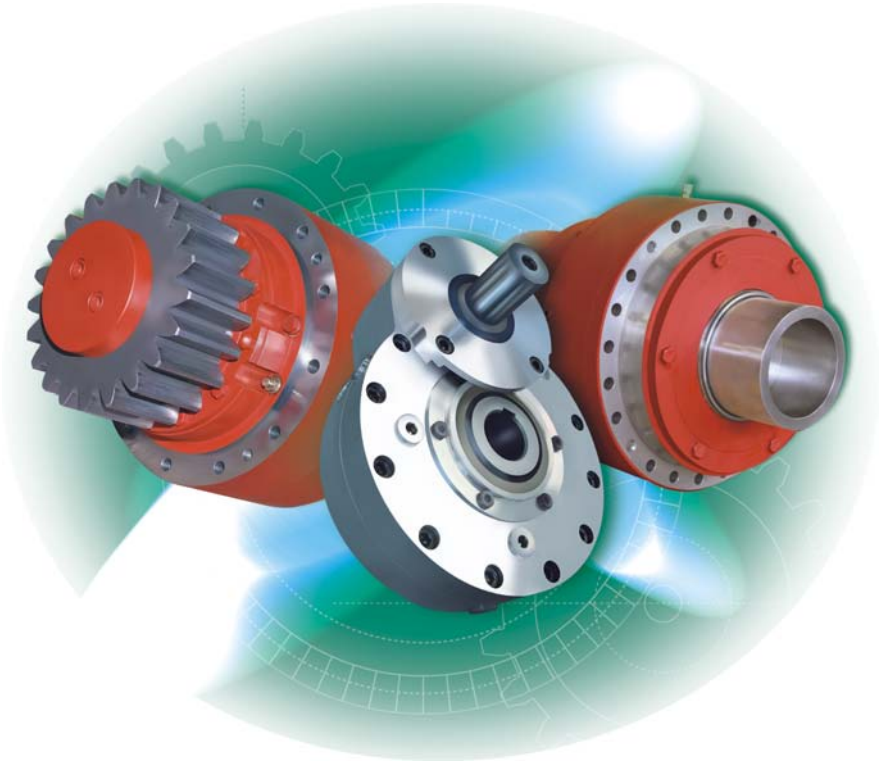
Operating and Maintenance Manual 05082500 for PULS gearboxes

PULS Gearboxes

Series P, PV, VP, S, SL, T, V, VV, W and special gearboxes



PULSGETRIEBE®

Read the instructions prior to performing any task!

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1 General

1.1 Information about this manual

General

This manual enables safe and efficient handling of the system. The operating manual is a component of the gearbox and must be kept in the vicinity of the gearbox where it is available to operating personnel at all times.

Personnel must have carefully read and understood this manual before performing any tasks. The basic prerequisite for safe work is compliance with all specified safety instructions and handling instructions.

In addition, the applicable local accident prevention regulations and general safety regulations must be complied with for the gearbox's area of implementation.

The illustrations in this manual are provided for purposes of basic understanding and can deviate from the actual version.

Other applicable documents

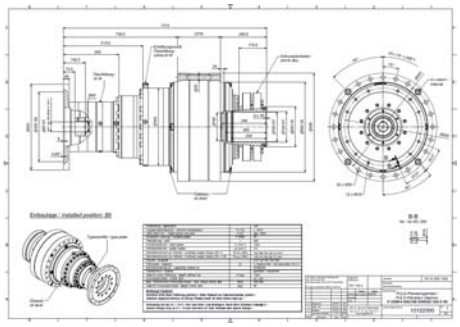


Fig. 1: Dimension sheet (example)

- Dimension sheet
- Order confirmation
- Catalogue
- Lubricant table
- Lubricant recommendations

The dimension sheet has the highest priority. If there are conflicts between the operating manual and the dimension sheet, the dimension sheet always applies!

The dimension sheet specifies which operating manual is valid for the gearbox. If reference is made in the dimension sheet to an operating manual other than this operating manual, request it from the manufacturer and comply with the instructions in it. If no operating manual is specified in the dimension sheet, consult with the manufacturer.

1.2 Explanation of symbols

Safety Instructions

Safety instructions are indicated by symbols in this manual. The safety instructions are introduced by signal words that express the scope of the hazard.

DANGER!
This combination of symbol and signal word indicates an imminent dangerous situation that can result in death or serious injury if it is not avoided.

WARNING!
This combination of symbol and signal word indicates a possible dangerous situation that can result in death or serious injury if it is not avoided.

CAUTION!
This combination of symbol and signal word indicates a possible dangerous situation that can result in minor injury if it is not avoided.

NOTICE!
This combination of symbol and signal word indicates a possible dangerous situation that can result in material damage if it is not avoided.

Tips and recommendations

This symbol indicates useful tips and recommendations, as well as information for efficient and trouble-free operation.

Other designations in the document

The following designations are used in this manual to indicate instructions, results, listings, references, and other elements:

Designation	Explanation
	Step-by-step handling instructions
⇨	Results of action steps
	References to sections of this manual and to other applicable documents
■	Listings without a specified sequence

1.3 Copyright

The contents of this manual are protected by copyright. Use of these contents is permissible as part of the use of the machine. Use beyond that cited above is not permitted without the written permission of the manufacturer.

1.4 Guarantee terms

The guarantee terms are included in the manufacturer's General Terms & Conditions.

1.5 Customer service

For technical information contact our customer service organisation:

Address	PULSGETRIEBE GMBH & Co. KG Hansastr. 17–21 76189 Karlsruhe
Telephone	+49 721 50008-0
Fax	+49 721 50008-88
E-mail	info@pulsgetriebe.de
Internet	http://www.pulsgetriebe.de

In addition, we are always interested in new information and experiences associated with the application that could prove valuable in improving our products.

2 Safety

2.1 Intended use

The gearbox is designed exclusively for installation in commercial systems.

The gearbox is use exclusively for converting and distributing rpm and torque.

The gearbox may only be used for the intended application and the intended loads.

Intended use also includes compliance with all the instructions in this manual.

Any use that extends beyond the intended use, or any other use is considered to be misuse.

WARNING!

Danger in the event of misuse!

Misuse of the gearbox can cause hazardous situations.

- Prior to installing the gearbox the precise area of implementation, the loads and the operating factors must be complied with.
- When operating the gearbox, ensure that the loads and the operating factors are complied with. If you determine that the actual loads and operating factors are greater than assumed, you must cease operation of the gearbox without delay. Otherwise the gearbox can be overloaded.

2.2 General danger sources

This section provides an overview of all important safety aspects for protection of personnel, as well as for safe and trouble-free operation. Additional task-related safety instructions are provided in the sections concerning the individual life phases.

2.2.1 Dangers due to high temperatures

Hot surfaces

WARNING!

Hot surfaces pose a burn hazard!

The surface of the gearbox can heat up significantly in operation. Skin contact with hot surfaces can cause severe burns.

- Always wear heat-resistant protective work clothing and protective gloves when performing any task in the vicinity of hot surfaces.
- Prior to all tasks ensure that all surfaces have cooled to ambient temperature.
- If the gearbox heats up in operation to temperatures in excess of 90 C, you must consult with the manufacturer. It may be necessary to provide cooling for the gearbox.

2.2.2 Danger due to electrical energy

Attachment of electrical components

WARNING!

Danger of injury when attaching electrical components!

Faulty attachment of electrical components can cause hazardous situations.

- When attaching electrical components (e.g. motor or hydraulic aggregate) pay attention to the configuration of the gearbox and the intended area of implementation.
- Pay attention to the electrical connected loads of the components.

2.2.3 Dangers due to mechanical systems

Rotating parts

WARNING!

Danger of injury due to rotating parts!

Input and output shafts or flanges rotate, depending on the design. Danger of injury if there is contact.

- An appropriate protective device must be installed over freely rotating parts on the gearbox.
- Only perform tasks on the gearbox when the machine is at a standstill or switched off.
- Always proceed with caution.

Danger of crushing

WARNING!

Danger of injury on the shift mechanism due to the pneumatic cylinder on the gearbox!

For shift gearboxes with pneumatic cylinders danger of crushing exists during operation.

- If the motor is running do not grasp the shift lever or pneumatic cylinder.
- Only perform tasks on the gearbox when the machine is at a standstill or switched off.
- Always proceed with caution.

2.2.4 Danger due to noise

Noise

WARNING!

Danger of injury due to noise!

The noise level that occurs during operation (60-100 dB depending on the implementation) can cause severe hearing damage.

- Always wear hearing protection for tasks performed on loud gearboxes.
- Only be in the implementation area of the gearbox to the extent required.

2.2.5 Dangers due to lubricants

Lubricants

WARNING!

Danger of health impairment due to lubricants!

Contact with lubricants can induce allergies and skin irritations.

- Wear protective gloves when handling lubricants.
- Do not swallow, do not inhale fumes.
- After unintentional eye contact, thoroughly rinse out lubricant with plenty of water, if necessary seek medical attention.
- After skin contact wash off thoroughly with plenty of water and soap.
- Comply with the instructions on the safety data sheet provided by the manufacturer of the lubricant.

2.2.6 Dangers for the gearbox

Improper handling

NOTICE!

Material damage due to improper handling of the gearbox!

Due to improper handling of the gearbox the gearbox can become overheated and/or damaged. If handled improperly the seal of the gearbox can no longer be guaranteed.

– Handle the gearbox properly.

Insufficient lubrication

NOTICE!

Damage to the gearbox due to inadequate lubrication!

If the oil level is low or if the oil supply is insufficient the gearbox can be damaged.

– Check the oil level or oil supply at regular intervals.
– If oil loss is detected, bring the gearbox to an immediate stop. Resumption of operation is only permitted after the cause of the fault has been clarified.

2.3 Responsibility of the owner

The owner is the person who operates the gearbox for commercial purposes himself or who provides it to a third party for use, and who bears the legal product responsibility for protection of the user, personnel, or third parties during operation.

The gearbox is used commercially. Consequently the owner of the gearbox is subject to legal occupational health and safety obligations.

In addition to the safety instructions in this operating manual, general occupational health and safety, accident prevention, and environmental protection regulations must be complied with for the area of implementation of the gearbox.

In this regard the following particularly applies:

- The owner must inform himself of applicable occupational health and safety regulations, and in a hazard analysis identify additional hazards that may exist at the installation site of the gearbox due to the special work conditions. The owner must convert this information into operating instructions for operation of the machine.
- The owner must ensure that all employees who handle the gearbox have read and understood this operating manual.

- The owner is also responsible for keeping the gearbox in faultless technical condition at all times.
- The owner is obligated to attach the safety devices and safety signs that are required for the respective area of implementation.
  If the gearbox heats up to over 50 °C in operation the owner must attach a sign warning of hot surfaces and possibly a contact protection element.

2.4 Personnel qualifications

WARNING!

Danger of injury due to inadequate personnel qualification!

If unqualified personnel perform tasks on the gearbox or are present in the danger zone of the gearbox, dangers occur that can cause severe injury and significant material damage.

– Only have activities performed by personnel who are qualified to perform these activities.
– Keep unqualified personnel away from the danger zones.

In this manual the qualifications of personnel for the various activity areas are cited below:

Specialised personnel

Specialised personnel are personnel, who due to their specialized training, skills, and experience, as well as knowledge of the applicable standards and regulations are capable of executing the tasks assigned to them, and of recognizing possible hazards and avoiding them on their own.

Manufacturer and customer service

Certain tasks should only be performed by the manufacturer's specialised personnel. Other personnel are not authorised to perform these tasks. Contact the manufacturer's customer service organisation for execution of the occurring tasks.

Laboratory

Oil samples are analysed in the laboratory. Laboratory personnel are personnel, who due to their specialized training, skills, and experience, as well as knowledge of the applicable standards and regulations are capable of executing the tasks assigned to them, and of recognizing possible hazards and avoiding them on their own.

Only persons from whom it is expected that they reliably perform their work are approved as personnel. Persons whose capacity to react is impaired, e.g. by drugs, alcohol, or medication are not approved as personnel.

Comply with the age-specific and job-specific regulations that apply at the site of implementation when selecting personnel.

2.5 Safety signs

If the gearbox heats up to over 50°C in operation the owner must attach a sign that warns of hot surfaces.

Hot surface

Hot surfaces, such as hot machine parts, containers or materials, but also hot fluids cannot always be perceived. Do not touch these objects or substances without protective gloves.

2.6 Personal protective equipment

Personal protective equipment is used to protect personnel against dangers that could impair the occupational safety or health of personnel.

When performing the various tasks on the gearbox, personnel must wear the personal protective equipment. Separate reference is made to this special equipment in the individual chapters of this manual.

This personal protective equipment is described below:

Safety footwear

Safety footwear protects against heavy falling parts and slipping on slippery substrates.

Protective goggles

Protective goggles protect eyes from flying parts and liquid splashes.

Safety gloves

- Protective gloves protect hands from friction, abrasion, puncture wounds, or deeper injuries, and from contact with hot surfaces.
- Chemical-resistant protective gloves protect the hands from aggressive chemicals.

Hearing protection

Hearing protection is used to protect against hearing damage due to the effects of noise.

Light respiratory protection

Light respiratory protection is used for protection against harmful dusts.

2.7 Safety devices

Safety devices required for the respective device type and area of implementation must be installed.

Vent valve or vent filter

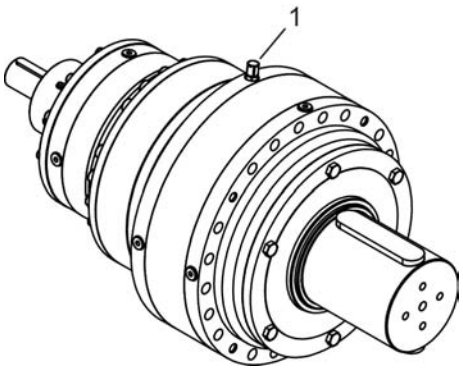


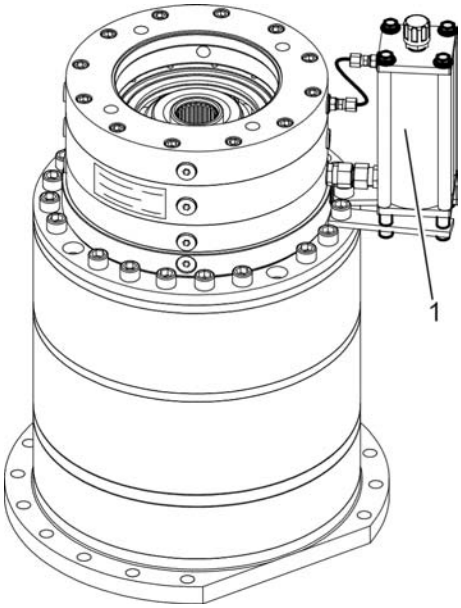
Fig. 2: Vent valve

So that excess pressure, which could damage the gearbox, does not build up, frequently the gearboxes are fitted with a vent valve (Fig. 2/1) or a vent filter. Position and type of the vent valve or vent filter vary depending on the design, install position and operating conditions. Additional information in this regard is in the dimension sheet.

Frequently the vent valves or vent filters are replaced by screw plugs and are delivered loose. In this case they must be mounted during installation in accordance with the information in the dimension sheet.

For oil injection or recirculating oil lubrication, venting can also occur via an excess-pressure valve in the oil circuit.

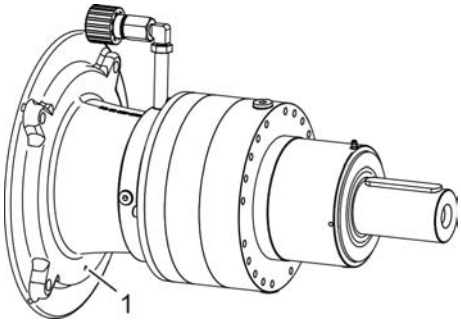
Compensation reservoir



In specific cases, particularly for gearboxes with vertical install position, the attachment of a compensation reservoir (Fig. 3/1) is recommended, if oil escapes at the excess pressure valve. Compensation reservoirs are available from the manufacturer.

Fig. 3: Compensation reservoir

Leak oil bore

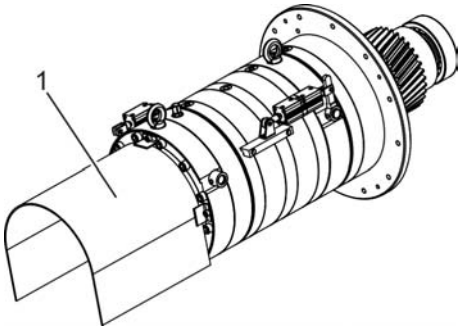


Gearboxes with intermediate motor flange for directly flanging an electric motor are frequently equipped with a leak oil bore (Fig. 4/1) that prevents oil from entering the electric motor if there is a leak. If oil escapes from the leak oil bore, proceed in accordance with the information in the fault table (↳ *Chapter 8.2 'Fault table' on page 54*).

The leak oil bore must point downward after installation.

Fig. 4: Gearbox with leak oil bore

Protective enclosure



Depending on the size and the install location of the gearbox, the owner must install a protective enclosure (Fig. 5/1). The possibility of a direct hazard posed by gearbox parts (e.g. a freely rotating gearbox shaft) must be excluded by appropriate protective devices!

Fig. 5: Protective enclosure

Earthing

To prevent electromagnetic charging of the gearbox, the gearbox must be earthed. This is done via the gearbox fastening or the motor that is directly flanged on (if present). As a rule, a special earthing connection is not present, because the gearbox consists entirely of metal and adequate possibilities for attaching earthing cables are provided.

2.8 Spare parts

WARNING!

Danger of injury if the wrong spare parts are used!

By use of the wrong or defective spare parts dangers for personnel can occur; and damage, malfunction or total machine failure can occur.

– Only use the manufacturer's original spare parts or spare parts that are expressly approved by the manufacturer.
– Always contact the manufacturer if there questions.

Loss of guarantee

Only use original spare parts. The guarantee is invalidated if non-original spare parts are installed.

Ordering spare parts

Spare parts are available from the manufacturer for virtually all gearboxes, for a period of many years.

Always specify the following when ordering spare parts:

- gearbox number (see type plate, Fig. 6)
- Type (see type plate)
- Item number of the required part on the spare parts sectional drawing (if present)
- Alternatively to the item no.: Type of the part (if necessary include a photo or a sketch)

Spare parts can be purchased via the appropriate form on the manufacturer's web site.

⇒ www.pulsgetriebe.de

2.9 Unauthorised conversions are prohibited

Unauthorised conversions

WARNING!

Danger due to unauthorised conversion measures!

If there are unauthorised changes the safety of the gearbox can no longer be ensured.

– Do not modify or convert the gearbox. If in doubt contact the manufacturer immediately.
– Only use original spare parts and accessories.

2.10 Environmental protection

NOTICE!

Hazards for the environment due to improper handling of environmentally-harmful substances!

If environmentally-harmful substances are handled incorrectly, particularly if they are disposed of incorrectly, significant environmental damage can occur.

– Always comply with the instructions cited below for handling and disposal of environmentally-harmful substances.
– If environmentally-harmful substances inadvertently get into the environment, immediately implement suitable measures. If in doubt inform the responsible municipal authorities of the damage and ask about suitable measures that should be implemented.

The following environmentally-harmful substances are used:

Lubricants

Lubricants, such as greases and oils contain toxic substances. These substances should not get into the environment. Disposal must be executed by a specialised disposal company.

Paints

Paints contain toxic substances. These substances should not get into the environment. Disposal must be executed by a specialised disposal company.

3 Technical data

The technical data (dimensions, weight, oil type, oil quantity, operating conditions, etc.) is provided on the associated dimension sheet. For standard gearboxes information is also provided in the appropriate catalogue and in some cases also in the order confirmation. Explanations concerning the different versions of the gearbox are provided in the catalogue.

3.1 Type plate

Fig. 6: Type plate (current version)

The type plate is attached on the gearbox.

Information on the currently installed type plate:

- Manufacturer
- Type: gearbox type
- S/N: Gearbox number (serial number that can be uniquely identified by the gearbox)
- Art. no.: Article number of the gearbox
- Ratio i: Ratio i
- Oil: Recommended oil type
- Litres: Recommended oil quantity

The Fig. 6 shows the standard type plate. In many cases (e.g. for explosion-protected gearboxes, or on customer request) the type plates can deviate, however for the most part they contain the same information.

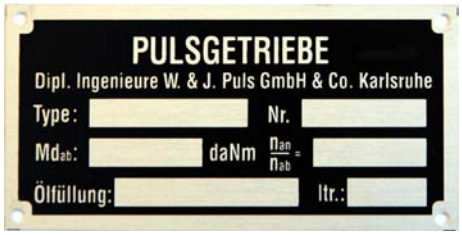


Fig. 7: Type plate (old version)

Information concerning the old type plate, which was installed until a few years ago:

- Manufacturer
- Type: Gearbox type
- No.: Gearbox number (serial number that can be uniquely identified by the gearbox)
- Md_{ab}: Maximum permissible torque
- n_{an}/n_{ab}: Ratio i
- Oil: Recommended oil type
- Litres: Recommended oil quantity

3.2 Lubricant type

The specified lubricant type is shown on the type plate and the dimension sheet. In the "Lubricant recommendations" and "Lubricant table" additional information is provided concerning the recommended lubricants and the manufacturers of these lubricants.

Obtain an approval from the manufacturer,

- If a lubricant other than the lubricant specified on the type plate will be used.
- if a lubricant that is not in the approved lubricant table will be used.

*Polyglycol-based synthetic oils (CLP PG ISO VG,etc.) cannot be mixed with other oils. When changing the lubricant, under some circumstances the gearbox must be **thoroughly** purged. If there are questions concerning the oil type always consult with the manufacturer.*

4 Structure and function

4.1 Gearbox types

This operating manual is valid for the following gearbox types (if nothing to the contrary is noted on the order acknowledgement, the invoice or the dimension sheet):

Gearbox type P 10, 15, 30, 60, 100, 250, 350, 450, 500, 700, 1200, 1203, 1700, 2000, 2003, 2500, 3500, 3503, 5000, 5003, 7500, 12000 and 18000

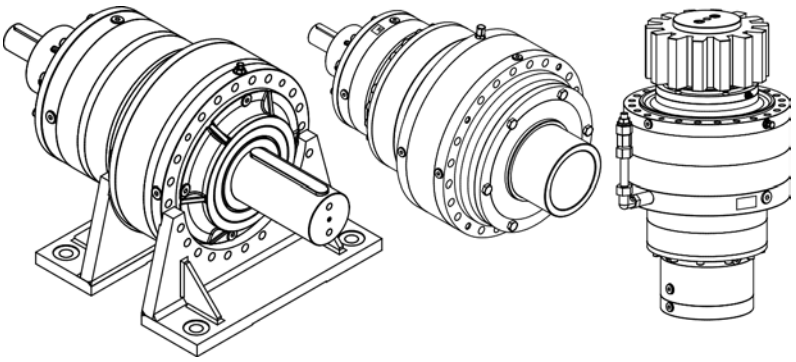


Fig. 8: Examples for gearbox type P

- Gearbox type: Planetary gearbox
- Input and output shaft coaxial, same direction of rotation
- Number after forward slash (e.g. for P 2003/3): Number of planetary stages
- Ratio (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type PV 63/180

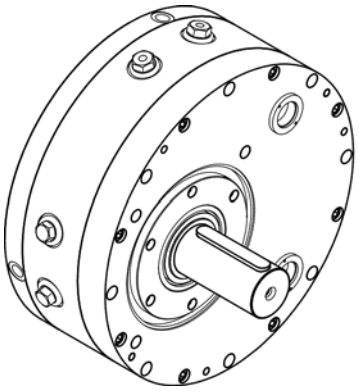


Fig. 9: Examples for gearbox type PV

- Gearbox type: Single-stage planetary gearbox, primarily for use on test beds
- Input shaft and output shaft with axial offset and dissimilar direction of rotation
- Nominal value 180 in kW
- Ratio (input rpm/output rpm) shown on the type plate (attention: Frequently overdrive speed ratio!)
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type S 15 - 18000

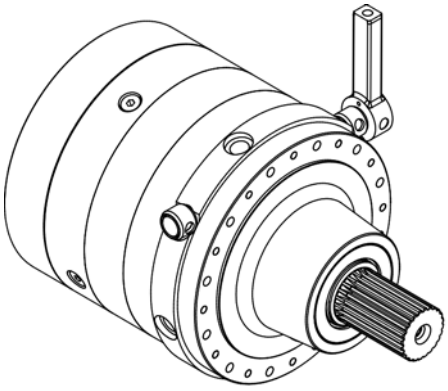


Fig. 10: Example for gearbox type S

- Gearbox type: Planetary gearbox / planetary spur gearbox
- Shifting is executed via clutch toothing mechanisms (manually, pneumatically, hydraulically or electrically activated, see the associated dimension sheet)
- Number after the forward slash: Number of gear stages
- Ratios (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type SL

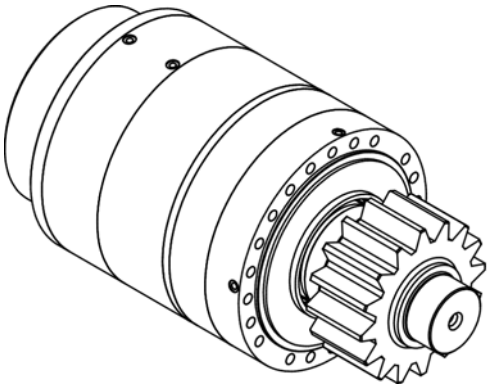


Fig. 11: Example for gearbox type SL

- Gearbox type: Planetary gearbox / planetary spur gearbox
- Power shifting by multi-plate clutch (pneumatically or hydraulically activated, see dimension sheet)
- Number after the forward slash: Number of gear stages
- Ratios (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type T 250 - 18000

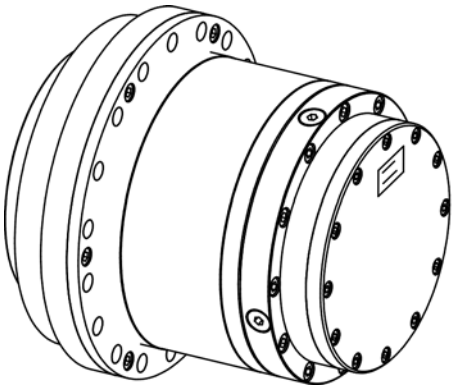


Fig. 12: Example for gearbox type T

- Gearbox type: Planetary gearbox with rotating housing e.g. for driving winches, chain wheels, or similar items
- Input shaft and output shaft opposed rotation
- Number after forward slash (e.g. for T 3500/3): Number of planetary stages
- Ratios (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type V 48, V 100, VZ 100, V 150, V 250, V 400

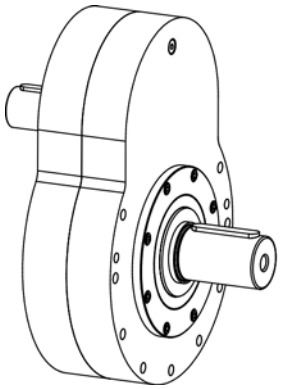


Fig. 13: Example for gearbox type V

- Gearbox type: Single-stage planetary gear
- Input shaft and output shaft with axial offset and dissimilar direction of rotation
- Ratio (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type VP 250, 350, 450, 700, 1200, 2000, 2500, 3500, 5000, 12000 and 18000

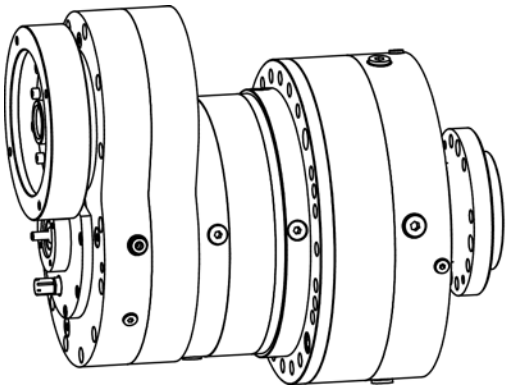


Fig. 14: Example for gearbox type VP

- Gearbox type: Planetary gearbox with step-down spur gear
- Input shaft and output shaft with axial offset and dissimilar direction of rotation
- Number after forward slash (e.g. for VP 3500/3): Number of gear stages
- Ratio (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Gearbox type W 25, W 45, VV 48, VV 400, VVx

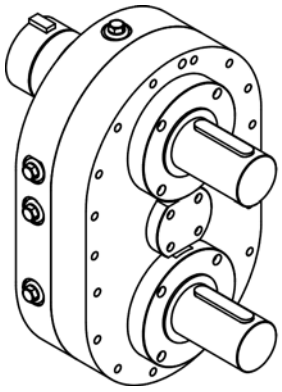


Fig. 15: Example for gearbox type W

- Gearbox type: Power take-off gearbox
- Different input and output shafts in accordance with the catalogue or dimension sheet
- Ratio (input rpm/output rpm = N1/n2) shown on the type plate
- Additional information on this gearbox type is provided in the manufacturer's catalogue and on request.

Special gearbox: Different type designations

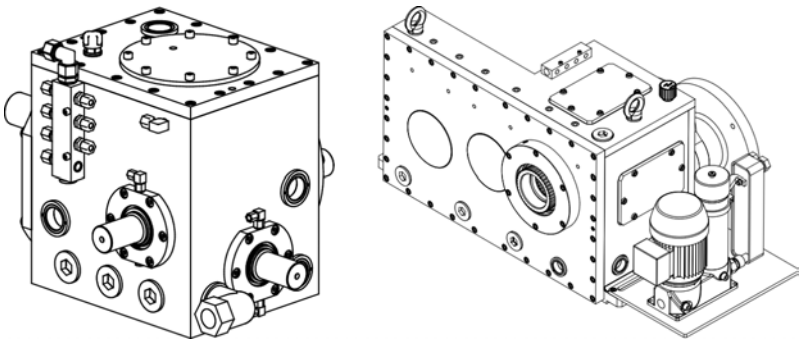


Fig. 16: Examples of special gear boxes

- Gearbox type: Usually spur gearboxes, in some cases with bevel gear sets and/or planetary sets
- See the dimension sheet for the precise description

Option: Reduced circumferential backlash

Almost all gearboxes are available with reduced circumferential backlash on request. See the data sheet for any information in this regard.

4.2 Functional description

The gearbox converts and distributes rpm and torque. The torque absorbed by the drive shafts is increased or reduced and transferred to one or multiple output shafts. The speed can be increased or reduced and transferred to one or multiple output shafts depending on the type of gearbox. The ratio determines the change of torque and rpm.

4.3 Components

The gearboxes are modularly structured. Consequently the type and number of components can vary.

The illustrations show different embodiments of the gearbox with different components that are possible. (The number of possible versions is clearly greater, there are merely representative examples!)

Pos.	Component	Pos.	Component
1	Input shaft	10	Type plate
2	Output shaft	11	Brake
3	Bearing pedestal	12	Pinion
4	Vent valve / vent filter	13	Lubricating nipple for re-lubrication
5	Oil level plug	14	Oil aggregate
6	Planetary sets	15	Circular oil level gauge
7	Intermediate flange	16	Connections for oil injection
8	Motor coupling	17	Oil fill plug
9	Oil drain plug	18	Oil compensation reservoir

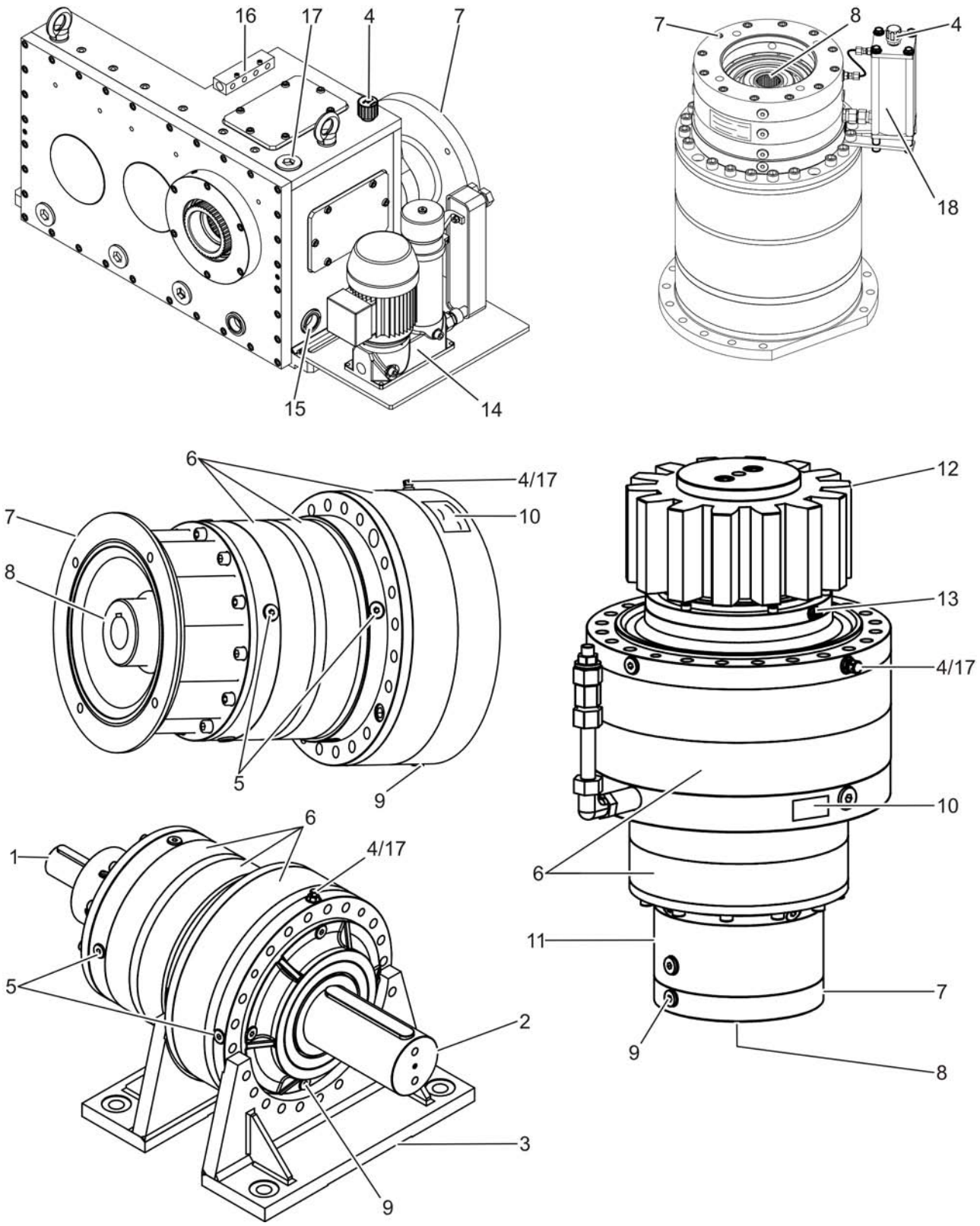


Fig. 17: Components

4.4 Connections

Oil

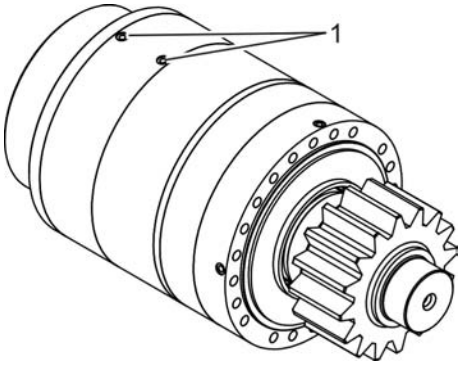


Fig. 18: Connections for pressurised oil on a gearbox of the SL series

For gearboxes with recirculating oil lubrication or oil injection, for series SL gearboxes, as well as for gearboxes with brake, there are oil connections (Fig. 18/1) on the gearbox that are shown on the dimension sheet.

Compressed air

For series S shift gearboxes it may be the case that pneumatic cylinders are installed (see Fig. 21/2 for example). Likewise for certain gearboxes direct connections for compressed air can also be present. The position and type of the connections are shown on the dimension sheet, or possibly in separate documentation for the pneumatic cylinders.

Power

The gearboxes themselves do not have a power connection. However components, such as motors, sensors, oil aggregates that do have a power connection can be attached. In this case comply with the instructions in the documentation for the respective component!

Earth connection

Earthing prevents electromagnetic charging of the gearbox. For detailed information see *'Earthing' on page 16*.

4.5 Display and operating elements

Circular oil-level gauges

Individual gearboxes are equipped with a circular oil-level gauge (Fig. 17/15) by which the oil level can be checked or the gearbox can be observed in operation.

Oil dip stick

In some cases gearboxes are supplied with a dip stick are that can be used to show the oil level.

Shift lever

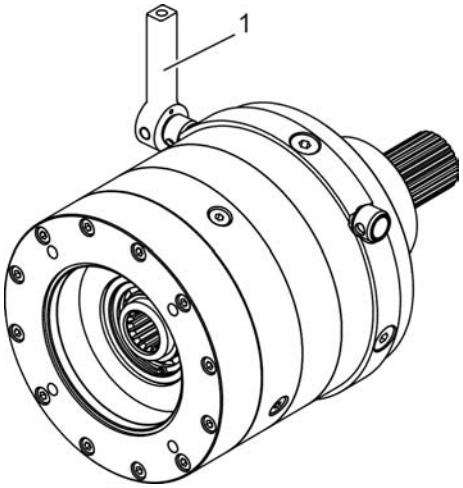


Fig. 19: Shift lever

For series S gearboxes frequently there is a shift lever (Fig. 19/1) on the gearbox. This lever can be used to change the ratio of the gearbox. See ↳ *Chapter 4.8 'Shifting - mode of operation (only series S and SL)' on page 31* and ↳ *Chapter 7.3 'Activating the shift mechanism (series S and SL)' on page 53* in this regard.

Additional display and operating elements

Particularly for special gear units additional display and operating elements may be present. In this case they will be described on the dimension sheet.

4.6 Lubrication

4.6.1 Position of the oil plugs

The precise positions of the oil plugs are shown on the dimension sheet. As a rule the following applies:

The oil fill plug (Fig. 17/17) is on top, the oil fill plug (Fig. 17/5) is usually slightly below the middle of the gearbox, and the oil drain plug (Fig. 17/9) is on the bottom. Usually the upper oil plug is equipped with a vent valve (Fig. 17/4). In some cases there are several screw plugs of the same type at approximately the same height. Individual gearboxes are equipped with a circular oil-level gauge (Fig. 17/15) or a transparent hose with two marks by which the oil level can be checked, or the gearbox can be observed in operation. For gearboxes with oil injection or oil recirculating oil lubrication the connections are shown on the dimension sheet.

4.6.2 Lubrication by oil sump (splash lubrication)

If nothing to the contrary is noted on the dimension sheet, the gearbox is lubricated by splash lubrication. For this the oil level must be correct.

Only use oil approved by the manufacturer. Consult with the manufacturer if other oil types are used.

More precise information concerning the oil types is provided in the lubricant table and the lubricant recommendations of the manufacturer (see also ↬ Chapter 3.2 'Lubricant type' on page 18).

The correct oil level can also be monitored with a sensor. If this is of interest to you contact the manufacturer.

4.6.3 Lubrication by oil injection or oil recirculation

For some gearboxes lubrication is executed via oil injection or oil recirculation. This is noted on the dimension sheet. In this case an appropriate oil aggregate must be present and connected. The connections for the oil feed line are shown on the dimension sheet and thus are configured so that optimal lubrication is ensured.

Oil quantity and oil pressure must be set in such a manner that maximum oil flow through the gearbox is ensured without formation of a noticeable oil sump. Excess pressure should not build up. The recommended values for oil quantity and oil pressure are specified on the dimension sheet. If the oil pressure drops below the minimum level, or fails entirely the gearbox will be insufficiently lubricated and will fail. For this reason we strongly recommend a pressure monitor that ensures immediate shut-down of the drive motor if there is a pressure drop in the oil supply line.

If the main supply line is clogged, the drive motor must be switched off immediately. For this a volumetric flow measurement device in the supply line, which is coupled with the controller of the drive motor, is recommended. Clogging of smaller auxiliary lines can result in insufficient lubrication of certain points in the gearbox and ultimately failure. Thus regular checking and monitoring of the temperature are indispensable.

At lower temperatures the oil becomes more viscous, thus a higher oil pressure is built up, which must be absorbed via an excess pressure valve in the supply line, that reduces the delivery quantity, or by preheating the oil. This depends on the ambient temperature and the viscosity of the oil used. Trouble-free quality of the injected oil must be ensured by appropriate filters (filter fineness 10 µm) and regular checking.

If the oil supply is insufficient the gearbox can overheat and be damaged. Consequently the oil supply must be checked at regular intervals. A volumetric flow monitor is recommended in every case.

4.6.4 Lubrication by grease filling

Some gearboxes are lubricated with grease,either wholly or in part (e.g. only on the top bearing). This is shown in the applicable documents (↳ *'Other applicable documents' on page 5*). Prior to commissioning you must ensure that the gearbox is adequately filled with the grease prescribed on the dimension sheet.

Replace the grease quantity on a regular basis. Only use grease approved by the manufacturer. Consult with the manufacturer if other grease types are used.

4.7 Cooling

If nothing to the contrary is noted in the applicable documents, the gearboxes are cooled by heat radiation. Ensure that the heat radiation is not obstructed. Avoid an obstruction of the air circulation (e.g. though enclosures), also avoid a dark paint finish if there is direct sunlight. Prevent thick dust layers; these can prevent the heat radiation. If the gearbox temperature increases excessively (see ↳ Chapter 7.2 'Gearbox temperature' on page 52), it may be necessary to retroactively install a cooling system. Consult with the manufacturer beforehand.

4.7.1 Cooling with cooling jacket (e.g. PV 63/180 or the KW option for other series)

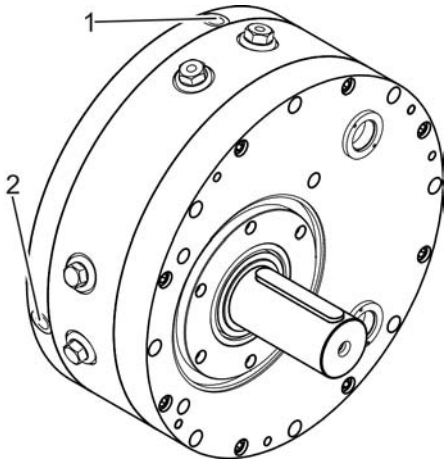


Fig. 20: Cooling with cooling jacket

1 Outflow of the cooling medium
2 Inflow of the cooling medium

Some gearboxes are equipped with a cooling jacket. This is noted on the dimension sheet. The gearbox is cooled by a cooling medium (e.g. water or oil). Coolant inflow and outflow are noted on the dimension sheet. Fig. 20 shows an example.

To regulate the gearbox temperature we recommend attaching a valve upstream of the coolant supply, which opens or closes the gearbox housing in accordance with adjustable temperature limit values. When regulating the temperature ensure than the gearbox is not cooled too quickly (abruptly). The maximum pressure for the cooling medium is specified on the dimension sheet and may not be exceeded.

4.7.2 Cooling by oil injection, oil recirculation

If the gearbox is cooled by injection of tempered oil, see the information on oil temperature and quantity on the dimension sheet. The minimum cooling capacity of the oil aggregate is also provided on the dimension sheet. The values specified on the dimension sheet are minimum values for the assumed installation and operating conditions. In operation it may still be necessary to adjust the values. Consult with the manufacturer if there questions. See also ↳ Chapter 4.6.3 'Lubrication by oil injection or oil recirculation' on page 29 in this regard.

4.8 Shifting - mode of operation (only series S and SL)

Series S

Shifting between the different ratios occurs with positive locking by toothed clutches. For this a clutch is moved axially.

Series SL

Shifting between the different ratios occurs with positive locking by toothed clutches. The discs are lubricated by the oil bath that is shared with the planetary gear.

4.9 Accessories

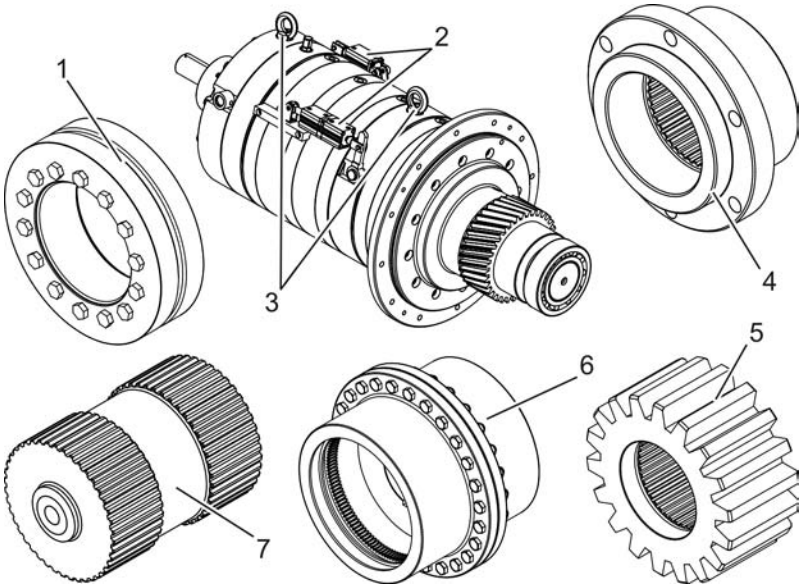


Fig. 21: Accessories

Depending on the gearbox accessories can include the following:

- Motor
- Shrink disks (Fig. 21/1)
- Pneumatic cylinders (Fig. 21/2) for the shift mechanism
- Attachment eyes for transport (Fig. 21/3)
- Flanges (Fig. 21/4)
- Pinions (Fig. 21/5)
- Toothed clutches (Fig. 21/6)
- Clutch shafts (Fig. 21/7)
- Valve island

In addition to this manual comply with the instructions in the documentation provide for the accessories.

5 Transport, packaging, and storage

5.1 Safety

Suspended loads

WARNING!

Life-threatening danger due to suspended loads!

When lifting loads a life-threatening hazard is posed by parts falling or swinging out of control.

- Never step under suspended loads.
- Comply with the information concerning the intended attachment points.
- Do not attach to projecting machine parts or to the lugs of attached components. Ensure that the sling gear is securely seated.
- Only use approved lifting devices and sling gear with sufficient bearing capacity.
- Do not use rope and belts that are torn or frayed.
- Do not place ropes and belts on sharp edges and corners; do not knot or twist ropes and belts.
- During transport ensure that personnel, objects, or obstructions are not in the swing range of the gearbox.

Danger of tipping

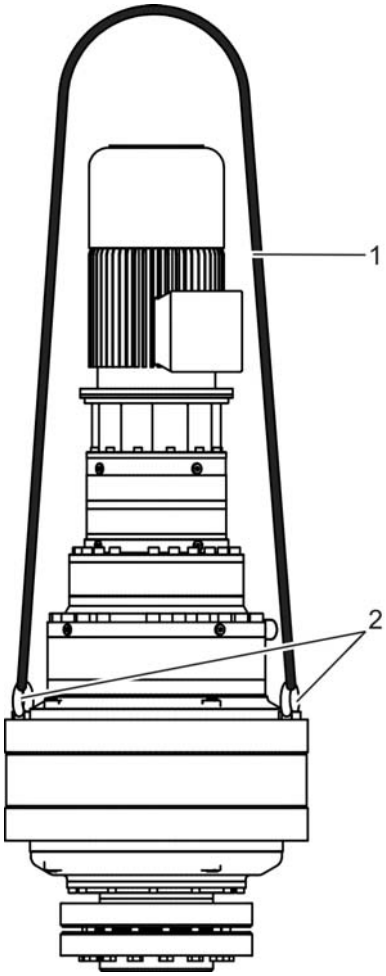


Fig. 22: Example of tipping danger

1 Strap
2 Low attachment points

WARNING!

Life-threatening danger if the gearbox tips over during transport!

Due to improperly executed transport, with certain gearbox designs the gearbox can tip over.

– Use the attachment points that are provided for transport.
– Adequately safeguard the gearbox from tipping when it is lifted.

Improper transport

NOTICE!

Material damage due to improper transport!

Transport items can fall or tip over if transported improperly. This can cause considerable material damage.

- When unloading transport items at delivery, as well as for inner-company transport, proceed carefully and pay attention to the instructions on the packaging.
- Only a specialised company or specialised personnel should transport the gearbox.
- Only use the intended attachment points. When lifting ensure correct fastening and securing of the gearbox.
- Particularly for gearboxes with a brake or brake motor, ensure that the gearbox is not self-inhibiting and that it can turn freely.
- For transport, unscrew valves and filters and replace them with a screw plug.
- Transport gearbox properly (e.g. with lift truck, forklift or with a crane). Attention: In some cases gearboxes can tip.
- Exclude the possibility of hazards due to suspended loads.
- Only remove packaging just prior to installation.

Attachment points

The attachment points can vary for each gearbox and may not be marked.

There are no attachment points on small, portable gearboxes.

5.2 Transport inspection

At receipt check any delivered parts for completeness and transport damage. Proceed as follows if there is visible external damage:

- Do not accept the delivery or, only accept delivery subject to reservation.
- Note the extent of damage on the transport documentation or on the forwarder's delivery ticket.
- Initiate/submit a complaint.

Report every defect as soon as it is detected. Damage claims will only be honoured within the applicable claim period.

5.3 Transport

The gearbox is delivered in a wire-mesh box, a crate, or on a pallet or wood planks.

Use a lift truck, forklift, or crane depending on the size of the gearbox.

Depending on the weight of the gearbox there is at least one tapped bore on the housing into which the eye for hooking in the crane hook can be screwed. When lifting with the crane use screw-insert eye bolts.

Possible thread for the use of screw-insert eye bolts is specified in the dimension sheet.

For transport and storage always ensure that no loads are attached and that no impacts are applied to the gearbox shafts.

5.4 Storage and preservation

NOTICE!

Material damage due to corrosion!

Avoid condensation in the interior of the gearbox, otherwise rust can form and the gearbox can be damaged.

General instructions for storage

- Do not store outdoors.
- Store in a dry and dust-free location.
- Do not expose to aggressive media.
- Protect from direct sunlight.
- Avoid mechanical vibration.
- Storage temperature: +15 to +35°C.
- Relative humidity: Max. 40%.

Longer-term storage

For storage over two months implement the following measures.

- Storage up to 6 months: Complete filling with gear oil in accordance with the specification.
- For storage periods longer than 6 months: Complete filling with gear oil as specified, mixed with 25% corrosion protection oil Klübersynth MZ4-17.
- In both cases a vent filter or a vent valve, (if present) must be replaced by a screw plug.
- Unprimed or unpainted parts of the gearbox must also be preserved on the outside for longer storage periods, to prevent rust formation.

6 Installation and initial commissioning

6.1 Installation

6.1.1 Required tools and materials

As a rule the following tools are required for installation:

- Torque wrench
- Measurement devices (e.g. dial gauge if the unit must be aligned)
- Loctite 270 or equivalent thread-lock compound
- Assembly grease
- Assembly compound (for shrink disks)
- Cleaning agent for grease-free surfaces

6.1.2 Installation of a gearbox

Danger of injury

WARNING!

Danger of injury due to improper transport!

Improper transport can cause severe injuries.

– Prior to starting tasks ensure that there is adequate free space for installation.
– Ensure the installation site is kept orderly and clean. Loosely stacked components or components and tools that are lying around can cause accidents.
– Secure the components so that they do not fall down or fall over.

Improper installation

NOTICE!

Material damage on the gearbox due to improper installation!

Improper installation can cause significant material damage.

- Comply with the install position as specified on the dimension sheet.
- Mount components properly. Maintain the prescribed bolt-tightening torque.
- For installation of the gearbox use the provided fastening holes.
- The fastening bolts for installing the gearbox must have at least a strength class 10.9 rating. Secure bolts with Loctite 270 or a comparable thread-lock compound.
- The support surfaces of the gearbox should be clean and must maintain the intended concentricity and run-out deviations. Alignment tasks may be necessary in this regard.
- Avoid misalignment and pay attention to evenness on the attachment surfaces.
- Avoid impacts on the input shaft and output shaft of the gearbox.
- Ensure that the air circulation is not obstructed. Otherwise the gearbox can overheat.
- Use the front thread to pull on coupling parts or gear pinions.
- For assembly outdoors (e.g. when attaching a motor) do not work in the rain.
- The ambient temperature of the gearbox must always be between 0°C and 40°C. If the ambient temperature is higher or lower, consult with the manufacturer.

Installing the gearbox

Personnel: ■ Specialised personnel

1. Clean gearbox (flanged surfaces, etc.) and attachment surfaces.
2. Check gearbox for leaks.
3. Examine shaft seal rings, screw plugs, oil valves, etc. for damage.

NOTICE!

If damage is determined **do not** place the gearbox in service.

4. *For transport, frequently the vent valves or vent filters are replaced by screw plugs and are delivered loose.*

   Replace the screw plug with the vent filter or the vent valve as specified on the dimension sheet.

5. To prevent deformation of the gearbox or parts of the gearbox, check the sub-construction for adequate torsional rigidity and evenness.

6. Install the gearbox in such a manner that the oil drain plugs are downward.

   NOTICE!

   Comply with the install situation and position of the oil drain plugs as specified in the dimension sheet.

   Install the gearbox in such a manner that the oil screws are easily accessible, and if possible so that the type plate is also easily legible. If there is a leak oil bore it must be pointing downward.

7. Earth the gearbox holder.

8. Check threaded unions and secure them with Loctite 270 or a comparable thread-lock compound.

9. For gearboxes with pinions on the output drive, after installation check the contact pattern with marking paint.

6.1.3 Install position

If nothing to the contrary is specified in the order, the gearboxes are manufactured for the install position specified in the dimension sheet or order confirmation and they must only be used in this install position.

NOTICE!

Damage to the gearbox due to the wrong install position!

The wrong install position of the gearbox can result in material damage due to an oil level that does not meet the specification.

- Only use the gearbox in the install position specified in the dimension sheet.
- If the gearbox should be used in a different install position, consult with the manufacturer.

6.1.4 Attachment of a motor

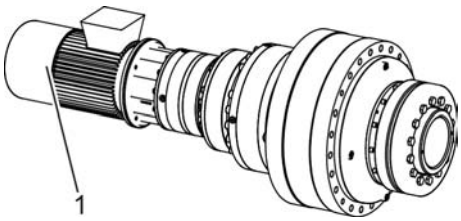


Fig. 23: Attachment of a motor

NOTICE!
The gearboxes are available for direct attachment of a motor (Fig. 23/1) (e.g. version "Em" or "EmR" for electric motors or "HyM" for hydraulic motors). If an intermediate flange is present, when flanging on the motor ensure that motor shaft and gearbox shaft can be introduced into each other without force so that the motor shaft does not exert any force on the drive pinion and its bearing arrangement. Ensure that the bolt length and possibly the bolt head height are correct.

6.1.4.1 Attachment of an electric motor with integrated torsionally flexible clutch (version EmR)

Personnel: ■ Specialised personnel

Fig. 24: Gearbox cleaned

1. Take the gearbox out of the packaging and clean the flange surface, as well as coupling with a clean cloth.

Fig. 25: Elastic element fitted on

2. Fit the elastic element (appearance can deviate from the illustration) onto the half of the coupling that is integrated in the gearbox.

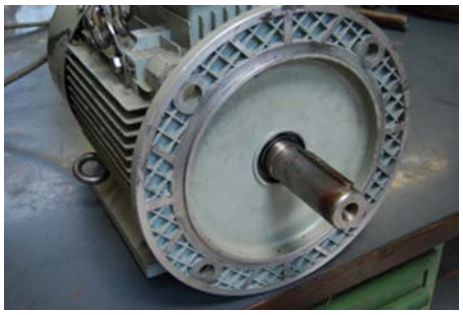


Fig. 26: Electric motor

3. Take the electric motor out of the packaging and clean the flange surface, as well as the shaft with a clean cloth. Grease the shaft with Klüber compound 46 MR 401 or a comparable product to facilitate installation and to prevent corrosion.

Fig. 27: Coupling half pushed onto the motor shaft

4. Slide the second, delivered coupling half onto the motor shaft.

Fig. 28: Distance A

5. On the gearbox measure distance A (distance A from the flange surface to the front of the coupling half).

Fig. 29: Distance B

6. On the motor measure distance B (distance B from the motor-side front surface of the coupling half to the flange surface).

NOTICE!

Axially position the coupling halves so that B is approx. 1-2 mm smaller than A ($B + 1 \leq A \leq B + 2$). Otherwise the couplings can exert reciprocal pressure, which can result in bearing damage in the gearbox and motor.

Fig. 30: Coupling half axially fixed in place

7. If distance B has not been correctly specified, fix coupling halves in place axially with a set screw (use thread-lock compound) and recheck distance B.

Fig. 31: O-ring inserted in the intended groove

8. On the gearbox side motor flange insert an O-ring into the provided groove (as a rule the O-ring is provided).

NOTICE!

If an O-ring is not provided, seal the flange surface with liquid surface sealant (e.g. epple 22).

If the space between motor and flange is not sealed, liquid can penetrate into this cavity and cause corrosion.

Fig. 32: Mounting the motor

9. Mounting the motor.

Depending on the size and weight of the motor and gearbox, either a vertical or horizontal mounting is recommended.

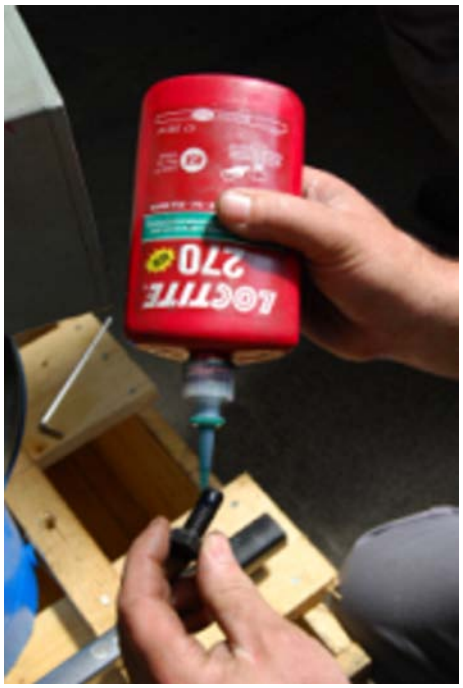


Fig. 33: Apply thread-lock compound to the bolts

10. Use bolts specified by the motor manufacturer to fasten the motor (as a rule strength class 8.8 is sufficient) and secure the bolts with thread-lock compound (Loctite 270 or equivalent).

Fig. 34: Tighten bolts

11. Use a torque wrench to tighten bolts with the specified tightening torque. First slightly tighten opposite bolts, then the other bolts - always in a cross pattern.

If in doubt contact the manufacturer, instead of introducing a safety risk and/or damaging the gearbox.

6.1.4.2 Attachment of electric or hydraulic motors without elastic coupling (e.g. Em or HyM version)

Personnel: ■ Specialised personnel

1. Take the gearbox out of the packaging and clean the flange surface, as well as hollow shaft with a clean cloth.

2. Take the motor out of the packaging and clean the flange surface, as well as the shaft with a clean cloth. Grease the shaft with Klüber compound 46 MR 401 or a comparable product to facilitate installation and to prevent corrosion.

3. On the gearbox side motor flange insert an O-ring into the provided groove (as a rule the O-ring is provided).

NOTICE!

If an O-ring is not provided, seal the flange surface with liquid surface sealant (e.g. epple 22).

If the space between motor and flange is not sealed, liquid can penetrate into this cavity and cause corrosion. For the HyM version oil can escape at this point.

4. Mounting the motor.

Depending on the size and weight of the motor and gearbox, either a vertical or horizontal mounting is recommended.

5. Use bolts specified by the motor manufacturer to fasten the motor (as a rule strength class 8.8 is sufficient) and secure the bolts with thread-lock compound (Loctite 270 or equivalent).

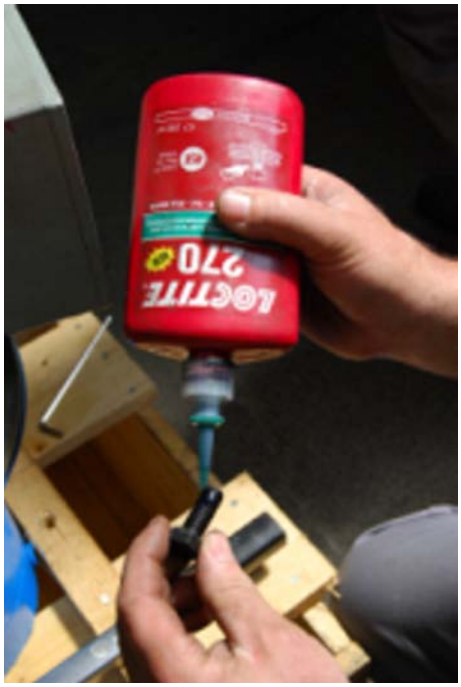


Fig. 35: Apply thread-lock compound to the bolts

Fig. 36: Tighten bolts

6. Use a torque wrench to tighten bolts with the specified tightening torque. First slightly tighten opposite bolts, then the other bolts - always in a cross pattern.

If in doubt contact the manufacturer, instead of introducing a safety risk and/or damaging the gearbox.

6.1.4.3 Attachment of a torque arm

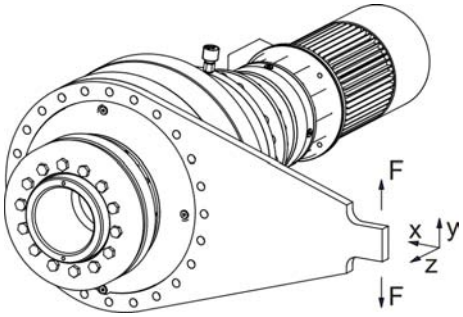


Fig. 37: Gearbox with torque arm

Personnel: ■ Specialised personnel

1. If a torque arm will be attached on the gearbox (Fig. 37) it must be freely movable in the direction of the x-axis and z-axis. In the direction of the y-axis movability of 0.5 - 1 mm must be maintained.

2. We recommend that the torque arm be supported with an elastic element to damp impacts if there are torque changes. Consult with the manufacturer if there questions.

6.1.5 Attachment of an output-side shrink disc

Personnel: ■ Specialised personnel

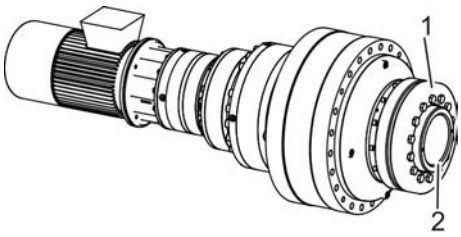


Fig. 38: Gearbox with output side shrink disc

1. If the gearbox has an output-side hollow shaft (Fig. 38/2) for a shrink disc (Fig. 38/1), when mounting the shrink disc also comply with the instructions in the documents provided by the manufacturer.
2. If the solid shaft that must be introduced into the hollow shaft does not have a bore, provide it with a small groove so that the air can escape out of the bore when sliding in the shaft.
3. Clean the hollow shaft of the gearbox and the solid shaft; do not grease any more.
4. Fit the shrink disc onto the gearbox shaft.
5. Introduce the solid shaft into the hollow shaft of the gearbox.
6. Tighten the screws in accordance with the information in the documentation of the shrink disc.

6.1.6 Attachment of accessories

Only have specialised personnel attach accessories (↬ Chapter 4.9 'Accessories' on page 31) that are delivered loose, in compliance with the instructions in the associated documentation.

6.2 Commissioning

Improper commissioning

WARNING!

Danger of injury due to improper commissioning!

Improper installation can cause severe injury or significant material damage.

- Do not operate the gearbox in the supplied packaging.
- Comply with the following before commissioning:
  - Ensure that all installation tasks have been properly executed and concluded in accordance with the instructions in this manual.
  - Ensure that no one is in the danger zone.

6.2.1 Instructions for commissioning

Comply with the following instructions before commissioning:

- All protective devices and safety devices must be installed.
- The drive should not be blocked.
- The brake (if present) must be vented.
- Ensure that the direction of rotation of the drive is correct.

Personnel: ■ Specialised personnel

1. Prior to commissioning, check the valves, circular oil-level gauges, and all plugs necessary for the oil filling to ensure that they are undamaged.

WARNING!
Start-up is prohibited if there is a defect.

2. Fill the gearbox with the quantity of lubricant (↳ *Chapter 6.2.2 'Filling the gearbox with oil' on page 48*) that is intended for operation.

NOTICE!
Too much lubricant results in malfunction and possibly damage to the gearbox.

3. If necessary re-attach vent filter or the vent valve.
4. Verify correct installation of the gearbox.
5. First let the gearbox run without load or with low load and a low speed.
6. Monitor the gearbox for noise, oil leaks, and warming.
7. After approx. 10 operating hours check fastening bolts for loosening.

6.2.2 Filling the gearbox with oil

6.2.2.1 Unsealed gearbox

Unsealed gearboxes are delivered without oil filling.

Personnel: ■ Specialised personnel

1. Seal the gearbox (usually by attaching a motor or other parts) and check for leaks.
2. Prior to commissioning fill the oil quantity and oil sort that is specified on the type plate.

It is also possible to fill the oil through the motor opening or through the oil fill plug.

When filling the gearbox with oil it can take several hours until the oil is distributed in the gearbox, particularly at cold temperatures.

NOTICE!

Material damage to the gearbox if the wrong lubricant is used!

If the wrong lubricant is used the gearbox can be damaged.

- Only use the oil and quantity of oil that are specified on the type plate.
- Do not allow the gearbox to run without oil filling under any circumstances.
- Check the oil level prior to commissioning.

3. After the oil is distributed in the gearbox, check the oil level via the oil level plug.

The oil level depends on the install position! If there is change in the install position it is possible that the quantity of oil that must be filled will also change. If there are questions concerning the oil filling always consult with the manufacturer.

6.2.2.2 Sealed gearbox

In some cases sealed gearboxes are delivered with oil filling.

Personnel: ■ Specialised personnel

1. Prior to commissioning fill the oil quantity and oil sort that is specified on the type plate.

When filling the gearbox with oil it can take several hours until the oil is distributed in the gearbox, particularly at cold temperatures.

NOTICE!

Material damage to the gearbox if the wrong lubricant is used!

If the wrong lubricant is used the gearbox can be damaged.

- Only use the oil and quantity of oil that are specified on the type plate.
- Do not let the gearbox run without oil or with too much oil, under any circumstances.
- Check the oil level prior to commissioning.

2. Check the gearbox for leaks.
3. Check the oil level via the oil level plug.

The oil level depends on the install position! If there is change in the install position it is possible that the quantity of oil that must be filled will also change. If there are questions concerning the oil filling always consult with the manufacturer.

6.2.2.3 Gearbox for oil injection or recirculation oil lubrication

As a rule gearboxes for oil injection or recirculating oil lubrication are delivered without oil filling. Prior to commissioning the oil injection or oil circulation system must be connected otherwise the gearbox will be damaged.

Personnel: ■ Specialised personnel

1. Prior to commissioning connect the oil supply and oil discharge to the gearbox.
2. Oil quantity and oil pressure must be set in such a manner that maximum oil flow through the gearbox is ensured without formation of a noticeable oil sump (↬ *Chapter 4.6.3 'Lubrication by oil injection or oil recirculation' on page 29*).

NOTICE!

There should be no build up of excess pressure.

The recommended values for oil quantity and oil pressure are specified on the dimension sheet. If the oil quantity or the oil pressure drops below the minimum level, or fails entirely the gearbox is insufficiently lubricated and will fail.

NOTICE!

Material damage to the gearbox if the wrong lubricant is used!

If the wrong lubricant is used the gearbox can be damaged.

– Only use the oil and quantity of oil that are specified on the type plate.
– Do not let the gearbox run without oil or with too much oil, under any circumstances.
– Check the oil level prior to commissioning.

7 Operation

7.1 Safety

Improper operation

WARNING!
Danger of injury due to improper operation!
Improper operation can cause severe injury or significant material damage.

- Ensure that all covers and protective devices are installed correctly and that they function properly.
- Never render safety devices inoperable during operation or bypass them.
- When operating the gearbox, ensure that the loads and the operating factors are complied with. If you determine that the loads and operating factors are actually greater than assumed, you must cease operation of the gearbox without delay. Otherwise the gearbox can be overloaded.
- If the functions of the gearbox change (e.g. if the play increases or the brake - if present - gives slightly), an immediate check is necessary.
- If there are changes in the noise, temperature or vibration behaviour (particularly on the bearing seats), and oil leaks on the surface of the housing, determine the cause. An immediate check can prevent more extensive damage.
- For extreme implementations carefully observe the gearbox.

Reduced circumferential backlash

NOTICE!
If a significant change in operation shows reduced circumferential backlash, consult with the manufacturer without delay.

7.2 Gearbox temperature

Gearbox temperature for standard gearboxes

- At a room temperature of 20°C the gearbox temperature on the housing surface should not exceed 90°C. Higher temperatures are entirely possible. In this case consult with the manufacturer.
- Note that the aging rate of the gear oil significantly increases at higher temperatures (rule of thumb: +10°C oil temperature = half the service life of the oil).
- Always keep the housing surface clean, so that heat dissipation is not impaired. If there is insufficient heat dissipation to the environment, an additional external cooling device must be supplied (☞ *Chapter 4.7 'Cooling' on page 30*).

7.3 Activating the shift mechanism (series S and SL)

The shift mechanism must be activated in accordance with the information on the dimension sheet. The appropriate connections are shown on the data sheet.

Series S

Only switch from one gear stage to the other at a speed of approx. 10 min^{-1}. If the shift procedure was not successful the first time, repeat it and let the motor turn at 10 min^{-1} until the toothed clutches engage.

Series SL

Shifting can be executed at standstill as well as to higher speeds (from 10 min^{-1} speed differential consult with the manufacturer). Torque should not be applied when shifting. Consult with the manufacturer if there questions.

7.4 Controller of the drive motor (series S and SL)

For shift gearboxes ensure that the controller of the drive motor takes the requirements of the shift mechanism and of the lubrication system into account (↬ Chapter 7.3 'Activating the shift mechanism (series S and SL)' on page 53). Consult with the manufacturer if necessary.

8 Faults

8.1 Safety

Improperly executed fault correction tasks

WARNING!

Danger of injury due to improper fault correction!

Improperly executed fault correction tasks can cause severe injury and significant material damage.

- Prior to starting tasks ensure that there is adequate free space for installation.
- Ensure the installation site is kept orderly and clean. Loosely stacked components or components and tools that are lying around can cause accidents.
- If components have been removed, ensure that they are properly reinstalled, that all fastening elements are reinstalled, and that all threaded connections are tightened with the specified screw-tightening torque.
- Comply with the following instructions before restarting:
  - Ensure that all fault correction tasks have been properly executed and concluded in accordance with the instructions in this manual.
  - Ensure that no one is in the danger zone.
  - Ensure that all parts of the gearbox are installed correctly and that they function properly.

8.2 Fault table

Behaviour if there is a fault

The following always applies:

1. For faults that pose an imminent danger to personnel or material assets, immediately take the gearbox out of operation.
2. Determine the cause of the fault.
3. Depending on the type of fault have authorised specialised personnel correct the fault.

The fault table below provides information concerning who is authorised to correct the fault.

Fault	Remedy	By whom?
Oil escapes from the vent valve / vent filter	■ Check the oil level ■ Check rpm ■ Check vent valve / oil filter ■ Check operating temperature ■ Check oil type ■ Contact the manufacturer	Specialised personnel
Oil escapes on the shafts	■ Check the oil level ■ Check operating temperature ■ Check venting	Specialised personnel
	■ Check seal	Manufacturer/customer service
Oil escapes on the shafts	■ Check the oil level ■ Check operating temperature ■ Check vent valve / oil filter	Specialised personnel
	■ Check seal	Manufacturer/customer service
Oil escapes from the leak oil bore	■ Check the oil level ■ Check operating temperature ■ Check vent valve / oil filter	Specialised personnel
	■ Check drive-side seal	(Specialised personnel)/manufacturer
Oil escapes at other points	■ Check the oil level ■ Check operating temperature ■ Check vent valve / oil filter	Specialised personnel
	■ Check seal	Manufacturer/customer service
Noise	■ Check the oil level ■ Check oil (e.g. chips in the oil)	Specialised personnel
	■ Open the gearbox	(Specialised personnel)/manufacturer
High temperature development	■ Check the oil level ■ Check rpm ■ Check vent valve / oil filter ■ Check the gearbox for fouling ■ Clean gearbox as needed ■ Check gearbox for unusual noise ■ Check oil (e.g. chips in the oil) ■ Consult with the manufacturer	Specialised personnel
Chips in the oil	■ Open the gearbox and check for damage ■ Replace the oil filling immediately	(Specialised personnel)/manufacturer
	■ Oil analysis	Laboratory

Fault table

Fault	Remedy	By whom?
No transmission of force or rpm	■ For shift gearboxes: Is the shift lever in idle position? ■ For all gearboxes: Is the clutch correctly fastened?	Specialised personnel
	■ Check whether there is gearbox damage	(Specialised personnel)/manufacturer
Vibrations	■ Check attachment parts (e.g. clutch) ■ Check fastenings ■ Check rpm ■ Check oil for chips	Specialised personnel
	■ Check gearbox	Customer service
Excessive circumferential backlash	■ Check the oil level ■ Check couplings ■ Check oil (e.g. chips in the oil)	Specialised personnel
	■ Open the gearbox	(Specialised personnel)/manufacturer

9 Maintenance

Introduction

In operation gearbox parts are subject to natural wear that depends on the duration of operation, load and warming. Consequently it is necessary from time to time to inspect the gearbox. The longest inspection interval should not exceed one year.

Recommendation

The manufacturer recommends having the gearbox inspected in the manufacturer's workshop and - depending on the specific case - after several years bringing the gearbox to the manufacturer for a complete overhaul.

9.1 Safety

Danger of burn injury

WARNING!

Danger of burn injury!

The gearbox heats up during operation! Danger of burn injury if there is contact.

– Allow oil to cool to under 30°C prior to performing maintenance tasks.

WARNING!

Danger of injury when executing maintenance tasks!

Improperly executed maintenance tasks can cause dangerous situations.

– Wear the required protective equipment for all tasks.
– For maintenance tasks on the gearbox switch off the drive and safeguard it from being switched on again.
– After concluding the maintenance tasks, properly reinstall all protective devices and safety devices.

9.2 Maintenance schedule

Interval	Maintenance task	Personnel
Daily	Check for impermissible vibration or noise	Specialised personnel
	Check the gearbox for oil leakage	Specialised personnel
	Check gear oil temperature	Specialised personnel
Weekly	Clean	
Monthly	Check gearbox bolts for firm seat	
	For gearboxes with lubricating nipples: Replace grease	Specialised personnel
	Check the oil level	
	For low backlash gearboxes check for increase of circumferential backlash	
After 300 operating hours (at the latest after 6 months)	Replace first lubricant filling	Specialised personnel
After 3000 operating hours	For synthetic lubricants: Analyse lubricant sample or change the lubricant	Specialised personnel
After 3000 operating hours (at the latest after 12 months)	For mineral lubricants: Change the lubricant	
After 6000 operating hours (at the latest after 12 months)	For synthetic lubricants: Change the lubricant	Specialised personnel

There may be additional maintenance tasks that are specified on the dimension sheet.

9.3 Maintenance tasks

9.3.1 Clean gearbox

Cleaning

→ Clean the gearbox regularly - at least weekly, if the environment is extremely dirty more frequently as needed - of dust and fouling.

9.3.2 Check the oil level

This check does not apply for gearboxes with grease filling.

Check the oil level via the oil level plug or with an oil dip stick

1. Switch off the system and safeguard it from being switched on again.
2. Wait until the oil in the gearbox has settled and is distributed (this can take up to several hours).
3. Unscrew the oil level plug or oil dip stick.
4. Check the oil level.

   – *For gearboxes with oil level plug the oil level must reach to the lower edge of the bore.*
   – *For gearboxes with oil dip stick wipe off the dip stick, re-insert it (do not screw it in), pull it out again and check whether the oil level reaches the mark.*

5. Top up oil as needed and wait until the oil is distributed in the gearbox (this can take up to several hours).
6. Check the oil level again.
7. Check the sealing ring under the oil plugs and replace as needed.
8. Screw the oil level plug or oil dip stick back into the gearbox.

Check the oil level by the circular oil-level gauges

When the gearbox is at a standstill the oil level is visible via the circular oil-level gauge. Wait until the oil in the gearbox is distributed (this can take up to several hours)!

9.3.3 Changing lubricant

Danger due to lubricants

WARNING!

Danger of health impairment due to lubricants!

Contact with lubricants can induce allergies and skin irritations.

- Wear protective gloves when handling lubricants.
- Do not swallow, do not inhale fumes.
- After unintentional eye contact, thoroughly rinse out lubricant with plenty of water, if necessary seek medical attention.
- After skin contact wash off thoroughly with plenty of water and soap.
- Comply with the instructions on the safety data sheet provided by the manufacturer of the lubricant.

Danger due to improper disposal

NOTICE!

Hazards for the environment due to improper disposal!

Hazards for the environment can occur due to improper disposal of the oil.

- Properly dispose of the drained oil.
- If in doubt obtain information on environmentally responsible disposal from local municipal authorities or specialised disposal companies.
- If environmentally-harmful substances inadvertently get into the environment, immediately implement suitable measures. If in doubt inform the responsible municipal authorities of the damage and ask about suitable measures that should be implemented.

Changing oil

1. When changing oil, drain oil at all of the underlying screw plugs.

NOTICE!
Ensure used oil does not get into the environment!

Depending on the temperature of the oil and the condition of the gearbox it can take up to several hours for the oil to completely drain out of the gearbox.

2. Check the escaping oil for chips, if necessary send it in for an oil analysis.

   Compare the drained quantity with the oil fill quantity on the type plate and if there are differences, determine the cause (e.g. oil loss, inadequate wait time when filling or draining the oil).

3. Check the sealing ring under the oil plugs and replace as needed.
4. Re-close the screw plugs.
5. Fill with new oil that agrees with the specification on the type plate (*Chapter 6.2.2 'Filling the gearbox with oil' on page 48*).

9.3.3.1 Changing synthetic oils (polyglycols)

- *Check oil level regularly.*
- *Replace the first oil filling after 300 operating hours at the latest, or after 6 months at the latest, (whichever comes first).*
- *After 3000 operating hours analyse an oil sample or change the oil.*
- *After 6000 operating hours or 12 months at the latest, (whichever comes first) change the oil.*
- *Also replace the gear oil after a longer standstill period.*

9.3.3.2 Changing mineral oils

- *Check oil level regularly.*
- *Replace the first oil filling after 300 operating hours at the latest, or after 6 months at the latest, (whichever comes first).*
- *For every subsequent oil filling after 3000 operating hours, or after one year at the latest, replace the oil.*
- *Also replace the gear oil after a longer standstill period.*

9.3.3.3 Lubricant change for grease filling

When changing the lubricant, for grease filling the same instructions apply that apply for changing oil. If a gearbox is lubricated with oil as well as with grease (e.g. grease filling on the top-most bearing) always change both lubricants at the same time. In addition for gearboxes with lubricating nipples, re-grease monthly.

9.4 Repairs

Only have repair tasks executed by the manufacturer.

No guarantee is accepted for any autonomously executed repair or maintenance tasks. For gearboxes that are still under guarantee (see the T&Cs of the manufacturer in this regard) the guarantee is invalidated if unauthorised repair tasks are performed on the gearbox.

10 Removal and disposal

10.1 Safety

Improper dismantling

WARNING!

Danger of injury due to improper dismantling!

Stored residual energy, angular components, points and corners on the gearbox or on the necessary tools can cause injuries.

- Prior to starting work ensure that there is adequate free space.
- Proceed carefully when removing the gearbox.
- Ensure order and cleanliness at the workstation! Loosely stacked components or components and tools that are lying around can cause accidents.
- Properly remove the gearbox. Pay attention to the high dead weight of the gearbox. If necessary use hoists.
- Secure the gearbox parts so that they do not fall down or fall over.
- Consult with the manufacturer if there are questions.

10.2 Removal

1. Switch off the system and safeguard it from being switched on again.
2. Disconnect the connected components from the gearbox.
3. Drain oil or grease.

NOTICE!

Ensure that lubricants do not get into the environment.

4. Remove the gearbox.

If necessary use pull-off devices for flanges, bearings and pinions.

NOTICE!

Ensure that flange surfaces and shafts are not damaged.

5. Properly pack the gearbox, e.g. to send it back to the manufacturer, to avoid damage (due to breakup or water ingress, for example).

10.3 Disposal

If a return or disposal agreement has not been concluded, then recycle dismantled components:

- Scrap metals.
- Sort and dispose of all other components according to material condition.

NOTICE!

Hazards for the environment due to improper disposal!

Hazards for the environment can occur due to improper disposal of the gearbox.

– Have electrical scrap and electronic components, lubricants and other auxiliary materials disposed of by approved specialist companies.
– If in doubt obtain information on environmentally responsible disposal from local municipal authorities or specialised disposal companies.

NOTICE!

Hazards for the environment due to improper disposal!

Hazards for the environment can occur due to improper disposal of the oil.

– Properly dispose of the drained oil.
– If in doubt obtain information on environmentally responsible disposal from local municipal authorities or specialised disposal companies.
– If environmentally-harmful substances inadvertently get into the environment, immediately implement suitable measures. If in doubt inform the responsible municipal authorities of the damage and ask about suitable measures that should be implemented.

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