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competence

# High precision bearings for combined loads

Fitting and maintenance manual

**SCHAEFFLER GROUP**  
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With its forward-looking bearing arrangement solutions for feed spindles, main spindles, rotary tables and linear guidance units, Schaeffler KG has been at the forefront of the world market for decades. The bearing components alone, however, are often no longer the decisive factor for these machine subsystems.

Our customers have of course benefited directly from significant performance improvements and unique selling propositions thanks to our “ready-to-fit” products; these compact, ready-to-fit bearings are used in accordance with the simple principle: unpack, screw mount, use. In order to optimise the entire machine tool system, however, it is becoming ever more important not simply to support the subsystems but to integrate important functions such as measurement, sealing, lubrication, braking etc. in the components themselves. This intellectual approach is fulfilled comprehensively by the new concept **added competence** in the Production Machinery Sector since it attaches central importance to systems solution thinking for the bearing, bearing position and entire system. This means that you can now access a product range that gives optimum coverage to all your applications in the machine tool.

Since direct drives and mechatronic solutions are used ever more frequently in machine tools, we have incorporated a further strong partner in the form of IDAM – INA Drives & Mechatronics – in our spectrum of capabilities. In this way, we can now supply you from a single source with bearing elements and the appropriate drive system to give complete systems that are precisely matched to each other. This opens up completely new technical and economic design possibilities for your requirements as well as significant advantages in the time and process chain.

In terms of products, we offer you a comprehensive, precisely balanced range, precision technology and top product quality. In order to match the pulse of your developments as closely as possible, furthermore, we have a worldwide network of engineers, service and sales technicians working for you and ensuring that we maintain close contact with you in your own location.

In conclusion, we are convinced that we will always have the right product for your application. Just contact us to see what we can do for you.



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## High precision bearings for combined loads

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# High precision bearings for combined loads

This manual describes the fitting and maintenance of:

- axial/radial bearings YRT, RTC, YRT<sub>Speed</sub>
- axial angular contact ball bearings ZKLDF
- axial/radial bearings YRT  
with integral angular measuring system YRTM.

**Caution!** The content of this fitting and maintenance manual must be communicated to the end user.

The Schaeffler Group accepts no liability for loss or damage arising from:

- incorrect fitting
- incorrect or inadequate maintenance
- incorrect communication of the content to third parties or a failure to do so.

## Notes on the description of fitting procedures

**Caution!** The sequence of operations depends on the design of the adjacent construction. It is therefore not possible to provide a single description that includes all the fitting variants.

Since, in the majority of applications, the bearing inner ring is fitted on the shaft first and the bearing outer ring is then fixed in place, the fitting of the bearings is described on the basis of this fitting process.

If the adjacent construction is different, fit the bearing appropriately or contact us for advice.

## Preparations for fitting

Axial/radial bearings and axial angular contact ball bearings are precision machine elements. These high precision rolling bearings will only achieve their maximum operating life and functional capability if they are fitted correctly.

**Caution!** Before and during fitting, the bearings and measurement system must be handled with care and in accordance with this fitting and maintenance manual.

Bearings should only be fitted using the tools and fitting aids specified. If unsuitable or contaminated tools and fitting aids are used, this will seriously impair the function of the bearings and significantly reduce their operating life.

## Bearings with integral angular measuring system

### Caution!

The bearing should be fitted in accordance with this manual (TPI 103), the measuring system in accordance with MON 18.

Bearings YRTM have a magnetic dimensional scale on the outside diameter of the shaft locating washer. The dimensional scale has a protective strip. The protective strip should be removed as late as possible, preferably after screw mounting of the bearing.

Protect the dimensional scale against shock loads. Shock loads can lead to flaking of the electroplated carrier layer for the dimensional scale.

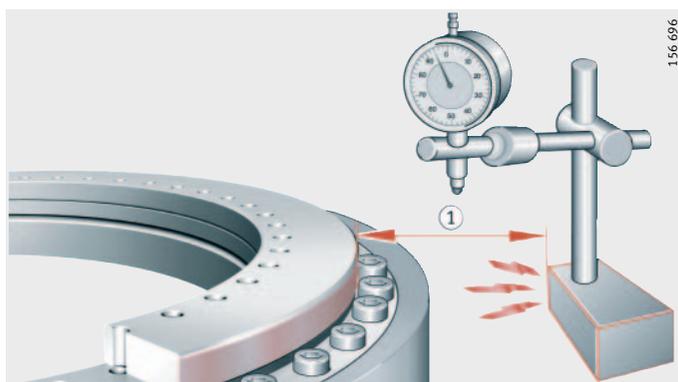
Keep the dimensional scale away from sources of magnetism. Magnetic fields will damage or erase the dimensional scale. This will lead to partial mismeasurement by the system. A field strength of approx. 70 mT or higher immediately on the coding carries the risk of damage to the magnetic increments.

Do not place magnetic dial gauge holders directly on the coded washer (guide value: at least 100 mm distance in air or 10 mm unalloyed steel), *Figure 1* and *Figure 2*.

Never touch the coding with magnetisable objects (e.g. knives, screwdrivers, screws, dial gauge feelers).

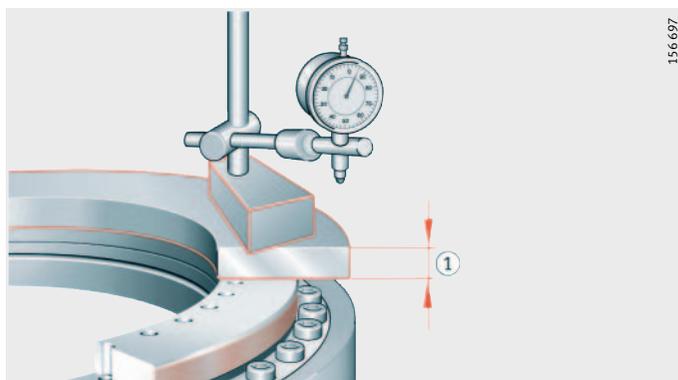
① Minimum distance > 100 mm

*Figure 1*  
Minimum distance between magnetic measurement stand and magnetic dimensional scale



① Shielding > 10 mm

*Figure 2*  
Shielding by unalloyed steel



# High precision bearings for combined loads

<b>Delivered condition of the bearings</b>	The bearings are wrapped in anti-corrosion paper and individually packed in plastic film; smaller sizes are also supplied in multiple packs.
<b>Initial greasing</b>	<p>The bearings are greased:</p> <ul style="list-style-type: none"><li>■ YRT, YRTM, YRT<sub>Speed</sub> with a lithium complex soap grease to DIN 51 825–KP2N–25</li><li>■ RTC with Arcanol L55</li><li>■ ZKLDF with a barium complex soap grease to DIN 51 825–KPE2K–30.</li></ul> <p>These greases are compatible with lubricants having a mineral oil base; for special versions see the bearing delivery drawing.</p>
<b>Caution!</b>	<p>The rotational resistance of the bearing is heavily dependent on the greasing. The frictional torque values given in the dimensional tables (TPI 120, Catalogue HR1 Rolling Bearings) are only valid for bearings with the original greasing.</p>
<b>Miscibility of greases</b>	<p>Greases may be mixed if:</p> <ul style="list-style-type: none"><li>■ they have the same base oil</li><li>■ they have matching thickener types</li><li>■ they have similar base oil viscosities – the difference must be no more than one ISO VG class</li><li>■ they have the same consistency (NLGI class).</li></ul> <p>If there is any doubt, please consult the lubricant manufacturer.</p>

## Bearing storage and shelf life

The shelf life of the bearings is limited by the storage life of the grease.

Experience shows that the greases used can be stored for up to 3 years under the following conditions:

- closed room or store
- dry, clean rooms with temperatures between 0 °C and +40 °C
- relative atmospheric humidity not exceeding 65%
- no exposure to chemical agents – vapours, gases or fluids.

After long storage periods, the frictional torque may temporarily be higher than that of freshly greased bearings. The lubricity of the grease may also have deteriorated.

## Compatibility and miscibility with anti-corrosion agents

The anti-corrosion agents in bearings with an oil-based preservative are compatible and miscible with lubricating oils having a mineral oil base. Compatibility must be checked if, for example, synthetic lubricants are to be used.

If there is an incompatibility, wash out the anti-corrosion oil before greasing if using:

- alkoxy fluoroether products
- products with a polyglycol oil base
- silicone oils

or if

- the lubricant is changed or
- the bearings are contaminated.

If in doubt, please contact the relevant lubricant manufacturer.

## Cleaning of bearings

In general, it is not necessary to remove the anti-corrosion agents from bearings coated with an oil-based preservative.

### Caution!

Use lint-free cloths for removing agents.

The cloth must only be used to clean the external surfaces of the bearing.

Cleaning can be carried out using:

- organic cleaning agents, such as paraffin oil free from water and acid, petroleum ether (not petrol) or freon 12 substitutes
- for hot cleaning, thin, clean oil.  
Use oil with a flash point of at least +250 °C and heat to approx. +120 °C. In addition to effective cleaning, this method also protects the bearings temporarily against corrosion.

### Caution!

Check the contaminant content of the cleaning baths – it should not exceed 0,1%.

Legal regulations (on environmental protection, health and safety at work, etc.) and the manufacturer's instructions (e.g. on handling) must be observed.

# High precision bearings for combined loads

## Removing bearings from packaging

Perspiration from handling leads to corrosion. Hands must be kept clean and dry; protective gloves should be worn if necessary.

Bearings should only be removed from their original packaging immediately before assembly. If the original packaging is damaged, the bearings must be checked. Clean any contaminated bearings.

## Bulk packaging

If bearings are removed from a batch packaged with dry preservative, close the package again immediately:

- the protective vapour phase can be maintained only in the closed package
- Ungreased bearings must be oiled or greased immediately after unpacking – for oils and greases, see page 4.

## Transport of bearings

Large bearings should only be stored lying flat and should be transported lying flat if possible, *Figure 3*. For vertical transport, the bore should always be braced in a crosswise arrangement.

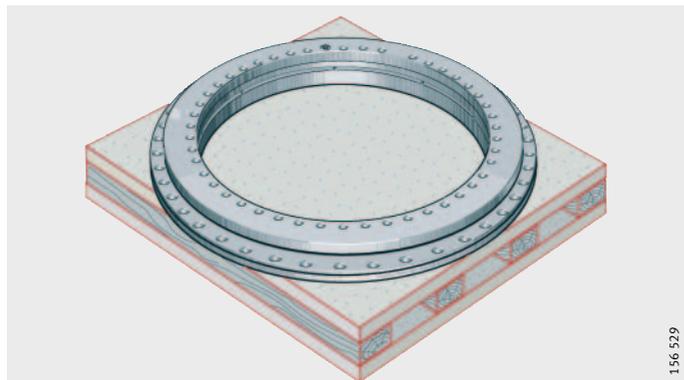
**Caution!** Do not store the bearings standing up.

Heavy bearings must only be transported using a hoist attached to the eye bolts or by means of textile slings, *Figure 4*.

**Caution!** Bearings must not be wrapped in a chain.

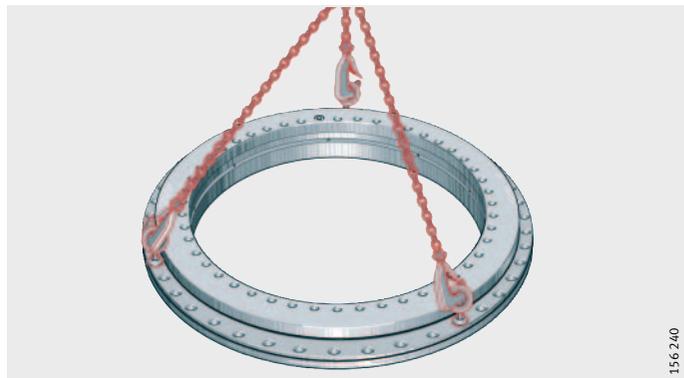
**Bearings should never be supported at one point only for lifting!**

*Figure 3*  
Storage lying flat



156 529

*Figure 4*  
Transport using hoist and eye bolts



156 240

## Design of the fitting area

### Caution!

The fitting area must be kept clean and free from dust, *Figure 5*. Contamination will impair the function and operating life of the bearings.

Hands must be kept clean and dry.

The bearings must be protected against moisture and aggressive media.

Keep the following away from the fitting area:

- swarf-producing tools such as files, emery paper, etc.
- lint-producing cleaning cloths, cleaning wool, etc.
- metal swarf, sand, sawdust, corrosive substances, etc.

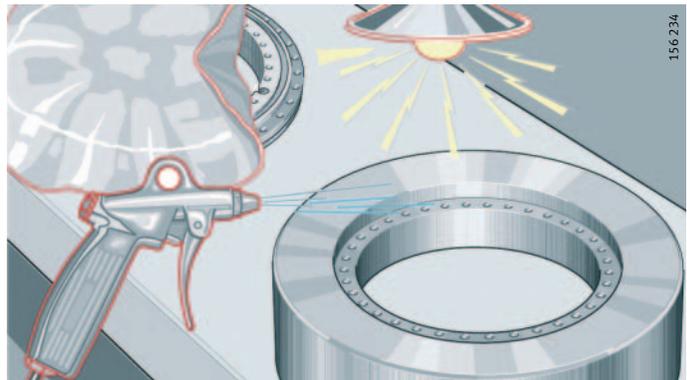
Ensure that work surfaces are bright, clean and free from fibres (e.g. plastic) and that lighting conditions are good.

Rolling bearings should be fitted in the workshop if possible.

If this is not possible:

- cover the machine
- protect the bearings against contamination from the surrounding area.

Bearings should only be unpacked immediately before fitting and must be protected against contamination.



*Figure 5*  
Design of fitting area

# High precision bearings for combined loads

## Bearing protection measures during fitting

**Caution!** If fitting the bearings is a very time-consuming process – for example with complex fitting processes – or fitting is interrupted, take appropriate measures to protect bearings against contamination and damage.  
Do not cover using cleaning wool or lint-forming cloths.

**Wrapping** The machine area can be completely covered using VCI paper or plastic sheeting.  
If this is not possible, cover the exposed bearing and shaft with a clean, lint-free cloth.

## Preparing the adjacent construction for fitting of the bearings

The locating surfaces for the bearing rings must be clean and free from burrs.

## Cleaning the adjacent construction

Suitable cleaning agents include petroleum, diesel oil, commercially available grease solvents (e.g. acetone, isopropanol).

**Caution!** The appropriate legal regulations relating to the use of cleaning agents (manufacturer's instructions and regulations covering health and safety at work, environmental protection, etc.) must be observed.

Cleaning agents must be disposed of correctly after use.

Cleaning:

- smooth the locating surfaces and burrs using an oil stone
- apply cleaning agents to the locating and bearing seating surfaces using a brush or suitable cloth
- clean and dry the surfaces.

**Caution!** Ensure that the adjacent components and lubrication holes are free from cleaning agents, solvents, washing emulsions and detaching particles.

If the adjacent construction and lubrication holes are not completely clean, the raceway system may become contaminated or the fit surfaces may rust.

## Selection of fasteners

Bearings must only be fixed using the screw types specified.

It is vital to follow the information:

- in the catalogue HR1, Rolling Bearings, see dimension tables
- in TPI 120, see dimension tables
- in the technical proposal.

**Caution!** The specifications relating to the fasteners must be observed. Any deviations will influence the effectiveness of the screw connection and the function – e.g. the frictional torque and the rigidity – as well as the life of the bearings.  
Use fixing screws of grade 10.9 to DIN 912 only – for other grades, please contact us.  
Ensure that the adjacent construction has adequate strength – VDI-Guideline 2 230.

## Checking the dimensional and geometrical tolerances of the screw mounting surfaces

The tolerances for the screw mounting surfaces on the adjacent construction must be within the stated values in accordance with TPI 120 and catalogue HR1, Rolling Bearings.

The measurement method depends on:

- the measuring equipment used
- the geometry of the adjacent components
- the requirements for running accuracy. In order to achieve the high measurement accuracy required, a measuring machine should be used if necessary.

### Inspection of the screw mounting surfaces

#### **Caution!**

The adjacent construction should be measured under the usual technical conditions (temperature in the region of the reference temperature +20 °C, no wide component temperature variations). The components should be allowed sufficient time to reach these temperatures where required (e.g. transport from cold environment to the hall).

The screw mounting surfaces of the adjacent construction must not exceed the permissible geometrical tolerances according to the diagram – see TPI 120 and catalogue HR1, Rolling Bearings.

# High precision bearings for combined loads

## Fitting Checking the dimensional and running accuracy of the bearings

**Caution!** To check the dimensional tolerances “D” and “d”, loosen the retaining screws used to secure the bearing during transport, *Figure 6*, page 11. The data supplied for the bearing diameter in TPI 120 and in catalogue HR1, Rolling Bearings, are mean values.

The running accuracy of the bearings can only be measured on a bearing that is already fitted, screw mounted and fully supported.

The full bearing running accuracy can only be transmitted to the complete assembly if there is a fit clearance  $< 0$  on the rotating bearing ring.

## Locating the bearing rings

### Caution!

Only apply fitting forces to the bearing ring that is to be fitted; i. e. when fitting the inner ring, direct forces only through the inner ring; when fitting the outer ring, direct forces only through the outer ring.

Fitting forces must never be directed through the rolling elements. Avoid direct blows on the bearing rings.

Bearing rings must be fitted without the use of external loads.

Bearing components must not be separated or interchanged during fitting and dismantling.

In order to facilitate fitting, the bearings can be heated.

Heating by between 10 K and 20 K is generally sufficient.

Allow the bearings to cool before tightening the screws.

## Locating the bearing inner ring

■ The seating surfaces for the bearing inner rings on the adjacent construction should be lightly oiled or rubbed with solid lubricant.

■ Loosen the retaining screws (2 or 3 depending on the bearing) so that the bearing rings on the shaft can centre themselves in relation to each other, *Figure 6*, ①.

If the two holes for the retaining screws are to be used for locating the bearing, unscrew the Hell-Coil threaded inserts (YRT, YRT<sub>Speed</sub>, YRTM, ZKLDF only).

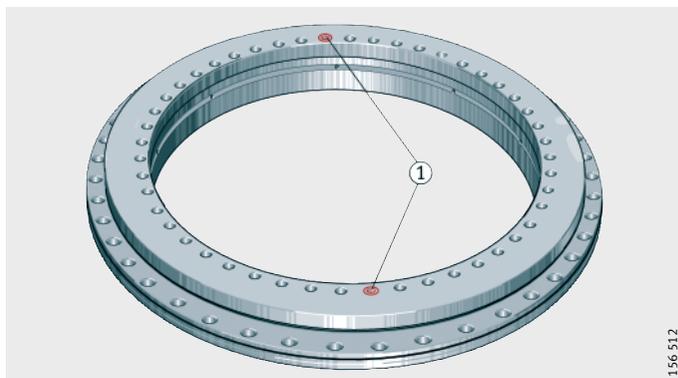
### Caution!

Once the retaining screws have been removed, the bearing arrangement is no longer self-retaining.

① Retaining screws

*Figure 6*

Loosening the retaining screws



■ Before the bearing is pushed into place, align the hole pattern in the bearing with the hole pattern in the adjacent construction. For example, threaded rods can be used.

■ Push the bearing onto the shaft, taking care not to tilt the bearing.

## High precision bearings for combined loads

- Insert the fixing screws in the holes and tighten finger tight. In axial angular contact ball bearings ZKLDF, rotate the unlocated bearing ring – this will centre the inner rings, *Figure 7*.
- Tighten the fixing screws in a crosswise sequence using a torque wrench in three stages to the specified tightening torque  $M_A$  – in the case of axial angular contact ball bearings ZKLDF, rotate the bearing ring, *Figure 8*:
  - Stage 1 40% of  $M_A$
  - Stage 2 70% of  $M_A$
  - Stage 3 100%  $M_A$ .

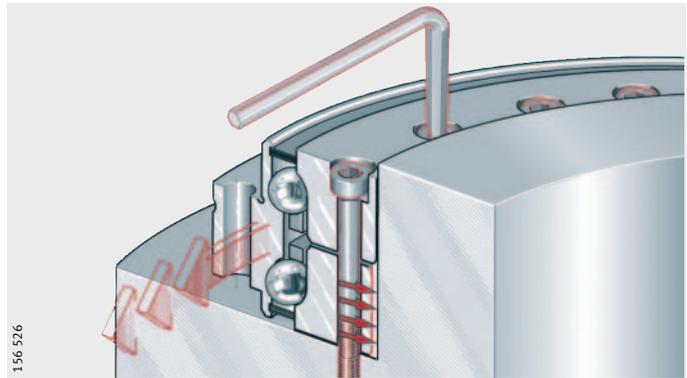
Tightening torques for fixing screws:  
see table Tightening torques  $M_A$ , page 14.

**Caution!** After fitting of the bearings, retighten or remove the retaining screws.

ZKLDF

*Figure 7*

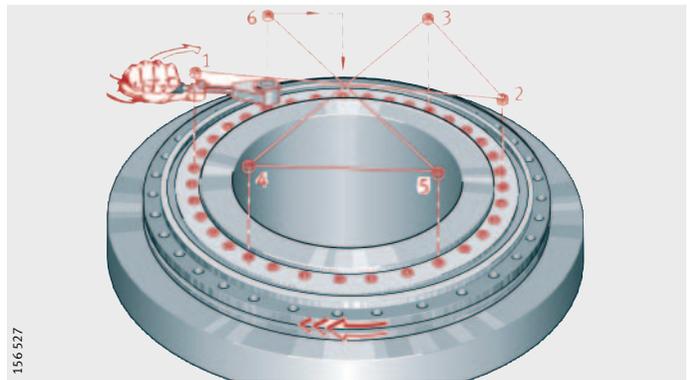
Rotating the unlocated bearing ring



ZKLDF

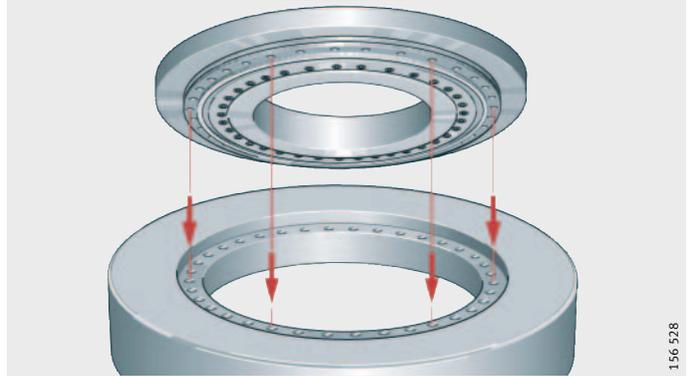
*Figure 8*

Locating the inner ring



### Locating the bearing outer ring

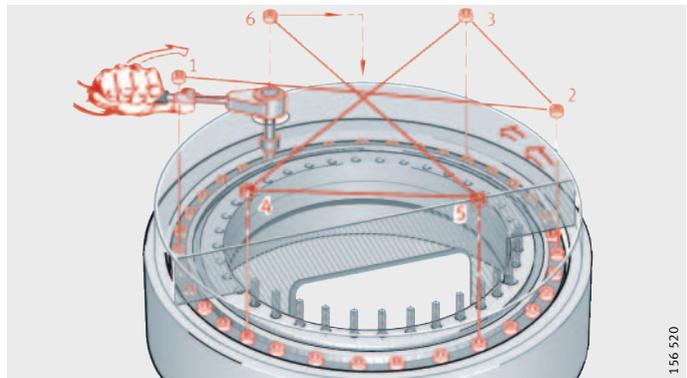
- The seating surface for the bearing outer ring in the housing should be lightly oiled or rubbed with solid lubricant.
- Fit the outer ring of the bearing/shaft assembly in the housing bore, *Figure 9*.



*Figure 9*  
Insert the outer ring into the housing bore

- Insert the fixing screws in the holes and tighten in a crosswise sequence using a torque wrench in three stages to the specified tightening torque  $M_A$ , *Figure 10*:
  - Stage 1 40% of  $M_A$
  - Stage 2 70% of  $M_A$
  - Stage 3 100%  $M_A$ .

Tightening torques for fixing screws:  
see table Tightening torques  $M_A$ , page 14.



*Figure 10*  
Locating the outer ring

### Caution!

All the fixing screw holes must be used.

If a smaller number of fixing screws is used, this will reduce the load carrying capacity of the screw connections as well as the running accuracy and rigidity of the bearing.

The rigidity values in the dimension tables of TPI 120 and in the catalogue HR1, Rolling Bearings, are only valid if all the fixing holes are used.

In order to prevent unacceptable variations between the screw tensioning forces, adhere exactly to the fixing sequence (tighten the screws in a crosswise sequence).

## High precision bearings for combined loads

### Tightening torques for fixing screws

Tightening torques  $M_A$  –  
axial-radial bearings YRT, YRTM,  
RTC, YRT<sub>Speed</sub>, ZKLDF

Bearing bore diameter mm	Fixing screw	Tightening torque $M_A$ <sup>1)</sup> Nm		
		Stage 1	Stage 2	Stage 3
		40% of $M_A$	70% of $M_A$	$M_A$
<b>50</b>	M5	3	6	8,5
<b>80</b>	M4	2	3	4,5
	M5	3	6	8,5
<b>100</b>	M5	3	6	8,5
<b>120</b>	M6	6	10	14
<b>150</b>	M6	6	10	14
<b>180</b>	M6	6	10	14
<b>200</b>	M6	6	10	14
<b>260</b>	M8	14	24	34
<b>325</b>	M8	14	24	34
<b>395</b>	M8	14	24	34
<b>460</b>	M8	14	24	34
<b>580</b>	M10	27	48	68
<b>650</b>	M12	46	81	116
<b>850</b>	M16	114	199	284
<b>950</b>	M16	114	199	284
<b>1030</b>	M16	114	199	284

<sup>1)</sup> Tightening torque  $M_A$  for fixing screws to DIN 912, grade 10.9.

## Checking the function

### Bearing frictional torque (rotational resistance)

When the fixing screws are tightened as specified, the bearing must rotate evenly.

Bearing frictional torques: see TPI 120 or catalogue HR1, Rolling Bearings, dimension tables and section Frictional torque.

**Caution!** The bearing frictional torque should only be measured on a bearing that is fitted, screw mounted and fully supported.

The rotational resistance is also influenced by:

- operating loads
- the screw tightening torque
- the geometrical accuracy of the fit and screw mounting surfaces
- the fit
- the temperature difference between the inner ring and outer ring
- the operating temperature
- the lubricant used
- the quantity of grease.

If the bearing is unusually difficult to move, loosen the fixing screws and tighten them again in steps in a crosswise sequence. This will relieve any distortion.

Functional inspection of the measuring system:  
Fitting Manual MON 18.

## Running accuracy

**Caution!** The running accuracy can only be checked once the bearing is fitted. Check the running accuracy using a dial gauge.

Incorrect running accuracy may be due to:

- inaccuracies in the adjacent construction that are then transmitted to the raceway system
- eccentric mounting of the bearing with a fit clearance
- fixing screws that are not tightened as specified
- retaining screws that were not loosened before the rings were mounted.

# High precision bearings for combined loads

## Safety checks

### Checking the fixing screws

The fixing screws must be checked regularly, especially in the following circumstances:

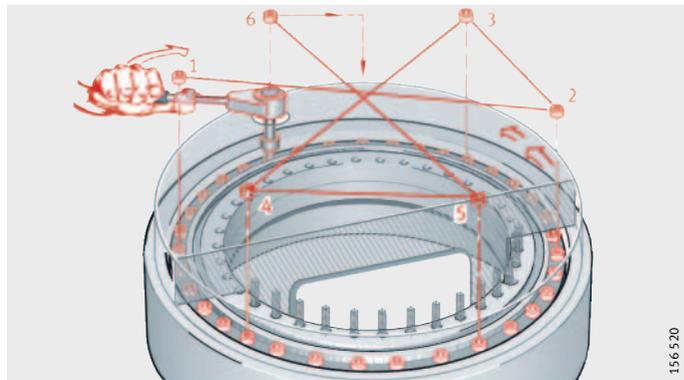
- high tilting moment load
- continuous and alternating axial load.

**Caution!** In order to compensate for settling effects, check the tightening torque  $M_A$  of the fixing screws after initial operation of the bearing and, if there is any deviation, tighten to the specified value, *Figure 11*.

Check the tightening torques  $M_A$  of the fixing screws within the framework of the machine service intervals and, if necessary, correct to the specified value.

Failure to follow these instructions can lead to personal injury or damage to property.

If the bearing is replaced, new fixing screws must always be used.



*Figure 11*

Checking the tightening torques  
of the fixing screws

156 520

## Lubrication

### Relubrication of bearings

If possible, the grease used should be the same as the grease with which the bearing was supplied (Initial greasing, page 4 and table Grease Application Group GA08, page 18).

#### Caution!

Relubrication should be carried out with the bearing warm from operation and rotating slowly.

Before relubrication is carried out, it must be ensured that the feed ducts in the adjacent construction do not contain any cleaning agents, solvents, washing emulsions or other contaminants.

### Lubricating the raceway

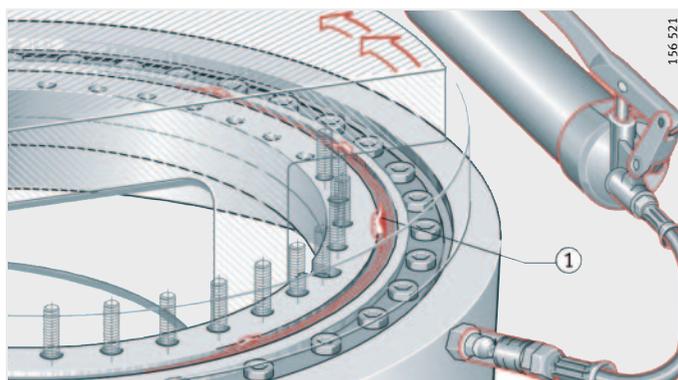
Bearings YRT(M), RTC and YRT<sub>Speed</sub> can be lubricated via the outer ring and inner ring, bearings ZKLDF via the outer ring only.

- Clean the lubrication nipples, clean or replace the lubricant filters.
- Inject grease into all the lubrication nipples until the relubrication quantity is reached, *Figure 12*
  - Rotate one bearing ring (in the direction of the arrow) during this process and ensure that old grease can exit the bearing without hindrance, *Figure 12*.

① Old grease

*Figure 12*

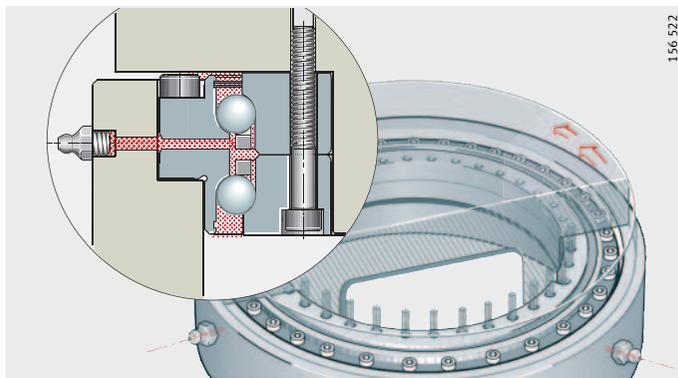
Lubricating the bearing



Before initial operation, it must be ensured that all the lubricant ducts to the bearing are filled with lubricant, *Figure 13*.

*Figure 13*

Filled lubricant ducts



# High precision bearings for combined loads

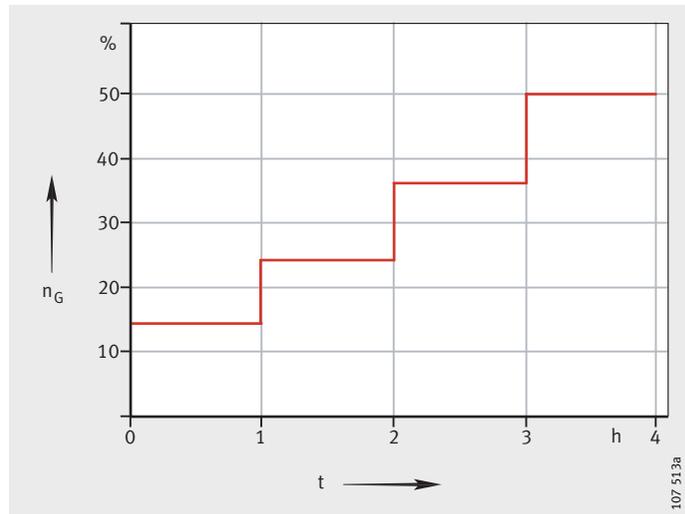
## Overlubrication

If the bearing is overlubricated, the bearing frictional torque and the temperature will increase. In order to achieve the original frictional torque again, a new running-in cycle should be carried out, *Figure 14*.

$n_G$  = limiting speed  
 $t$  = time  
 $h$  = hours

*Figure 14*

Running-in cycle after overlubrication



## Greases for relubrication

### Grease Application Group GA08

The grease GA08 stated in the table is suitable.

Designation	Classification	Type of grease	Operating temperature range °C	NLGI class	Speed parameter $n \cdot d_M$ $\text{min}^{-1} \cdot \text{mm}$	ISO VG class (base oil) <sup>1)</sup>
GA08	Grease for line contact	Lithium complex soap, mineral oil	-30 to +140	2 to 3	500 000	150 to 320

<sup>1)</sup> Dependent on bearing type.

## Relubrication intervals

Relubrication intervals and quantities can be calculated by specifying the load spectrum (speed, load, operating duration) and environmental conditions (temperature, contamination, dust, water etc.). Please ask us about this.

**Caution!** Bearings should always be relubricated before and after extended breaks in operation, under high moisture levels and within the specified lubrication intervals – observe the data in the assembly drawing.

For the following applications, please contact us:

- if the bearings are stationary
- with vibration
- with very small oscillating movements.

**Caution!** Further information on operating temperature and miscibility of lubricants: see catalogue HR1, Rolling Bearings, and TPI 120.

**Further information  
on high precision bearings**

Catalogue HR1, Rolling Bearings and TPI 120 give comprehensive information on high precision bearings for combined loads.

These cover the significant questions on calculation and design of bearing arrangements with these bearings.

All the available bearings are described in the dimension tables.

For questions on fitting and maintenance as well as advice on the selection and application of high precision bearings, our skilled application engineers and engineering service are available to assist you.

**Hotline** Telephone +49 9132 82-7300

E-mail [RT-INFO@schaeffler.com](mailto:RT-INFO@schaeffler.com)

**Publication request** Catalogue HR1, TPI 120, TPI 103 and MON 18 can be obtained by contacting us:

mailto: [kataloge.schaeffler@pvs-ff.com](mailto:kataloge.schaeffler@pvs-ff.com)

download <http://medien.schaeffler.de>



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TPI 103 GB-D