Crossed roller bearings

for high precision applications

Publication KSX

This technical publication has been produced with a great deal of care and attention and all data have been checked for their accuracy. However, no liability can be assumed for any incorrect or incomplete data.

⚠ Product pictures are for illustrative purposes only and must not be used for design work.

Designs must only be prepared in accordance with the technical information, dimension tables and dimension drawings in this edition. In case of doubt, please consult the INA engineering service.

Due to constant development of the product range, we reserve the right to make modifications.

The sales and delivery conditions in force are those which form the basis of the invoices and contracts.

Produced by:

INA-Schaeffler KG
91072 Herzogenaurach (Germany)

Postal address:
Industriestraße 1–3
91074 Herzogenaurach (Germany)

www.ina.com

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KSX Crossed roller bearings

INA crossed roller bearings SX have long been the optimum solution in technical and economic terms where compact, easy-to-fit bearings with high tilting moment load carrying capacity, rigidity and accuracy are required in a bearing position. These bearings can support radial loads, axial loads from both directions, tilting moments and any combination of loads. As a result, conventional bearing arrangements with radial and axial bearings can generally be reduced to a single bearing position. This reduces, in some cases considerably, the costs and work required in the design of the adjacent construction and the fitting of bearings.

In order to further increase the customer benefits and range of applications for bearing arrangements with crossed roller bearings, INA has expanded the product range for the small and medium diameter range to include the following series:

- crossed roller bearings XSU 08
  - these crossed roller bearings are preloaded and the bearing rings are screw mounted directly on the upper and lower construction
- crossed roller bearings XV
  - in these crossed roller bearings, the bearing clearance is set or the bearing preloaded by means of the split inner ring, while the outer ring is simply screw mounted on the adjacent construction.

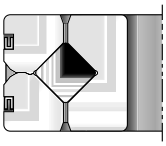
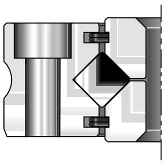
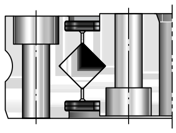
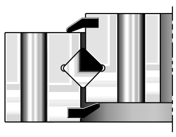
These new series allow even more flexible use of crossed roller bearings, for example in machine tools, lifting gear, conveying equipment and vehicle components, precision engineering and medical equipment and particularly in robots and handling systems.

This publication KSX has been completely revised from the previous edition. It gives information on the standard range of proven crossed roller bearings SX and the new series XSU and XV. Any information in previous editions which does not concur with the data in this edition is therefore invalid.

INA-Schaeffler KG
Herzogenaurach (Germany)

Product range

Overview/comparison

Characteristic / Crossed roller bearings	Bore diameter	Load carrying capacity[1]			Tilting rigidity[1) 2)]	Accuracy[1]		Friction[1) 2)]
		radial stat.	axial on both sides stat.	tilting moment stat.		radial	axial	
SX 	70 mm to 500 mm							
XV 	30 mm to 110 mm							
XSU 08 	130 mm to 360 mm							
XSU 14 	344 mm to 1 024 mm							

■ Design of crossed roller bearing.

1) The data refer to the smallest and largest bearing diameters.

	Maximum circumferential speed with		Bearing clearance			Sealed on both sides	Operating temperature	Anti-corrosion protection[3)]	Features
	grease lubrication	oil lubrication	standard clearance	low clearance RL0	preloaded				See page
	4 m/s ($n \times D_M$ = 76 400) with standard clearance 2 m/s ($n \times D_M$ = 38 200) with preload	8 m/s ($n \times D_M$ = 152 800) with standard clearance 4 m/s ($n \times D_M$ = 76 400) with preload	■	■	■		–30 °C to +80 °C	■	44
	2 m/s ($n \times D_M$ = 38 200) with preload	4 m/s ($n \times D_M$ = 76 400) with preload	adjustable from clearance-free to preloaded			■	–30 °C to +80 °C	■	44
	2 m/s ($n \times D_M$ = 38 200) with preload	4 m/s ($n \times D_M$ = 76 400) with preload			■	■	–30 °C to +80 °C	■	45
	2 m/s ($n \times D_M$ = 38 200) with preload	4 m/s ($n \times D_M$ = 76 400) with preload			■	■	–30 °C to +80 °C	■	45

2) Determined at 20% of maximum permissible tilting moment, without axial or radial load and with moderate preload.

3) Special design with INA special plating Corrotect®. Available by agreement.

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Application example

Datasheet KRF (detachable)
Crossed roller bearings for processing of quotation

Product index

sorted alphanumerically

Page	Type	Description
44	SX	Crossed roller bearing corresponding to dimension series 18 to DIN 616, not sealed, greased, with clearance, reduced clearance or preloaded, outer ring circumferentially split and held together by three retaining rings
45	XSU	Crossed roller bearing, sealed on both sides, greased, preloaded, centred on the inside and outside diameter, bearing rings can be screw mounted directly on the adjacent construction
44	XV	Crossed roller bearing, sealed on both sides, greased, with clearance, can be preloaded by locknut, inner ring circumferentially split, outer ring can be screw mounted directly on the adjacent construction

Index of suffixes

Suffix	Description
RL0	Low clearance design
VSP	Bearing with preload
RR	Corrosion-resistant design with INA special plating Corrotect®

Ordering designation

Ordering example

The ordering designation gives an abbreviated description of the crossed roller bearing.

It consists of:

- the designation
- suffixes
  - for special bearing features only.

Designation (Figure 1)

Every crossed roller bearing has a designation. This is given in the *dimension tables* and describes the standard design of the bearing.

The designation consists of several parts.
It indicates, taking the crossed roller bearing SX as an example:

- the type
  - crossed roller bearing SX
- the series
  - series 01
- the dimension series
  - dimension series 18 to DIN 616
- the dimension-specific part
  - size 24.

Suffix (Figure 2)

Suffixes are placed after the dimension-specific part.

They indicate:

- the bearing clearance or preload
  - e.g. VSP for a preloaded bearing
- the special design
  - e.g. RR for the corrosion-resistant design.

Ordering example, ordering designation (Figure 3)

Crossed roller bearing	SX
Series	01
Dimension series	18 to DIN 616
Size	24
With preload	VSP
Corrosion-resistant	RR

Ordering designation:

SX 01 1824 VSP RR

⚠ The correct sequence of characters must be observed when ordering!

Figure 1 · Designation

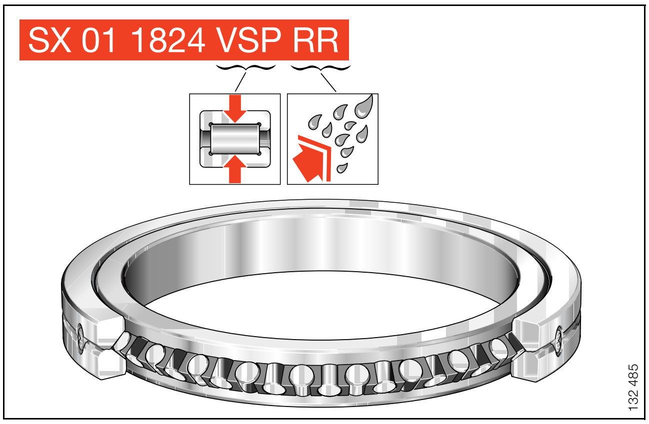


Figure 2 · Designation and suffixes

Figure 3 · Ordering example, ordering designation

Symbols and units

Unless stated otherwise in the text, the values used in this catalogue have the following symbols, units and definitions.

C	N	Basic dynamic load rating
C_0	N	Basic static load rating
D_M	mm	Rolling element pitch circle diameter
D_W	mm	Rolling element diameter
f_A	–	Application factor
f_S	–	Factor for additional safety
f_{0r}	–	Static radial load factor
F_a	kN	Dynamic bearing load (axial)
F_{aB}	kN	Ultimate axial load
F_r	kN	Dynamic bearing load (radial)
F_{0a}	kN	Static bearing load (axial)
F_{0q}	kN	Equivalent bearing load (static)
F_{0r}	kN	Static bearing load (radial)
k_F	–	Dynamic load factor
L	10^6 rev.	Basic rating life in millions of revolutions
L_h	h	Basic rating life in operating hours
M_{AL}	Nm	Tightening torque for locknut
M_L	Nm	Breakaway torque with M_{AL}
M_M	$kg \cdot cm^2$	Mass moment of inertia
M_k	kNm	Dynamic tilting moment load
M_m	Nm	Tightening torque for grub screws
M_{0k}	kNm	Static tilting moment load
M_{0q}	kNm	Equivalent tilting moment load (static)
n	min^{-1}	Operating speed of crossed roller bearing
n_{osc}	min^{-1}	Frequency of to and fro movement
p	–	Life exponent
P_{axial}	kN	Equivalent dynamic axial bearing load
$P_{0\ axial}$	kN	Equivalent static axial bearing load
S_0	kN	Static load safety factor
δ_B	mm	Maximum permissible flatness deviation
ϵ	–	Load eccentricity parameter
γ	°	Half of swivel angle

Load carrying capacity and life

Static load carrying capacity

The size of the crossed roller bearing required is dependent on the demands made on its:

- static and dynamic load carrying capacity
- life
- operational reliability.

Dynamic load carrying capacity, see page 14.

Definition of static load carrying capacity

Crossed roller bearings that undergo rotary motion only infrequently, undergo slow swivel motion, rotate only slowly or are subjected to load while stationary are dimensioned on the basis of their static load carrying capacity since the permissible load in these cases is determined not by material fatigue but by the load-induced deformations at the contact points between the rolling elements and raceways.

The static load carrying capacity is described by:

- the basic static load ratings C_0 (see *dimension tables*)
- the static limiting load diagrams *Raceway* and *Fixing screws* (see *dimension tables* and *calculation example*, page 13).

The size of a statically loaded crossed roller bearing for a particular application can therefore be checked in approximate terms using the basic static load ratings C_0 and the static limiting load diagrams.

Checking the static load carrying capacity

The static load carrying capacity can be checked in approximate terms only when:

- the load arrangement is in accordance with Figure 1
- all the requirements stated in this publication are fulfilled in relation to
  - clamping rings, flange rings and fastening
  - fitting, lubrication and sealing.

⚠ Where load arrangements are more complex or the conditions are not fulfilled, please consult INA.

In order to check the static load carrying capacity, the following equivalent static operating values msut be determined:

- the equivalent static bearing load F_{0q}
- the equivalent static tilting moment load M_{0q}.

Checking is possible for applications with or without radial load.

Determining the equivalent static bearing load without radial load and checking the static load carrying capacity in the static limiting load diagram *Raceway*

If only axial and tilting moment loads are present:

$$F_{0q} \triangleq F_{0a} \cdot f_A \cdot f_S$$

$$M_{0q} \triangleq M_{0k} \cdot f_A \cdot f_S$$

F_{0q} kN
Equivalent axial bearing load (static)

F_{0a} kN
Static axial bearing load

f_A –
Application factor (see Table 1, page 12)

f_S –
Factor for additional safety

f_{0r} –
Static radial load factor (see Figure 1)

M_{0q} kNm
Equivalent tilting moment load (static)

M_{0k} kNm
Static tilting moment load.

- Using the values for F_{0q} and M_{0q}, determine the load point in the static limiting load diagram *Raceway*. The load point must be below the raceway curve!

In addition to the raceway, check the dimensioning of the fixing screws as well (see *calculation example*, page 13)!

Determining the equivalent static bearing load with radial load and checking the static load carrying capacity in the static limiting load diagram *Raceway*

⚠ Radial loads can only be taken into consideration if the radial load F_{0r} is smaller than the basic static radial load rating C_0 according to the *dimension table*!

- Calculate the load eccentricity parameter ϵ using the formula.
- Determine the static radial load factor f_{0r} as follows:
  - determine the ratio F_{0r}/F_{0a} in Figure 1
  - from the ratio F_{0r}/F_{0a} and ϵ, determine the static radial load factor f_{0r} from Figure 1.
- Determine the application factor f_A according to Table 1, page 12 and the safety factor f_S if required.
- Calculate the equivalent axial bearing load F_{0q} and the equivalent tilting moment load M_{0q} using the formulae.
- Using the values for F_{0q} and M_{0q}, determine the load point in the static limiting load diagram *Raceway* (see *calculation example*, page 13). The load point must be below the raceway curve!

$$\epsilon = \frac{2\,000 \cdot M_{0k}}{F_{0a} \cdot D_M}$$

$$F_{0q} = F_{0a} \cdot f_A \cdot f_S \cdot f_{0r}$$

$$M_{0q} = M_{0k} \cdot f_A \cdot f_S \cdot f_{0r}$$

ϵ –
Load eccentricity parameter

M_{0k} kNm
Static tilting moment load

F_{0a} kN
Static bearing load (axial)

D_M mm
Rolling element pitch circle diameter (*dimension tables*)

F_{0q} kN
Equivalent bearing load (static)

f_A –
Application factor (see Table 1, page 12)

f_S –
Factor for additional safety

f_{0r} –
Static radial load factor (see Figure 1)

M_{0q} kNm
Equivalent tilting moment load (static).

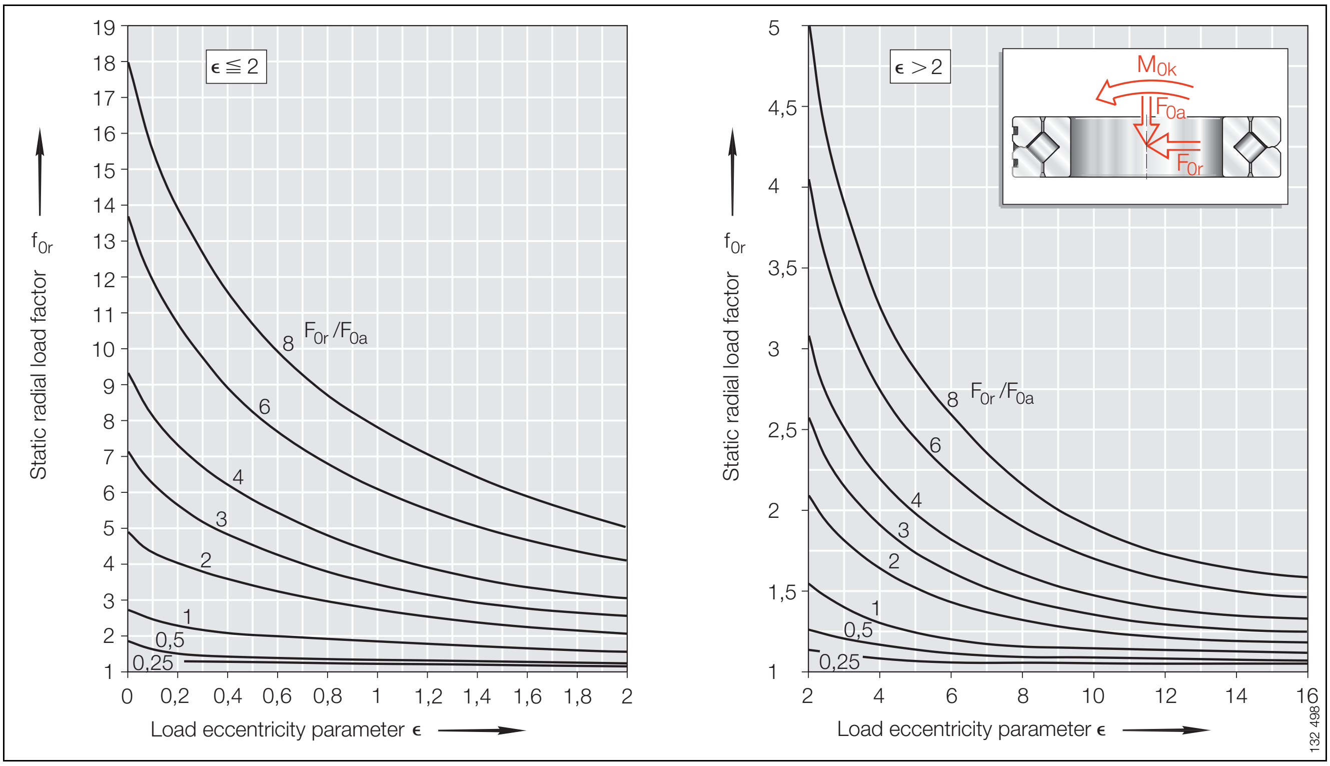


Figure 1 · Main load directions and static radial load factor f_{0r} for crossed roller bearings

Application factors

The application factors f_A in Table 1 are empirical values. They take account of the most important requirements – e.g. the type and severity of operation, rigidity or running accuracy.

If the precise requirements of an application are known, the values may be altered accordingly.

⚠ Application factors < 1 must not be used!

A large proportion of applications can be statically calculated using an application factor of 1 – e.g. bearings for gearboxes and rotary tables.

We recommend that, in addition to static calculation, the life should also always be checked (*Dynamic load carrying capacity*, page 14).

Table 1 · Application factors f_A for determining equivalent bearing load (static)

Application	Operating/ requirement criteria	Application factor f_A
Robots	Rigidity	1,25
Antennae	Accuracy	1,5
Machine tools	Accuracy	1,5
Measuring equipment	Smooth running	2
Medical equipment	Smooth running	1,5

Safety factors

The factor for additional safety is $f_S = 1$.

It is not normally necessary to factor in any additional safety in calculation.

⚠ In special cases – e.g. approval specifications, internal specifications, requirements stipulated by inspection bodies etc. – use the appropriate safety factor!

Calculation example

The static load carrying capacity of the crossed roller bearing SX 01 1860 is to be checked.

Given

Static bearing load (axial)	F_{0a}	=	70	kN
Static bearing load (radial)	F_{0r}	=	17,5	kN
Static tilting moment load	M_{0k}	=	22,5	kNm
Rolling element pitch circle diameter	D_M	=	340	mm
Application factor	f_A	=	1,25	(Table 1)
Safety factor	f_S	=	1	

Required

Static load carrying capacity of the bearing.

Solution

$$\epsilon = \frac{2000 \cdot M_{0k}}{F_{0a} \cdot D_M}$$

$$\epsilon = \frac{2\,000 \cdot 22,5}{70 \cdot 340} = 1,89$$

$$\frac{F_{0r}}{F_{0a}} = \frac{17,5}{70} = 0,25$$ (Figure 1, page 11)

$$f_{0r} = 1,2$$ (Figure 1, page 11)

$$F_{0q} = F_{0a} \cdot f_A \cdot f_S \cdot f_{0r}$$

$$F_{0q} = 70 \cdot 1,25 \cdot 1 \cdot 1,2 = 105 \text{ kN}$$

$$M_{0q} = M_{0k} \cdot f_A \cdot f_S \cdot f_{0r}$$

$$M_{0q} = 22,5 \cdot 1,25 \cdot 1 \cdot 1,2 = 33,75 \text{ kNm}$$

Determining the load point in the static limiting load diagram – checking the static load carrying capacity

Using the values for F_{0q} and M_{0q}, the load point in the static limiting load diagrams *Raceway* and *Fixing screws* is determined (see Figure 2 and Figure 3).

The load point is below the raceway and screw curves. The bearing is adequately dimensioned and thus suitable for the application.

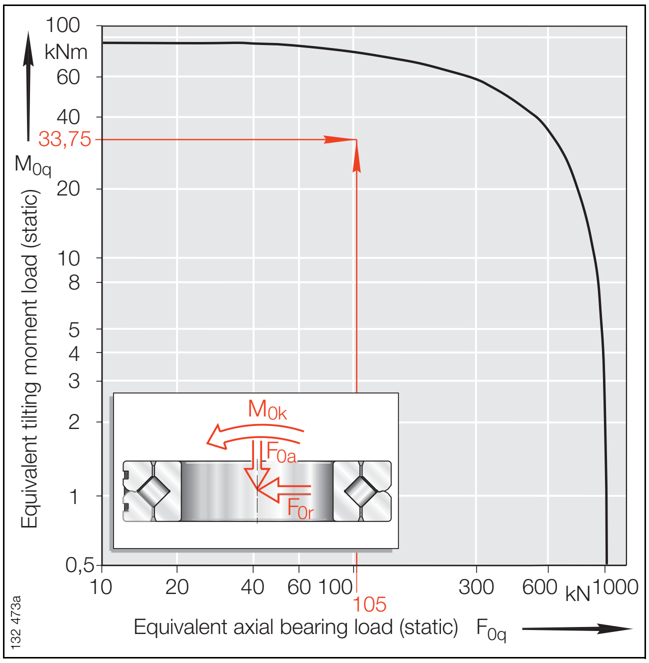


Figure 2 · Static limiting load diagram *Raceway* – compressive load

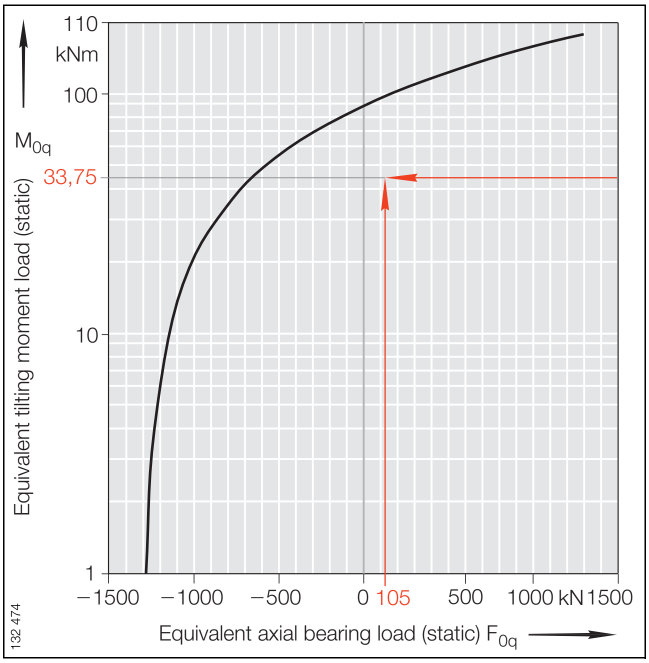


Figure 3 · Static limiting load diagram *Fixing screws* – compressive load

Load carrying capacity and life

Dynamic load carrying capacity

Dynamically loaded crossed roller bearings – i.e. bearings undergoing predominantly rotary motion – are dimensioned in accordance with their dynamic load carrying capacity.

Definition of dynamic load carrying capacity

The dynamic load carrying capacity is determined by the fatigue behaviour of the material. The life as a fatigue period depends on the load and operating speed of the bearing and the statistical probability of the first occurrence of failure (for a definition, see also *INA Catalogue 307*).

The dynamic load carrying capacity is described by:

- the basic dynamic load ratings C (see *dimension tables*)
- the basic (calculated) rating life L or L_h.

The size of a dynamically loaded crossed roller bearing for a particular application can therefore be checked in approximate terms using the basic dynamic load ratings and the basis rating life.

Definition of basic rating life

The basis for calculation is the theory of probability, according to which a defined percentage of a sufficiently large group of apparently identical bearings achieves or exceeds a particular number of revolutions before the first evidence of material fatigue appears. Calculation is based on a requisite reliability of 90%.

⚠ The basic rating life is only an approximate value for guidance and comparative purposes!

Calculation of an adjusted rating life in accordance with ISO 281 is recommended if the nominal viscosity of the lubricant is not achieved for the specific operating load case (see *INA Catalogue 307*)!

Determining the basic rating life

The life formulae for L and L_h are only valid:

- with a load arrangement in accordance with Figure 1
- if all the requirements stated in this publication are fulfilled in relation to
  - location (the bearing rings must be rigid or firmly connected to the adjacent construction)
  - fitting, lubrication and sealing
- if the load and speed can be regarded as constant during operation
  - if the load and speed are not constant, equivalent operating values can be determined which will cause the same fatigue conditions as the actual loads (see *Equivalent operating values*, *INA Catalogue 307*)
- if the load ratio F_r/F_a is $\leqq 8$.

⚠ If more complex load arrangements are present, the ratio F_r/F_a is > 8 or the conditions differ from those stated, please consult INA!

Determining the basic rating life for bearings subjected to combined loads

For bearings subjected to combined loads – bearings with axial, radial and tilting moment loads – the life L and L_h is calculated as follows:

- Calculate the load eccentricity parameter ϵ using the formula.
- Determine the ratio of the dynamic radial bearing load F_r to the dynamic axial bearing load F_a (F_r/F_a).
- Using the values for ϵ and the ratio F_r/F_a in Figure 1, determine the dynamic load factor k_F.
- Calculate the equivalent dynamic axial bearing load $P_{axial} = F_a \times k_F$ according to the formula.
- Enter the equivalent dynamic axial bearing load P_{axial} and the basic dynamic axial load rating C_a in the life formulae for L or L_h and calculate the life. If swivel operation is present, enter the operating speed n calculated using the formula in the life formula L_h.

Determining the basic rating life for bearings subjected to radial loads only

For slewing rings subjected to *radial loads only*, the following values are entered in the life formulae for L and L_h:

- instead of the equivalent dynamic axial bearing load P_{axial}, the equivalent dynamic radial bearing load P_{radial} (i.e. F_r)
  - $P_{radial} = F_r$
- the basic dynamic radial load rating C_r.

$$\epsilon = \frac{2000 \cdot M_k}{F_a \cdot D_M}$$

$$P_{axial} = k_F \cdot F_a$$

$$L = \left(\frac{C}{P_{axial}}\right)^p$$

$$L_h = \frac{16\,666}{n} \cdot \left(\frac{C}{P_{axial}}\right)^p$$

$$n = n_{osc} \cdot \frac{\gamma}{90^\circ}$$

ϵ –
Load eccentricity parameter

M_k kNm
Dynamic tilting moment load

F_a kN
Dynamic bearing load (axial)

D_M mm
Rolling element pitch circle diameter (*dimension tables*)

P_{axial} kN
Equivalent dynamic axial bearing load.
For slewing rings subjected to radial loads only, enter P_{radial}

k_F –
Dynamic load factor (see Figure 1)

L 10^6 rev.
Basic rating life in millions of revolutions

C_r, C_a kN
Basic dynamic axial or radial load rating according to *dimension table.*
For slewing rings subjected to radial loads only, enter C_r

p –
Life exponent for crossed roller bearings: $p = 10/3$

L_h h
Basic rating life in operating hours

n min^{-1}
Operating speed of crossed roller bearing

n_{osc} min^{-1}
Frequency of to and fro movement

γ °
Half of swivel angle

P_{radial} kN
Equivalent dynamic radial bearing load

F_r kN
Dynamic bearing load (radial).

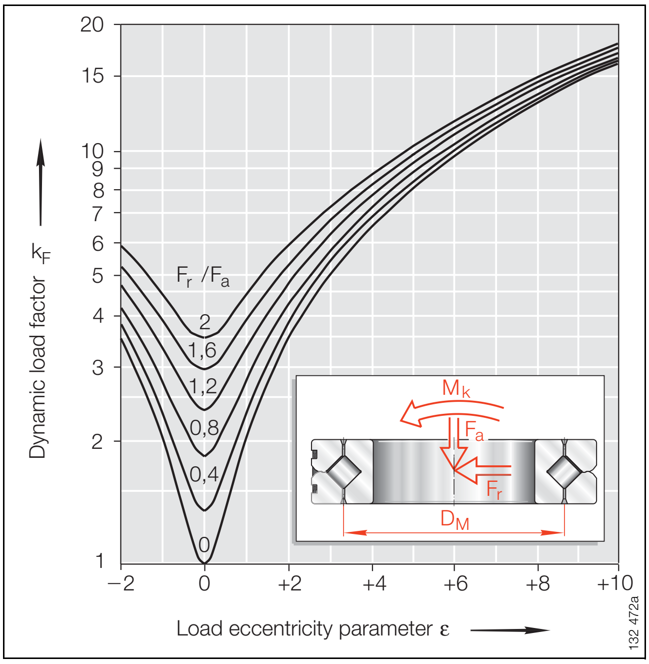


Figure 1 · Dynamic load factor k_F for crossed roller bearings

Influences on the operating life of crossed roller bearings

The operating life is the life actually achieved by a crossed roller bearing. This can deviate significantly from the calculated basic rating life due to wear and/or fatigue.

Possible causes include:

- oscillating bearing motion with very small swivel angles – false brinelling
- vibration while the bearing is stationary
- unsuitable design or deformation of the adjacent construction
- excessively high operating temperatures
- incorrect maintenance or lubrication
- contamination
- incorrect fitting
- insufficient preload of the fixing screws.

Due to the variety of installation and operating conditions, it is not possible to precisely predetermine the operating life. The most reliable way of arriving at a close estimate is by comparison with similar applications.

Calculation example

Given

Crossed roller bearing	SX 01 1820
Rolling element pitch circle diameter according to *dimension table*, page 48	D_M = 112 mm
Basic dynamic load rating (axial) according to *dimension table*, page 49	C_a = 28 kN
Life exponent for crossed roller bearings	p = 10/3
Dynamic bearing load (axial)	F_a = 20 kN
Dynamic bearing load (radial)	F_r = 4 kN
Dynamic tilting moment load	M_k = 1 kNm

Required

Basic rating life L in millions of revolutions.

Solution

$$\epsilon = \frac{2\,000 \cdot M_K}{F_a \cdot D_M}$$

$$\epsilon = \frac{2\,000 \cdot 1}{20 \cdot 112} = 0{,}89$$

$$\frac{F_r}{F_a} = \frac{4}{20} = 0{,}2$$

k_F = 2,1 (Figure 2)

$$P_{axial} = k_F \cdot F_A$$

$$P_{axial} = 2{,}1 \cdot 20\text{ kN} = 42\text{ kN}$$

$$L = \left(\frac{C_a}{P_{axial}}\right)^p$$

$$L = \left(\frac{28}{42}\right)^{\frac{10}{3}} = 0{,}26 \cdot 10^6 \text{ revolutions}$$

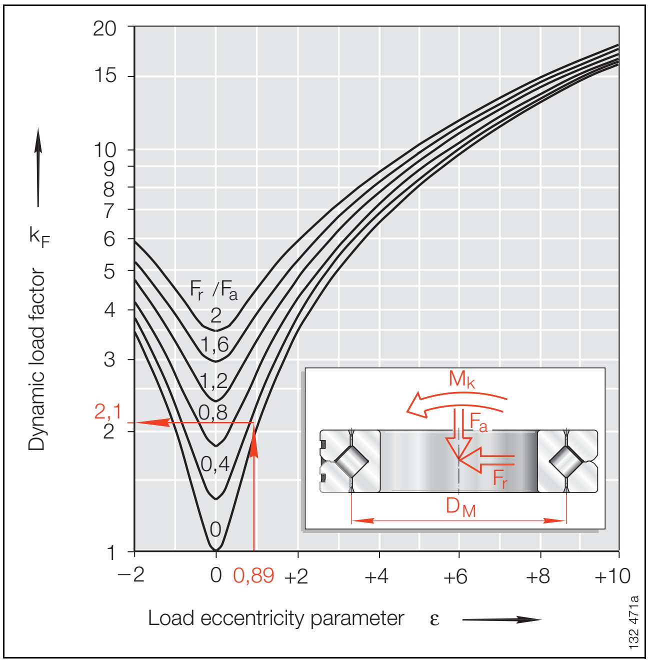


Figure 2 · Dynamic load factor k_F for crossed roller bearings

Fasteners

Static and dynamic load carrying capacity
of fixing screws

INA precision locknuts

In addition to the raceway, the load carrying capacity of the fixing screws must also be checked. This is based on the information in the section *Static load carrying capacity*.

Conditions for checking load carrying capacity

The load carrying capacity of the fixing screws can be checked if the following conditions are fulfilled:

- the criteria in *Static load carrying capacity* are fulfilled
- the screws are tightened as specified using a torque wrench
  - screw tightening factor α_A = 1,6, tightening torques according to Table 1, page 43
- the permissible contact pressure is not exceeded
- screws of the recommended size, quantity and grade are used.

Indicator of load carrying capacity

The load carrying capacity of the screws is described by:

- the curves in the limiting load diagrams *Fixing screws* (example: see Figure 1)
- the maximum permissible radial load $F_{r\,perm}$ (friction locking) in the *dimension tables*.

Static limiting load diagrams

The screw curves are shown in the static limiting load diagrams *Fixing screws*. The curves are based on screws of grade 10.9, tightened to 90% of their proof stress including the torsion content.

If screws of grade 8.8 or 12.9 are used, the equivalent static loads F_{0q} and M_{0q} (see *Static load carrying capacity*, page 10, must be converted using the following factors:

- grade 8.8 (F_{0q}×1,65, M_{0q}×1,65)
- grade 12.9 (F_{0q}×0,8, M_{0q}×0,8).

Checking the static load carrying capacity

The static load carrying capacity of the screw is limited by its proof stress.

Static load carrying capacity for applications without radial load

Determine the equivalent static bearing loads F_{0q} and M_{0q} (see: *Determining the equivalent static bearing load without radial load*, page 10).

Using the values for F_{0q} and M_{0q}, determine the load point in the static limiting load diagram *Fixing screws*.
The load point must be below the appropriate screw curve (see example, Figure 1)!

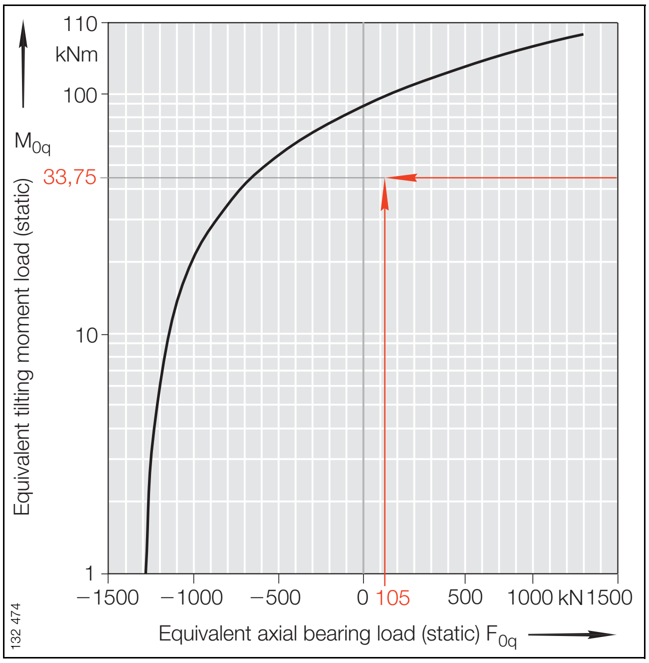


Figure 1 · Static limiting load diagram *Fixing screws* – example for crossed roller bearing SX 01 1860

Static load carrying capacity for applications with radial load

Determine the equivalent static bearing loads F_{0q} and M_{0q} (see: *Determining the equivalent static bearing load with radial load*, page 10).

Using the values for F_{0q} and M_{0q}, determine the load point in the static limiting load diagram *Fixing screws*. The load point must be below the appropriate screw curve!

Influence of radial load on the static load carrying capacity of the fixing screws

If radial loads occur in uncentred bearing rings, the screw connections must prevent displacement of the bearing rings on the adjacent construction.

In order to check this:

- multiply the radial bearing load by an application factor f_A according to Table 1, page 12
- compare the values determined with the maximum permissible radial load $F_{r\ perm}$ in the *dimension tables*.

⚠ The maximum radial load $F_{r\ perm}$ of the fixing screws depends on their friction locking, which is stated for each bearing in the *dimension tables* and not on the radial load carrying capacity of the bearing!

If the radial load of the bearing is higher than the friction locking of the fixing screws according to the *dimension table*, or very high radial loads are present ($F_r/F_a > 4$), please consult INA!

Checking the dynamic load carrying capacity

The dynamic load carrying capacity corresponds to the fatigue strength of the screw.

Dynamic load carrying capacity

- Based on the dynamic loads present, determine the equivalent loads F_{0q} and M_{0q} according to the section
  – instead of the application factor f_A, always increase the operating load by the following factors:
  grade 8.8 (factor 1,8)
  grade 10.9 (factor 1,6)
  grade 12.9 (factor 1,5).
- Check the load carrying capacity in the static limiting load diagram *Fixing screws*. The load point must be below the appropriate screw curve (see example, Figure 1)!

INA precision locknuts

INA precision locknuts of series AM, ZM and ZMA are proven components for setting and fixing bearing clearance or for preloading, see page 46.

⚠ The tightening torques for locknuts according to the technical quotation letter or *dimension tables*, pages 58 and 59, must be adhered to. The tightening torque required should also be stated in the assembly drawing!

Precision locknuts AM

The locking forces are applied through the segments of the locknut, see page 46.

⚠ Never tighten the locknut using only one segment! Tightening should if possible be carried out using an INA socket wrench AMS, which ensures uniform loading of all segments, or the nut must be tightened using a hook wrench to DIN 1810 B!

Secure the nut using the grub screws in the segments! In order to prevent axial deformation of the segments, only tighten the grub screws in a crosswise sequence to the specified tightening torque!

Ensure that the nut is fully screwed onto the shaft thread!

Precision locknuts ZM, ZMA

Locknuts of these series are secured against rotation by means of two locking pegs, see page 46.

⚠ Locknuts should be tightened using a hook wrench to DIN 1810 B!

Lubrication

Basic principles

Correct lubrication and regular maintenance are important preconditions for achieving a long operating life with crossed roller bearings.

The lubricant serves to:

- form a lubricant film capable of supporting loads on all contact surfaces
- seal the bearing against external influences (in the case of grease lubrication) and thus prevent the ingress of solid and liquid contaminants
- reduce the running noise
- protect the bearing against corrosion
- dissipate heat from rolling bearing subjected to heavy loads (in the case of oil lubrication).

Types of lubrication

Crossed roller bearings can be lubricated with grease or oil.

The following factors are significant in determining the appropriate type of lubrication and the quantity of lubricant required:

- the design and size of the bearing
- the design of the bearing environment
- the lubricant feed
- the operating conditions.

Criteria for grease selection

Operating temperature range (Figure 1)

The range must correspond to the potential range of temperatures in the rolling bearing.

The possible operating temperatures should not exceed the upper and lower limiting values:

- the maximum operating temperature should be 20 °C less than the upper limit value
- the minimum operating temperature should be 20 °C above the lower limit value. At very low temperatures, greases release very little base oil. This can result in inadequate lubrication.

Type of grease (Figure 2)

The characteristics of a grease depend on:

- the base oil
- the viscosity of the base oil
  - – this is important for the speed range
- the thickener
  - – the shear strength is important for the speed range
- the additives.

Consistency of greases (Figure 3)

Greases are divided into consistency classes – known as NLGI grades (DIN 51818). Grades 1, 2 and 3 are preferred for rolling bearings.

The greases should not become:

- too soft at high temperatures (NLGI 1)
- too stiff at low temperatures (NLGI 3).

Greases should be selected by their speed parameter $n \cdot d_M$:

- greases with a high speed parameter should be selected for rolling bearings running at high speeds or with low start-up torques
- greases with a low speed parameter should be used for bearings running at low speeds.

⚠ The consistency of polycarbamide greases can be altered by shear stresses.

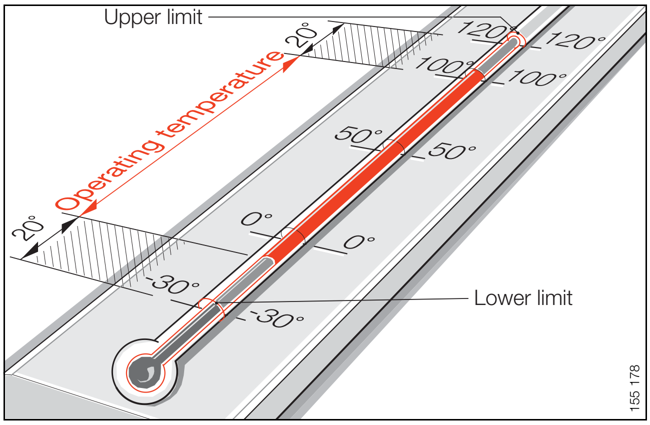


Figure 1 · Operating temperature range

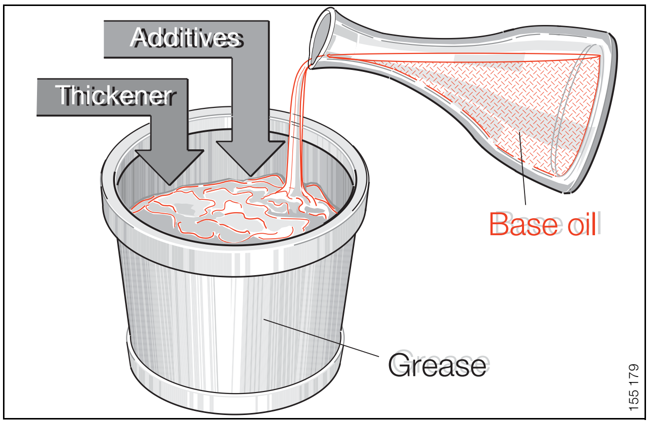


Figure 2 · Type of grease

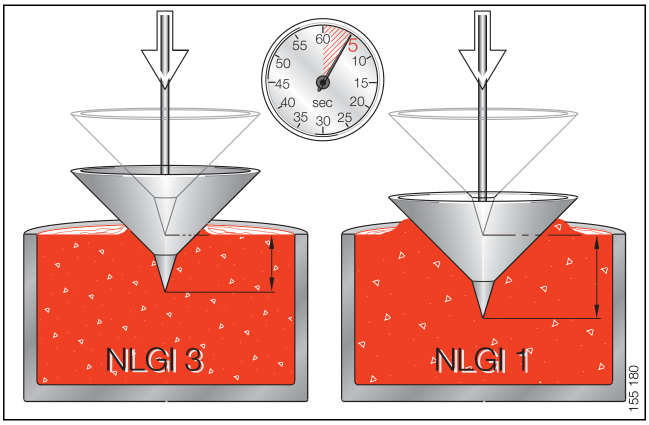


Figure 3 · Consistency of greases

Behaviour in the presence of water (Figure 4)

Water in the grease has a highly detrimental effect on the operating life of the bearing:

- the behaviour of greases in the presence of water is assessed according to DIN 51807 (see Table 1)
- the anti-corrosion characteristics can be checked in accordance with DIN 51802 – information is given in the grease manufacturer's data sheets.

Pressure properties

- The viscosity must be sufficiently high at the operating temperature for the formation of a lubricant film capable of supporting loads
- At high loads, greases with EP (extreme pressure) characteristics and high base oil viscosity should be used (KP grease to DIN 51502).

⚠ The load-supporting capability of common greases can change if EP additives containing lead are not used.

Therefore:

– check the grease selection
– consult the lubricant manufacturer.

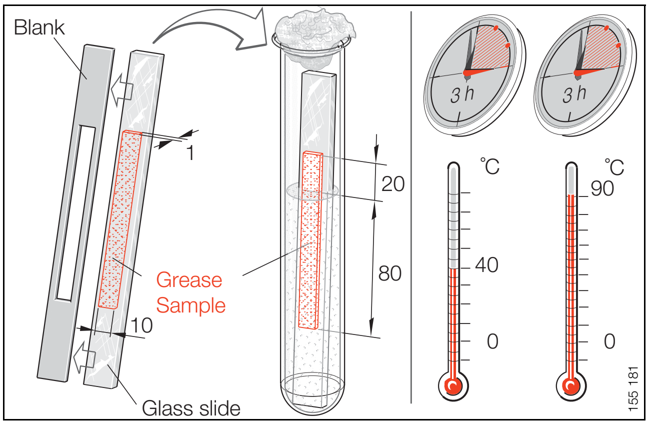


Figure 4 · Behaviour in the presence of water to DIN 51807

Table 1 · Rolling bearing grease for initial greasing

INA designation	Designation to DIN 51825	Type of grease	Temperature range °C	NLGI grade (consistency)	Speed parameter $n \cdot d_M$ min^{-1} mm	Kinematic viscosity at 40 °C (base oil) $mm^2 s^{-1}$	Behaviour in the presence of water to DIN 51807
SM03	KP2N–25	Lithium complex soap grease (mineral oil base)	–30[1] to +150	2	500 000	160	1–90

[1] Determined according to IP 186/85.

Miscibility

The preconditions are as follows:

- they must have the same base oil
- they must have compatible thickener types
- they must have similar base oil viscosities
  – the difference must not be more than one ISO VG class
- they must have same consistency – NLGI grade.

⚠ If greases are to be mixed with each other, contact the grease manufacturer.

Storage (Figure 5)

⚠ Lubricants age due to environmental influences. The information provided by the lubricant manufacturer should be adhered to.

INA uses greases with a mineral oil base. Experience shows that these greases can be stored for up to 3 years.

This applies under the following conditions:

- closed room or store
- temperatures between 0 °C and +40 °C
- relative atmospheric humidity not more than 65%
- no contact with chemical agents (vapours, gases or fluids)
- the rolling bearings are sealed.

After extended periods of storage, the start-up frictional torque of greased bearings may be temporarily higher than normal. The lubricity of the grease may also have deteriorated.

⚠ Greases – even those obtained from the same manufacturer – may vary in their characteristics. Therefore, INA does not accept any liability for lubricants and their behaviour during operation.

Initial greasing

INA crossed roller bearings are supplied greased (for the grease used, see Table 1, page 22). The grease is a high quality lithium complex soap grease with a mineral oil base to DIN 51825 KP2N–25.

The free space in the raceway system of the bearing is filled with grease. The grease is suitable for the operating temperature range –30 °C to +150 °C.

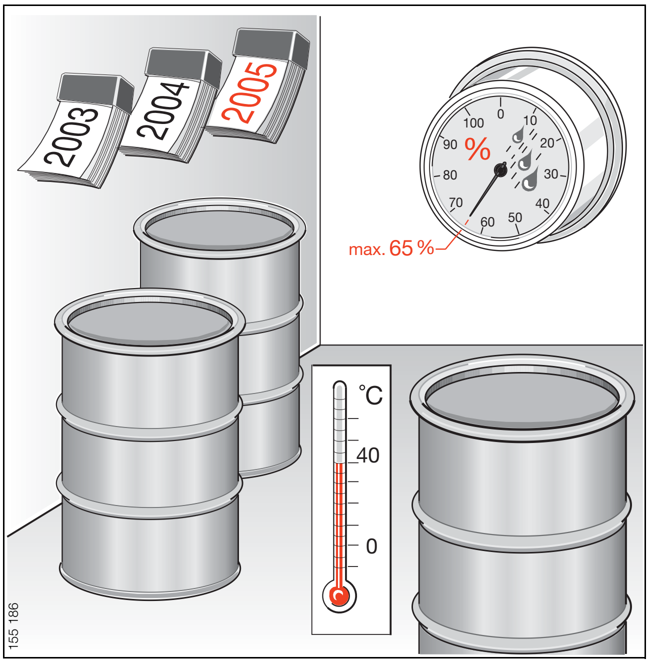


Figure 5 · Storage

Lubrication intervals

The lubrication intervals are essentially dependent on:

- the operating conditions
- the environmental influences such as contamination, water, etc.
- the type of crossed roller bearing.

⚠ The lubrication intervals can only be determined by means of tests under the specific application conditions:
- sufficiently long observation periods must be allowed
- the condition of the grease must be checked at regular intervals.

Grease operating life

If relubrication is not possible, the grease operating life becomes the decisive factor.

Based on experience, the guide value for the grease operating life in the majority of applications is higher than the guide value for the lubrication interval by a factor of 2.

At operating temperatures above +70 °C, the lubrication interval and therefore the grease operating life are reduced.

In order to ensure operational reliability, the grease operating life should not exceed 3 years.

Relubrication procedure

During the lubrication procedure, foreign matter such as contaminants, dust, spray water and condensation that have entered the crossed roller bearing are pressed out.

If possible, the grease used for relubrication should be the same as that used in initial operation.

Lubrication should always be carried out on bearings that are warm from operation.

- Clean the lubrication nipples.
- Grease should then be pressed into the lubrication nipples until a collar of fresh grease forms around both seals (one bearing ring should be slowly rotated during this process)
  - the old grease must be allowed to flow out unhindered.

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

For oil lubrication, INA recommends oils of type CL/CLP to DIN 51 517 or HL/HLP to DIN 51 524 (ISO VG 10 to 100).

The oils can be used at operating temperatures from –30 °C to +100 °C.

⚠ Note the limiting speeds for $n_{G\ grease}$ and $n_{G\ oil}$ according to the *dimension tables*!

Selection of the oil

A lubricant film which is capable of supporting loads is required at the contact points between the rolling elements and the raceway.

Depending on the operating speed, at the operating temperature the oil must have:

- at least the nominal viscosity ν_1 (Figure 6).

Nominal viscosity for mineral oils

The guide value for ν_1 is dependent on:

- the mean bearing diameter d_M
- the speed n.

The guide value takes into consideration:

- the EHD theory on the formation of a lubricant film
- practical experience.

Determining the nominal viscosity ν_1 (Figure 6)

- Assign ν_1 to an ISO VG nominal viscosity grade between 10 and 1500
  - mean viscosity to DIN 51 519.
- Intermediate values should be rounded to the nearest ISO VG grade
  - this is due to the steps between the viscosity groups.

⚠ This method cannot be used for synthetic oils
- these have different speed/pressure and speed/temperature characteristics.

Influence of temperature on viscosity

As the temperature increases, the viscosity of the oil decreases.

⚠ When selecting the viscosity, the lowest operating temperature should be taken into consideration:
- increasing viscosity reduces the flowability of the oil and leads to increased power losses.

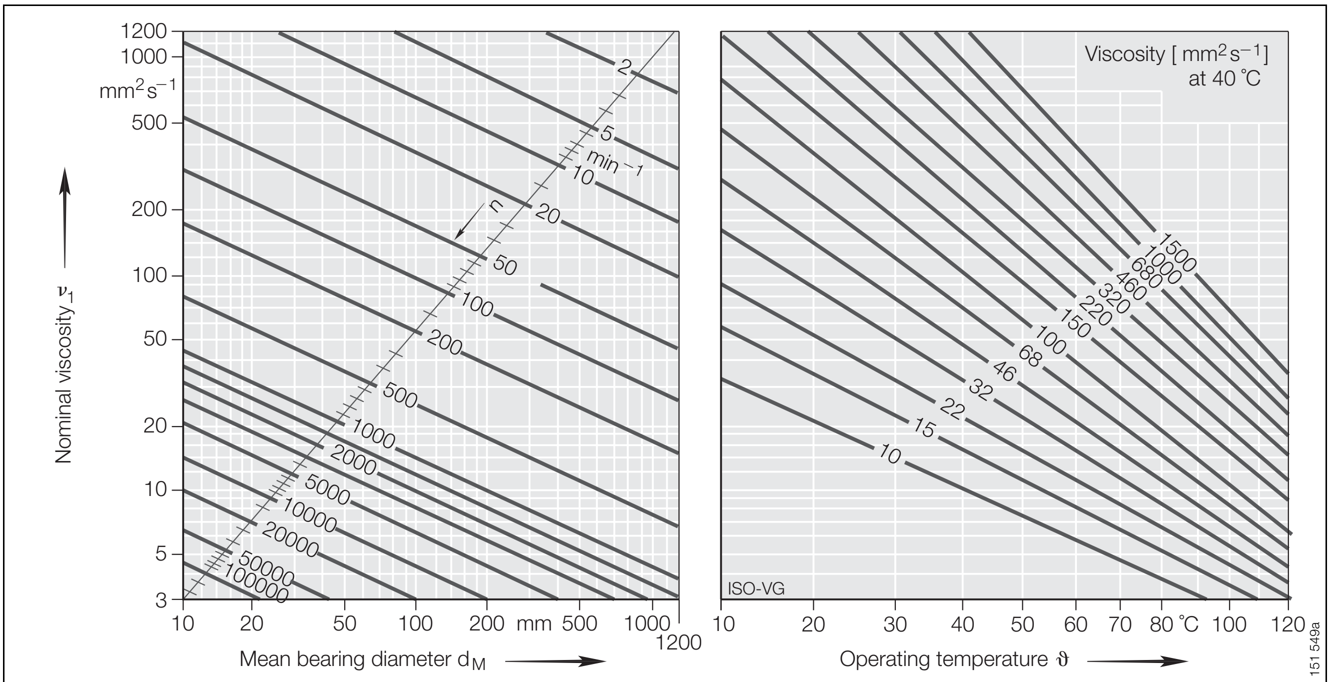


Figure 6 · Determining the nominal viscosity ν_1

Sealing of the bearing arrangement

INA seal profiles

INA crossed roller bearings SX are supplied without seals. Depending on the requirements and the type of contamination, seals must be provided for the bearing position in the adjacent construction.

INA crossed roller bearings of series XSU and XV are sealed. For severe contamination, spray or flood water etc., however, additional sealing of the bearing arrangement in the adjacent construction may be necessary.

INA seal profiles

For sealing of the bearing arrangement in the adjacent construction, INA supplies various seal profiles by the metre. These profiles fulfil a wide variety of requirements (see Table 1).

⚠ The seal profiles are not suitable for applications requiring leakproof operation – or for grease lubrication! If leakage losses are unacceptable, measures such as rotary shaft seals can be applied!

Seal profile materials

The standard material for the profiles is the synthetic elastomer NBR 70. This material is characterised by:

- good resistance to oils and greases
- good wear resistance.

Operating temperature

INA seal profiles can be used at temperatures from –40 °C to +80 °C.

For temperatures lower or higher than this range, extreme environmental influences (e.g. ozone) or high speeds, please consult INA.

Fitting of seal profiles

⚠ The area around the bearing seal must be designed such that the seal profiles are not damaged during operation! Ensure that the profiles are not damaged while fitting the slewing ring!

Fit the profiles according to the following procedure:

- Clean the area where the seal is to be fitted.
- Press the seal profile carefully into the fitting space leaving an excess length of approximately 5%
  – e.g. with a blunt wooden wedge (Figure 2).
- Cut the profile to the exact length (Figure 2) – ensure that the joint faces are even.
- Join the grease-free joint faces using a cyanacrylate adhesive without displacement (Figure 3) – e.g. using Loctite 406.
- Complete the fitting of the profile (Figure 3).

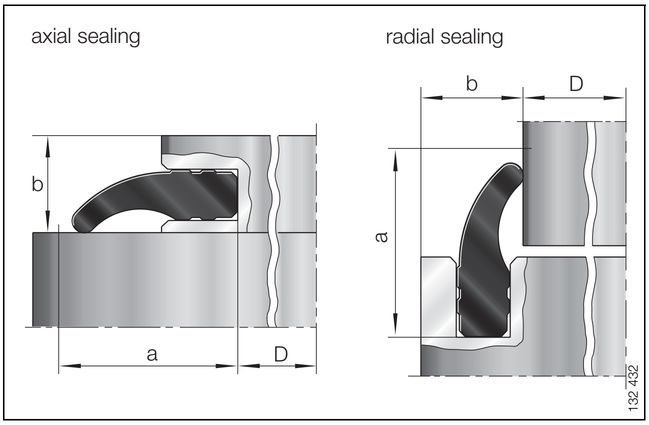


Figure 1 · Dimensioning of the fitting space and the diameter

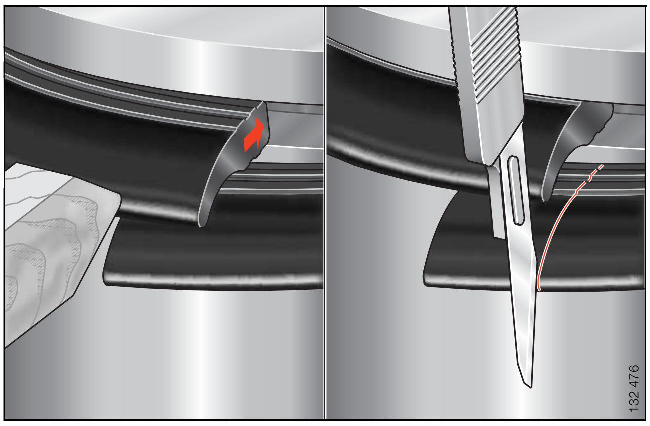


Figure 2 · Pressing in and cutting of the profile in the fitting space

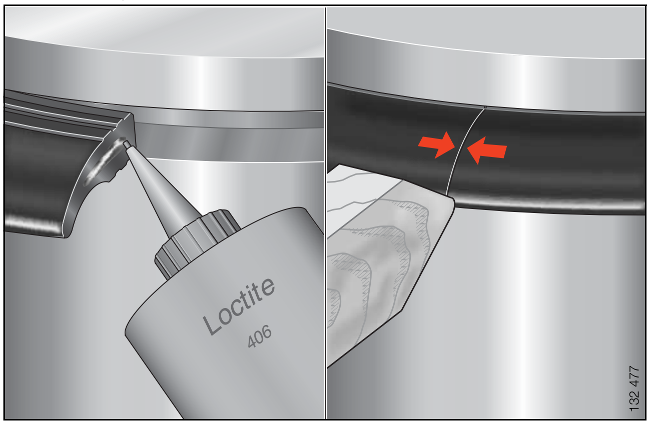
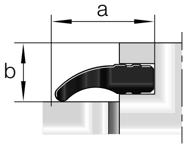
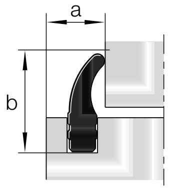
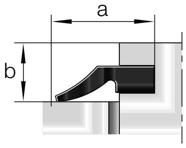
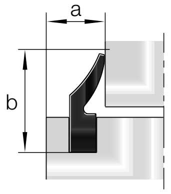
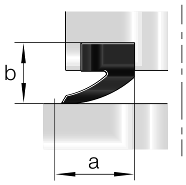
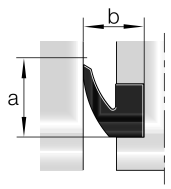
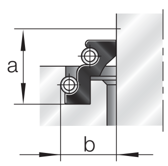
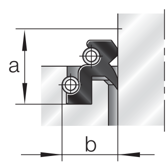
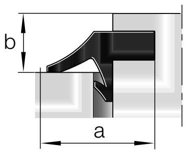
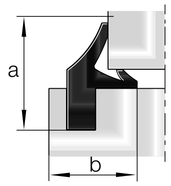


Figure 3 · Bonding of the joint faces and final fitting of the profile

Table 1 · Seal profiles – selection scheme and characteristics

Profile Cross-section		Designation	Diameter range[1] D		Fitting space required (guide values)[1]		Characteristics
axial sealing	radial sealing		axial	radial	a	b	
		**A/R 0101** **A/R 0106** **A/R 0207** **A/R 0509**	100 to 500 100 to 500 300 to 1000 > 400	100 to 500 200 to 700 300 to 1000 > 400	8 9,5 11 17	5 5 7,5 10	– for normal sealing requirements – also suitable for severe contamination
		**A/R 0218** **A/R 0419**	300 to 1000 > 400	300 to 1000 > 400	12 16	7,5 10	– low frictional torque
		**A/R 1025** **A/R 1126** **A/R 1227**	> 200 > 400 > 400	200 to 1000 400 to 1000 > 400	8 12 16	5,5 9 11	– requires little fitting space – protected by fitting in the bearing gap
radial sealing							
R 2001 	**R 2009** 	**R 2001** **R 2009**	–	> 300	13	9,5	– higher contact pressure due to tension spring – particularly suitable for sealing of fluids – only for low speeds or swivel operation
axial and radial sealing							
		**AR 0501**	> 400	> 400	19	14,5	– long maintenance intervals – double direction (axial and radial)

Installation drawings can be requested for the individual seal profiles.

[1] Dimensioning of the fitting space and the diameter: see Figure 1.

Design of bearing arrangements

INA crossed roller bearings can support high loads. Due to the X arrangement of the rolling elements, these bearings can in a single bearing position (Figure 1) support:

- axial loads from both directions
- radial loads
- tilting moment loads
- any combination of loads.

In order that these advantages can be utilised comprehensively, the adjacent construction must be designed that it is appropriately rigid.

⚠ Bearing rings must always be rigidly and uniformly supported around their entire circumference and width (Figure 2).

The adjacent construction must be designed only in accordance with the information in this section!
Any deviations from the specifications, material strength and adjacent components will considerably reduce the load carrying capacity and operating life of the crossed roller bearings.

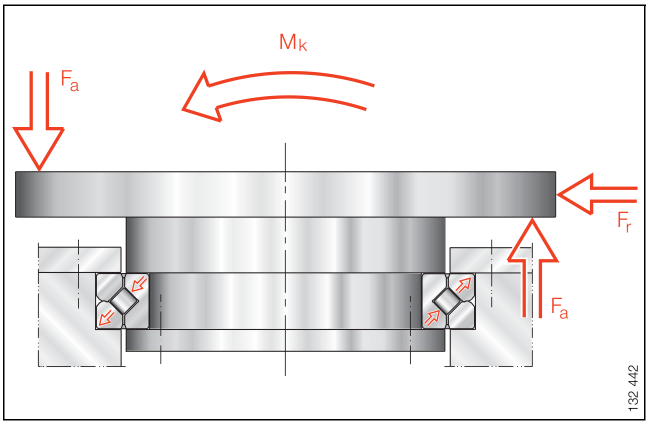


Figure 1 · Load transmission – axial, radial, tilting moment load

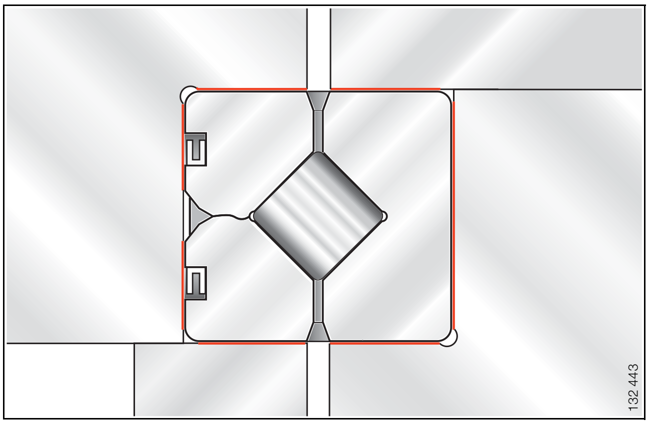


Figure 2 · Uniform support of bearing rings by the adjacent construction – example: crossed roller bearing SX

Sealing of the bearing position

If the bearing arrangement is sealed by means of a seal in the adjacent construction, observe the design guidelines for seal profiles in the section *Sealing of the bearing arrangement*, page 26.

⚠ The area around the bearing seal must be designed such that the seal profiles are not damaged during operation!

Fixing screws

Screws of grade 10.9 in accordance with Table 2, page 31, are suitable for fixing the bearing rings or clamping rings – the dimensioning and tightening torque are dependent on the bearing size.

⚠ Any deviations from the recommended size, grade and number of screws will considerably reduce the load carrying capacity and operating life of the bearings!

For screws of grade 12.9, observe the minimum strength of the clamping rings (see page 30) or use quenched and tempered washers!

Crossed roller bearings SX

Depending on the application, the bearing arrangement must fulfil differing requirements for running accuracy.

Fitting tolerances for normal applications

For normal applications, sufficient tolerances are K7 for the housing and h7 for the shaft (see Table 1).

Fitting tolerances for precision applications

In precision applications, the bearing seat in the housing should be designed to tolerance K6 and the bearing seat on the shaft to h6 (see Table 1).

Table 1 · Fitting tolerances (deviations in μm)

Shaft						Housing bore					
Nominal range		Nominal deviations				Nominal range		Nominal deviations			
>	≦	h6		h7		>	≦	K6		K7	
		upper	lower	upper	lower			upper	lower	upper	lower
65	80	0	–19	0	–30	–	–	–	–	–	–
80	100	0	–22	0	–35	80	100	+4	–18	+10	–25
100	120	0	–22	0	–35	100	120	+4	–18	+10	–25
120	140	0	–25	0	–40	120	140	+4	–21	+12	–28
140	160	0	–25	0	–40	140	160	+4	–21	+12	–28
160	180	0	–25	0	–40	160	180	+4	–21	+12	–28
180	200	0	–29	0	–46	180	200	+5	–24	+13	–33
200	225	0	–29	0	–46	200	225	+5	–24	+13	–33
225	250	0	–29	0	–46	225	250	+5	–24	+13	–33
250	280	0	–29	0	–52	250	280	+5	–27	+16	–36
280	315	0	–32	0	–52	280	315	+5	–27	+16	–36
315	355	0	–36	0	–57	315	355	+7	–29	+17	–40
355	400	0	–36	0	–57	355	400	+7	–29	+17	–40
400	450	0	–40	0	–63	400	450	+8	–32	+18	–45
450	500	0	–40	0	–63	450	500	+8	–32	+18	–45
–	–	–	–	–	–	500	560	0	–44	0	–70
–	–	–	–	–	–	560	630	0	–44	0	–70

Location using clamping rings

For location of crossed roller bearings SX, clamping rings ① have proved effective (Figure 3).

⚠ The thickness of the clamping rings and mounting flanges must not be less than the minimum thickness s according to Table 2!

Counterbores to DIN 74, type J, for screws to DIN 6912 are permissible. For deeper counterbores, the thickness of the clamping ring s must be increased by the additional counterbore depth.

Mounting dimensions: see Table 2 and Figure 5.

Minimum strength of clamping rings

For screws of grade 10.9, the minimum strength under the screw heads or nuts must be 500 N/mm^2.
Washers are not necessary for these screws.

For fixing screws of grade 12.9, the strength must not be less than the minimum strength of 850 N/mm^2 or quenched and tempered washers must be used under the screw heads or nuts.

Bearing seat depth

In order that the clamping rings retain the bearing securely, the bearing seat depth t must be in accordance with Table 2 (Figure 4).

⚠ The depth of the bearing seat influences the bearing clearance and the rotational resistance.

Preloaded bearings (suffix VSP) have a considerably higher rotational resistance.

If particular requirements for rotational resistance apply, the depth t must be produced to match the relevant height of the bearing ring. It has proved useful to tolerance the depth t to deviations that are the same as or further restricted compared to the dimension h in the *dimension tables*. For safety, internal tests should in any case be carried out.

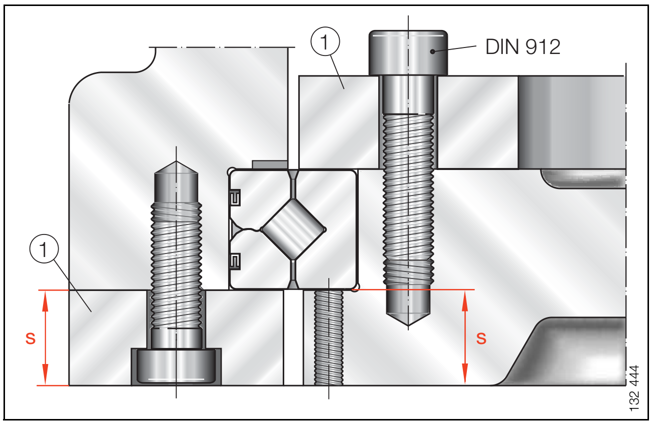


Figure 3 · Crossed roller bearing SX located by means of clamping rings

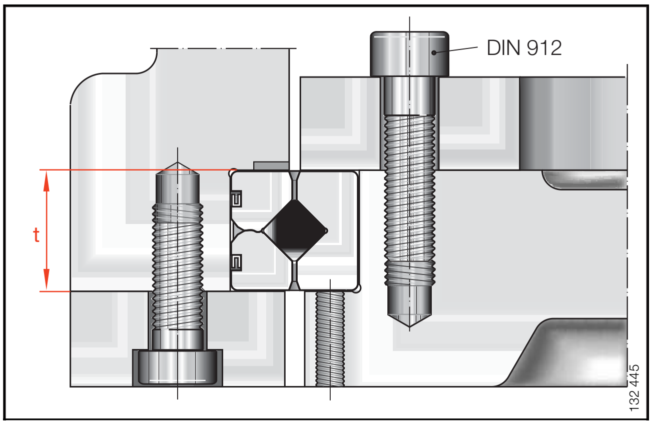


Figure 4 · Bearing seat depth t

Table 2 · Mounting dimensions for the adjacent construction

Designation	Mounting dimensions in mm										Fixing screw Grade 10.9	
	d_i h7 (h6)	D_a K7 (K6)	t	s min.	d_{Ra}	d_{Ri}	D_{Ri}	D_{Ra}	L_i max.	L_a min.	Dimensions	Quantity
SX 01 1814	70	90	$10^{-0,005}_{-0,015}$	8	78	42	82	118	60	100	M5	18
SX 01 1818	90	115	$13^{-0,005}_{-0,020}$	10	100	61	104	144	80	125	M5	24
SX 01 1820	100	125	$13^{-0,005}_{-0,020}$	10	110	71	114	154	90	135	M5	24
SX 01 1824	120	150	$16^{-0,005}_{-0,025}$	12	132	84	138	186	108	162	M6	24
SX 01 1828	140	175	$18^{-0,005}_{-0,030}$	14	154	94	160	221	124	191	M8	24
SX 01 1832	160	200	$20^{-0,02}_{-0,05}$	15	177	111	183	249	144	216	M8	24
SX 01 1836	180	225	$22^{-0,02}_{-0,05}$	17	199	121	205	284	160	245	M10	24
SX 01 1840	200	250	$24^{-0,02}_{-0,06}$	18	221	139	229	311	180	270	M10	24
SX 01 1848	240	300	$28^{-0,02}_{-0,06}$	21	266	166	274	374	216	324	M12	24
SX 01 1860	300	380	$38^{-0,04}_{-0,10}$	29	335	201	345	479	268	412	M16	24
SX 01 1868	340	420	$38^{-0,04}_{-0,10}$	29	375	241	385	519	308	452	M16	24
SX 01 1880	400	500	$46^{-0,04}_{-0,10}$	35	445	275	455	625	360	540	M20	24
SX 01 18/500	500	620	$56^{-0,04}_{-0,10}$	42	554	350	566	770	452	668	M24	24

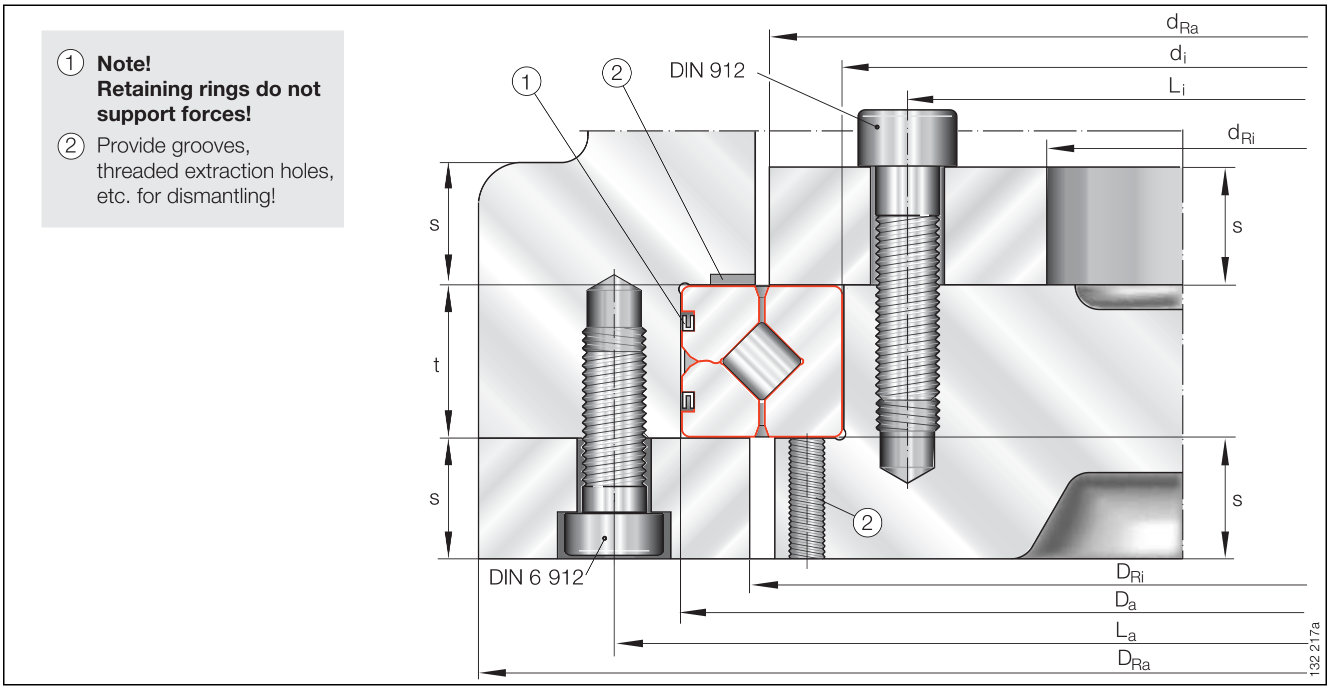


Figure 5 · Design of bearing arrangements – mounting dimensions

Crossed roller bearings XV

Location by means of flange mounting and locknut

Crossed roller bearings XV are screw mounted directly on the housing through the outer ring and centred if necessary (Figure 6).

The inner ring is retained radially by an appropriate fit, abutted axially on a shaft shoulder and located by means of a locknut (Figure 6).

If the bearings are to be lubricated via a lubrication duct ① in the adjacent construction (Figure 6), this must be taken into consideration in the design of the housing.

⚠ Before fitting, at least one pressed-in lubrication nipple ② must be removed from the bearing.

Housing and shaft design

The accuracy of the bearing seat in the housing and on the shaft and shaft shoulder should correspond to the accuracy of the bearing and the requirements of the application.

The following data for the dimensional and geometrical accuracy and roughness are guide values for standard applications (if there are any deviations, please consult INA):

- for the seating and support surfaces in the housing, accuracy according to Figure 7 is required
- for the seating and support surfaces on the shaft, accuracy according to Figure 8 is required.

Table 3 · Fitting tolerances for shaft and housing

		Normal applications	Precision applications
Bore $\varnothing D_{ae}$	Figure 7	K6	K5
Shaft $\varnothing d_{ie}$	Figure 8	h6	h5

<u>INA precision locknuts</u>

For INA precision locknuts of series AM, ZM, ZMA (see *dimension tables*), the thread on the shaft should have an accuracy in accordance with Table 4.

Table 4 · Accuracy for shaft thread

Runout	Metric ISO thread of locknut	Shaft thread (Figure 8)	
Thread/ axial face		Normal applications	Precision applications
µm	"fine"	"medium"	"fine"
5	5H	6g	4h
	DIN 13 Part 21-24	DIN 13 Part 21-24	

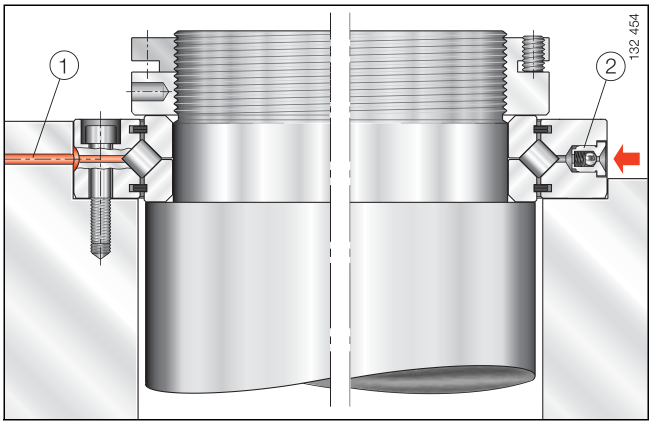


Figure 6 · Radial and axial location of bearing rings – lubricant duct in the adjacent construction

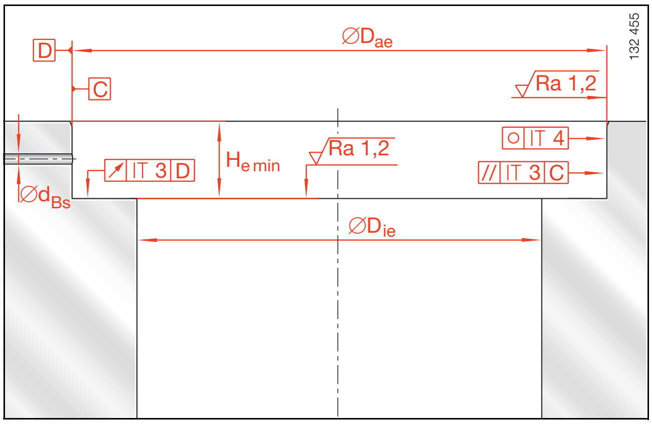


Figure 7 · Housing design

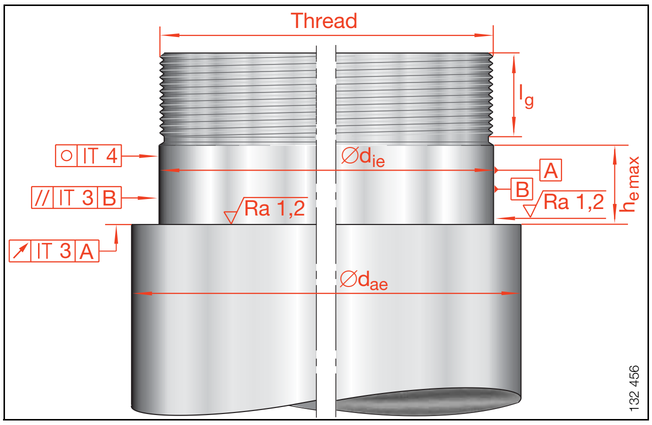


Figure 8 · Shaft design

Crossed roller bearings XSU

Inner and outer ring suitable for flange mounting

Crossed roller bearings XSU are screw mounted directly to the adjacent construction through both bearing rings (Figure 9).

The adjacent construction must be flat and uniformly rigid, while the connection between the bearing adjacent components must be by force locking. For the upper and lower adjacent construction, a cylindrical pot with a flange ring has proved effective (Figure 9).

The wall thickness of the pot should be approximately one third of the flange thickness s and the pot height H_T should be at least five times the flange thickness s (Figure 9). For a more uniform rigidity of the bearing arrangement, thicker walls of the pot and flange ring are more favourable than thin walls with ribs.

In order to achieve the most linear force flow possible, arrange the pot precisely above or below the row of rolling elements!

⚠ Flange rings should be dimensioned such that they support the whole width of the bearing rings!

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 10)
- the perpendicularity deviation must not exceed the permissible value δ_W (Figure 10).

Permissible flatness deviation (Figure 10)

The flatness deviation δ_B is calculated using the following formula and applies in the circumferential and transverse direction:

- 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.

$$\delta_B = \frac{D_M + 1000}{20000}$$

δ_B mm
Maximum permissible flatness deviation

D_M mm
Rolling element pitch circle diameter.

Permissible perpendicularity deviation (Figure 10)

The perpendicularity deviation δ_W applies in the transverse direction:

- relative to a flange width of 100 mm, the perpendicularity deviation δ_W must not exceed half of the permissible flatness deviation δ_B ($\delta_W \leqq 0,5\ \delta_B$).

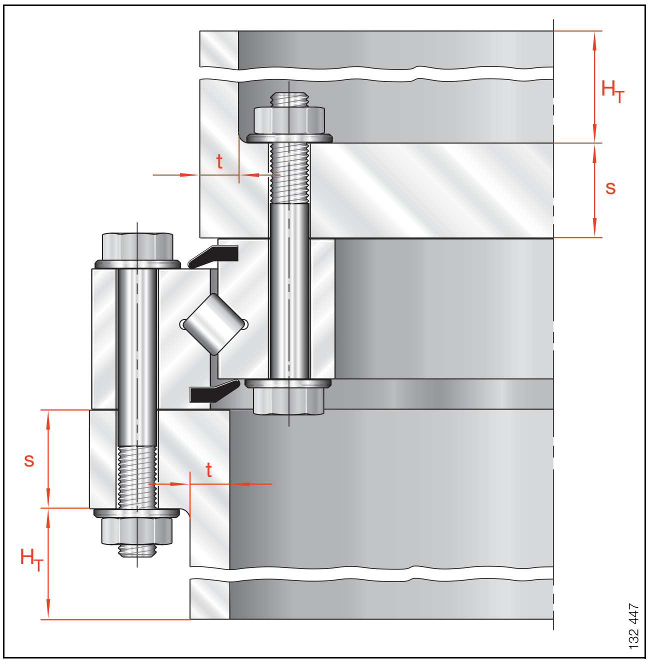


Figure 9 · Crossed roller bearing XSU between upper and lower adjacent construction

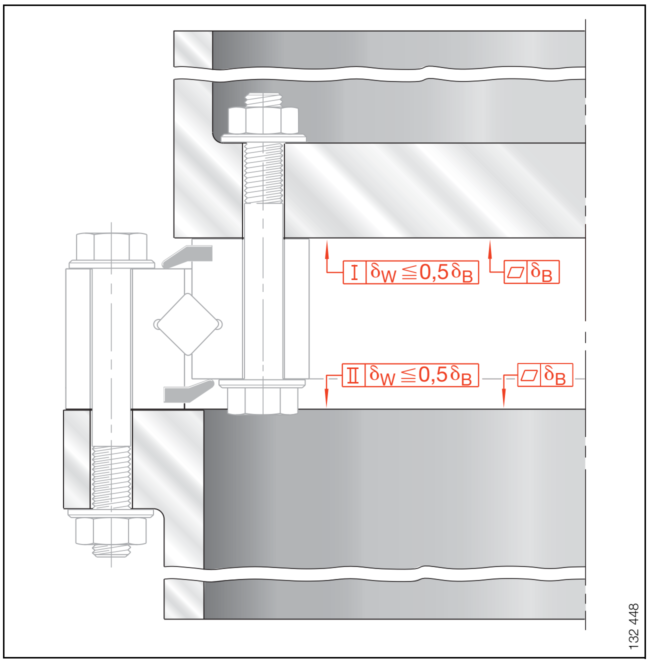


Figure 10 · Permissible flatness deviation

Fitting

Preparations for fitting

Crossed roller bearings are precision machine elements. These bearings must be handled very carefully both before and during fitting. 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 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 seat surfaces can rust or the raceway system can become contaminated!

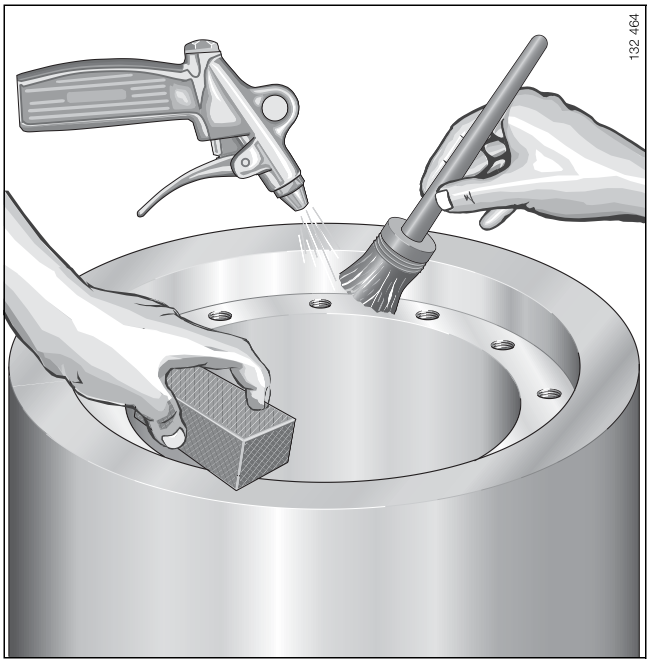


Figure 1 · Preparing the adjacent construction

Checking the bearing seat and bearing mounting surfaces on the adjacent construction

Series SX (Figure 2)

- 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.

⚠ The minimum strength of the adjacent components under the screw heads or nuts is 500 N/mm^2! If fixing screws of grade 10.9 are used, washers are not necessary.

If fixing screws of grade 12.9 are used, the minimum strength must not be less than 850 N/mm^2 or quenched and tempered washers must be used under the screws or nuts.

- Check the fitting tolerances in accordance with the section *Design of bearing arrangements* – Table 1, page 29 and Table 2, page 31 – or the assembly drawing.
- Check the bearing seat depth t in accordance with the section *Design of bearing arrangements* – Table 2, page 31 or the assembly drawing.
- Check the minimum thickness s for clamping rings and mounting flange and the depth of the counterbores in accordance with the section *Design of bearing arrangements* – Table 2, page 31 – or the assembly drawing.

Series XV (Figure 3)

- Check the edge radius at the end of the thread X, the undercut on the shaft shoulder Y and the lead chamfer on the housing bore Z in accordance with the assembly drawing.
- Check the surface quality and the dimensional and geometrical accuracy of the seating and locating surfaces, Figure 7 and 8, page 32.

⚠ Check the shaft and housing seat using a micrometer screw at a minimum of two points.

The bearing locating surfaces on the shaft shoulder or in the housing bore must be perpendicular to the cylindrical fit surfaces.

The abutment diameter on the shaft shoulder and the bearing seat depth in the housing must not be less than the minimum values in the section *Design of bearing arrangements*, Figure 7 and 8, page 32, or the assembly drawing.

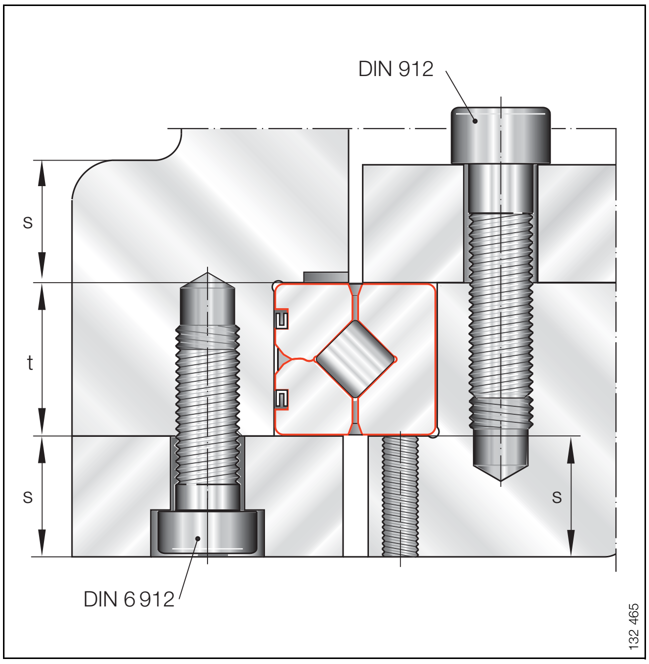


Figure 2 · Bearing seat depth t, clamping ring thickness s

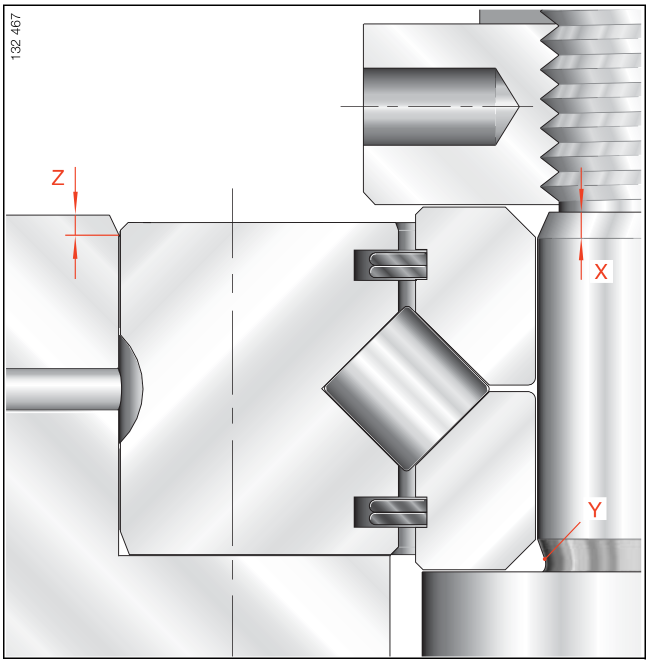


Figure 3 · Edge radius, undercut, lead chamfer

Series XSU (Figure 4)

- 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 flange height H and the flange width t in accordance with the section *Design of bearing arrangements*, page 33 or the assembly drawing.
- Check the flatness and perpendicularity deviation of the adjacent construction in accordance with the section *Design of bearing arrangements*, page 33.

⚠ The permissible deviations must not be exceeded.

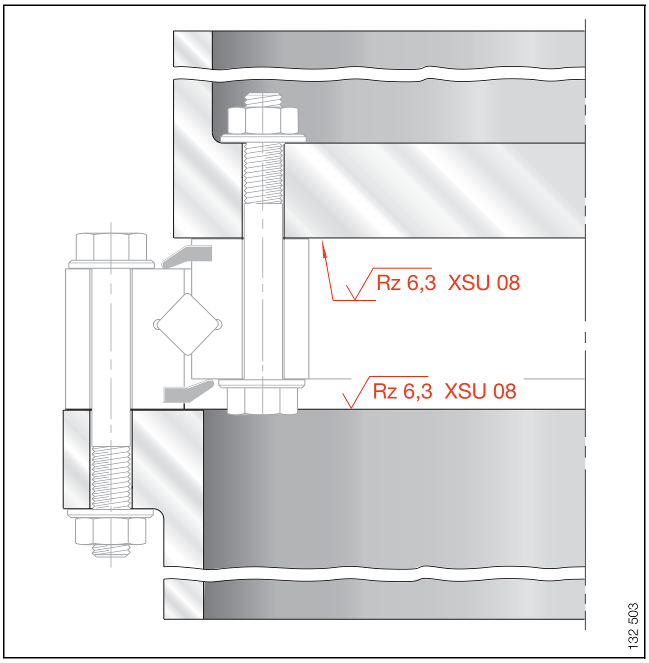


Figure 4 · Surface quality

Delivery condition of crossed roller bearings

Bearings of series SX, XSU and XV are:

- greased with lithium complex soap grease KP2N–25 to DIN 51 825 and dry preserved using VCI paper.

Storage and storage life of crossed roller bearings

⚠ Bearings should only be stored lying down, never standing up (Figure 5)!

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 (Figure 6):

- 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.

Unpacking and transporting crossed roller bearings

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 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 7).

⚠ Bearings must not be wrapped in a chain!
Bearings should never be supported at one point only for lifting!

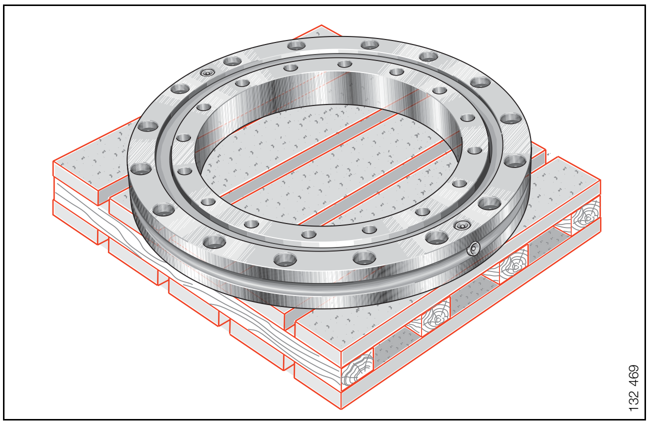


Figure 5 · Storage of crossed roller bearings

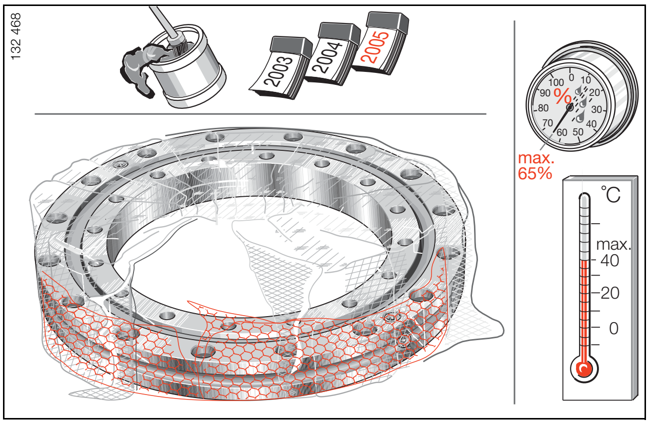


Figure 6 · Storage life

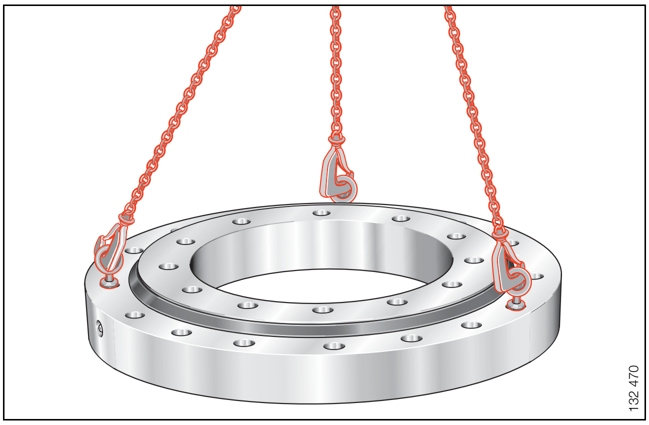


Figure 7 · Transport of bearings

Selection of fasteners

⚠ The specifications relating to the fasteners must be adhered to!

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 publication
- the technical quotation documents
- the customer's assembly drawing.

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

INA precision locknuts

The split inner ring of crossed roller bearing XV can be axially located using a nut. At the same time, this nut sets the bearing clearance or preloads the bearing.

INA precision locknuts of series AM, ZM and ZMA are proven components for locating and setting the bearing clearance or for preloading the bearing (see *Fasteners*, page 19).

⚠ Do not under any circumstances exceed the tightening torques M_{AL} of the locknuts in the *dimension table* (page 58 to 60). The tightening torque required should also be stated in the assembly drawing.

Precision locknuts must be secured using grub screws after screw mounting.

Securing of screws

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

⚠ Not every method of securing screws is suitable for crossed roller bearings!

Never use spring washers or split washers!

General information on 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 companies.

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! Direct blows on the bearing rings must be avoided.

Bearing rings should be located consecutively and without external load.

Bearings must not be heated using a naked flame! The material undergoes excessive localised heating, reducing its hardness. Furthermore, this will induce stresses in the bearing.

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

Fitting of crossed roller bearings SX

⚠ The outer ring is split and is held together by three retaining rings ①. Never apply tensile loads to the retaining rings!

Lightly oil or grease the bearing seat and locating surfaces 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).

Locating the bearing outer ring (Figure 8)

- Insert or press the bearing ② into the external adjacent construction ③ via the outer ring.
- Position the external clamping ring ④.
- Insert the fixing screws ⑤ in the clamping ring and tighten in steps up to the specified tightening torque M_A.
  - Tighten the screws in a crosswise sequence ⓐ in order to prevent unacceptable fluctuations in the screw tensioning forces.
  - Tightening torques M_A for fixing screws: see Table 1, page 43.

Locating the bearing inner ring (Figure 9)

- Insert the bearing ② in the internal adjacent construction ⑥.
- Position the internal clamping ring ⑦.
- Insert the fixing screws ⑧ in the clamping ring and tighten in steps up to the specified tightening torque M_A.
  - Tighten the screws in a crosswise sequence ⓐ in order to prevent unacceptable fluctuations in the screw tensioning forces.
- Check the function of the bearing (see *Checking the function*, page 42).

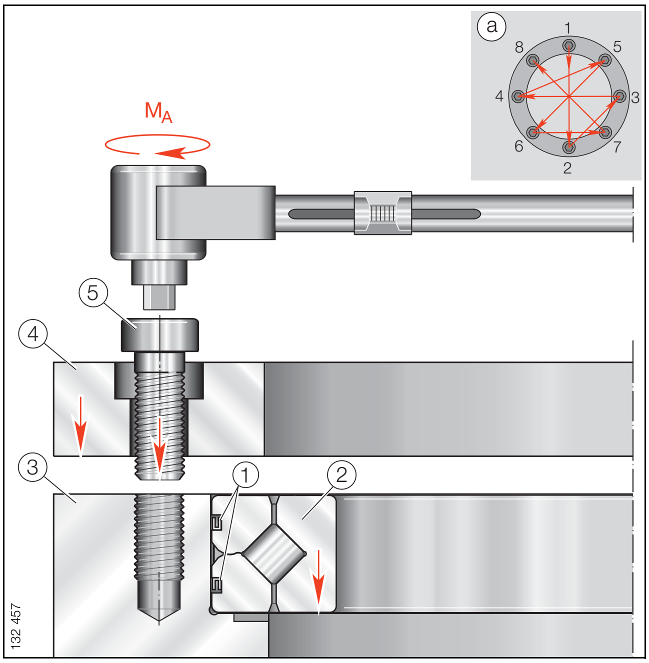


Figure 8 · Locating the external bearing ring

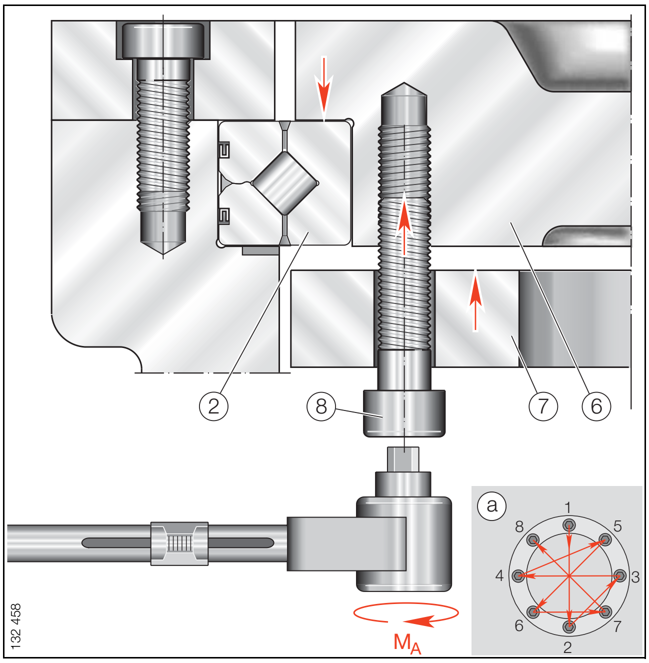


Figure 9 · Locating the internal bearing ring

Fitting of crossed roller bearings XV

Lightly oil or grease the bearing seat and locating surfaces for the bearing rings on the adjacent construction and the thread on the shaft.

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).

Locating the bearing outer ring (Figure 10)

- Insert or press the crossed roller bearing ① into the locating bore of the adjacent construction ② via the outer ring.
- Insert the fixing screws ③ – with washers if necessary – in the outer ring and tighten in steps up to the specified tightening torque M_A.
  - Tighten the screws in a crosswise sequence ⓐ, so that the bearing rings are fitted as far as possible without distortion.
  - While the outer ring is being tightened, rotate the inner ring by several times the spacing of several screw pitches.
  - Tightening torques M_A for fixing screws: see Table 1, page 43.

Locating the bearing inner ring (Figure 11)

- Insert the shaft ④ in the inner ring bore as far as the locating shoulder.
- Locate the inner ring ⑤ axially using INA precision locknuts ⑥.
- Set the bearing clearance or apply preload by tightening the locknut using a hook wrench. Do not exceed the tightening torque M_{AL}.
- In order to secure the locknut, tighten the grub screws ⑦ uniformly and alternately ⑥ up to the specified tightening torque M_m in accordance with the value in the table.
- Check the function of the bearing (see *Checking the function*, page 42).

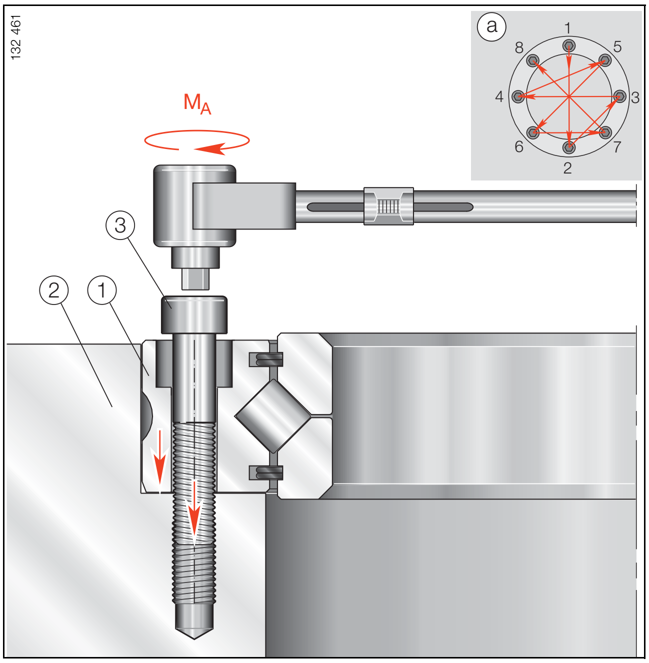


Figure 10 · Locating the external bearing ring

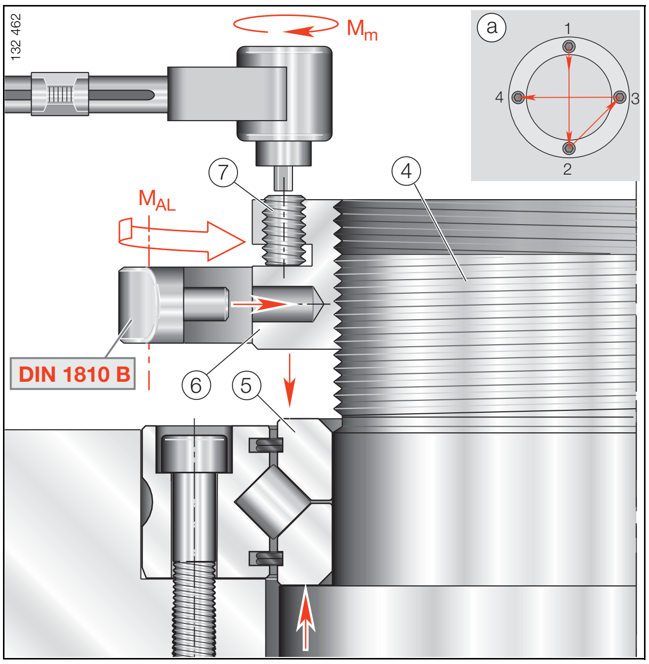


Figure 11 · Locating the internal bearing ring

Fitting of crossed roller bearings XSU

Lightly oil or grease the bearing seat 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).

Locating the bearing outer ring (Figure 12)

- Position the crossed roller bearing on the screw mounting surface of the adjacent construction ② via the outer ring ①.
- Insert the fixing screws ③ – with washers if necessary – in the outer ring and tighten in steps up to the specified tightening torque M_A.
  - Tighten the screws in a crosswise sequence ⓐ in order to prevent distortion of the bearing rings.
  - While the outer ring is being tightened, rotate the inner ring by several times the spacing of several screw pitches.
  - Tightening torques M_A for fixing screws: see Table 1, page 43.

Locating the bearing inner ring (Figure 13)

- Position the crossed roller bearing on the screw mounting surface of the adjacent construction ⑤ via the inner ring ④ or the adjacent construction on the bearing ring.
- Insert the fixing screws ⑥ – with washers if necessary – in the inner ring and tighten in steps up to the specified tightening torque M_A.
  - Tighten the screws in a crosswise sequence ⓐ in order to prevent distortion of the bearing rings.
- Check the function of the bearing (see *Checking the function*, page 42).

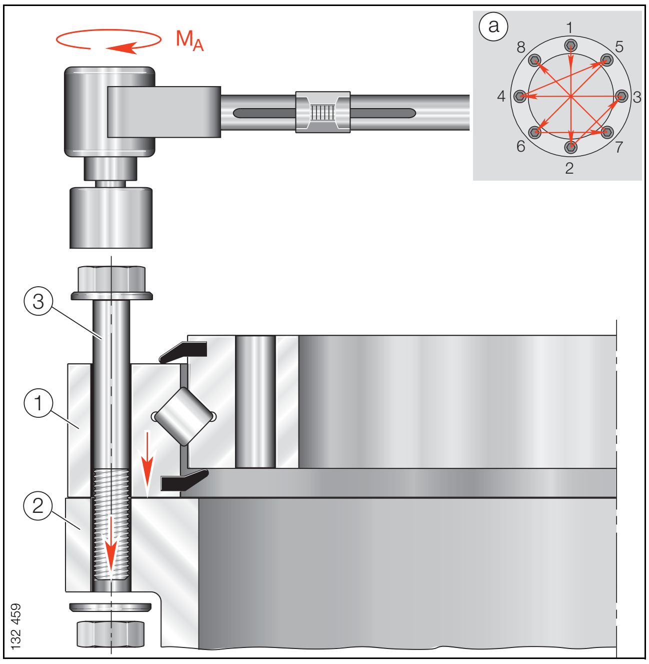


Figure 12 · Locating the external bearing ring

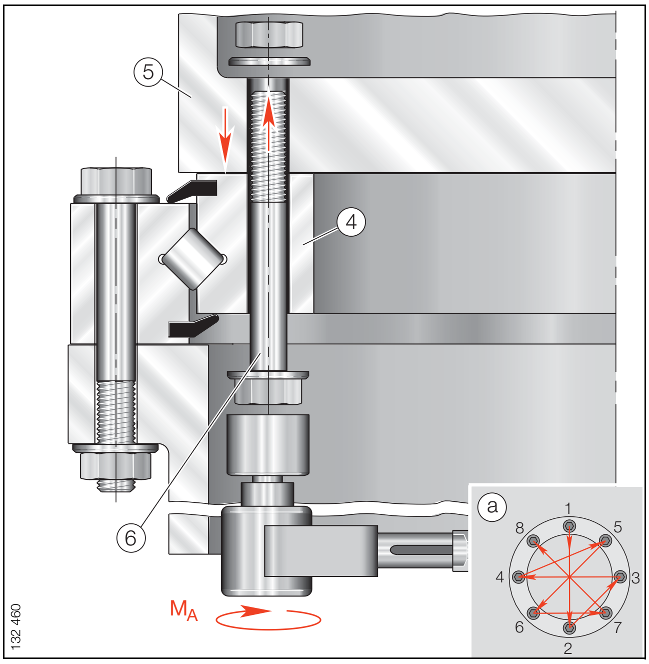


Figure 13 · Locating the internal bearing ring

Once assembly is complete, the operation of the fitted crossed roller bearing 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 publication!

Running accuracy

- Check the running accuracy using a dial gauge.
  - For values, see the assembly drawing or the *dimension tables*.

⚠ Deviations from the values may be the result of:
- inaccuracies in the adjacent construction
- unevenly stressed bearings due to incorrectly tightened clamping rings, fixing screws or locknuts.

Rotational resistance

The rotational resistance is essentially determined by:
- the rolling resistance of the rolling elements
- the bearing 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.

Table 1 · Tightening torques M_A and assembly preload forces F_M for the torque-controlled tightening of fixing screws (set screws)

Fixing screw Dimensions	Clamping cross-section	Core cross-section	Tightening torque M_A[1] in Nm Grade			Fitting preload F_M[2] in kN Grade		
	A_s mm^2	A_{d3} mm^2	8.8	10.9	12.9	8.8	10.9	12.9
M 4	8,78	7,75	2,25	3,31	3,87	4,05	5,95	6,96
M 5	14,2	12,7	4,61	6,77	7,92	6,63	9,74	11,4
M 6	20,1	17,9	7,8	11,5	13,4	9,36	13,7	16,1
M 8	36,6	32,8	19,1	28	32,8	17,2	25,2	29,5
M10	58	52,3	38	55,8	65,3	27,3	40,2	47
M12	84,3	76,2	66,5	97,7	114	39,9	58,5	68,5
M14	115	105	107	156	183	54,7	80,4	94,1
M16	157	144	168	246	288	75,3	111	129
M18	192	175	229	336	394	91,6	134	157
M20	245	225	327	481	562	118	173	202
M22	303	282	450	661	773	147	216	253
M24	353	324	565	830	972	169	249	291

[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 $\mu_G = 0{,}12$.

Crossed roller bearings

with or without seals

Features

Crossed roller bearings

- are complete units comprising an outer ring, inner ring, rolling elements (cylindrical rollers) and spacers
  - depending on the series, the inner ring or outer ring is unsplit or circumferentially split
- can, due to the X arrangement of the rolling elements, support axial loads from both directions as well as radial loads, tilting moment loads and any combination of loads with a single bearing position
  - this allows designs with two bearing positions to be reduced to a single bearing position (see page 45)
- have high rigidity and high running accuracy
- are preloaded and suitable, with grease lubrication, for circumferential speeds up to
  - 2 m/s ($n \cdot D_M$ = 38 200)
- are greased, but can alternatively be lubricated using oil
- are particularly easy to fit
- are also available in a corrosion-resistant design with the INA special plating Corrotect®.

Crossed roller bearings SX

- have normal clearance or are preloaded
- are fixed to the adjacent construction using clamping rings
- are suitable with normal clearance for circumferential speeds:
  - with oil lubrication up to 8 m/s ($n \cdot D_M$ = 152 800)
  - with grease lubrication up to 4 m/s ($n \cdot D_M$ = 76 400)
- are preloaded and suitable, with oil lubrication, for circumferential speeds up to
  - 4 m/s ($n \cdot D_M$ = 76 400).

Crossed roller bearings XSU

- are preloaded
- are screw mounted by means of the bearing rings directly on the adjacent construction.

Crossed roller bearings XV

- are screwed mounted through the outer ring to the adjacent construction
  - the inner ring is located by means of a locknut
- can be adjusted very precisely to give clearance or preload by means of the locknut.

Crossed roller bearings

SX

132 450

- conform to dimension series 18 to DIN 616
- cylindrical rollers to DIN 5402, spacers made from plastic
- outer ring split in a circumferential direction and held together by three retaining rings
- without seals
- for operating temperatures from –30 °C to +80 °C
- for shaft diameters from 70 mm to 500 mm

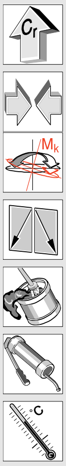
48/50

XV

132 451

- cylindrical rollers to DIN 5402, spacers made from plastic
- inner ring split in circumferential direction
- sealed on both sides
- for operating temperatures from –30 °C to +80 °C
- for shaft diameters from 30 mm to 10 mm
- two lubrication nipples radially and two lubrication nipples axially

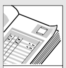
52



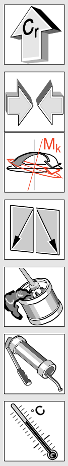
XSU 08

132 452

- series XSU 08
- cylindrical rollers to DIN 5402, spacers made from plastic
- centring on the inside and outside diameter
- sealed on both sides
- for operating temperatures from –30 °C to +80 °C
- for shaft diameters from 130 mm to 360 mm
- two lubrication nipples radially and two lubrication nipples axially



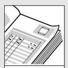
54



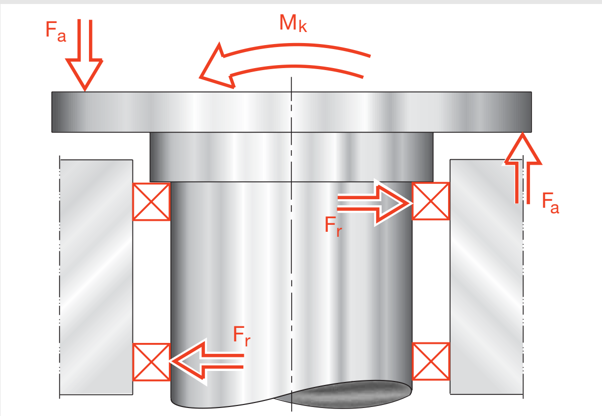
XSU 14

132 453

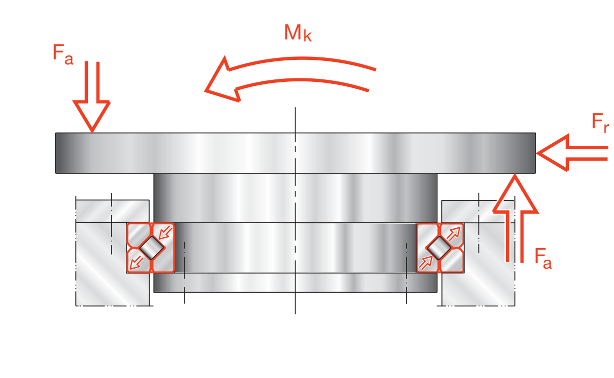
- series XSU 14
- also available with internal or external gear teeth
- cylindrical rollers to DIN 5402, spacers made from plastic
- centring on the inside and outside diameter
- sealed on both sides
- for operating temperatures from –30 °C to +80 °C
- for shaft diameters from 344 mm to 1024 mm



56



Conventional bearing arrangement with two bearing positions



132 463a

Optimised bearing arrangement with one crossed roller bearing

Precision locknuts

AM
ZM, ZMA

Features

Precision locknuts

- are used for crossed roller bearings XV in order to
  - axially locate the split inner ring
  - set the bearing clearance or preload the bearing
- have a high runout accuracy
- have high rigidity
- can support axial forces.

Precision locknuts AM

- are segmented in order to apply the clamping forces:
  - the hexagon socket grub screws are tightened
  - the segments undergo deformation
  - the thread flanks of the segments press against the flanks of the shaft thread
  - the locknut can no longer be loosened
- are secured against rotation by the grub screws in the segments.

Precision locknuts ZM, ZMA

- have two radially arranged locking pegs in order to apply the clamping forces:
  - the locking pegs are manufactured together with the internal thread of the locknut
  - they grip like comb teeth in the shaft thread
  - the locking pegs are located by countertensioning grub screws
  - the locknut can no longer be loosened
- are secured against rotation by the locking pegs.

Breakaway torque and ultimate axial load

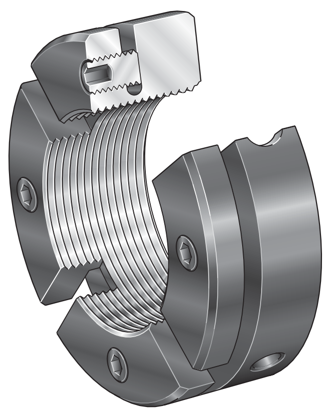
The breakaway torques M_L are given in the *dimension tables* and relate to a locknut that is tightened against a firm shaft collar to the tightening torque M_{AL} and secured; see *Fasteners*, page 19.

The ultimate axial loads F_{aB} are valid for a shaft thread with:

- tolerance 6g or narrower
- a minimum strength of 700 N/mm^2.

For dynamic loading, the permissible value can be taken as 75% of the ultimate axial load F_{aB}.

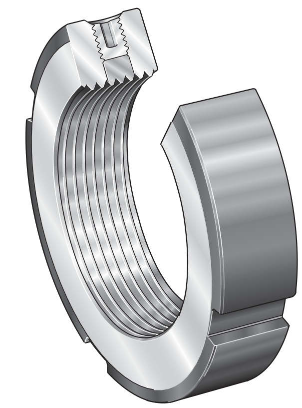
AM



107 282a

- for shaft threads from M15×1 to M90×2

ZM
ZMA



107 281a

- ZM for shaft threads from M6×0,5 to M150×2
- ZMA: heavy series
- ZMA for shaft threads from M15×1 to M100×2

Dimension tables

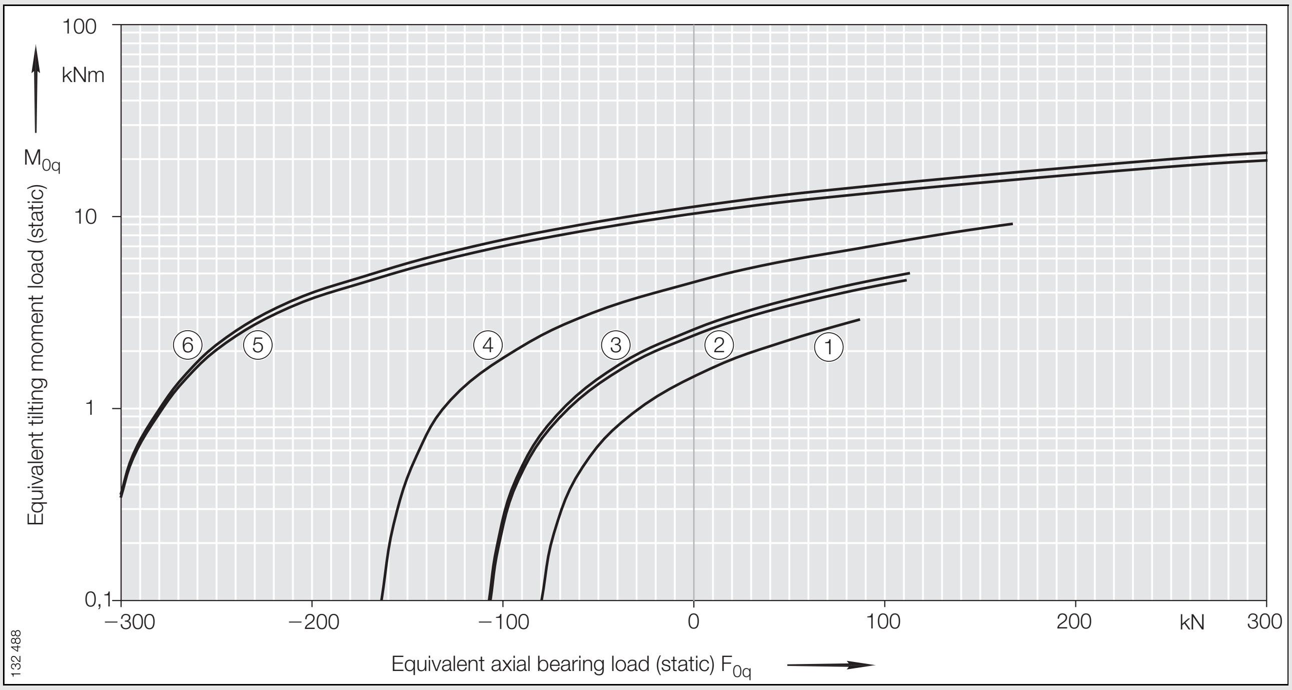
Crossed roller bearings

Series SX

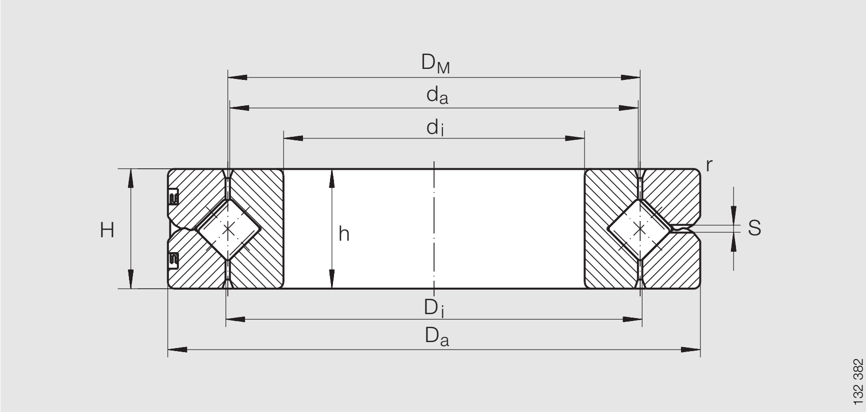
Dimension table · Dimensions in mm

Designation	No.[4]	Mass	Dimensions									Fixing screws	Running accuracy relative to raceway	
		≈ kg	D_M	d_i K6	D_a h6	H[1]	h[1]	d_a	D_i	r_s min.	S[2]	$F_{r\ perm}$ (friction locking) kN	radial	axial
SX 01 1814	①	0,3	80	$70^{+0,004}_{-0,015}$	$90_{-0,022}$	$10\pm0,10$	$10_{-0,01}$	79,5	80,5	0,6	1,2	7,5	0,010	0,010
SX 01 1818	②	0,4	102	$90^{+0,004}_{-0,018}$	$115_{-0,022}$	$13\pm0,12$	$13_{-0,01}$	101,5	102,5	1	2	10	0,010	0,010
SX 01 1820	③	0,5	112	$100^{+0,004}_{-0,018}$	$125_{-0,025}$	$13\pm0,12$	$13_{-0,01}$	111,5	112,5	1	2	10	0,010	0,010
SX 01 1824	④	0,8	135	$120^{+0,004}_{-0,018}$	$150_{-0,025}$	$16\pm0,12$	$16_{-0,01}$	134,4	135,6	1	2	23	0,010	0,010
SX 01 1828	⑤	1,1	157	$140^{+0,004}_{-0,021}$	$175_{-0,025}$	$18\pm0,12$	$18_{-0,01}$	156,3	157,7	1,1	2,5	42,3	0,015	0,010
SX 01 1832	⑥	1,7	180	$160^{+0,004}_{-0,021}$	$200_{-0,029}$	$20\pm0,12$	$20_{-0,025}$	179,2	180,8	1,1	2,5	42,3	0,015	0,010

[1] H: section height of bearing,
h: height of individual ring.
[2] Lubrication hole: 3 holes spaced evenly about the circumference.
[3] Basic load ratings in radial direction: for radial loads only.
[4] See static limiting load diagram *Raceway* and *Fixing screws*.

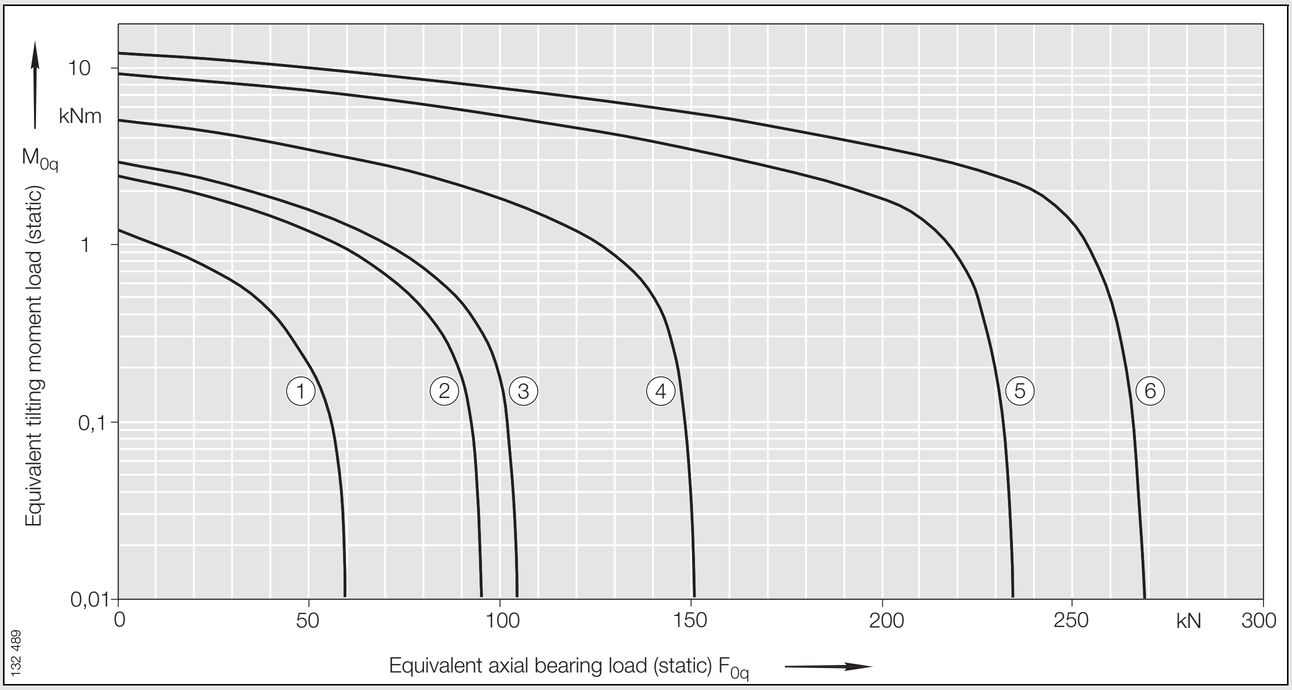


Static limiting load diagram *Fixing screws* – compressive load



SX

Standard clearance				Low clearance RLO		preload VSP		Basic load ratings				Limiting speeds				Dimensionally identical to
radial clearance		axial tilting clearance		radial clearance	preload			axial		radial[3)]		with standard clearance		with preload		ISO dimension series 18
								dyn. C_a kN	stat. C_{0a} kN	dyn. C_r kN	stat. C_{0r} kN	n_G oil min^{-1}	n_G grease min^{-1}	n_G oil min^{-1}	n_G grease min^{-1}	
min.	max.	min.	max.	max.	max.	min.	max.									
0,003	0,015	0,006	0,03	0,003	0,006	0,003	0,015	18	60	12	30	1910	955	955	475	618 14
0,003	0,015	0,006	0,03	0,003	0,006	0,003	0,015	26	96	17	47	1500	750	750	375	618 18
0,005	0,020	0,010	0,04	0,004	0,008	0,005	0,020	28	106	18	52	1360	680	680	340	618 20
0,005	0,020	0,010	0,04	0,004	0,008	0,005	0,020	41	153	26	75	1130	565	565	280	618 24
0,005	0,020	0,010	0,04	0,004	0,008	0,005	0,020	64	237	41	116	975	485	485	240	618 28
0,005	0,020	0,010	0,04	0,004	0,008	0,005	0,020	69	272	44	133	850	425	425	210	618 32



Static limiting load diagram *Raceway* – compressive load

Crossed roller bearings

Series SX

Dimension table · Dimensions in mm

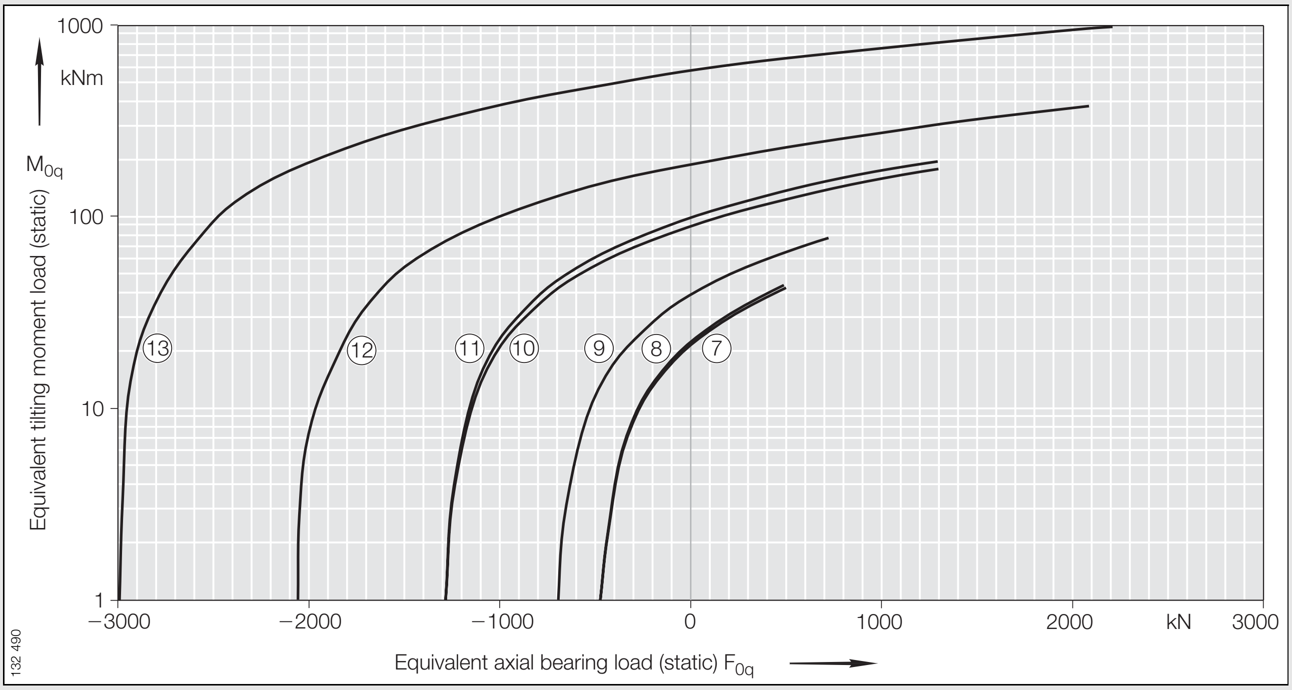
Designation	No.[4]	Mass	Dimensions									Running accuracy relative to raceway	
		≈ kg	D_M	d_i K6	D_a h6	H[1]	h[1]	d_a	D_i	r_s min.	S[2]	radial	axial
SX 01 1836	⑦	2,3	202	$180^{+0,004}_{-0,021}$	$225_{-0,029}$	$22_{\pm 0,13}$	$22_{-0,025}$	201,2	202,8	1,1	2,5	0,015	0,010
SX 01 1840	⑧	3,1	225	$200^{+0,005}_{-0,024}$	$250_{-0,029}$	$24_{\pm 0,13}$	$24_{-0,025}$	224,2	225,8	1,5	2,5	0,015	0,010
SX 01 1848	⑨	5,3	270	$240^{+0,005}_{-0,024}$	$300_{-0,032}$	$28_{\pm 0,13}$	$28_{-0,025}$	269,2	270,8	2	2,5	0,020	0,010
SX 01 1860	⑩	12	340	$300^{+0,005}_{-0,027}$	$380_{-0,036}$	$38_{\pm 0,14}$	$38_{-0,05}$	339,2	340,8	2,1	2,5	0,020	0,010
SX 01 1868	⑪	13,5	380	$340^{+0,007}_{-0,029}$	$420_{-0,040}$	$38_{\pm 0,14}$	$38_{-0,05}$	379,2	380,8	2,1	2,5	0,025	0,010
SX 01 1880	⑫	24	450	$400^{+0,007}_{-0,029}$	$500_{-0,040}$	$46_{\pm 0,15}$	$46_{-0,05}$	449	451	2,1	2,5	0,030	0,010
SX 01 18/500	⑬	44	560	$500^{+0,008}_{-0,032}$	$620_{-0,044}$	$56_{\pm 0,16}$	$56_{-0,05}$	558,8	561,2	3	2,5	0,040	0,010

1) H: section height of bearing,
h: height of individual ring.

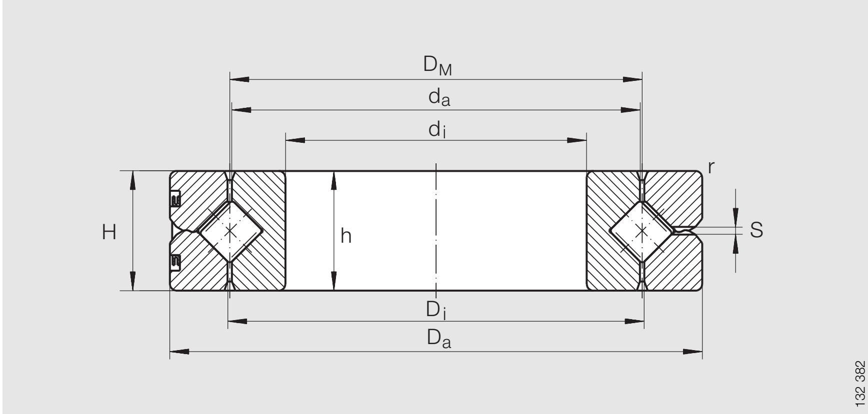
2) Lubrication hole: 3 holes spaced evenly about the circumference.

3) Basic load ratings in radial direction: for radial loads only.

4) See static limiting load diagram *Raceway* and *Fixing screws*.

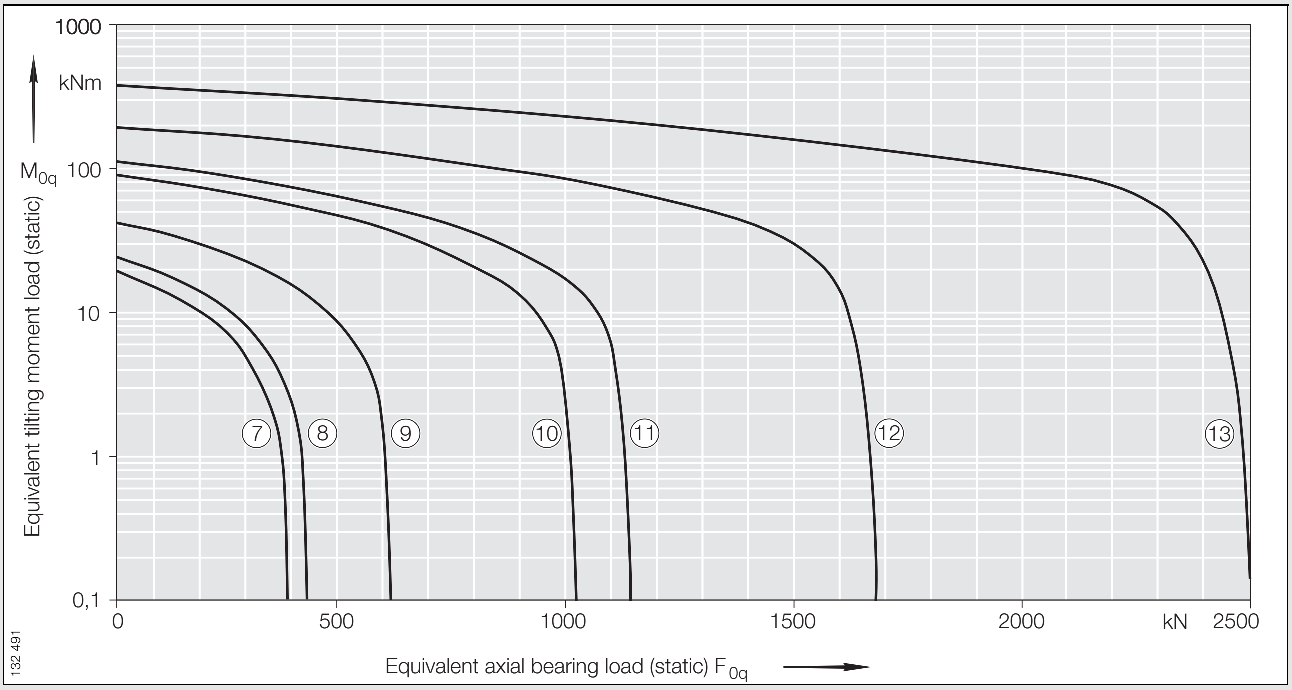


Static limiting load diagram *Fixing screws* – compressive load



SX

Standard clearance				Low clearance RLO		preload VSP		Basic load ratings				Limiting speeds				Dimensionally identical to
radial clearance		axial tilting clearance		radial clearance	preload			axial		radial[3)]		with standard clearance		with preload		ISO dimension series 18
min.	max.	min.	max.	max.	max.	min.	max.	dyn. C_a kN	stat. C_{0a} kN	dyn. C_r kN	stat. C_{0r} kN	n_G oil min^{-1}	n_G grease min^{-1}	n_G oil min^{-1}	n_G grease min^{-1}	
0,005	0,025	0,010	0,05	0,005	0,010	0,005	0,025	98	381	63	187	755	375	375	185	618 36
0,005	0,025	0,010	0,05	0,005	0,010	0,005	0,025	106	425	68	208	680	340	340	170	618 40
0,010	0,030	0,020	0,06	0,005	0,010	0,005	0,025	149	612	95	300	565	280	280	140	618 48
0,010	0,040	0,020	0,08	0,005	0,010	0,005	0,025	245	1027	156	504	450	225	225	110	618 60
0,010	0,040	0,020	0,08	0,005	0,010	0,005	0,025	265	1148	167	563	400	200	200	100	618 68
0,010	0,050	0,020	0,10	0,005	0,010	0,005	0,025	385	1699	244	833	340	170	170	85	618 80
0,015	0,060	0,030	0,12	0,006	0,012	0,005	0,030	560	2538	355	1244	275	135	135	65	618/500



Static limiting load diagram *Raceway* – compressive load

Crossed roller bearings

sealed

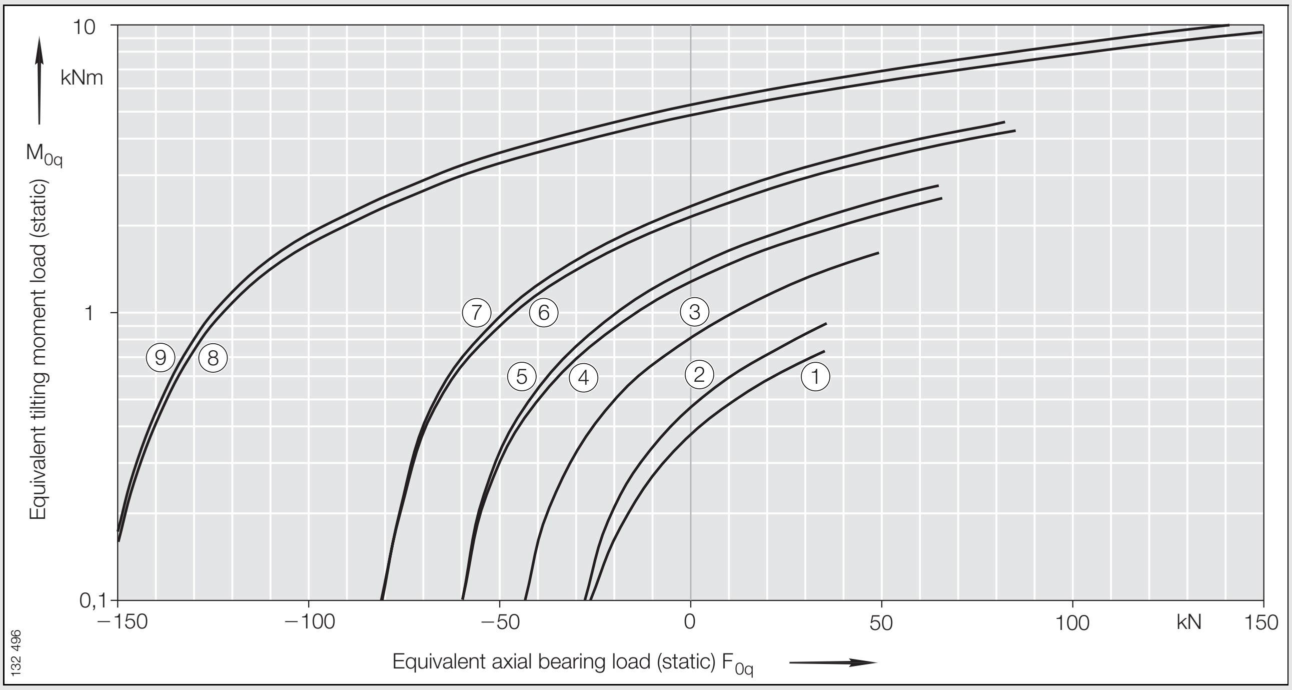
Series XV

Dimension table · Dimensions in mm

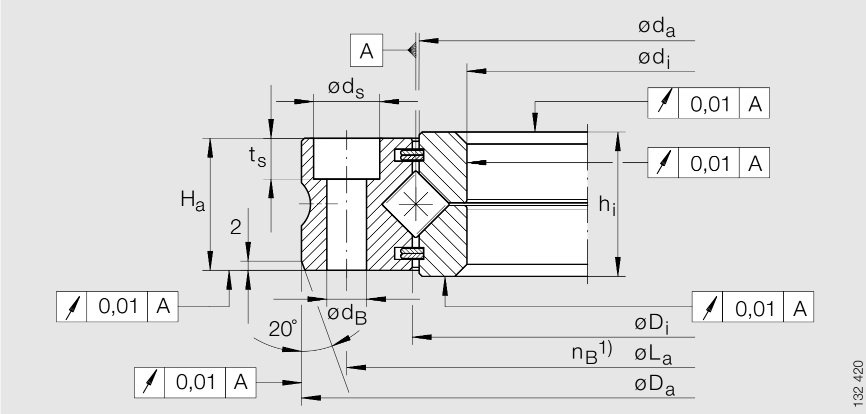
Designation	No.[2]	Mass	Dimensions						Fixing holes	
		≈	D_a	d_i	H_a	h_i	D_i	d_a	L_a	n_B[1]
		kg	h6	J6						
XV 30	①	0,37	$75^{+0}_{-0,019}$	$30^{+0,008}_{-0,005}$	14	15	42,5	41,5	60	12
XV 40	②	0,44	$85^{+0}_{-0,022}$	$40^{+0,010}_{-0,006}$	14	15	52,5	51,5	70	12
XV 50	③	0,67	$100^{+0}_{-0,022}$	$50^{+0,010}_{-0,006}$	16	17	64,5	63,5	85	12
XV 60	④	0,75	$110^{+0}_{-0,022}$	$60^{+0,013}_{-0,006}$	16	17	74,5	73,5	95	16
XV 70	⑤	0,84	$120^{+0}_{-0,022}$	$70^{+0,013}_{-0,006}$	16	17	84,5	83,5	105	16
XV 80	⑥	1,18	$135^{+0}_{-0,025}$	$80^{+0,013}_{-0,006}$	18	19	95,5	94,5	120	16
XV 90	⑦	1,29	$145^{+0}_{-0,025}$	$90^{+0,016}_{-0,006}$	18	19	105,5	104,5	130	16
XV 100	⑧	2,31	$170^{+0}_{-0,025}$	$100^{+0,016}_{-0,006}$	22	23	117,5	116,5	150	16
XV 110	⑨	2,48	$180^{+0}_{-0,025}$	$110^{+0,016}_{-0,006}$	22	23	127,5	126,5	160	16

1) Number of holes per ring.

2) See static limiting load diagram *Raceway* and *Fixing screws*.

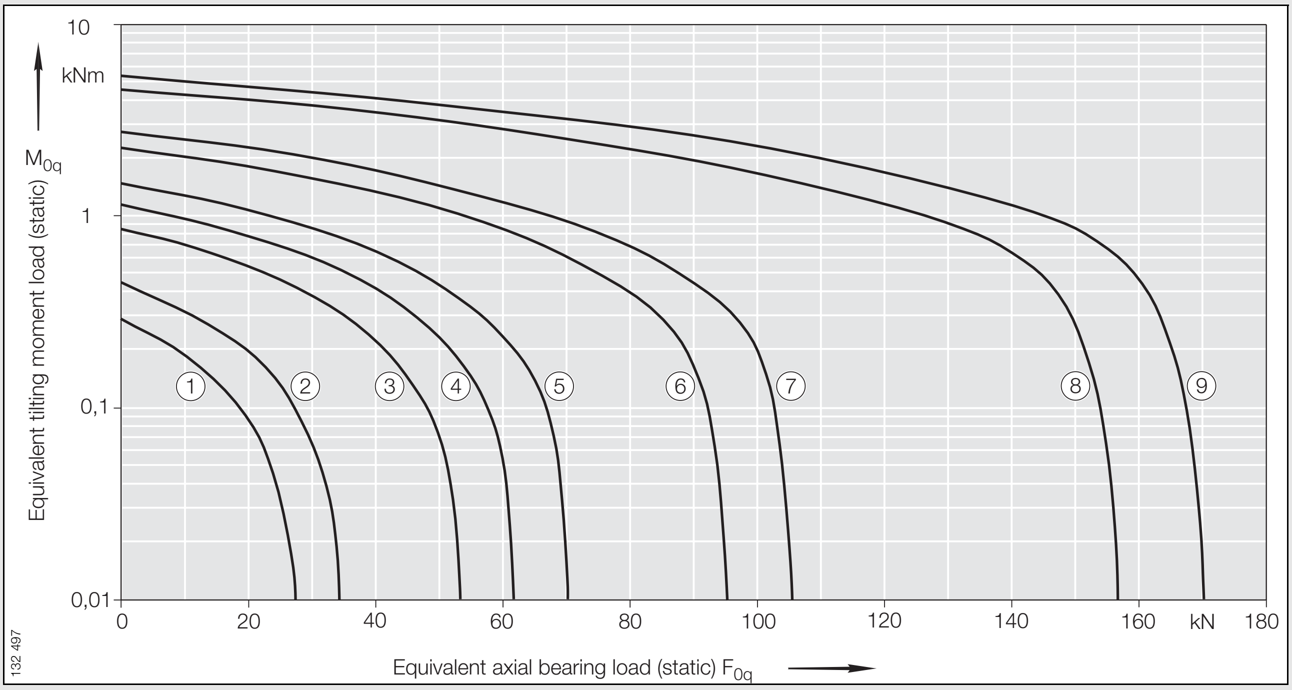


Static limiting load diagram *Fixing screws* – compressive load



XV

d_B	d_s	t_s	Fixing screws $F_{r\,perm}$ (friction locking) kN	Basic load ratings axial dyn. C_a kN	 axial stat. C_{0a} kN	 radial dyn. C_r kN	 radial stat. C_{0r} kN	Limiting speeds with preload min^{-1}	 with clearance min^{-1}
4,6	8	4,6	5	11,6	26	7,4	10,4	910	1819
4,6	8	4,6	5	13,6	34,5	8,7	13,8	735	1469
5,6	10	5,4	8,18	20,6	54	13,1	21,5	597	1194
5,6	10	5,4	10,9	22,6	64	14,4	25,5	516	1032
5,6	10	5,4	10,9	23,6	70	15,1	28	455	910
6,6	11	6,4	15,3	33,5	101	21,4	40,5	402	804
6,6	11	6,4	15,3	35	111	22,3	44,5	364	728
9	15	8,5	28,2	54	163	34,4	65	326	653
9	15	8,5	28,2	57	180	36,2	72	301	602



Static limiting load diagram *Raceway* – compressive load

Crossed roller bearings

sealed

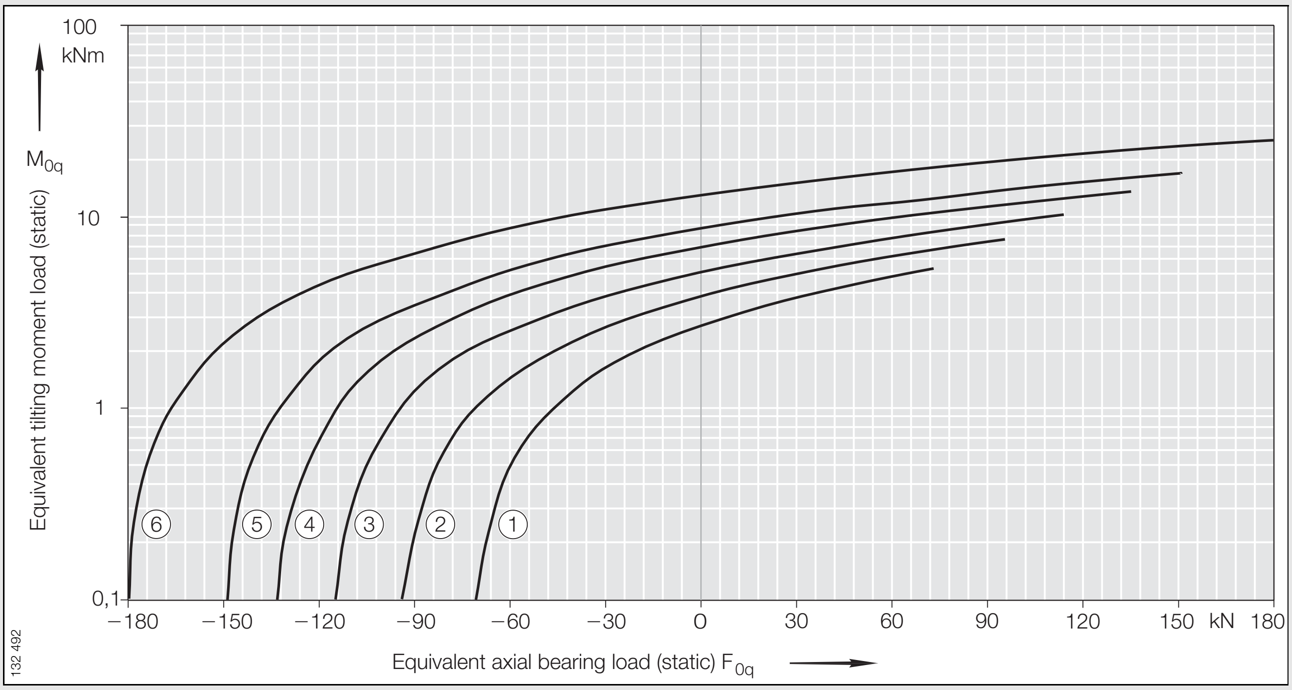
Series XSU

Dimension table · Dimensions in mm

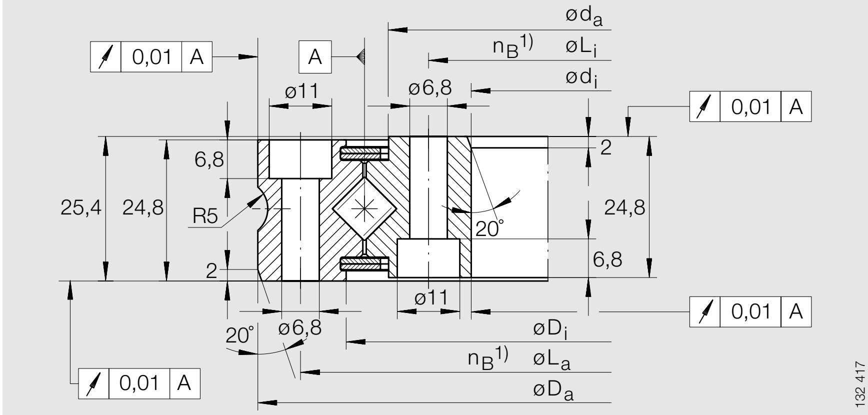
Designation	No.[2]	Mass	Dimensions				Fixing holes		
			D_a	d_i	D_i	d_a	L_a	L_i	n_B[1]
		≈ kg	h6	H6					
XSU 080168	①	3,3	$205^{+0}_{-0,029}$	$130^{+0,025}_{-0}$	174	159	190	145	12
XSU 080188	②	3,7	$225^{+0}_{-0,029}$	$150^{+0,025}_{-0}$	194	179	210	165	16
XSU 080218	③	4,3	$255^{+0}_{-0,032}$	$180^{+0,025}_{-0}$	224	209	240	195	20
XSU 080258	④	5,1	$295^{+0}_{-0,032}$	$220^{+0,029}_{-0}$	264	249	280	235	24
XSU 080318	⑤	6,3	$355^{+0}_{-0,036}$	$280^{+0,032}_{-0}$	324	309	340	295	28
XSU 080398	⑥	7,8	$435^{+0}_{-0,040}$	$360^{+0,036}_{-0}$	404	389	420	375	36

[1] Number of holes per ring.

[2] See static limiting load diagram *Raceway* and *Fixing screws*.

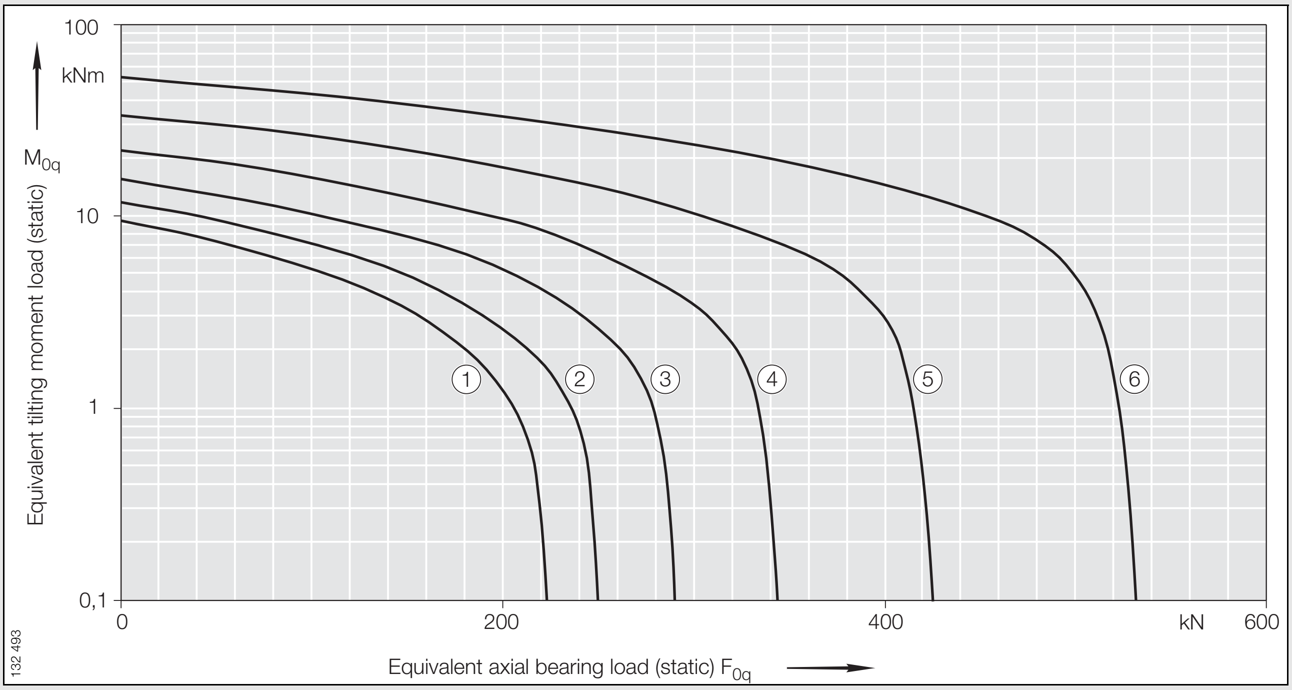


Static limiting load diagram *Fixing screws* – compressive load



XSU 08

Fixing screws $F_{r\ perm}$ (friction locking) kN	Basic load ratings axial dyn. C_a kN	 stat. C_{0a} kN	 radial dyn. C_r kN	 stat. C_{0r} kN	Limiting speeds min⁻¹
8,18	66	240	42	96	227
10,9	71	275	46	110	203
13,6	77	315	49	127	175
16,4	84	375	54	151	148
19,1	93	465	59	185	120
24,5	106	590	68	236	96



Static limiting load diagram *Raceway* – compressive load

Crossed roller bearings

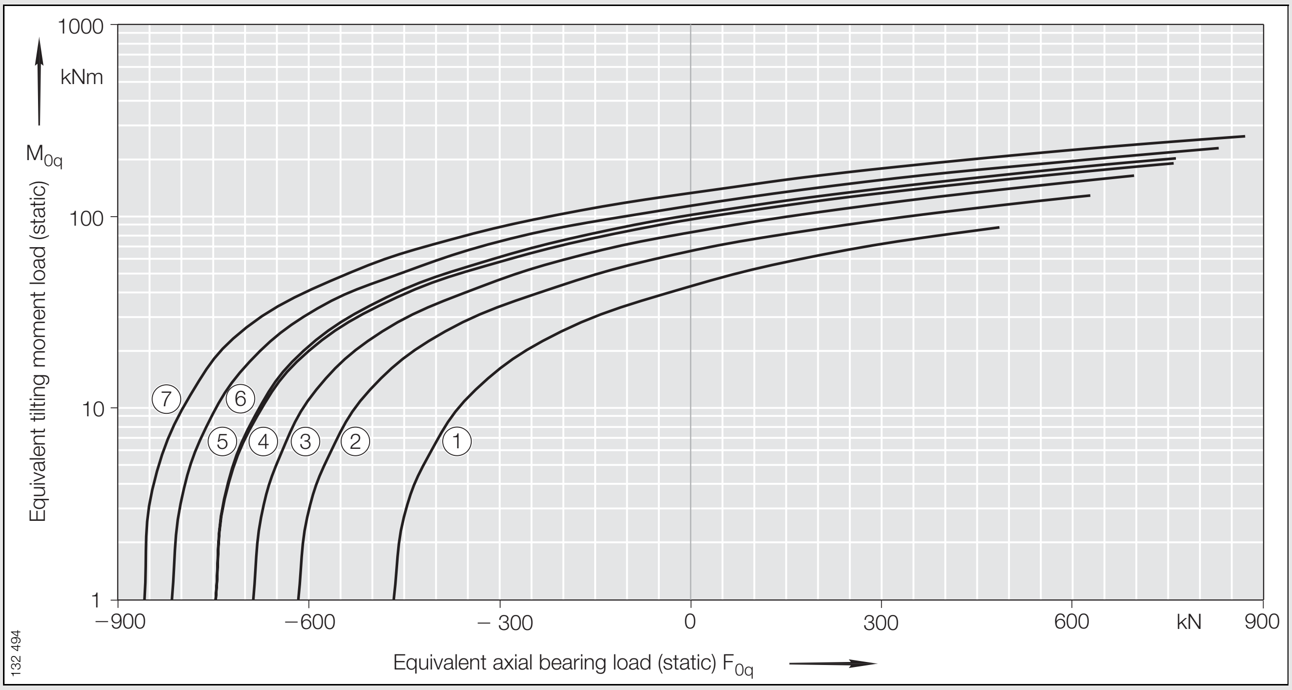
sealed

Series XSU

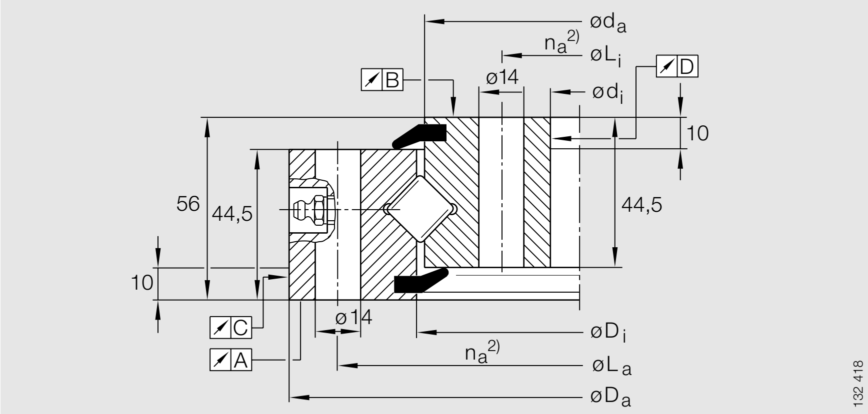
Dimension table · Dimensions in mm

Designation	No.[3]	Mass	Dimensions				Fixing holes			
			D_a[1]	d_i[1]	D_i	d_a	L_a	n_B[2]	L_i	n_i[2]
		≈ kg	h7	H7						
XSU 140414	①	28	$484^{+0}_{-0,06}$	$344^{+0,06}_{-0}$	415	413	460	24	368	24
XSU 140544	②	38	$614^{+0}_{-0,07}$	$474^{+0,06}_{-0}$	545	543	590	32	498	32
XSU 140644	③	44	$714^{+0}_{-0,08}$	$574^{+0,07}_{-0}$	645	643	690	36	598	36
XSU 140744	④	52	$814^{+0}_{-0,09}$	$674^{+0,08}_{-0}$	745	743	790	40	698	40
XSU 140844	⑤	60	$914^{+0}_{-0,09}$	$774^{+0,08}_{-0}$	845	843	890	40	798	40
XSU 140944	⑥	67	$1014^{+0}_{-0,11}$	$874^{+0,09}_{-0}$	945	943	990	44	898	44
XSU 141094	⑦	77	$1164^{+0}_{-0,11}$	$1024^{+0,11}_{-0}$	1095	1093	1140	48	1048	48

[1] Centring lengths: see dimension drawing.
[2] Number of holes per ring.
[3] See static limiting load diagram *Raceway* and *Fixing screws*.



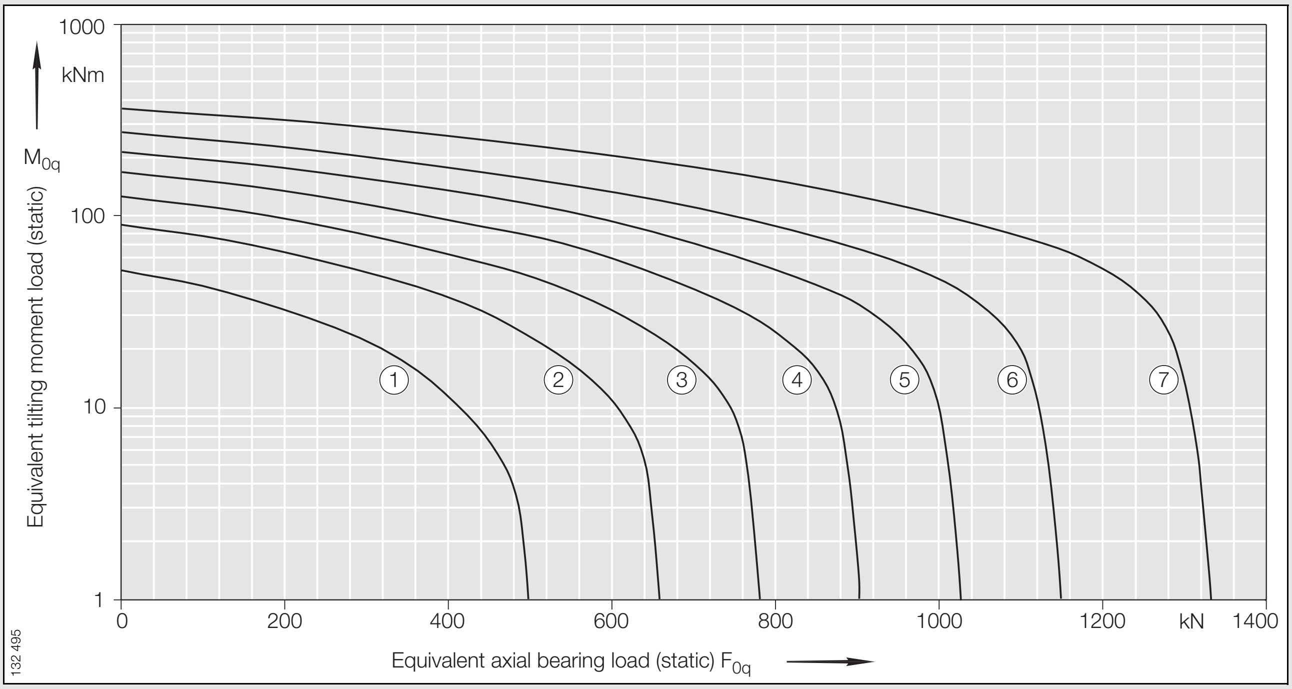
Static limiting load diagram *Fixing screws* – compressive load



XSU 14

4 taper type lubrication nipples, DIN 71412 – A M8×1, arranged evenly about the circumference and recessed

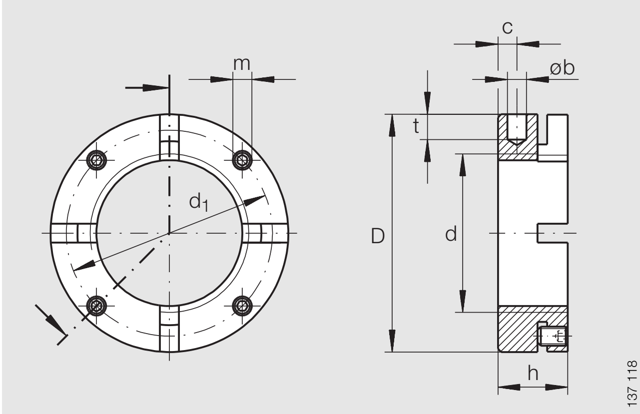
Fixing screws	Running accuracy relative to raceway				Basic load ratings				Limiting speeds
					axial		radial		
$F_{r\ perm}$ (friction locking) kN	A	B	C	D	dyn. C_a kN	stat. C_{0a} kN	dyn. C_r kN	stat. C_{0r} kN	min^{-1}
98,3	0,04	0,04	0,06	0,06	229	520	146	250	92
131	0,04	0,04	0,07	0,06	270	680	170	330	70
147	0,05	0,05	0,08	0,07	270	680	185	395	59
164	0,05	0,05	0,09	0,08	315	930	200	455	51
164	0,06	0,06	0,09	0,08	340	1050	215	510	45
180	0,06	0,06	0,11	0,09	360	1170	227	580	40
197	0,07	0,07	0,11	0,11	390	1360	246	670	35



Static limiting load diagram *Raceway* – compressive load

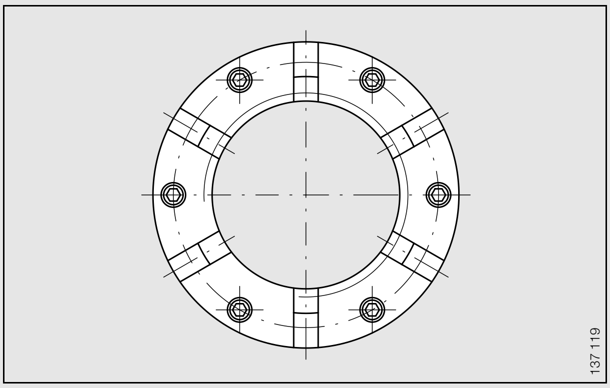
Precision locknuts

Series AM



AM 15 to AM 40

Dimension table · dimensions in mm														
Thread	Designation	Mass	Dimensions							Set screw	Locknut			
										Tightening torque	Ultimate axial load	Breakaway torque at	Tightening torque	Mass moment of inertia
			D	h	b	t	d_1	c	m	M_m	F_{aB}	M_L	M_{AL}	M_M
d		≈ kg								Nm	kN	Nm	Nm	kg · cm^2
M15×1	**AM 15**	0,06	30	18	4	5	23	5	M4	2	102	20	10	0,089
M17×1	**AM 17**	0,07	32	18	4	5	26	5	M4	2	120	25	15	0,113
M20×1	**AM 20**	0,13	38	18	4	6	29,5	5	M6	5	145	45	18	0,225
M25×1,5	**AM 25**	0,16	45	20	5	6	35	6	M6	5	205	60	25	0,491
M30×1,5	**AM 30**	0,2	52	20	5	7	40	6	M6	5	246	70	32	0,86
M35×1,5	**AM 35/58**	0,23	58	20	5	7	48	6	M6	5	282	90	40	1,3
M35×1,5	**AM 35**	0,33	65	22	6	8	48	6	M6	5	329	100	40	2,41
M40×1,5	**AM 40**	0,3	65	22	6	8	51	6	M6	5	347	120	55	2,26
M45×1,5	**AM 45**	0,34	70	22	6	8	56	6	M6	5	360	220	65	2,94
M50×1,5	**AM 50**	0,43	75	25	6	8	62	8	M6	5	450	280	85	4,34
M60×2	**AM 60**	0,65	90	26	6	8	75	8	M6	5	547	365	100	9,4
M70×2	**AM 70**	0,79	100	28	8	10	85	9	M8	10	654	450	130	14,7
M90×2	**AM 90**	1,58	130	32	8	10	112	13	M8	10	912	1 100	200	49,4

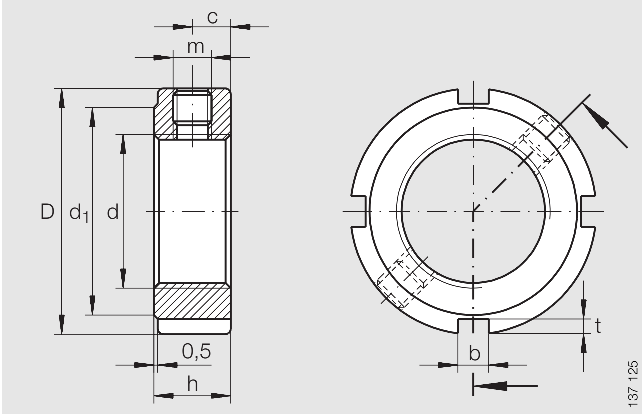


AM 45 to AM 90

Precision locknuts

Series ZM
ZMA

Dimension table · dimensions in mm														
Thread	Designation	Mass	Dimensions							Set screw	Locknut			
										Tightening torque	Ultimate axial load	Breakaway torque at	Tightening torque	Mass moment of inertia
			D	h	b	t	d_1	c	m	M_m	F_{aB}	M_L	M_{AL}	M_M
d		≈ kg								Nm	kN	Nm	Nm	kg · cm^2
M 6×0,5	**ZM 06**	0,01	16	8	3	2	12	4	M4	1	17	20	2	0,004
M 8×0,75	**ZM 08**	0,01	16	8	3	2	12	4	M4	1	23	25	4	0,004
M10×1	**ZM 10**	0,01	18	8	3	2	14	4	M4	1	31	30	6	0,006
M12×1	**ZM 12**	0,015	22	8	3	2	18	4	M4	1	38	30	8	0,013
M15×1	**ZM 15**	0,018	25	8	3	2	21	4	M4	1	50	30	10	0,021
	ZMA 15/33	0,08	33	16	4	2	28	8	M5	3	106	30	10	0,14
M17×1	**ZM 17**	0,028	28	10	4	2	23	5	M5	3	57	30	15	0,401
M20×1	**ZM 20**	0,035	32	10	4	2	27	5	M5	3	69	40	18	0,068
	ZMA 20/38	0,12	38	20	5	2	33	10	M5	3	174	40	18	0,297
	ZMA 20/52	0,32	52	25	5	2	47	12,5	M5	3	218	40	18	1,38
M25×1,5	**ZM 25**	0,055	38	12	5	2	33	6	M6	5	90	60	25	0,157
	ZMA 25/45	0,16	45	20	5	2	40	10	M6	5	211	60	25	0,572
	ZMA 25/58	0,43	58	28	6	2,5	52	14	M6	5	305	60	25	2,36
M30×1,5	**ZM 30**	0,075	45	12	5	2	40	6	M6	5	112	70	32	0,304
	ZMA 30/52	0,22	52	22	5	2	47	11	M6	5	270	70	32	1,1
	ZMA 30/65	0,55	65	30	6	2,5	59	15	M6	5	390	70	32	3,94
M35×1,5	**ZM 35**	0,099	52	12	5	2	47	6	M6	5	134	80	40	0,537
	ZMA 35/58	0,26	58	22	6	2,5	52	11	M6	5	300	80	40	1,66
	ZMA 35/70	0,61	70	30	6	2,5	64	15	M6	5	460	80	40	5,2
M40×1,5	**ZM 40**	0,14	58	14	6	2,5	52	7	M6	5	157	95	55	0,945
	ZMA 40/62	0,27	62	22	6	2,5	56	11	M8	15	310	95	55	2,07
	ZMA 40/75	0,67	75	30	6	2,5	69	15	M8	15	520	95	55	6,72
M45×1,5	**ZM 45**	0,17	65	14	6	2,5	59	7	M6	5	181	110	65	1,48
	ZMA 45/68	0,35	68	24	6	2,5	62	12	M8	15	360	110	65	3,2
	ZMA 45/85	0,92	85	32	7	3	78	16	M8	15	630	110	65	11,9
M50×1,5	**ZM 50**	0,19	70	14	6	2,5	64	7	M6	5	205	130	85	1,92
	ZMA 50/75	0,43	75	25	6	2,5	68	12,5	M8	15	415	130	85	4,89
	ZMA 50/92	1,06	92	32	8	3,5	84	16	M8	15	680	130	85	16,1
M55×2	**ZM 55**	0,23	75	16	7	3	68	8	M6	5	229	150	95	2,77
	ZMA 55/98	1,17	98	32	8	3,5	90	16	M8	15	620	150	95	20,5



ZM, ZMA

Dimension table (continued) · Dimensions in mm

Thread	Designation	Mass	Dimensions							Set screw	Locknut			
										Tightening torque	Ultimate axial load	Breakaway torque at	Tightening torque	Mass moment of inertia
			D	h	b	t	d_1	c	m	M_m	F_{aB}	M_L	M_{AL}	M_M
d		≈ kg								Nm	kN	Nm	Nm	kg · cm^2
M 60×2	**ZM 60**	0,25	80	16	7	3	73	8	M 6	5	255	180	100	3,45
	ZMA 60/98	1,07	98	32	8	3,5	90	16	M 8	15	680	180	100	19,6
M 65×2	**ZM 65**	0,27	85	16	7	3	78	8	M 6	5	280	200	120	4,24
	ZMA 65/105	1,21	105	32	8	3,5	97	16	M 8	15	750	200	120	25,6
M 70×2	**ZM 70**	0,36	92	18	8	3,5	85	9	M 8	15	305	220	130	6,61
	ZMA 70/110	1,4	110	35	8	3,5	102	17,5	M 8	15	810	220	130	33
M 75×2	**ZM 75**	0,4	98	18	8	3,5	90	9	M 8	15	331	260	150	8,41
	ZMA 75/125	2,11	125	38	8	3,5	117	19	M 8	15	880	260	150	62,2
M 80×2	**ZM 80**	0,46	105	18	8	3,5	95	9	M 8	15	355	285	160	11,2
	ZMA 80/120	1,33	120	35	10	4	105	17,5	M 8	15	810	285	160	44,6
M 85×2	**ZM 85**	0,49	110	18	8	3,5	102	9	M 8	15	385	320	190	13,1
M 90×2	**ZM 90**	0,7	120	20	10	4	108	10	M 8	15	410	360	200	21,8
	ZMA 90/130	2,01	130	38	10	4	120	19	M 8	15	910	360	200	64,1
	ZMA 90/155	3,36	155	38	10	4	146	19	M 8	15	1 080	360	200	150
M100×2	**ZM 100**	0,77	130	20	10	4	120	10	M 8	15	465	425	250	28,6
	ZMA 100/140	2,23	140	38	12	5	128	19	M10	20	940	425	250	82,8
M105×2	**ZM 105**	1,05	140	22	12	5	126	11	M10	20	495	475	300	44,5
M110×2	**ZM 110**	1,09	145	22	12	5	133	11	M10	20	520	510	350	50,1
M115×2	**ZM 115**	1,13	150	22	12	5	137	11	M10	20	550	550	400	56,2
M120×2	**ZM 120**	1,28	155	24	12	5	138	12	M10	20	580	600	450	68,4
M125×2	**ZM 125**	1,33	160	24	12	5	148	12	M10	20	610	640	500	76,1
M130×2	**ZM 130**	1,36	165	24	12	5	149	12	M10	20	630	700	550	84,3
M140×2	**ZM 140**	1,85	180	26	14	6	160	13	M12	38	690	800	600	133
M150×2	**ZM 150**	2,24	195	26	14	6	171	13	M12	38	750	900	650	188

Application example

Lorry-mounted crane

Pedestal bearing arrangement

The lorry-mounted crane has a telescopic jib with a reach of 12,5 m and can lift a mass of 960 kg. By the mounting of additional jibs, it can reach 19,1 m and can lift 270 kg.

The linear motion of the hydraulically driven toothed rack is converted into rotary motion of the crane by means of a pinion. The bearing arrangement must transmit high axial and radial loads as well as large tilting moments. The pedestal bearing arrangement of the crane should be as small as possible. The bearing is subjected to heat, cold and moisture.

Operating data (bearing load)		
Resultant axial load	F_a	35 kN
Resultant radial load	F_r	170 kN
Resultant tilting moment	M_k	170 kNm

INA design solution

The crane rotates in a preloaded crossed roller bearing SX..VSP, so there are no tilting movements. This particularly rigid bearing supports loads from all directions as well as moments. This solution has advantages over conventional bearing arrangements with two bearings: only one bearing seat must be machined and only one bearing must be fitted. There is therefore no need to match two bearings to each other. The crossed roller bearings takes up very little space, so the pedestal bearing arrangement is small.

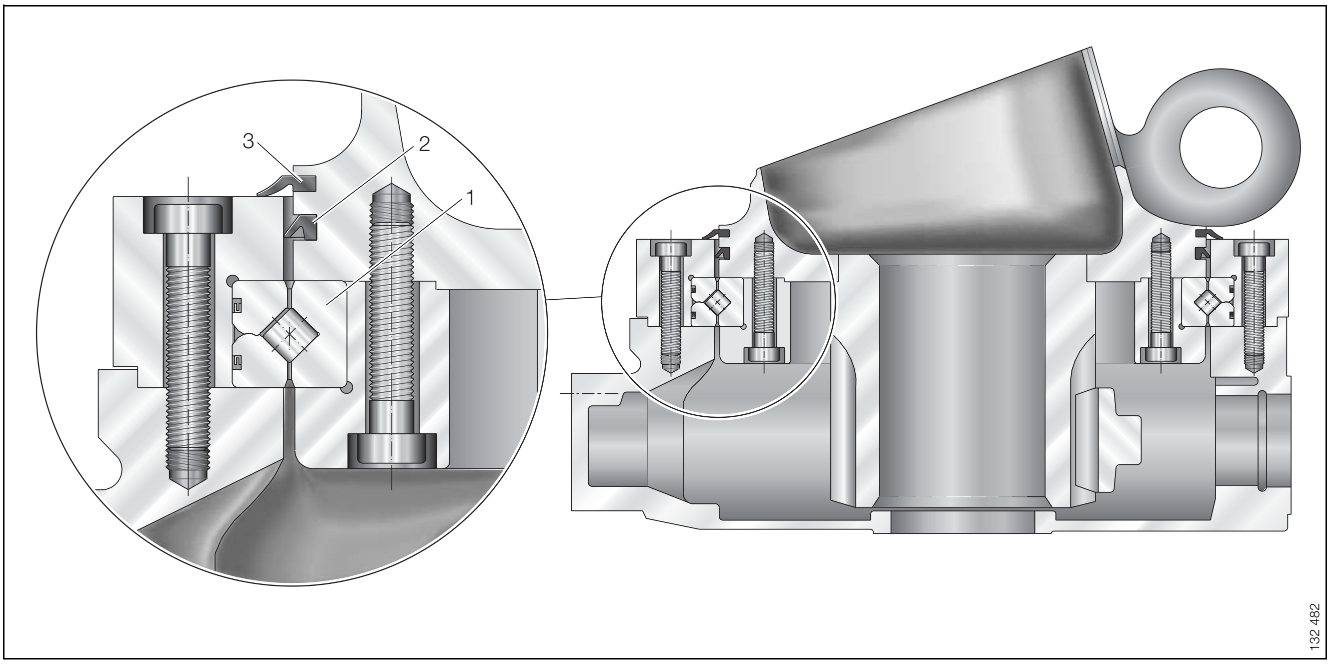
The bearing is suitable for temperatures from –30 °C to +80 °C.

The adjacent construction contains seal profiles A/R 1025 and A/R 0218, which protect the bearing from contaminants and retain the grease in the bearing. The crossed roller bearing is located by means of clamping rings.

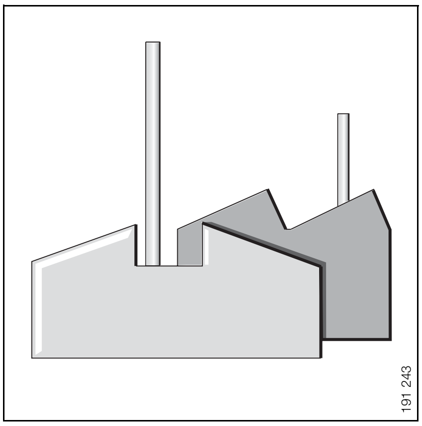
The adjacent construction was optimised using the Finite Element Method.

INA products used

1 Crossed roller bearing SX..VSP
2 Seal profile A/R 1025
3 Seal profile A/R 0218



Manufacturing Plants



Headquarters

INA-Schaeffler KG
91072 Herzogenaurach
Postal address:
Industriestraße 1–3
91074 Herzogenaurach
Tel. +49/9132/82-0
Fax +49/9132/82-4933

Australia

INA Bearings Australia Pty. Ltd.
Locked Bag 1
Taren Point 2229
Tel. +61/2/97101100
Fax +61/2/95403299

Brazil

INA Brasil Ltda.
Av. Independência, nr. 3500
Bairro de Éden
18087-050 Sorocaba/São Paulo
Caixa Postal 334
18001-970 Sorocaba
Tel. +55/15/2351500
Fax +55/15/2351990

China

INA (China) Co. Ltd.
18 Chaoyang Road
Taicang
Economic Development Area
Jiangsu Province 215400
Tel. +86/512/53580948
Fax +86/512/53580995

Czech Republic

INA Lanskroun s. r.o.
Dvorakova 328
56301 Lanskroun
Tel. +420/465355 5111
Fax +420/465355 5190

France

Haguenau
INA France
93, route de Bitche
BP 186
67506 Haguenau Cedex
Tel. +33 (0) 388634040
Fax +33 (0) 388634041
Telex 870936

Schweighouse sur Moder
INA France
Division Découpage de Précision
Zone Industrielle
67590 Schweighouse sur Moder
Tel. +33 (0) 388634060
Fax +33 (0) 388634061
Telex 890696

Germany

Gunzenhausen
INA-Schaeffler KG
Industriestraße 9
91710 Gunzenhausen
Tel. +49/9831/6786-0
Fax +49/9831/6786-310

Hirschaid
INA-Schaeffler KG
Industriestraße 1
96114 Hirschaid
Tel. +49/9543/68-0
Fax +49/9543/68-360

Germany

Höchstadt
INA-Schaeffler KG
INA-Straße 1
91315 Höchstadt (Aisch)
Tel. +49/9193/80-0
Fax +49/9193/80-202

Hörselberg
REGE Motorenteile GmbH & Co. KG
Industriestraße 4
Industriegebiet Eisenach/Kindel
99819 Hörselberg
Tel. +49/36920/12-0
Fax +49/36920/12-407

Homburg (1)
INA-Schaeffler KG
Postfach 1553
66406 Homburg (Saar)
Postal address:
Berliner Straße 134
66424 Homburg (Saar)
Tel. +49/6841/701-0
Fax +49/6841/701-555

Homburg (2)
INA-Schaeffler KG
Postfach 1541
66406 Homburg (Saar)
Postal address:
Hasenäckerstraße 30
66424 Homburg (Saar)
Tel. +49/6841/705-0
Fax +49/6841/705-105

Homburg (3)
INA-Schaeffler KG
Linear Technology Division
66406 Homburg (Saar)
Postal address:
Berliner Straße 134
66424 Homburg (Saar)
Tel. +49/6841/701-0
Fax +49/6841/701-625

Ingolstadt
INA-Schaeffler KG
Ettinger Straße 26
85057 Ingolstadt
Tel. +49/841/8890
Fax +49/841/81935

Lahr
INA-Schaeffler KG
Postfach 1760
77907 Lahr
Postal address:
Rheinstraße 17
77933 Lahr
Tel. +49/7821/584-0
Fax +49/7821/584-129

Luckenwalde
INA-Schaeffler KG
Industriestraße 2a
14943 Luckenwalde
Tel. +49/3371/674-0
Fax +49/3371/674-423

Germany

Magdeburg
REGE Motorenteile GmbH & Co. KG
Blumenstraße 13
39122 Magdeburg
Tel. +49/391/4096-0
Fax +49/391/4096-10

Steinhagen
INA-Schaeffler KG
Postfach 1162
33791 Steinhagen
Postal address:
Gottlieb-Daimler-Straße 2-4
33803 Steinhagen
Tel. +49/5204/999-0
Fax +49/5204/999-100

Witzenhausen
REGE Motorenteile GmbH & Co. KG
Am Eschenbornrasen 23
37213 Witzenhausen
Tel. +49/5542/604-0
Fax +49/5542/604-90

Great Britain

INA Bearing Company Ltd
Bynea
Llanelli, CARMS
SA14 9TG, Wales
Tel. +44/1554/772288
Fax +44/1554/771201

India

INA Bearing India Pvt. Ltd.
Indo-German Technology Park
Survey No. 297, 298, 299
Urawade, Tal: Mulshi
Dist. Pune, Pin: 412108
Tel. +91/20/4 10 10 36
Fax +91/20/4 00 12 44

Italy

WPB Water Pump Bearing
GmbH & Co. KG
Strada Regionale 229 - km.17
28015 Momo (Novara)
Tel. +39/0321/928503
Fax +39/0321/928900

Korea

INA Bearing Chushik Hoesa
1054-2 Shingil-dong
Ansan-shi, Kyounggi-do
425-839 Korea South
Tel. +82/31/4906911
Fax +82/31/4943888

Romania

INA Schaeffler Brasov S.R.L.
O. P. BV 2
C. P. 67
2200 Brasov
Tel. +40/268/423889
Fax +40/268/423831

Slovak Republic

Skalica
INA Skalica spol. s r.o.
Dr. G. Schaefflera 1
90901 Skalica
Tel. +421/34/6961111
Fax +421/34/6645568

Kysucké Nové Mesto
INA Kysuce, a.s.
ul. Dr. G. Schaefflera
02401 Kysucké Nové Mesto
Tel. +421/41/4205111
Fax +421/41/4205100

Spain

Rodisa S.A.
Ballibar Kalea, 1
20870 Elgoibar
Tel. +34/943/749100
Fax +34/943/749102

Switzerland

Romanshorn (1)
HYDREL AG
Postfach 180
8590 Romanshorn
Tel. +41/71/4666666
Fax +41/71/4666333

Romanshorn (2)
HYDREL AG
Hofstraße 40
8590 Romanshorn
Tel. +41/71/4666666
Fax +41/71/4666333

USA

Cheraw (1)
INA USA CORPORATION
One INA Drive
P.O. Box 390
Cheraw, South Carolina 29520
Tel. +1/843/537-9341...9346
Fax +1/843/537-8751

Cheraw (2)
INA USA CORPORATION
Highway 9 West
P.O. Box 390
Cheraw, South Carolina 29520
Tel. +1/843/537-9341
Fax +1/843/537-8752

Fort Mill (3, 6)
INA USA CORPORATION
308 Springhill Farm Road
Fort Mill, South Carolina 29715
Tel. +1/803/548-8500
Fax +1/803/548-8599

Spartanburg (4)
INA USA CORPORATION
New Cut Road
P.O. Box 570
Spartanburg, South Carolina 29304
Tel. +1/864/583-4541
Fax +1/864/591-8890

Crossed roller bearings

Technical data for processing of quotation (appendix to publication KSX)

Customer

Application

Load			Max. static operating load[1]	Test load	Dynamic life load	
1	F_{0a}	kN			F_a	kN
2	F_{0r}	kN			F_r	kN
3	M_{0k} from F_{0a}	kNm			M_{k1}	kNm
4	M_{0k} from F_{0r}	kNm			M_{k2}	kNm

Utilisation life[2] B a

Mean operating hours per year h_a h/a

Load cycles per hour L_{sph} h^{-1}

Operating time per day h/d

including rotating or swivel time %

Required life a

in shift operation

Continuous rotating/ swivel motion mean °

maximum °

Speed normal min^{-1}

maximum min^{-1}

Do severe shocks or vibrations occur yes/no

Proposal for sealing in adjacent construction required? yes/no

against[3]

Does particular contamination occur yes/no

Bearing clearance[4] yes/no

Bearing free from clearance and preloaded (VSP)[4] yes/no

Particular requirements for rotational resistance

Operating and ambient temperatures minimum °C

maximum °C

Bearing temperature maximum °C

Which ring is heated more? inner ring (IR)/outer ring (AU)

Temperature differential between inner and outer ring maximum °C

Bearing lubrication planned

Oil lubrication yes/no

Grease lubrication yes/no

Central lubrication yes/no

Price based on pieces

Required delivery time

Required quotation date

Probable requirement per year pieces

Call-off quantities pieces

Processed

Date

1) Including inertia forces (e.g. in cranes).
2) Planned utilisation life of equipment.
3) State not only the medium against which sealing is to be provided but also any aggressive environmental influences or atmospheres.
4) For values see dimension tables.

Comments/diagrams

INA-Schaeffler KG

91072 Herzogenaurach · Germany

Internet www.ina.com
E-Mail info@ina.com

In Germany:
Telephone 0180 / 5 00 38 72
Fax 0180 / 5 00 38 73

From other countries:
Telephone +49 / 91 32 / 82-0
Fax +49 / 91 32 / 82-49 50

INA-Schaeffler KG

91072 Herzogenaurach · Germany

Internet www.ina.com
E-Mail info@ina.com

In Germany:
Telephone 0180 / 5 00 38 72
Fax 0180 / 5 00 38 73

From other countries:
Telephone +49 / 91 32 / 82-0
Fax +49 / 91 32 / 82-49 50

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