RIGIA Precision Slewing Bearings Fittings

Permissible flatness and perpendicularity deviation of the adjacent construction

The screw mounting surfaces of the adjacent construction must fulfil the following requirements:

- the flatness deviation must not exceed the permissible value δ_B (Figure 4)
- the perpendicularity deviation must not exceed the permissible value δ_W (Figure 5).

Permissible flatness deviation

The flatness deviation δ_B applies in the circumferential ① and transverse direction ② (Figure 4):

- in the circumferential direction, it can only be reached once in a sector of 180°. The permissible curve is similar to a slowly rising or slowly falling sine curve.

The permissible flatness deviation for four point contact bearings of a standard design (i.e. with internal clearance) is determined using this formula:

$$\delta_B = \frac{D_M + 500}{10\,000}$$

The following formula is valid for:

- through hardened bearings
- preloaded four point contact bearings
- crossed roller bearings.

$$\delta_B = \frac{D_M + 1\,000}{20\,000}$$

δ_B mm
Maximum permissible flatness deviation

D_M mm
Rolling element pitch circle diameter.

Permissible perpendicularity deviation

The perpendicularity deviation δ_W applies in the transverse direction ① (Figure 5):

- relative to a flange width of 100 mm, the perpendicularity deviation δ_W must not exceed half the permissible flatness deviation δ_B ($\delta_W \leqq 0{,}5\ \delta_B$). For other flange widths, the permissible deviation can be converted proportionally.

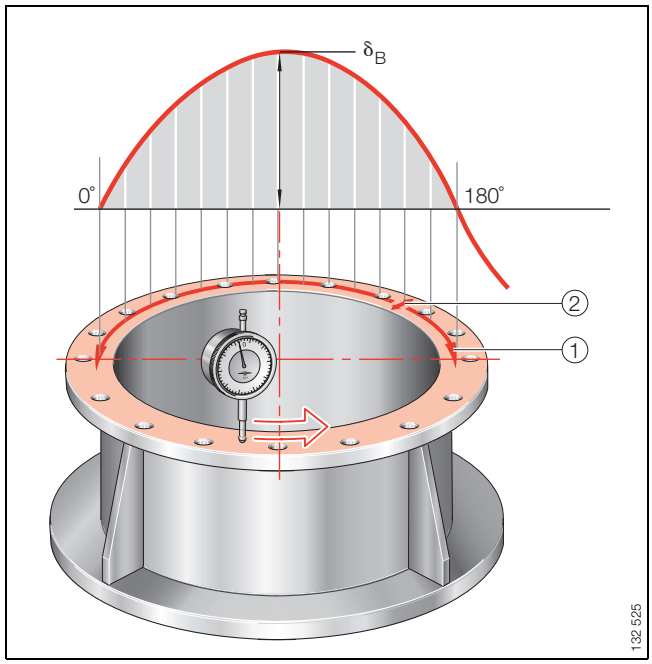


Figure 4 · Permissible flatness deviation

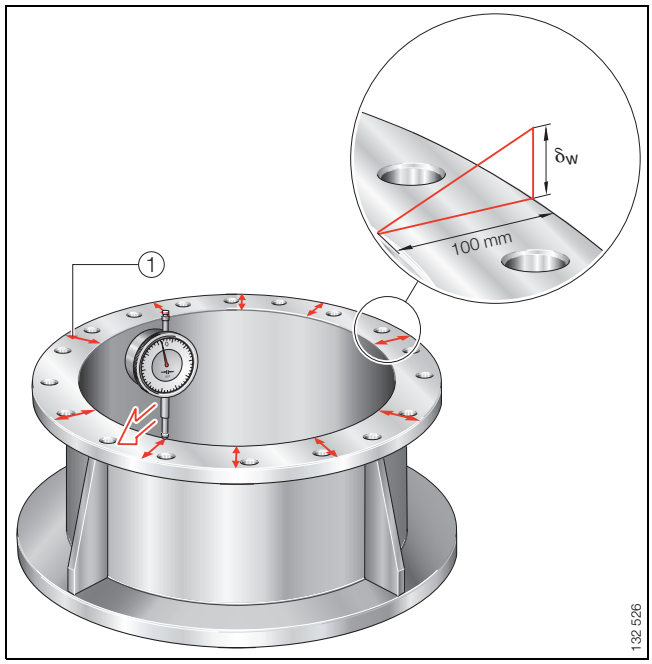


Figure 5 · Permissible perpendicularity deviation

Fitting

Slewing rings must be handled with care before and during assembly. Their function and operating life are also dependent on the care taken in fitting.

Design of the assembly area

⚠ Machines, equipment, etc. that produce swarf or generate dust must not be used in the immediate vicinity of the assembly area.

The bearings must be protected against dust, contamination, swarf, moisture, adhesives, etc. Contamination will impair the function and operating life of the bearings.

Bearings should be fitted in a workshop if possible. If this is not possible, the fitting position and bearing should be protected against contaminant from the environment.

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

Preparing the adjacent construction for fitting of the bearings

The bores and edges of the adjacent components must be free from burrs:

- any burrs present must be removed using an oilstone (Figure 1).

The support surfaces for the bearing rings must be clean.

Cleaning (Figure 1):

- apply cleaning agents using a brush or a suitable, lint-free cloth.
- remove any foreign matter and dry the surfaces.

⚠ Ensure that all adjacent components and lubrication ducts are free from cleaning agents, solvents and washing emulsions. The bearing seating surfaces can rust or the raceway system can become contaminated.

Checking the seating and screw mounting surfaces for the bearing on the adjacent construction

- Check the surface quality and the geometrical accuracy of the screw mounting surfaces in accordance with the section *Design of bearing arrangements* or the assembly drawing.
- Check the flange thickness s, the pot height H_T and the pot wall thickness t in accordance with the section *Design of bearing arrangements* or the assembly drawing (Figure 2).
- Check the flatness and perpendicularity deviation of the adjacent construction in accordance with the section *Design of bearing arrangements* or the assembly drawing (page 38).

⚠ Do not exceed the permissible deviations.

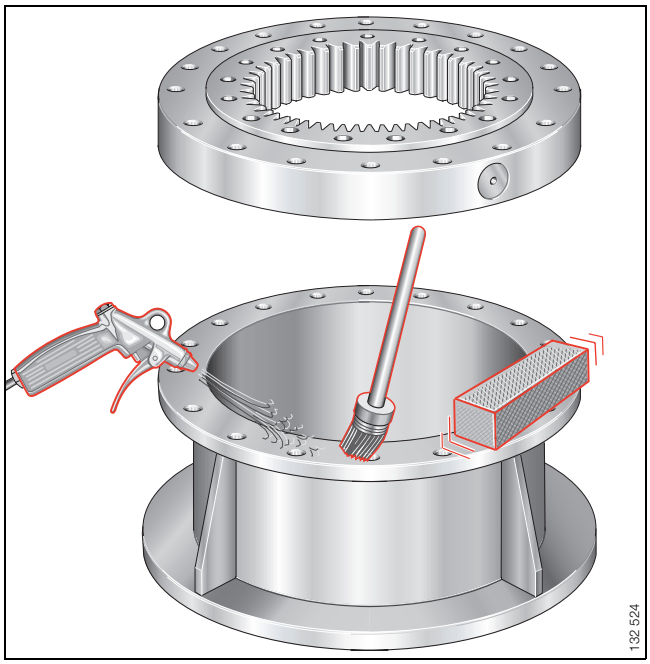


Figure 1 · Preparing the adjacent construction

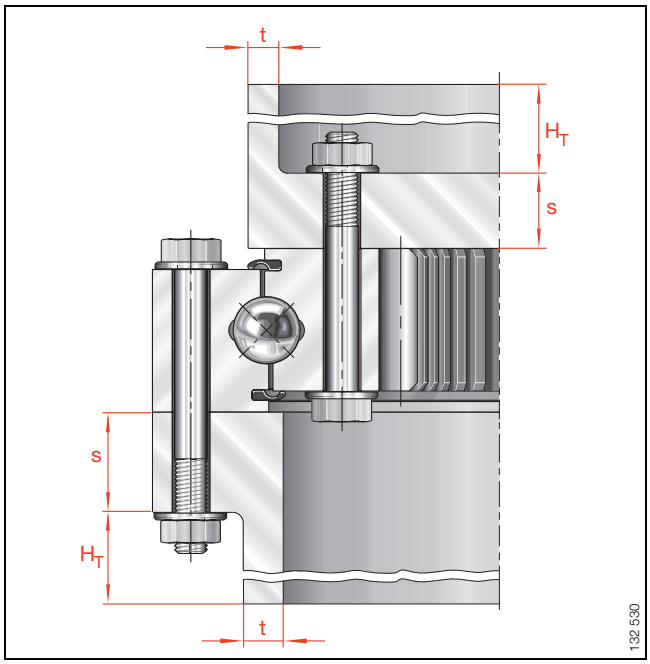


Figure 2 · Flange thickness s, pot height H_T and pot wall thickness t

Storage and storage life of slewing rings

⚠ Bearings should only be stored lying down, never standing up (Figure 3).

The storage life of the bearings is limited by the storage life of the grease. Experience shows that the greases with a mineral oil base used can be stored for up to 3 years if the following preconditions are met:

- closed storage room
- dry, clean rooms with temperatures between 0 °C and +40 °C
- relative atmospheric humidity not more than 65%
- no influence by chemical agents such as
  – vapours, gases, 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.

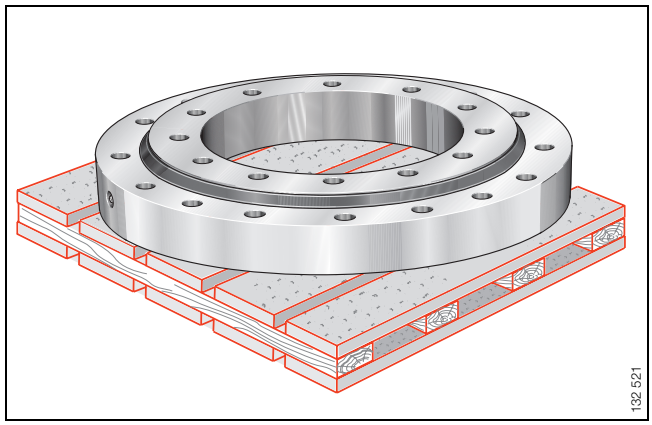


Figure 3 · Storage of slewing rings

Delivered condition of slewing rings

INA slewing rings are:

- greased with a lithium complex soap grease KP2N–20 to DIN 51825
- dry preserved using VCI paper.

Unpacking and transporting slewing rings

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

Bearings should not be removed from their original packaging until immediately before assembly. If the original packaging is damaged, check the condition of the bearing.

Large bearings should only be transported lying down if possible.

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

⚠ Bearings must not be wrapped in a chain.

Bearings should never be supported at one point only for lifting.

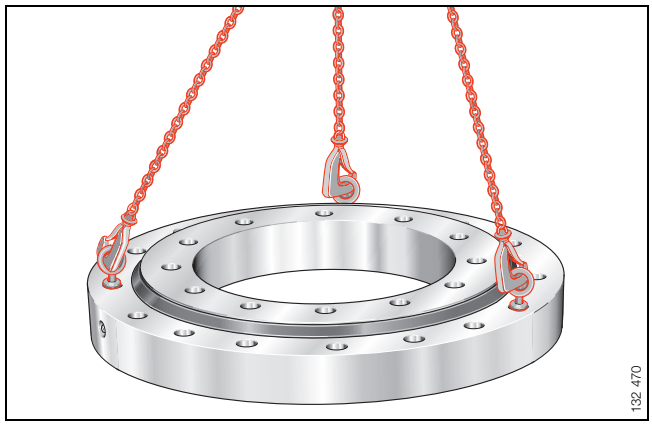


Figure 4 · Transport of bearings

Cleaning of slewing rings

Any anti-corrosion coatings must be removed from the support and contact surfaces of the bearing rings before the slewing ring is fitted. Suitable cleaning agents include:

- petroleum, diesel oil, commercially available grease solvents (e.g. acetone, isopropanol).

⚠ 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:

⚠ Cleaning agents must not be allowed to penetrate the raceway system of the slewing ring.

In slewing rings with gear teeth, the narrowest point of the tooth set is marked in green at the tooth tip ① (Figure 5). This marking must not be removed since the tooth flank backlash ② is set at this point.

- apply cleaning agents using a brush or a suitable, lint-free cloth.
- remove any foreign matter and dry the surfaces.

Hardness gap on slewing rings

For the fitting of slewing rings, not only the marking on the tooth tip but also the so-called hardness gap is important.

The hardness gap is the point between the start and end of the raceway hardening. This point is indicated by (Figure 6):

- the indented INA logo ①
- the closing plug ②.

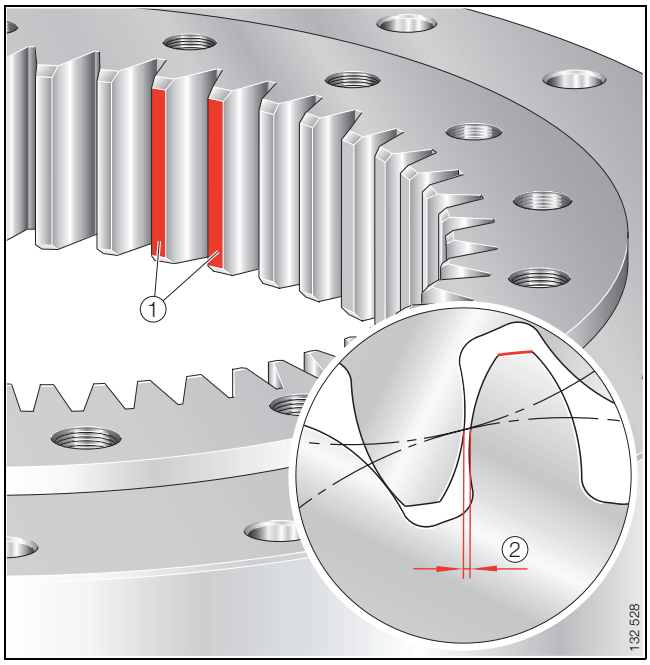


Figure 5 · Narrowest point of tooth set

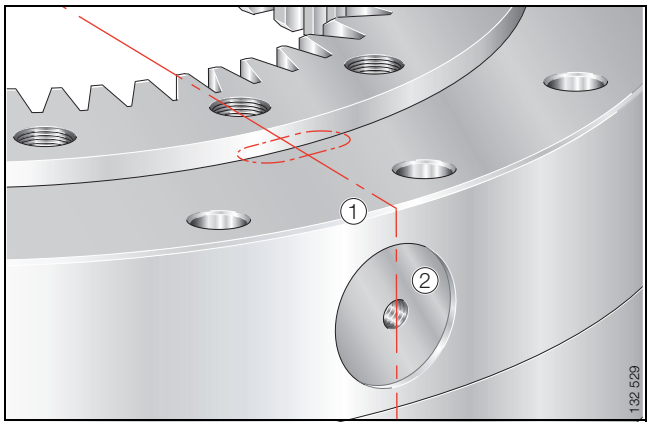


Figure 6 · Hardness gap

Provision of fasteners

⚠ The specifications relating to the fasteners must be observed.

Any deviations will influence:

– the effectiveness of the screw connection
– the function – e.g. the accuracy and rigidity – as well as the operating life of the bearings.

Fixing screws

Bearings must only be fixed using the screw types specified. It is essential that the information in the following sources is followed:

- this catalogue
- the technical proposal
- the customer's assembly drawing.

The sizes, quantity and grades of the screws are given in the *dimension tables* or in the assembly drawing.

Permissible contact pressure

The permissible contact pressure under the screw heads and nuts given in Table 1 must not be exceeded. If the contact pressure is higher, quenched and tempered washers must be used under the nuts.

If screws of grade 12.9 are used, it is essential that quenched and tempered washers are always used.

Table 1 · Permissible contact pressure for bearing rings and adjacent construction

Permissible contact pressure for bearing rings made from	Contact pressure N/mm^2	Permissible contact pressure for adjacent construction made from	Contact pressure N/mm^2
normalised steel C45N or 42CrMo4V65	500	St37	260
quenched and tempered steel 42CrMo4V	850	St52	420

Securing of screws

Normally, the screws are adequately secured by the correct preload. If regular shock loads or vibrations occur, however, it may be necessary to provide additional means of securing the screws.

⚠ Not every method of securing screws is suitable for slewing rings.

Never use spring washers or split washers.

General information on the securing of screws is given in DIN 25 201, and securing by means of adhesive in particular is described in DIN 25 203, issued in 1992.

If these are to be used, please consult the relevant manufacturers.

General safety and operating guidelines

⚠ Assembly forces must only be applied to the bearing ring to be fitted; they must never be directed through the rolling elements or seals. Avoid direct blows on the bearing rings.

Bearing rings should be located consecutively and without external load.

Bearings must not be heated using a naked flame. In this case, the material undergoes excessive localised heating, which will reduce its hardness. Furthermore, stresses will be induced in the bearing.

Do not cool the bearings excessively. The formation of condensation can lead to corrosion in the bearings and on the bearing seating surfaces.

Sequence of operations

The sequence depends on the design of the adjacent construction. The description of fitting is based on applications that have proved successful in practice.

If the adjacent construction is different, fit the bearing appropriately or consult INA.

Lightly oil or grease the bearing seating and locating surfaces for the bearing rings on the adjacent construction.

⚠ Lightly oil the thread of the fixing screws in order to prevent varying friction factors (do not oil or grease screws that will be secured by means of adhesive).

Positioning of slewing rings (Figure 7)

- Place the slewing ring ① on the screw mounting surface of the adjacent construction ②.
- Position the hardness gap (see *Hardness gap on slewing rings*, page 41) such that the bearing ring subjected to point load is offset at 90° to the zone under maximum load.
- Check ③ that the bearing ring to be fitted is in contact with the adjacent construction over its whole width.

Location of slewing rings (Figure 8)

Bearing rings should be located consecutively and without external load:

- in the case of bearings without gear teeth, first fit the bearing ring subjected to point load
- in the case of bearings with gear teeth, first fit the ring without gear teeth.

Location:

- insert the fixing screws ① – with washers if necessary – in the bearing ring to be fitted and tighten in steps to the specified tightening torque M_A according to Table 3, page 46 ②
  - during this process, rotate the unlocated bearing ring ③ several times by a distance corresponding to several screw pitches
  - tighten the screws in a crosswise sequence in order to prevent unacceptable fluctuations in the screw tensioning forces
- screw mount the unlocated bearing ring in the same way as the adjacent construction.
- check the function of the bearing (see *Checking the function*, page 45).

Hydraulic clamping device

If a hydraulic clamping device is used, the clamping forces for the preload must not exceed 90% of the proof stress of the screws

- if hydraulic clamping devices are used, please consult INA on fitting preload forces.

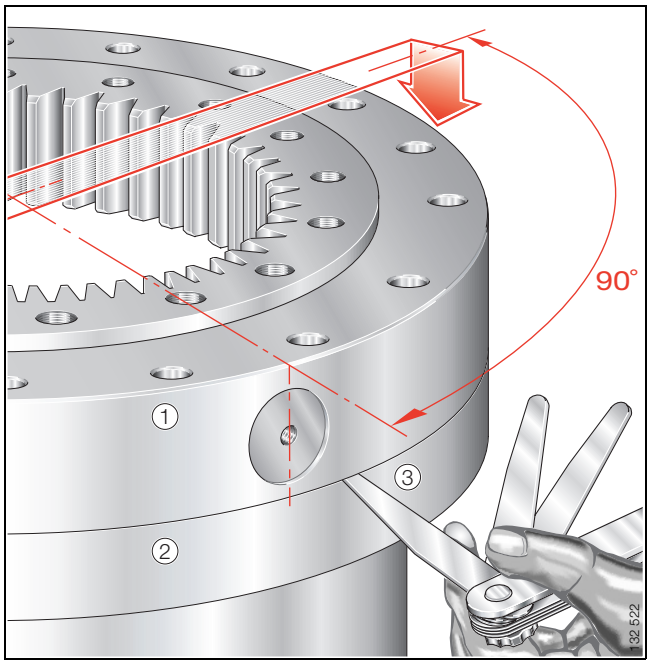


Figure 7 · Positioning of slewing rings

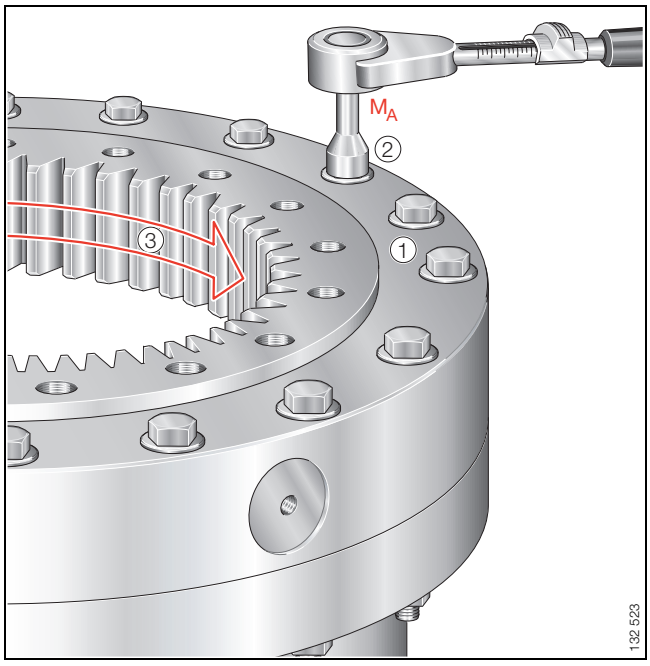


Figure 8 · Screw mounting of slewing rings to the adjacent construction

Checking and adjustment of tooth flank backlash

In the case of slewing rings with gear teeth, the flank backlash of the gear teeth must be checked and if necessary adjusted after the bearing rings have been screw mounted to the adjacent construction.

Checking (Figure 9):

- determine the flank backlash at the point marked in green on the tooth tip ① – e. g. using a feeler gauge
- adjust the backlash to the nominal value of 0,03 to 0,04×modulus
  - this is the standard flank backlash j_n in accordance with DIN 868 and DIN 3960.

Measuring the tilting clearance

The tilting clearance $\delta_{S\ tilt}$ increases during operation. In order to allow the increase to be calculated, the tilting clearance of the fitted bearing must be determined before it is first put into operation.

The tilting clearance $\delta_{S\ tilt}$ consists of:

- the tilting clearance of the bearing when new
- the elastic deformations in the bearing and the adjacent construction
  - mark the measurement point in the main load direction for subsequent checking by measurement ①.
  - note the measured value (see *TPI 13*).

The measurement point is located between the lower adjacent construction and the bearing ring screw mounted to the upper construction (Figure 10).

The maximum permissible increase in the tilting clearance is shown in Table 2.

Table 2 · Maximum permissible increase in tilting clearance

Bearing type	Maximum permissible increase in tilting clearance δ_{Stilt} mm
Four point contact bearings	$0{,}035 \cdot D_W$[1)] + 0,6
Crossed roller bearings	$0{,}017 \cdot D_W$[1)] – 0,024

[1)] D_W is the rolling element diameter in mm.

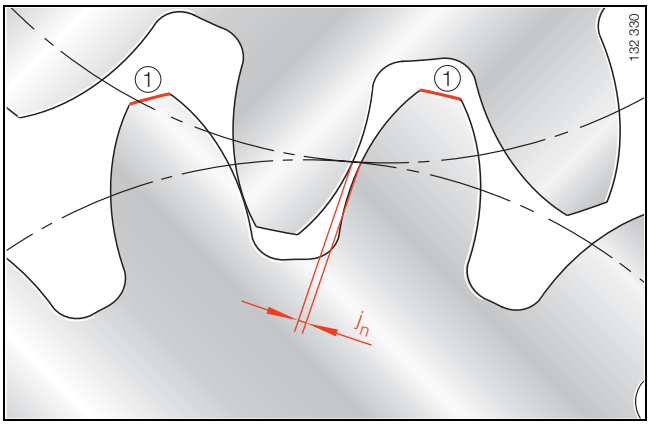


Figure 9 · Checking and adjusting the tooth flank backlash j_n

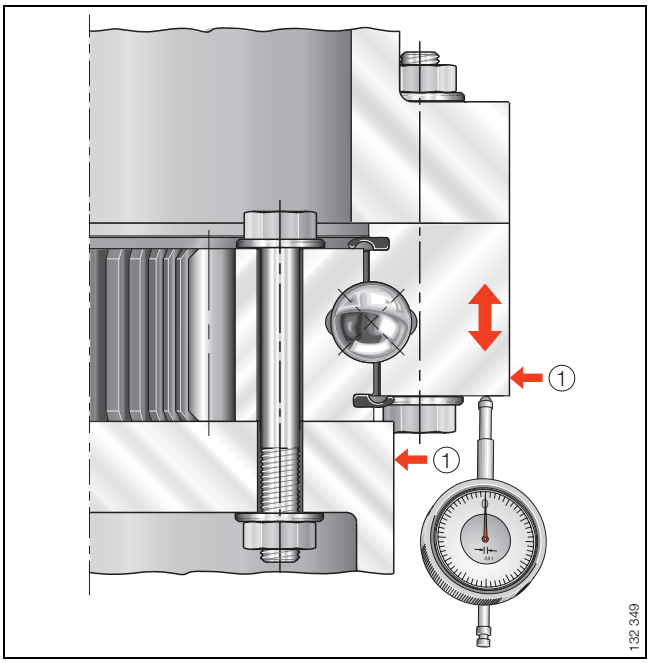
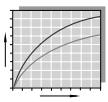


Figure 10 · Measuring the tilting clearance of a fitted bearing



Once assembly is complete, the operation of the fitted slewing ring must be checked.

⚠ If the bearing runs irregularly or roughly, or the temperature in the bearing shows an unusual increase, dismantle and check the bearing and reassemble the bearing in accordance with the fitting guidelines in this catalogue or *INA Technical Product Information TPI 13*.

Rotational resistance

The rotational resistance is essentially determined by (see also *Rotational resistance*, page 22):

- the rolling resistance of the rolling elements
- the internal clearance or bearing preload
- the friction of the spacers
- the friction of the seals
- the grease
- a deformed or defective adjacent construction
- errors in fitting of the bearings.

⚠ Due to the preload in the raceway system, the rotational resistance is higher than in a bearing with clearance.

At higher speeds, a high preload can lead to generation of significant heat in the bearing; if necessary tests must be carried out with bearings preloaded to various values.

Bearing temperature

After initial operation, the temperature in the bearing can increase – in the case of grease lubrication, for example, until the grease is evenly distributed in the bearing arrangement.

A further increase or unusually high temperatures may be caused by one of the following:

- the bearing is lubricated using an unsuitable grease
- there is excessive lubricant in the bearing
- the load on the bearing is excessively high
- the bearings are fitted unevenly
- the adjacent construction deviates from the specifications.

Safety checks

⚠ After each period of 500 hours of operation, but at least every six months, check and if necessary correct or replace:

– the condition and tightening torque of the fixing screws
– the tilting clearance.

A failure to follow these instructions can lead to considerable personal injury or damage to property.

The procedure and scope of the safety checks is described in detail in *INA Technical Product Information TPI 13*. This TPI is supplied with slewing rings and can also be requested from INA.

Fitting

Tightening torques and fitting preload forces for fixing screws

Table 3 · Tightening torques M_A and fitting preload forces F_M for the torque-controlled tightening of fixing screws (set screws)

Fixing screw Dimensions	Tightening torque M_A[1] in Nm Grade			Fitting preload F_M[2] in kN Grade		
	8.8	10.9	12.9	8.8	10.9	12.9
M 5	4,9	7	7,6	7	10	11
M 6	7,5	11,7	13,3	9	14	16
M 8	18,9	27,8	32,2	17	25	29
M10	37,5	55,6	63,9	27	40	46
M12	66,7	98,4	111,8	40	59	67
M14	107	155,7	179	55	80	92
M16	166,8	246,9	282,4	75	111	127
M18	230,2	337,8	387,8	92	135	155
M20	328	480,9	553,2	118	173	199
M22	449,5	660,5	758,4	147	216	248
M24	567,1	830,7	954,1	170	249	286
M27	836,9	1227,2	1411,1	223	327	376
M30	1130,1	1663,8	1909,9	271	399	458

1) M_A according to VDI Guideline 2230 (July 1986) for $\mu_K = 0{,}08$ and $\mu_G = 0{,}12$.

2) F_M according to VDI Guideline 2230 (July 1986) for $\mu_G = 0{,}12$.

Table 4 · Fitting preload forces F_M[1] for the use of hydraulic clamping devices (set screws)

Fixing screw Dimensions	Clamping cross-section A_S[2] mm²	Core cross-section A_{d3}[2] mm²	Fitting preload F_M[1] for grade		
			8.8 kN	10.9 kN	12.9 kN
M16	157	144,1	90	133,2	155,7
M18	193	175,1	114,3	162,9	190,8
M20	245	225,2	145,8	207	243
M22	303	281,5	180	256,5	301,5
M24	353	324,3	209,7	297	351
M27	459	427,1	274,5	387	450
M30	561	519	333	477	558

1) $F_M = 0{,}9 \cdot F_{0,2}$.

2) A_S and A_{d3} and $F_{0,2}$ according to VDI Guideline 2230.