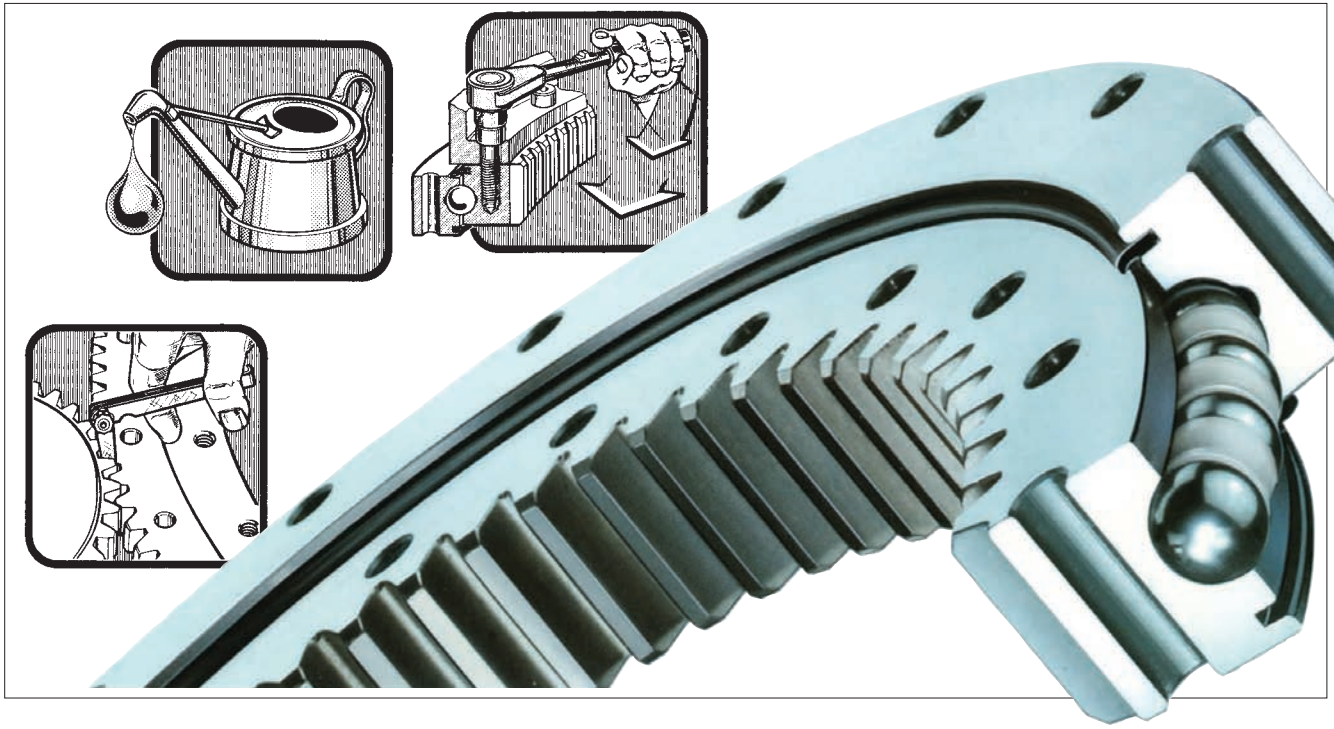


Slewing rings

Fitting and maintenance instructions

Technical Product Information TPI 13

TPI 13

Slewing rings

Fitting and maintenance instructions

INA slewing rings offer a very high safety factor and long operating life.
However, in order to ensure correct function and operational safety, these bearings must be correctly installed and maintained.

This book of instructions describes the
- fitting and
- maintenance

of the INA slewing rings shown in the catalogue 404.

It replaces previous editions of the Technical Product Information TPI 13. All data in previous editions which does not concur with data in this edition are therefore now invalid.

These instructions are to be included with the product or the contents passed on to the final user in writing. All work is to be carried out by suitably trained personnel.

INA does not accept any liability for damage caused by:
- incorrect fitting
- incorrect maintenance or
- omitting to pass on or passing on incorrectly the content of this book to a third party.

Schaeffler Technologies AG & Co. KG

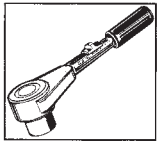
Meaning of symbols

The symbols used in these fitting and maintenance instructions have the following meaning:

⚠	Information which is preceded by this warning sign must be followed exactly. If this information is not taken into consideration, this can lead to danger to: – personnel – the bearings or – the installation or equipment.

► Work steps are indicated by a triangle.
These work steps must be carried out in the sequence indicated.

Note Supplementary or explanatory information on fitting or maintenance is given under this heading in each section.



Tools, equipment and lubricants required for fitting or maintenance are shown as pictograms: these are arranged above the relevant figure.

Contents

Fitting

Preparation for fitting

Cleaning the supporting structure and the slewing ring

The supporting structure for the bearing rings of the slewing ring must be clean. Remove the corrosion protection coating from the slewing ring.

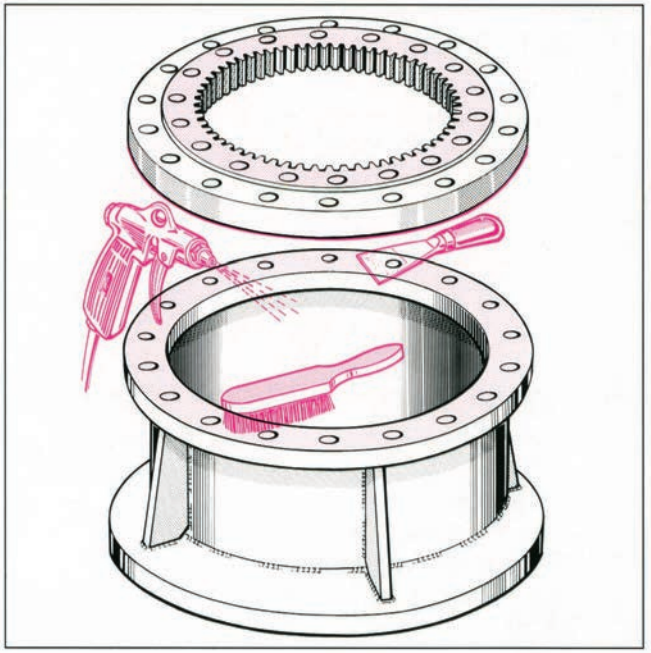
⚠
- Under no circumstances must the cleaning media be allowed to enter the slewing ring raceway system.
- Note the relevant information on using cleaning media (manufacturers' specifications, health and safety instructions, environmental protection etc.)
- Dispose of used cleaning media properly.

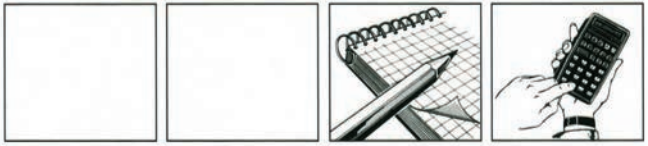
Suitable cleaning media:

– benzine, diesel oil, commercial grease-free solutions.

Cleaning

- ► Brush on cleaning medium.
- ► Remove foreign matter from the supporting structure (including solid paint residue or welding beads).
- ► Wash corrosion protection coating off the slewing ring; dry the mounting surface/bearing.
- ► Wipe bearings with oil preservative with a lint-free cloth.





Calculating and checking the flatness deviation of the supporting structure

The flatness of the mounting surfaces on the supporting structure must not exceed the permissible flatness deviation δ_B. δ_B is dependent on the type and design of bearing and applies in both the circumferential and radial directions.

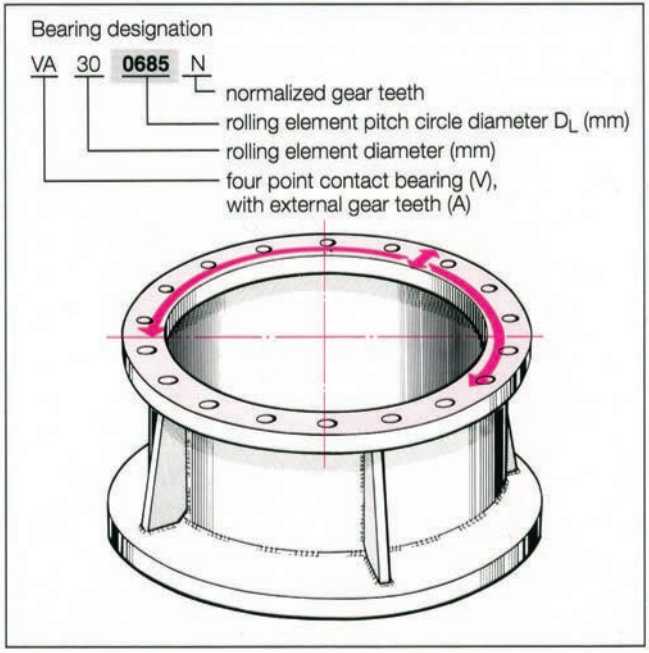
Calculation of δ_B

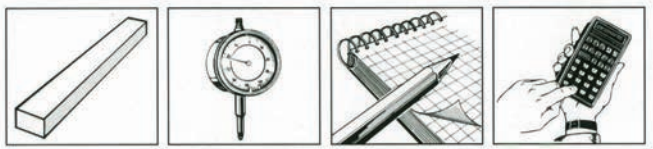
- δ_B for four point contact bearings in standard design (i.e. with bearing clearance) can be calculated from Formula (1); see page 8 for sample calculation. The rolling element pitch circle diameter (D_L) can be taken from the second group of numbers in the bearing designation.

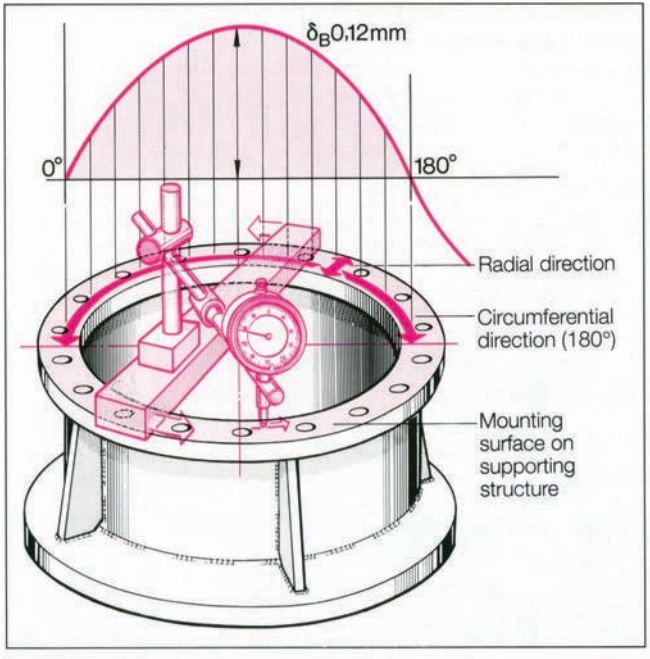
$$\delta_B = \frac{D_L + 500}{10\ 000} \qquad (1)$$

- δ_B can be calculated from Formula (2) for the following types:
  - preloaded four point contact bearings (bearing clearance VSP)
  - crossed roller bearings and
  - through hardened bearings.

$$\delta_B = \frac{D_L + 1000}{20\ 000} \qquad (2)$$







Checking δ_B

- ▶ Check flatness deviation in circumferential and radial directions at various points on the supporting structure using an inspection parallel and a dial indicator.
- ▶ Compare measured values with calculated values.

The value for δ_B in the circumferential direction may not be reached more than once in a sector of 180°. The permissible curve is similar to a sine curve, rising and falling gently.

Sample calculation for δ_B

Four point contact bearing in standard design (with bearing clearance).

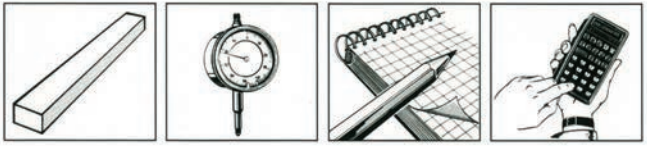
Rolling element pitch circle diameter

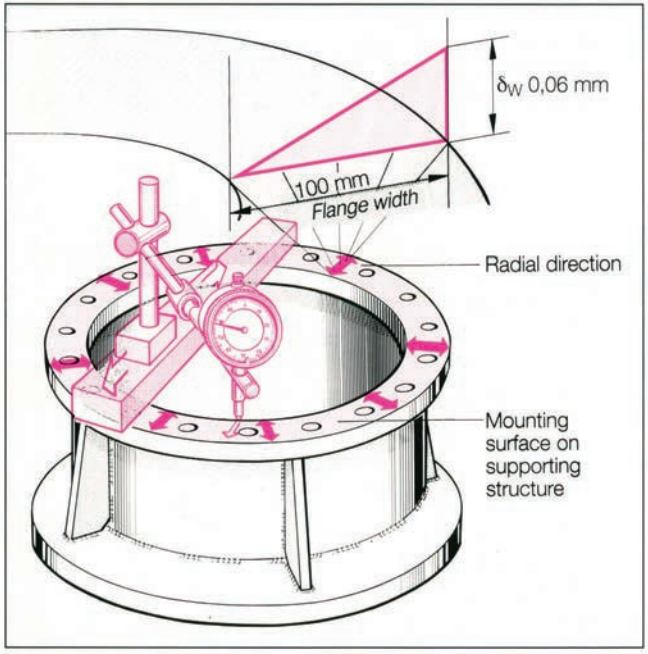
D_L = 685 mm.

$$\delta_B = \frac{D_L + 500}{10\ 000} \qquad \text{(Formula 1)}$$

$$\delta_B = \frac{685 + 500}{10\ 000}$$

δ_B = 0,12 mm (permissible flatness deviation).





Calculating and checking the perpendicularity deviation of the supporting structure

The permissible perpendicularity deviation δ_W applies in the radial direction.

Calculating δ_W

- $\delta_W = 0{,}5\ \delta_B$ for a flange width of 100 mm. The permissible deviation is converted as a direct proportion for other flange widths.

Checking δ_W

- Check the perpendicularity deviation in circumferential and radial directions at various points on the supporting structure using a inspection parallel and a dial indicator and compare measured values with calculated values.

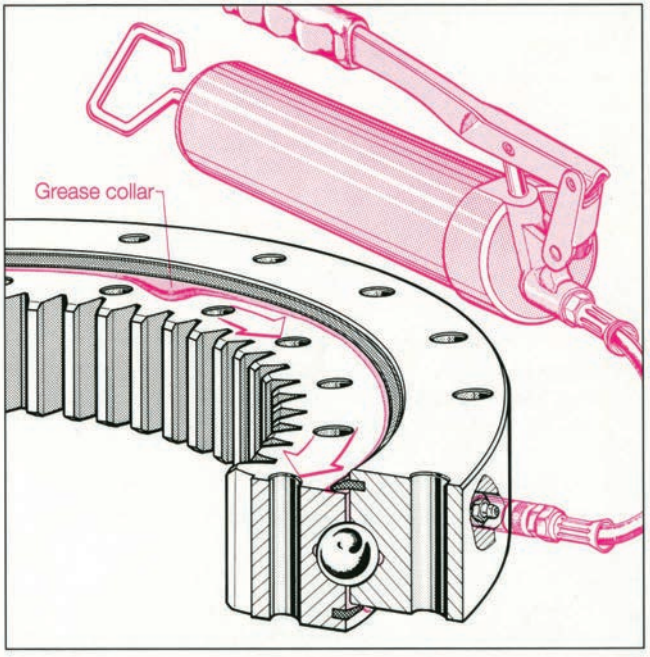
Sample calculation for δ_W

Permissible flatness deviation from sample calculation on page 8:

δ_B = 0,12 mm

$\delta_W = 0{,}5\ \delta_B$

δ_W = 0,06 mm (permissible perpendicularity deviation).



Initial grease lubrication for the slewing ring

Standard slewing rings are supplied greased. Special cases are indicated on the delivery drawing. Ungreased slewing rings must be greased before being put into operation for the first time.

Greasing

- Press grease into all the lubricating nipples one after the other until a collar of fresh grease forms at both sealing lips or the bearing gap.

See page 29, Table 5 for suitable greases.

Selection of fixing screws

Only prescribed screws may be used to fix slewing rings. Further information is available in:

- Catalogue 404, dimension tables or
- technical quotation.

The dimensions, quantity and quality grade must be taken into consideration.

⚠
- All information on fixing screws must be taken into account.
  Deviations from this will have an influence on the retentive properties of the screw connection as well as the function and life of the slewing ring.
- If the permissible surface pressure is exceeded (see Catalogue 404), and screws of quality grades higher than 10.9 are used, toughened washers must be used under the screw heads and the nuts.
- Suitable washers should always be used for screws of quality 12.9.

⚠
- Always use new fixing screws when replacing bearings.

Selection of screw retention

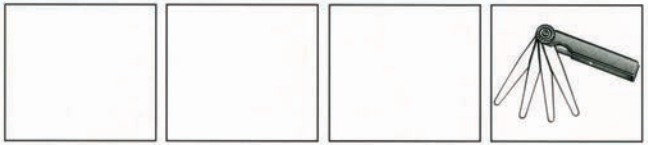
The fixing screws are usually sufficiently located by correct preloading.

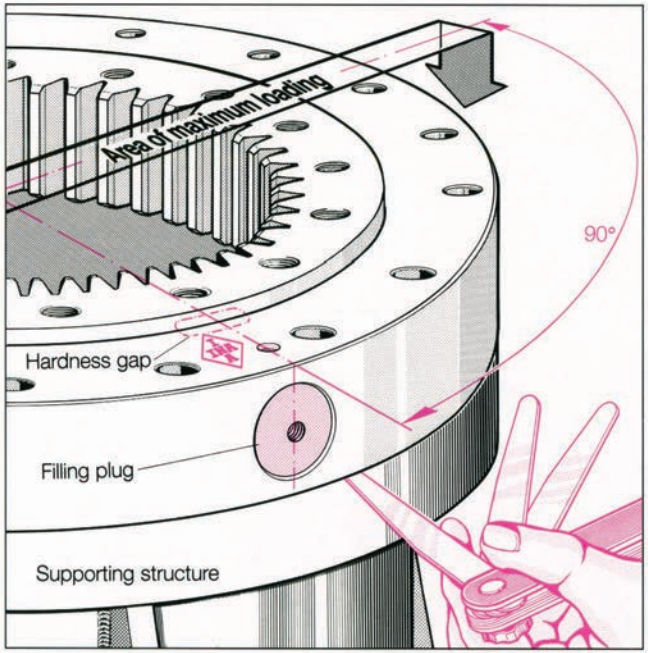
⚠
- Additional screw retention may be required if regular shock loads or vibrations occur.
- Not every type of screw retention is suitable for slewing rings.
- Locking washers or spring washers should never be used.

Information on screw retention can be found in DIN 25 201 or DIN 25 203 for particular details on retention by adhesive.

A suitable adhesive manufacturer such as Loctite should be contacted for specific information.

Fitting the slewing ring

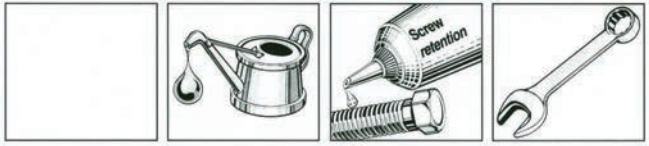


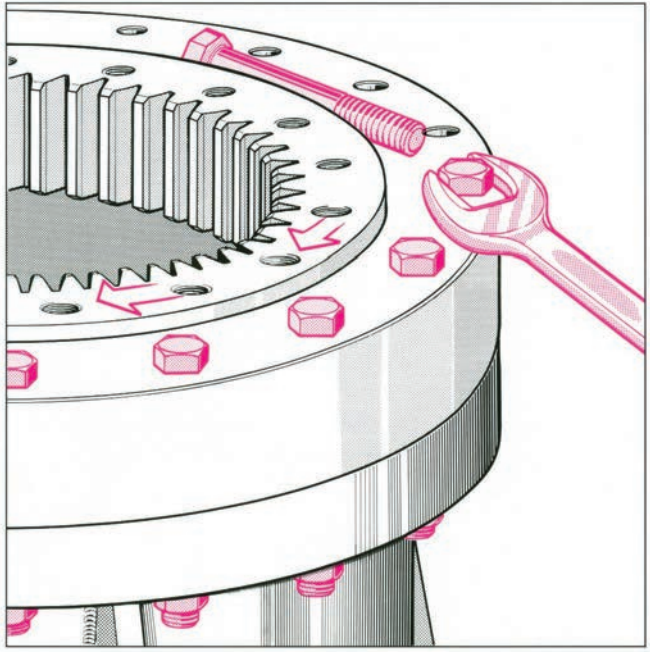


Aligning the slewing ring

- Place slewing ring on the seating surface.
- Determine point of maximum loading.
- For bearing rings with stationary loading, position hardness gap at 90° to the area of maximum loading.

  The hardness gap is marked by either
  - the INA diamond symbol or
  - the plug in the filling hole.
- Check using feeler gauges that the bearing rings are supported across their whole width by the flanged ring of the supporting structure.





Fixing the slewing ring

When fixing the rings on the slewing ring, fix one ring first and then the other; the rings must be free from external loading.

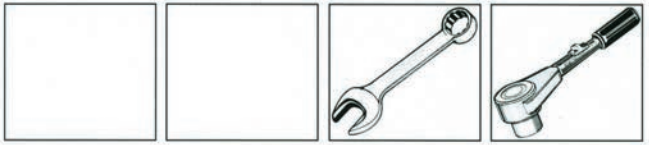
For

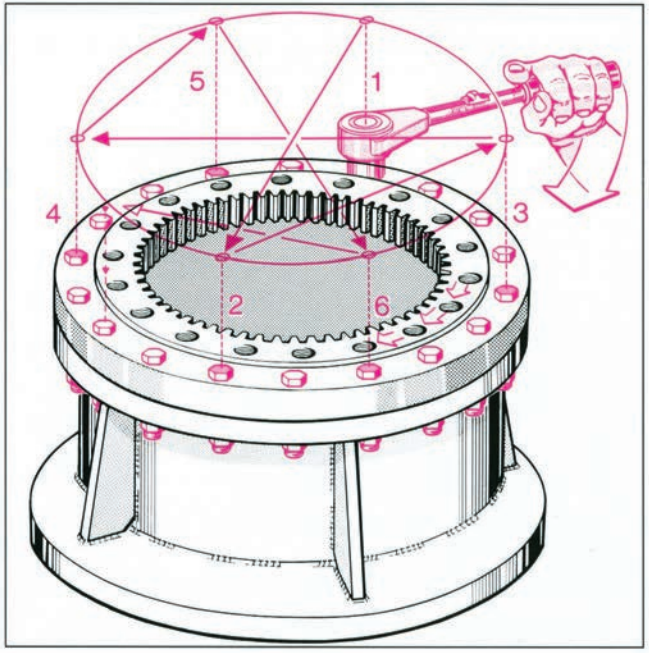
- slewing rings without gear teeth, fix the bearing ring with stationary loading first
- slewing rings with gear teeth, fix the bearing ring without gear teeth first.

> ⚠ – In order to avoid impermissible variations between the screw tightening forces, the following procedure should be used.

Fixing

- ► Lightly oil the screw threads to prevent differences in the coefficient of friction (this should not be done if adhesive screw retention is being used).
- ► If the screws are secured with adhesive, follow the manufacturer's instructions.
- ► Fit screws, with washers if necessary, and tighten slightly.
- ► Rotate the unfixed ring a few times.



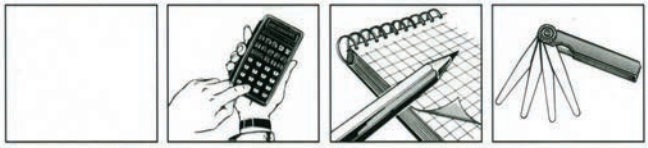


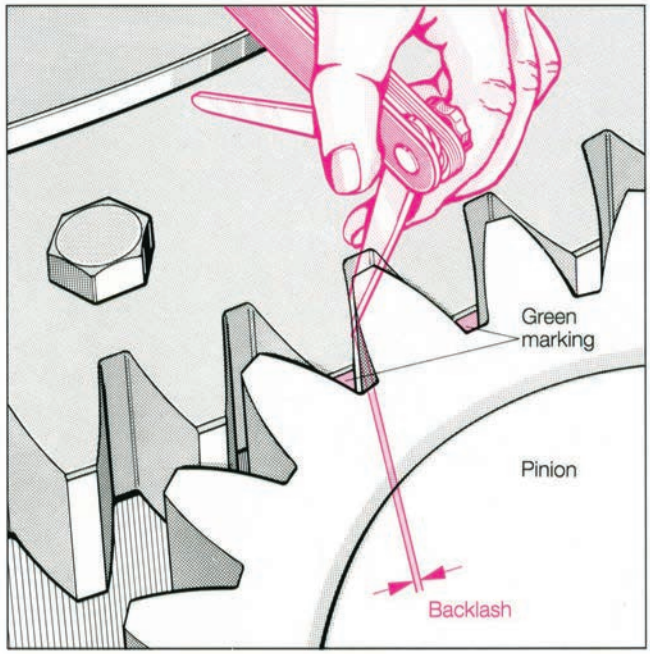
- Tighten the screws on the fixed ring in a cross-wise sequence while rotating the unfixed ring through several screw pitches.
- Preload the screws gradually to the prescribed value (use a torque wrench and dial indicator).
- Screw the unfixed ring of the slewing ring to the supporting structure using the same procedure.

Tightening torques for fixing screws up to M30 are given in Table 1, page 19.

> – If an hydraulic tightening device is used, the tightening forces for the preload must not exceed 90% of the elastic limit.

When using an hydraulic tightening device, the assembly preload forces given in Table 2, page 19 should be used.



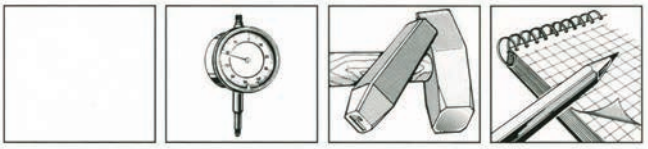


Calculating, checking and adjusting the backlash

When fitting slewing rings with gear teeth, the backlash between the gear wheel and the drive pinion must be checked and adjusted if necessary.

Calculation, checking and adjustment

- Calculate nominal value (0,03 to 0,04 × module).
- Using feeler gauges, determine the actual backlash value at the point at which maximum runout of the gear pitch circle diameter occurs. This point is marked on the slewing ring with green paint on the tip of the tooth.
- Compare nominal value with value determined.
- If the actual value deviates from the calculated nominal value, adjust the backlash to the nominal value.



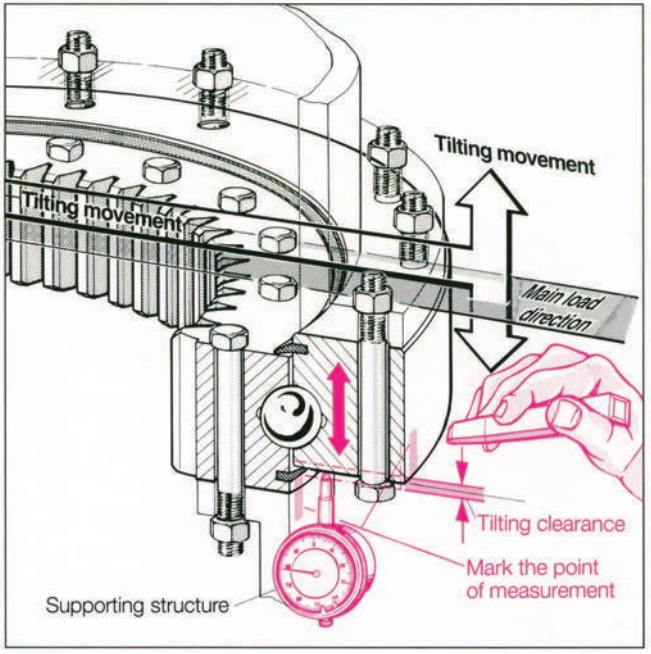
Determining the actual tilting clearance

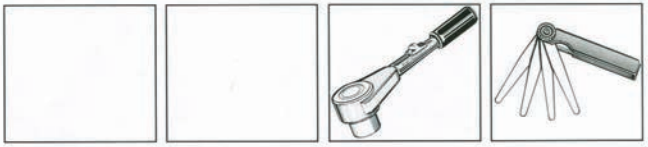
The tilting clearance increases under operating conditions.

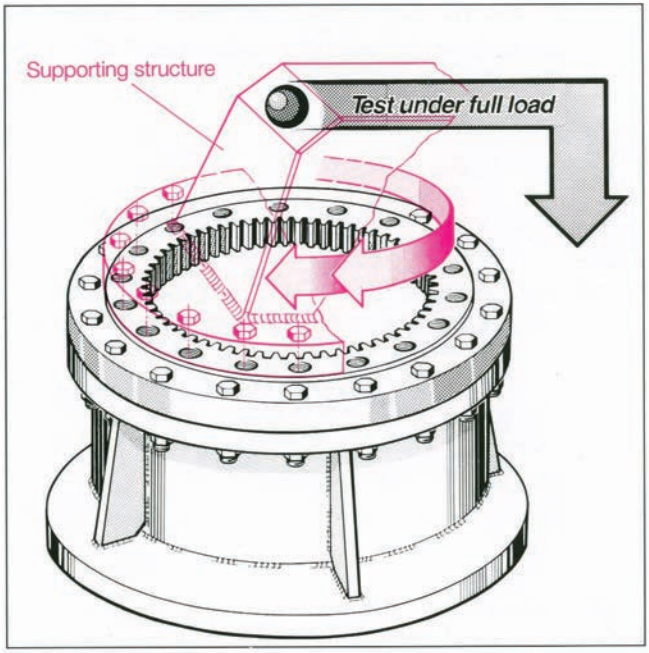
In order to be able to evaluate the increased tilting clearance, the actual tilting clearance present after the bearing is installed but before being put into initial operation must be determined.

- Mark the measuring point in the main load direction for subsequent inspections.
- Note measured value.

Follow procedures as given in section *Safety checks, Checking tilting clearance*, page 22.







Functional testing

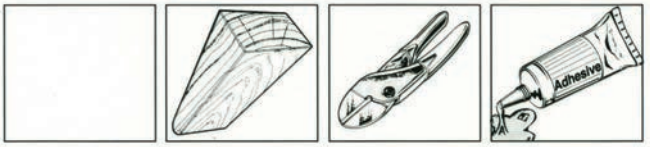
The slewing ring must be able to rotate smoothly with correctly tightened fixing screws and correctly adjusted backlash. The influence of external loads and deviations in the supporting structure can effect the frictional resistance.
A higher frictional resistance is to be expected for bearings of the "light series 20" due to their design.

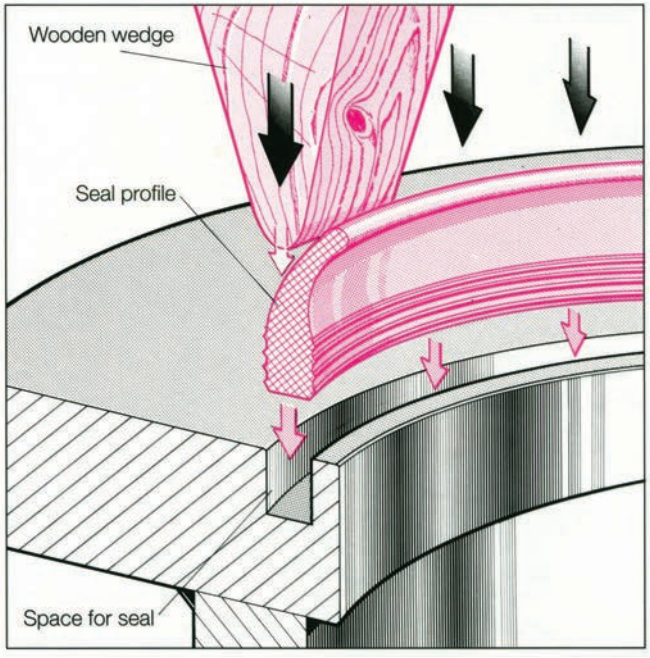
> ⚠ – Reasons for variable values for the frictional resistance can be binding between the pinion and the gear teeth or a bearing mounted out of round.

Functional test

- ► Rotate mounted slewing ring a few times.
- ► Check that the slewing ring rotates uniformly and smoothly.
- ► Carry out further test runs, preferably under full loading.

> ⚠ After the test run, check the bearing again and tighten or adjust to prescribed values if necessary.
>
> – See Table 1, page 19 for values for screw preload forces.
>
> – See page 15 for backlash.





Fitting the seal profile into the supporting structure

The bearing position can be provided with a seal in the supporting structure if required.

Fitting

- Clean the space provided for the seal.

> ⚠ – Take care not to damage the seal profile when fitting.

- Carefully push the seal profile into the space provided (e.g. with a blunt wooden wedge) leaving an excess length of approximately 5%.
- Cut the seal profile to an exact length with a pair of universal shears. Take care to ensure the joint faces are square.
- Stick the grease-free joint faces with a cyanoacrylate adhesive ensuring there is no excess.
- Finish the fitting procedure.

Note

The cleaner the surfaces to be stuck together, the lower the expected loss due to leakage.

Table 1 · Tightening torques M_A [1] and assembly preload forces F_M [2] for fixing screws tightened with a torque wrench (set screws)

Fixing screw	Tightening torque M_A [1] Quality			Assembly preload force F_M [2] Quality		
Size	8.8 Nm	10.9 Nm	12.9 Nm	8.8 kN	10.9 kN	12.9 kN
M 6	10,4	15,5	18	9,4	13,7	16,1
M 8	25	37	43	17,2	25	29,5
M10	51	75	87	27,5	40	47
M12	87	130	150	40	59	69
M14	140	205	240	55	80	94
M16	215	310	370	75	111	130
M18	300	430	510	94	135	157
M20	430	620	720	121	173	202
M22	580	830	970	152	216	250
M24	740	1060	1240	175	249	290
M27	1100	1550	1850	230	330	385
M30	1500	2100	2500	280	400	465

Table 2 · Assembly preloads F_M [3] when using hydraulic tightening devices (set screws)

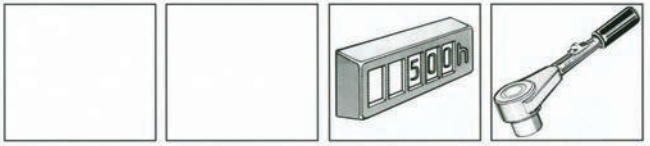
Fixing screw	Stress area	Minor diameter	Assembly preload F_M [3] Quality		
Size	A_S [4] mm^2	A_{d3} [4] mm^2	8.8 kN	10.9 kN	12.9 kN
M16	157	144,1	90	133,2	155,7
M18	193	175,1	114,3	162,9	190,8
M20	245	225,2	145,8	207	243
M22	303	281,5	180	256,5	301,5
M24	353	324,3	209,7	297	351
M27	459	427,1	274,5	387	450
M30	561	519	333	477	558

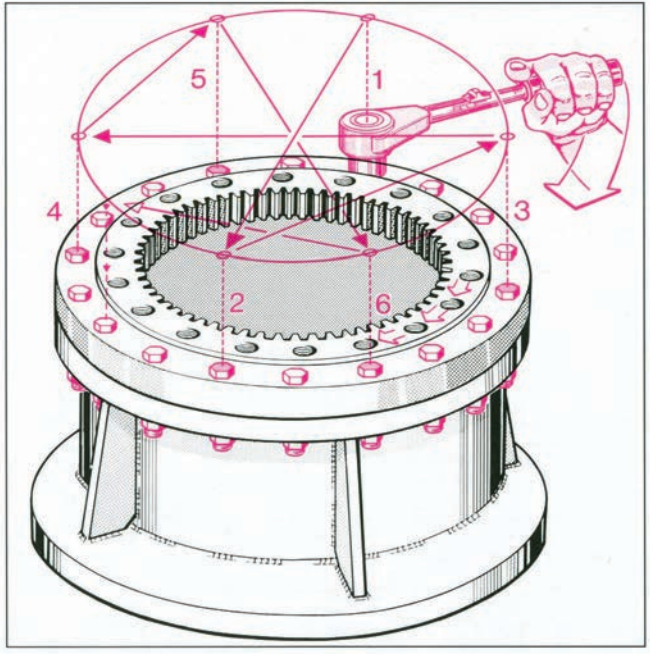
1) M_A in accordance with VDI guideline 2 230, sheet 1 (July 1986) for $\mu_K = 0{,}14$ and $\mu_G = 0{,}12$.

2) F_M in accordance with VDI guideline 2 230, sheet 1 (July 1986) for $\mu_G = 0{,}12$.

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

4) A_S and A_{d3} and $F_{0,2}$ in accordance with VDI guideline 2 230.





Checking fixing screws

The fixing screws must be checked at regular fixed intervals of time or operating hours particularly if the following occur:

– high tilting moment loading or

– suspended axial loading.

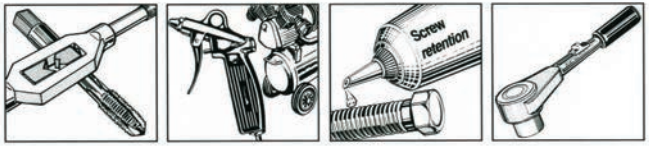
⚠
– To compensate for possible settling, check the tightening torque of the fixing screws after the first 100 operating hours and tighten to prescribed values if necessary.

– Inspect fixing screws after every 500 operating hours or at least every 6 months.
Failure to do this can endanger personnel and equipment.

Checking

► Relieve external tensile loading from screws without additional retention or mechanically secured screws.

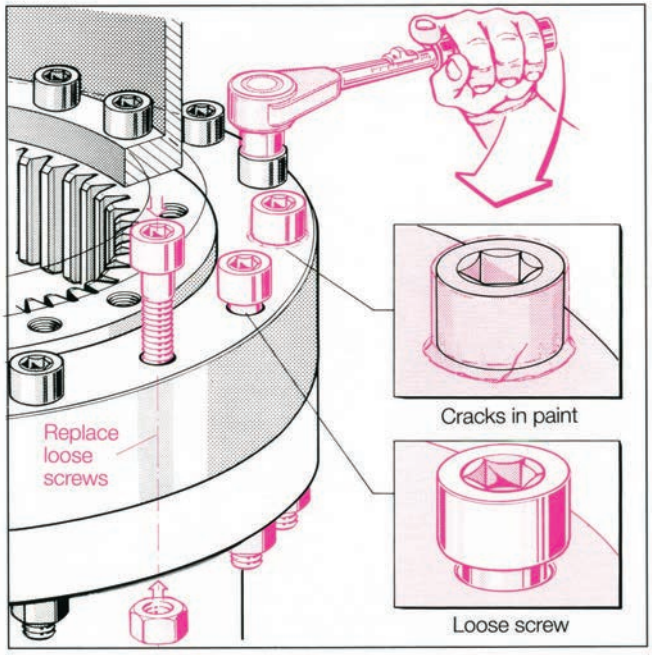
► Check preload with torque wrench and tighten to prescribed value if necessary.
See Tables 1 and 2, page 19, for values.

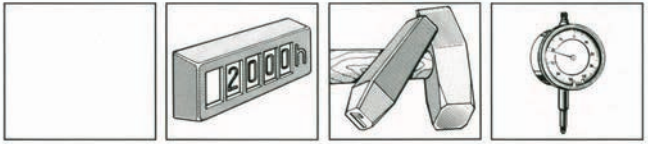


- Check painted screws and nuts for cracks in the paint (possible loosening).
- Remove loosened screws.
- Remove residual adhesive by re-cutting the thread bore. Blow out holes with compressed air.
- Use new fixing screws.
- Add adhesive to fixing screws and screw in. Follow manufacturer's instructions.
- Tighten screws using prescribed tightening torque or tighten to required assembly preload force. See Tables 1 and 2, page 19, for values.

⚠ – Use new fixing screws if replacing the bearing.

See page 11 for further information on screw retention.





Checking the tilting clearance

Wear or changes in the raceway system lead to increased bearing clearance. The tilting clearance must therefore be checked regularly, particularly if the following occur:

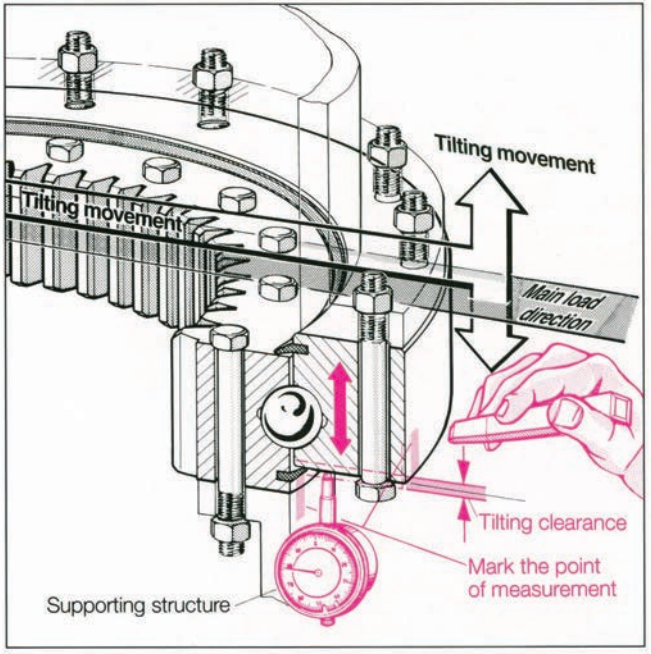
- high tilting moment loading or
- suspended axial loading.

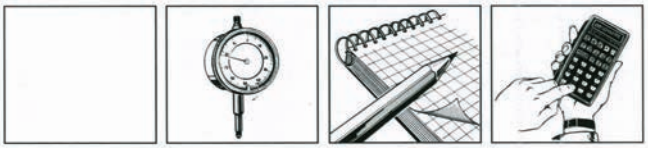
> ⚠ – Check axial tilting clearance every 2000 operating hours or at least after 12 months at the latest. Failure to do this can endanger personnel and equipment.

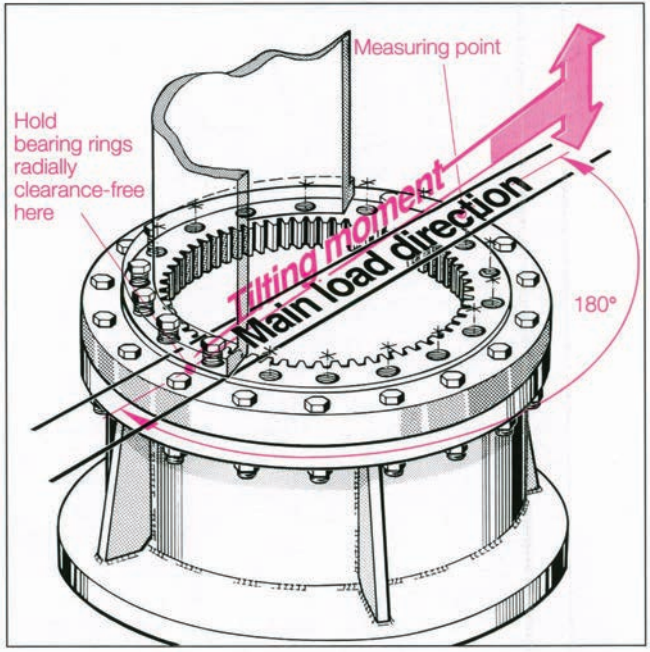
The checking procedures 1 and 2 described below are for initial and subsequent measurements on fitted bearings. When measuring the tilting clearance, there is always some influence from the supporting structure and elastic deformation in the bearing itself.

Checking procedure 1:
Measurements taken directly on the bearing

- ▶ Determine and mark the measuring point in the main load direction between the lower supporting structure and the bearing ring screwed to the upper structure. This is where the greatest tilting clearance values occur due to wear.
- ▶ Mark the position of the bearing rings with respect to each other.





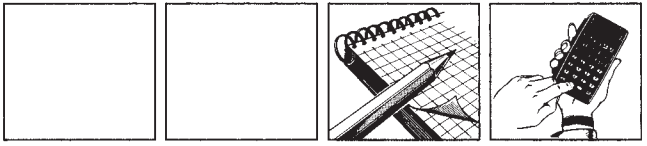


- Hold the bearing rings clearance-free at a position 180° opposite the point of measurement.
- Position dial indicator and set to zero.
- Exert defined tilting moment on the bearing (tilt the bearing rings with respect to each other).
- Read the measured value and note for later inspection measurements.

> ⚠ – All subsequent checks must be made at the same measuring point, with the same load, with the bearing rings in the same position with respect to each other and using the same method.
> – Always note measured values.

- Calculate the increase in the tilting clearance δ_{Stilt} (δ_m) for each subsequent measurement (all measurements after the initial measurement) using Formula (3).
  Subtract the current measured value m_x from the initial measurement m_1.
  Sample calculation on page 24.

$$\delta_{Stilt} = \delta_m = m_x - m_1 \qquad (3)$$



► Calculate maximum permissible increase in the tilting clearance (limiting value) for four point contact bearings and crossed roller bearings using formulae in Table 3. Sample calculation shown right.

⚠ – If the increased tilting clearance is more than approximately 75% of the maximum permissible increase, reduce the inspection interval (e.g. to 200 operating hours).
If the tilting clearance is even greater, reduce the inspection interval further (e.g. 100 to 50 operating hours).
– If the limiting value is reached, stop the unit and replace the slewing ring.

Table 3 · Maximum permissible increase in the tilting clearance

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

[1]) D_W is the diameter of the rolling element.

Sample calculation for checking procedure 1

Four point contact bearing

Rolling element diameter	D_W =	30 mm
Initial measurement	m_1 =	0,5 mm
Subsequent measurement (current)	m_x =	1,8 mm

Increase in tilting clearance = δ_m = $\delta_{Stilt.}$

$\delta_{Stilt} = \delta_m = m_x - m_1$

$\delta_{Stilt} = \delta_m = 1{,}8 - 0{,}5 = 1{,}3$ mm

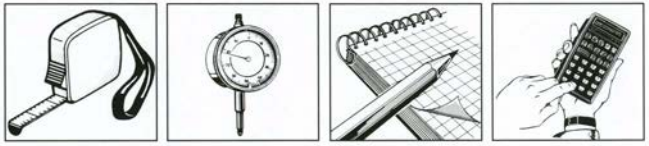
Increase in tilting clearance δ_{Stilt} is 1,3 mm.

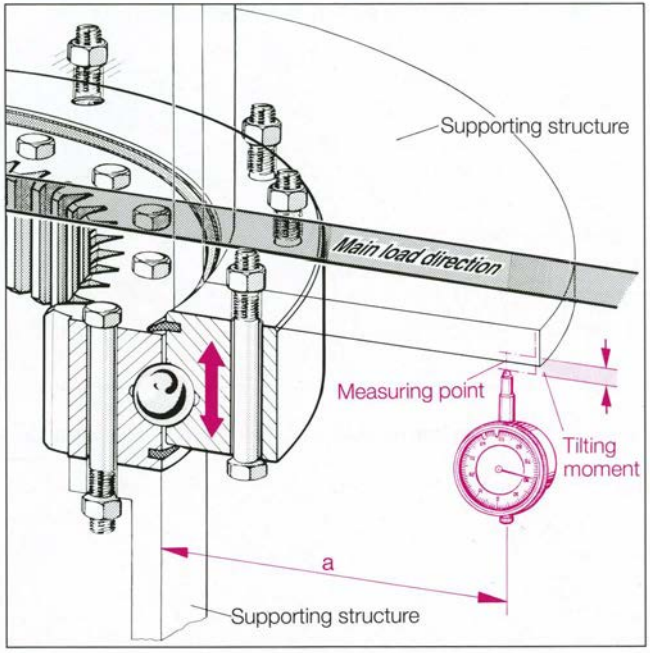
Maximum permissible value from Table 3 is:

$\delta_{Stilt} = 0{,}035 \times D_W + 0{,}6$

$\delta_{Stilt} = 0{,}035 \times 30 + 0{,}6 = 1{,}65$ mm.

The maximum permissible increase in the tilting clearance (limiting value) has not been reached.





Checking procedure 2:
Measurements not taken directly on the bearing

This checking procedure is valid for initial and subsequent measurements.

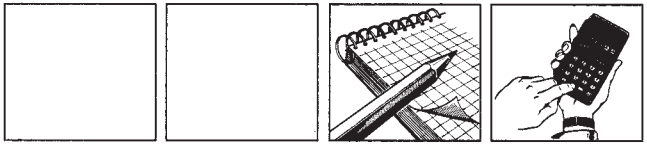
- ► Determine and mark the measuring point in the main load direction outside the bearing.
- ► Continue as described for checking procedure 1 up to Formula (3).

> ⚠ – All subsequent checks must be made at the same measuring point, at the same distance a, with the same load, with the bearing rings in the same position with respect to each other and using the same method.
> – Always note measured values.

- ► Calculate the increase in the tilting clearance δ_{Stilt} (δ_m) using Formula (4). Sample calculation on page 26.

$$\delta_{Stilt} = \delta_m \cdot \frac{D_L}{D_L + 2a} \qquad (4)$$

- ► Calculate maximum permissible increase in the tilting clearance (limiting value) using the formulae in Table 3. Sample calculation on page 26.



Sample calculation for checking procedure 2

Four point contact bearing

Rolling element diameter	D_W =	30	mm
Rolling element pitch circle diameter	D_L =	685	mm
Distance from measuring point to the outside diameter of the inner ring	a =	150	mm
Initial measurement	m_1 =	0,7	mm
Subsequent measurement (current)	m_x =	2,6	mm
Difference between current and initial measurement	=		δ_m
Increase in tilting clearance	=		δ_{Stilt}

$\delta_m = m_x - m_1$ (Formula 3)

$\delta_m = 2,6 - 0,7 = 1,9$ mm

$$\delta_{Stilt} = \delta_m \cdot \frac{D_L}{D_L + 2a}$$ (Formula 4)

$$\delta_{Stilt} = \delta_m \cdot \frac{685}{685 + (2 \cdot 150)}$$

$$\delta_{Stilt} = 1,9 \cdot \frac{685}{985}$$

$\delta_{Stilt} = 1,9 \cdot 0,7$

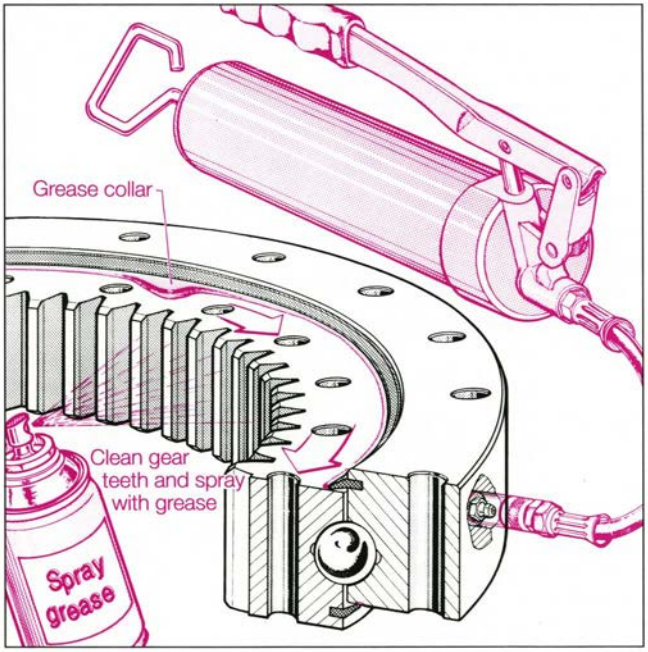
$\delta_{Stilt} = 1,3$ mm.

Maximum permissible value (limiting value) from Table 3, page 24, is:

$\delta_{Stilt} = 0,035 \times D_W + 0,6$

$\delta_{Stilt} = 0,035 \times 30 + 0,6 = 1,65$ mm.

The maximum permissible increase in the tilting clearance (limiting value) has not been reached.



Relubrication procedure

If possible, use the same lubricant for the raceway system and the gear teeth as used for initial operation.
Always relubricate with the bearing warm from operation.

> ⚠ – All relevant legal specifications for using lubricants must be followed.

Raceway system

- ▶ Clean lubricating nipples.
- ▶ Press grease into all the lubricating nipples consecutively until a collar of fresh grease forms at both sealing lips or at the bearing gap.
  Rotate one of the bearing rings at the same time.
- ▶ Ensure the old grease can flow out of the bearing freely.
- ▶ Before returning to operation, ensure that all lubrication channels to the bearing are also filled with lubricant.

Gear teeth

- ▶ Clean the gear teeth, particularly the base.
- ▶ Spray or paint grease onto the gear teeth.

See page 29, Table 5 for suitable lubricants for raceway systems and gear teeth.

Relubrication interval

Relubrication intervals are basically dependent on:

- the operating conditions
- the environmental influences such as contamination, water etc.
- the design of the slewing ring.

The relubrication interval can only be precisely determined by carrying out tests under operating conditions.
If comparable results are not available, the guide values for the relubrication interval given in Table 4 can be used.

The values given in the table are based on the following conditions:

- operating temperature T < 70 °C
- circumferential speed < 0,5 m/s
- low to medium loading.

Slewing rings should always be relubricated in the following instances:

- after each cleaning e.g. spraying with water, steam etc.
- before and after long stationary periods e.g. for cranes and building machinery during the inactive winter months
- if high levels of moisture occur.

Table 4 · Guide values for the relubrication interval

Operating conditions[1]	Relubrication interval (guide value)[2]
Dry and clean indoor area: e.g. rotary tables, robots	approx. 500 h
Heavier contamination: operating in open air e.g. cranes, hydraulic excavators	100 to 200 h
Extreme contamination: e.g. drilling machines, steel works	continuous lubrication via central lubrication or grease cartridges

[1] Please contact the INA engineering service if other operating conditions occur.

[2] Half these values can be used as guide values for gear teeth.

Note

Futher information on operating temperature, miscibility and grease cartridges is available in the Catalogue 404, page 24.

Table 5 · Lubricants for raceway systems and gear teeth

Raceway system	Gear teeth	Temperature range[1)]	Manufacturer
Aralub HLP 2	Aralub LFZ 1	–30 °C to +130 °C	Aral
Energrease LS–EP 2	Energol WRL	–20 °C to +120 °C	BP
Gilssando EP 2	Trixolit 2 X	–30 °C to +140 °C	DEA
EPEX ELF 2	CARDREXA DC 1	–30 °C to +130 °C	ELF
BEACON EP 2	Surret Fluid 4 k	–25 °C to +130 °C	ESSO
Centoplex GLP 402	Grafloscon C–SG–O Plus (Spray lubrication) Grafloscon CG 901 (Hand lubrication)	–20 °C to +130 °C	Klüber
–	Voler Compound 2000 E	–	Manke
Mobilux EP 2	Mobiltac D (Spray lubrication) Mobiltac A (Hand lubrication)	–20 °C to +120 °C	Mobil
Alvania EP 2	Cardium Compound C	–20 °C to +120 °C	Shell
Retinax LX 2 (INA designation: SM 03)	Cardium Fluid C	–30 °C to +120 °C	

[1)] The temperature ranges given apply to lubricants for the raceway system.

Appendix

Further information on slewing rings

Catalogue 404 and INA address

This catalogue provides up-to-date information on INA slewing rings in the following designs:

- four point contact bearings
- crossed roller bearings
- crossed roller bearings, series SX
- four point contact bearing insert elements, series DVE
- special designs.

It deals with the essential questions on calculation and design of bearing arrangements using INA slewing rings.
All the available bearings are described in full in the dimension tables.

The Catalogue 404 and the Technical Product Information TPI 13, Fitting and Maintenance Instructions for Slewing Rings are available free of charge.

Our qualified applications engineers are always available to answer questions on fitting and maintenance and to offer advice on the selection and use of slewing rings.

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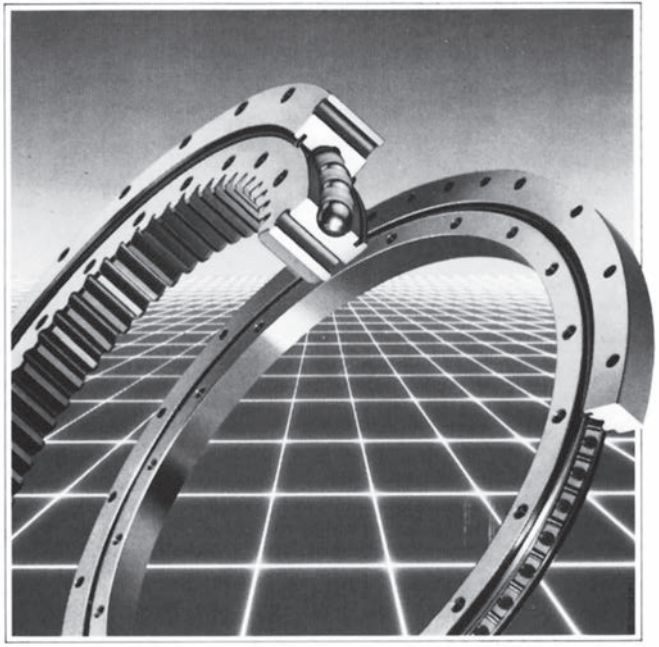

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