved. This is essential for any claim for damages!
- If possible, 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).
• Name the damaged parts.

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

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

4.3 Storage of shipments
Packaged goods can be stored outdoors when the following conditions are complied with.

Selection and arrangement of the storage location should meet the following requirements:
• Stored goods are protected 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.
• Carrying capacity of the substrate under the goods is sufficient.
• Entrance and exit paths are kept free.

Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

4.4 Unpacking shipments and checking for transportation damages
• Wherever possible keep the crate packaged for transport to the place where installation will take place.
• When unpacking, check the condition of the packaged goods.
• Check completeness based on the delivery slip.
5 Drying transformer

5.1 Drying transformer in autoclave

Observe the following information when drying the transformer in an autoclave.

**NOTICE**

**Damage to drive shaft, on-load tap-changer and transformer!**

If the drive shaft is dried in a furnace, this may cause damage to the drive shaft and restrict its correct function.

► Do not dry drive shaft in an autoclave.

5.2 Drying transformer in the transformer tank

If you dry the active part in the transformer tank, the drive shaft may remain fitted to the transformer.
6 Fitting drive shaft

In accordance with IEC standard 60214, all drive shafts located on the outside of the transformer need to be protected with safety coverings.

**NOTICE**

Damage to the on-load tap-changer!

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

► Before actuating the on-load tap-changer for the first time, the tap selector must be completely immersed in transformer oil and the diverter switch oil compartment completely filled with oil.

► The on-load tap-changer can be operated in the temperature range of the surrounding transformer oil of between -25 ° and +105 °C and with overload up to +115 °C in accordance with IEC 60214-1.

Observe the following during mounting:

**NOTICE**

Damage to drive and on-load tap-changer or off-circuit tap-changer!

Trouble-free operation of the motor-drive and the on-load tap-changer or off-circuit tap-changer cannot be guaranteed.

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

Minor axial displacement can be tolerated as long as it does not exceed 35 mm per 1000 mm square tube length (that corresponds to 2°).

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

The square tubes and the vertical protective cover are supplied in overlengths (graded standard lengths). These parts must be cut to the required size before mounting on the transformer. In rare cases the inner tube of the telescopic protective tube has to be cut.

<table>
<thead>
<tr>
<th>Standard lengths</th>
<th>Motor-drive unit</th>
<th>Manual drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>600</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>900</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>1300</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>1700</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>2000</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>2500</td>
<td>Not permitted</td>
<td>•&lt;sup&gt;1)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Table 7: Graded standard lengths of square tubes

The maximum total drive shaft length of the drive - last pole = 15 m.
1) I>2000 only possible for vertical installation without shaft protection! Telescopic protective tubes for manual drives with vertical dimensions V1> 2462 should be delivered vertically, similar to the motor-drive unit with intermediate bearing.

6.1 Fitting vertical drive shaft

Couple drive shaft with motor-drive unit and on-load tap-changer as described in MR operating instructions for TAPMOTION® ED.

**WARNING**

The motor-drive unit may be started by accident if the motor protective switch is not tripped!

Risk of injury from starting the motor-drive unit by accident!

- Trip motor protective switch before starting to fit the drive shafts!

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

1. Grease the coupling bolts, coupling brackets and ball heads, e.g. ISO-FLEX TOPAS L 32.

Figure 5: Grease the coupling bolts, coupling brackets and ball heads.
2. Determine dimension A between the shaft end of the drive and the shaft end of the bevel gear. Shorten square tube to length of A–9 mm.

Figure 6: Shortening square tube

3. Deburr cut surface of square tube.

Figure 7: Deburring cut surfaces
4. Slide loosely screwed together coupling part onto square tube until stop is reached.

Figure 8: Sliding coupling part onto square tube

5. Insert coupling bolt into lower shaft end. Grease coupling parts and coupling bolts. Slide square tube with coupling part on to coupling bolt.

Figure 9: Sliding square tube with coupling part on to coupling bolt
6 Fitting drive shaft


Figure 10: Mounting vertical drive shaft on drive

7. Pivot square tube with coupling part.

Figure 11: Pivoting square tube

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

Inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.
Figure 12: Deburring inner tube

<table>
<thead>
<tr>
<th>Dimension A (= distance between the shaft end of the drive and the shaft end of the bevel gear)</th>
<th>Inner tube</th>
<th>Outer tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>170 mm...190 mm</td>
<td>Shorten to 200 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>191 mm...1130 mm</td>
<td>Dimension A + 20 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>1131 mm...1598 mm</td>
<td>= 700 mm</td>
<td>= 1150 mm</td>
</tr>
<tr>
<td>1599 mm...2009 mm</td>
<td>= 1150 mm</td>
<td>= 1150 mm</td>
</tr>
</tbody>
</table>
9. Slide outer tube over inner tube (with slot at bottom). Slide telescopic protective tubes onto square tube. Then slide hose clips over telescopic protective tubes.

Figure 13: Sliding on telescopic protective tube


Figure 14: Fitting adapter ring and coupling bolt
11. Grease coupling brackets and mount on bevel gear. Set a unilateral axial clearance of 3 mm between the coupling bolt and upper coupling piece.

To prepare for alignment, tighten screws to approx. 6 Nm. After aligning on-load tap-changer to drive (see MR operating instructions for TAPMOTION® ED), tighten screws to 9 Nm.

Figure 15: Mounting coupling brackets
12. Attach protective tube (inner tube) with a hose clip to the bearing collar of the drive 1. Then slider upper protective tube (outer tube) over adapter on bevel gear 2. Secure upper protective tube with hose clip both at top end and at transition to bottom protective tube 3.

Figure 16: Mounting protective tube

6.2 Fitting horizontal drive shaft

**NOTICE**

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

Damage to the on-load tap-changer due to incorrect alignment of the upper gear unit!

- Only align upper gear unit if pressure segments are loosened.
- Never turn upper gear unit around its own axis to align it.
- Only align upper gear unit by turning drive shaft of upper gear unit.

To fit the horizontal drive shaft, proceed as follows.
1. Calculate dimension A between shaft end of upper gear unit and shaft end of bevel gear and shorten square tube to length A – 9 mm.

![Figure 17: Shortening square tube](image)

2. Calculate inside width B between housings of upper gear unit and bevel gear. Cut guard plate (LSB = length of guard plate) accordingly and deburr the cutting surface. Protect guard plate against corrosion with a coat of paint.

![Figure 18: Shortening, deburring and coating guard plate](image)
3. Slide loosely screwed together coupling part onto square tube until stop is reached.

Figure 19: Sliding coupling part onto square tube

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

Figure 20: Attaching coupling part to bevel gear
5. Mount horizontal drive shaft on bevel gear.

Figure 21: Mounting horizontal drive shaft on bevel gear


Figure 22: Mounting horizontal drive shaft on upper gear unit
7. Now attach shortened guard plate to housing lugs on the on-load tap-changer head and bevel gear. Secure each end of guard plate with a hose clip.

Figure 23: Fitting guard plate

8. If using a bearing bracket or angle gear, attach caps to the guard plate.

Figure 24: Bearing bracket caps
Figure 25: Angle gear caps
7 Fitting drive shaft with cardan joints

**NOTICE**

Damage to drive shaft!
Damage to expansion bellows from bending cardan joint!
► Ensure a matching position of the opposing cardan joint straps!

Installation of the drive shaft with cardan joints is mainly designed as a vertical drive shaft between motor-drive unit and bevel gear. Technically, a horizontal design is also possible. Note, however, that when using the horizontal design the guard plate supplied has to be adapted accordingly.
To fit the drive shaft with cardan joints, proceed as follows:
1. Grease the coupling bolts, coupling brackets and ball heads, e.g. ISO-FLEX TOPAS L 32.

![Figure 27: Grease the coupling bolts, coupling brackets and ball heads.](image1)

2. Insert adapter in neck of pivotable protective tubes 1. Place both parts of pivotable protective tube inside one another 2 and turn towards one another 3 to set the corresponding angle.

![Figure 28: Inserting adapter in pivotable protective tubes](image2)
3. When supplied, the cardan joints are fitted with coupling bolts. To mount on the shaft end, the following steps must be taken: Remove hose clip. Slide up expansion bellows. Remove coupling bolt. Slide cardan joint over device’s output shaft. Push in coupling bolt. Slide expansion bellows over this. Secure expansion bellows with hose clip.

Figure 29: Mounting cardan joints

4. Connect shorter cardan joint supplied to ball-shaped head of motor-drive unit with cardan joint bolt.

Figure 30: Fitting cardan joint to ball-shaped head of motor-drive unit

5. Fit second, longer cardan joint to bevel gear. If a cardan joint is attached to the upper gear unit, then use a cardan joint with an inner hub diameter of 25 mm.
Figure 31: Fitting second cardan joint on bevel gear

6. Secure cardan shaft bolt to expansion bellows with hose clip.

Figure 32: Securing cardan shaft bolt with hose clip

7. Provisionally connect loose shaft ends of the joints to an angle bar and align.

Figure 33: Connecting shaft ends with angle bar
8. Determine dimension A between the shaft ends. Cut square tube to LR = A + 106 mm (LR = length of square tube). Deburr cut surface of square tube.

Figure 34: Shortening square tube
7 Fitting drive shaft with cardan joints

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

![Figure 35: Shortening telescopic tubes](image)

10. Fit one adapter to bearing collar of motor-drive unit and fit other adapter to bearing collar of bevel gear.

![Figure 36: Fitting adapters](image)
11. Slide previously shortened and deburred square tube over upper cardan joint end until stop is reached.

![Figure 37: Sliding square tube over upper cardan joint end](image)

12. Thread upper flexible protective tube with long outlet up onto square tube from below.

![Figure 38: Sliding flexible protective tube over square tube](image)
13. Thread on outer and inner tubes such that the slotted sides of the outer and inner tube are both facing down.

Figure 39: Sliding on telescopic tubes

14. Slide everything up and secure with a screw clamp.

Figure 40: Securing everything with a screw clamp
15. Slide bottom flexible protective tube (also with long outlet up) on to the square tube and secure with screw clamp.

Figure 41: Sliding bottom flexible protective tube onto square tube
16. Swing in square tube and slide all the way down.

Figure 42: Swinging square tube in

17. Tighten bottom coupling brackets. Shaft end and coupling part must be securely connected such that no axial clearance remains between the coupling bolt and coupling bracket.

To prepare for alignment, tighten screws to approx. 6 Nm. After aligning on-load tap-changer to drive (see MR operating instructions for TAPMOTION® ED), tighten screws to 9 Nm.
18. Fit upper coupling brackets with 3 mm axial clearance.

19. Working from top to bottom, mount the individual parts of the shaft protection. Set angle position between both parts of pivotable protective tube and fix with available hose clip. Secure both upper and lower protective tubes with a hose clip at both ends. Secure the two telescopic protective tubes to one another using a hose clip.
The plastic adapters must be at the respective end of the pivotable protective tube. Only slide telescopic pipe into upper and lower pivotable protective tubes by the width of the adapter before tightening the hose clips.

Figure 45: Securing telescopic pipes and flexible protective tubes with hose clips
8 Fitting drive shaft with insulator

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

![Diagram](image)

Figure 46: Model with insulator (~ maximum permissible offset = 2°)

The insulator can also be used in connection with the universal cardan shaft.

![Diagram](image)

Figure 47: Model with insulator (~ maximum permissible offset = 20°)
9.1 Bevel gear - dimensional drawing (892916)

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