

SCHAEFFLER



Super Precision Bearings

Spindle bearings

Super precision cylindrical roller bearings

Axial angular contact ball bearings



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Super precision cylindrical roller bearings
Axial angular contact ball bearings

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Preface

Market and technology leadership

With its forward-looking bearing solutions for main spindles, feed spindles, rotary tables and linear axes in machine tools, Schaeffler with its brands INA and FAG has been at the forefront of the world market for decades.

Precision and operational security

FAG super precision bearings for main spindles stand for very high precision and absolute operational security. Innovative FAG spindle bearing solutions are continually raising standards in relation to speeds, accuracy and rating life. For the main spindle system and the overall machine tool system to be successful, however, bearing components alone are no longer sufficient as a guarantee. Significant increases in performance and the creation of unique selling propositions for the customer are now achieved when the bearing manufacturer offers advice and carries out development work on the basis of wide-ranging system knowledge as well as being able to provide support through a range of service functions. It is through close partnership with the manufacturers of spindles and machine tools and through shared knowledge, founded on experience, of the requirements of end users and their customers that the potential exists for achieving a leading role in the market.

“added competence” for production machinery

The competence in application engineering, advisory work and production technology built up by Schaeffler over more than 130 years is always provided, together with one of the largest product portfolios worldwide, to our customers to enhance their own know-how. In return, the Schaeffler Group benefits from close proximity to the actual application and from intensive contact with its partners. This mindset of co-operative partnership in order to achieve “higher speed, better accuracy, longer life and more cost-effectiveness” in both the subsystem and the complete system is described by the Schaeffler Business Unit Production Machinery as “added competence”.

Optimised customer benefit

The dominant objective of this approach is optimum benefit for the customer. In the case of main spindle bearings too, this standard extends well beyond the manufacture of the best products. At the focus is the point of use and the end user together with all his requirements. For all the areas of the company involved in the manufacture of FAG super precision bearings, this creates requirements for top quality and technological leadership, maximum proximity to the customer and the very highest cost-effectiveness for the specific application.

The integration of important functions such as sealing, lubrication, location, damping, corrosion protection and many others leads to a reduction in the number of interfaces as well as increased operational security, freedom from maintenance, increased energy efficiency, time advantages in the market and cost savings. Customer benefit is also increased by the provision of fundamental research, calculation programs, mounting aids and training through a close-knit network of sales and production facilities. The reliable, timely and local presence of Schaeffler employees secures our greatest resource: our “personal contact” with you, our partners.

Preface



Figure 1
The very highest precision and
purity in production ...



Figure 2
... in the mounting of bearings



Figure 3
... in inspection



Figure 4
... in the results of production

Preface

Solutions for the main spindle

The starting point and objective of all activities in the company is proximity to and benefit for the customer. Precise knowledge of specific application requirements and processes is the decisive factor in selection of the technically optimum product that also incurs the lowest system costs. This may be sourced from the fully developed standard range of spindle bearings, which is unsurpassed in its scope worldwide. Equally, it may lie in an individual, application-specific solution that is provided rapidly and reliably by the Schaeffler Group.

FAG super precision bearings set standards in machine tools, in the textile industry, in woodworking machinery and wherever extreme demands are placed on reliability, running accuracy and high speeds, individually or in combination. Due to the comprehensive product range, it is possible to achieve optimum designs for all bearing positions and applications.

Technical and economic leadership

Building on principles developed in the research facilities of the Schaeffler Group and close contact with customers, further development is carried out continually on existing products and the product range is steadily expanded. FAG super precision bearings are always a combination of the technical solution to a bearing application with the economic solution. This is clear from the complete consideration of the bearing arrangement system in calculation, simulation and design as well as in distribution, mounting and service.

Schaeffler Technologies also offers proven calculation and simulation tools, for in-house use or as a service, as well as comprehensive training and advice events.

FAG accuracy P4S

The accuracy of bearings initially appears to be sufficiently well described in the DIN, ISO and ABEC accuracy classes. For FAG super precision bearings, however, this is not enough. Where it is necessary to achieve tolerances to P4 or better, the performance characteristics involved are not described in the reference works.

FAG super precision angular contact ball bearings fulfil the standard P4S. Super precision cylindrical roller bearings and axial angular contact ball bearings (2344) are manufactured in accordance with the accuracy standards SP or UP that are matched to machine tool requirements.

About this catalogue

Catalogue SP1 gives an overview of the FAG product range of super precision bearing arrangements as well as the most important rules covering bearing selection, bearing arrangement design and mounting.

One function of the catalogue is to present the product range of FAG super precision bearings for main spindles. In addition, it is also intended as a technical compendium for the selection and design of bearing arrangements using super precision bearings.

This catalogue brings together the most important technical principles for the designer. It thus gives a transparent representation of the FAG portfolio covering all components, competences and services.

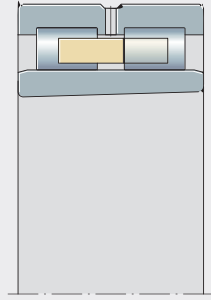
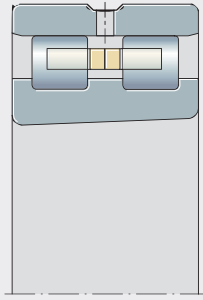
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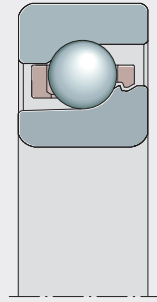
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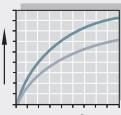
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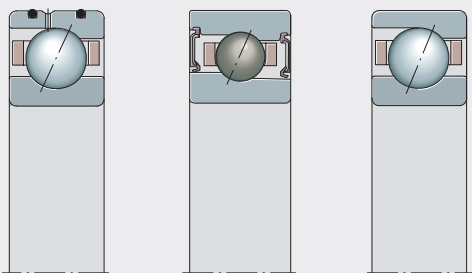


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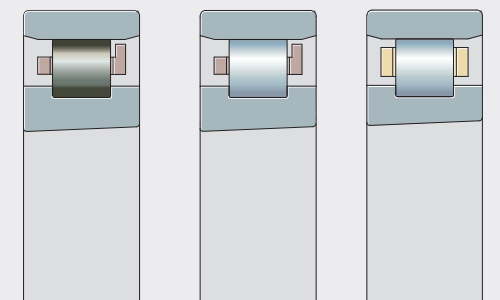
Technical principles



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Spindle bearings

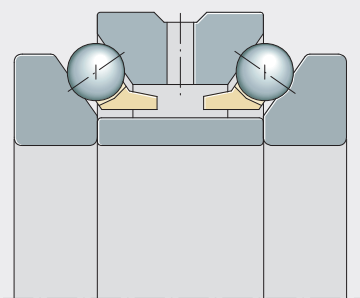
- Universal bearings
 - Single row
 - Contact angle: 15°, 20°, 25°
 - With large or small balls
 - Rolling elements: rolling bearing steel or ceramic
 - Rings: rolling bearing steel or Cronidur



00016A71

Super precision cylindrical roller bearings

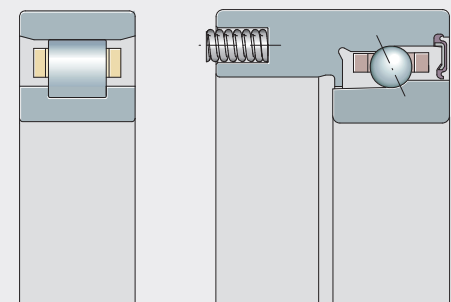
- Single row
- Double row
- Rolling elements: rolling bearing steel or ceramic
- Cages: brass, polyamide or PEEK
- Standard
- Full or half number of rollers



00016A72

Axial angular contact ball bearings 2344, axial bearings BAX

- Double direction
- Contact angle: 30°, 40°, 60°
- Rolling elements: rolling bearing steel or ceramic
- Rings: rolling bearing steel
- Cages: brass, laminated material



00096857

Customer solutions

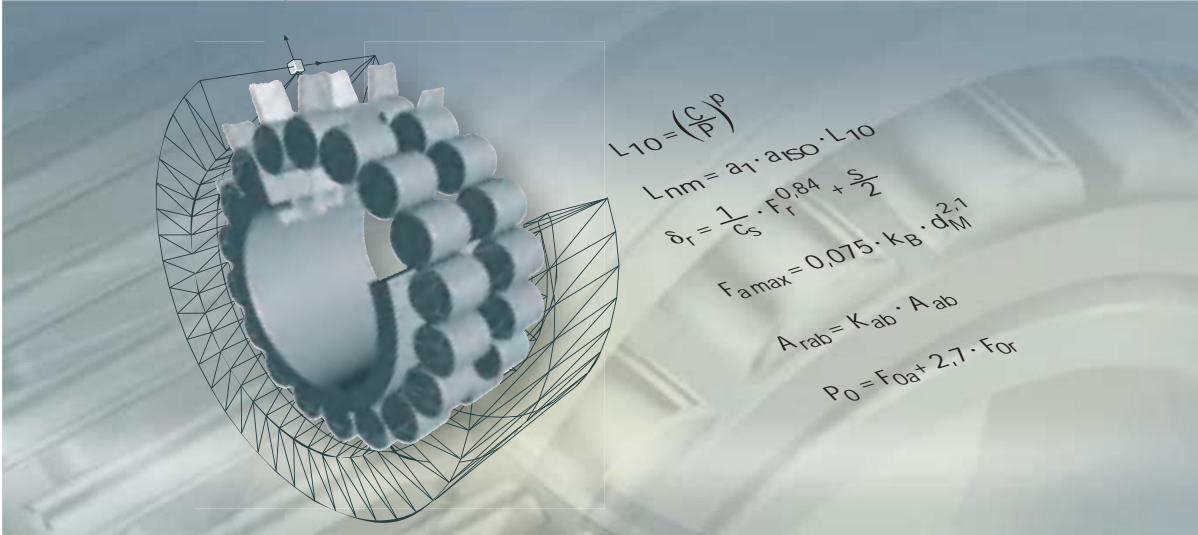
- Spindle bearings
 - Thin dense chromium coating on outside diameter
 - Open bearings supplied greased
- Cylindrical roller bearings
 - Bearings with cylindrical bore and special radial internal clearance

Appendix

- Addresses
- Checklists and order forms



FAG



Technical principles

Components and materials

Tolerances

Speeds

Rigidity

Load carrying capacity and operating life

Lubrication

Operating temperature

Design and examples of bearing arrangements

Mounting

Bearing monitoring



Technical principles

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Components and materials

Steels for bearing rings and rolling elements

Standard rolling bearing steel 100Cr6

The bearing rings and rolling elements of FAG standard spindle bearings are made in principle from the through hardening rolling bearing steel 100Cr6. Ring made from these materials are dimensionally stabilised as standard to at least +120 °C. Other dimensional stabilisations are available by agreement.

High performance steel Cronidur 30

For high performance applications, especially in motor spindles with very high speeds, Schaeffler offers the bearings with rings made from the high performance steel Cronidur 30 (X30CrMonN15-1) and ceramic rolling elements. The material used for the rings is a highly nitrided, corrosion-resistant steel.

Cronidur 30 has, in comparison with the normal rolling bearing steel 100Cr6, a significantly finer structure. As a result, less heat is generated in the bearing and the permissible contact pressure is higher.

Tests on the material fatigue life have given life values higher by a factor of ten compared to 100Cr6.

In the mixed friction region, Cronidur 30 has proved highly effective in comparison with the standard material 100Cr6.

It is also significantly superior to the conventional rolling bearing steels on the criteria of corrosion resistance and high temperature hardness.

The longer life of Cronidur bearings compared to conventional bearings makes a considerable contribution to reducing system costs.

Materials for rolling elements

Standard bearings have rolling elements made from 100Cr6.

Standard and High Speed hybrid bearings (HCB, HC..) as well as Cronidur 30 bearings are fitted with ceramic balls made from silicon nitride (Si_3N_4). In comparison with steel rolling elements, ceramic rolling elements offer many advantages:

- excellent tribological behaviour in the combination of steel and ceramic. In hybrid bearings, the strain on the material and lubricant is significantly reduced.
- lower density. Since the mass is lower than steel by 60%, the centrifugal forces on the rolling elements are reduced and the kinematics of the bearing are improved.
- a lower coefficient of thermal expansion of the ceramic rolling elements. This has a positive effect on the change in bearing preload in response to temperature differences in operation.
- no magnetism, high current insulation.



Comparison of the rolling bearing steel 100Cr6 with silicon nitride Si_3N_4

Material parameters at room temperature		Silicon nitride Si_3N_4	Rolling bearing steel 100Cr6
Density	g/cm^3	3,2 to 3,25	7,8 to 7,85
Coefficient of thermal expansion	10^{-6}K^{-1}	3,2	11,5
Modulus of elasticity	kN/mm^2	315 to 320	200 to 210
Hardness	HV 10	1 600	700
Flexural strength	N/mm^2	600, 700	2 500
Fracture toughness	$\text{MN} \cdot \text{m}^{-3/2}$	7	20
Thermal conductivity	W/mK	30 to 35	40 to 45
Specific electrical resistance	$\Omega \cdot \text{mm}^2\text{m}^{-1}$	approx. 1 000	0,1 to 1

n/n_G = speed relative to limiting speed
 M_R = frictional torque of bearing
 ϑ = temperature of outer ring

- ① Relative change in frictional torque and temperature
- ② Steel bearing
- ③ Hybrid bearing

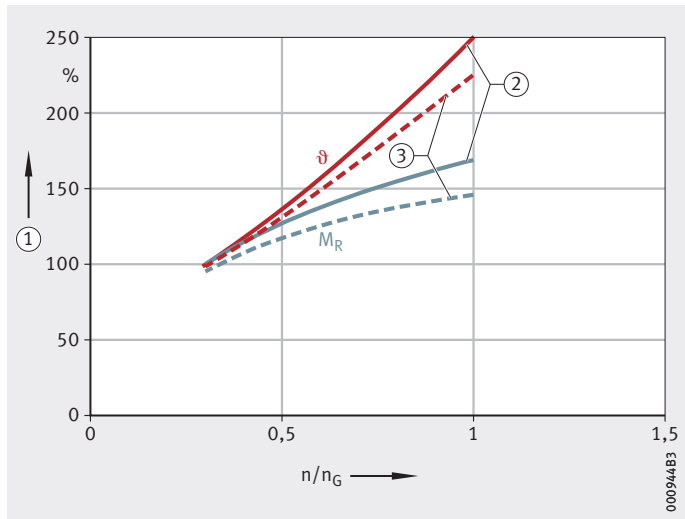


Figure 1
 Frictional torque and temperature profile – comparison of steel/hybrid bearings

While these bearings were originally envisaged only for the high speed range, they are now used at significantly lower speeds too. The reasons for this include their robust design and reliability as well as the significantly longer grease operating life.

Components and materials

Cage function and materials for cages

The cage, as an important functional part in a rolling bearing:

- keeps the rolling elements separate from each other
- maintains the spacing between the rolling elements, thus giving more uniform load distribution
- guides the rolling elements in the unloaded zone of the bearing
- prevents the rolling elements from falling out in bearings that can be separated or swivelled out, thus allowing easier mounting of the bearing.

FAG super precision bearings are fitted with various solid cages made from laminated fabric, brass or plastic.

Angular contact ball bearings Laminated fabric cages

FAG standard and High Speed angular contact ball bearings of P4S accuracy as well as axial bearings BAX are fitted with phenolic resin/cotton hard material cages. They are guided on the outer ring and have good emergency running characteristics (suffix T). This material is a high performance material with excellent tribological characteristics. In cases of lubricant starvation in particular, the material is characterised by excellent emergency running characteristics and is thus superior to many thermoplastics. The maximum operating temperature of hard fabric cages is +100 °C.

Cylindrical roller bearings and double direction axial angular contact ball bearings Solid brass cages

Single and double row super precision bearings of the series FAG NNU49 and NN30 with a bore diameter outside the range 30 to 120 mm have solid brass cages as standard (suffix M1 with crosspiece rivets for single row bearings, M for double row bearings). Furthermore, double direction axial angular contact ball bearings of the series 2344 and 2347 are fitted with ball-guided solid brass cages (suffix M). The maximum operating temperature of brass cages is +150 °C.

Polyphthalamide (PPA) cages for X-life cylindrical roller bearings

The new FAG X-life cylindrical roller bearings of series N10 and NN30 in the bore diameter range 30 to 120 mm are fitted with a window cage made from the high performance plastic PPA (polyphthalamide). In tests, double row bearings in particular show a significantly improved speed suitability and a temperature lower by up to 12 K in comparison with bearings with brass cages. The lower increase in temperature ensures that speeds up to 25% higher can be achieved in the limiting speed test.

A further advantage of the lower running temperature is the longer grease operating life. The basic dynamic load rating is higher by up to 19%. Due to the use of the plastic cage (suffix TVP) with low mass and better damping characteristics, there is a positive change in the bearing noise – the bearings run more quietly. The maximum operating temperature of TVP cages is +120 °C.



PEEK cages for High Speed cylindrical roller bearings

High Speed super precision cylindrical roller bearings, especially for motor spindles, are available with a cage made from PEEK (poly-ether ether ketone) (suffix PVPA1). Since displacement on the non-locating bearing side of motor spindles only ever occurs in one direction, the cage can be guided on one side, which leads to a more rapid grease distribution cycle with lower maximum temperatures and subsequently to a lower temperature level with smaller scatter, see section Super precision cylindrical roller bearings, page 68.

As a result, the non-locating bearing function is more reliable even in the highest speed ranges. The maximum operating temperature of PEEK cages is +150 °C.



Figure 2
Cages

Components and materials

Seal materials

Main spindle bearings sealed on both sides and greased “for life” of the standard series B (with large balls, suffix - 2RSD -), High Speed H and Cronidur bearings X (with small balls, prefix S) and corresponding versions of the FAG axial bearings BAX have non-contact sealing by means of sealing washers made from nitrile butadiene rubber (NBR). Bearings for pneumatic oil lubrication of the design DLR are each fitted with two O rings. Seals and O rings made from NBR can be used up to a temperature of +100 °C. For temperatures at a continuously high level, seals made from FKM materials are recommended (available by agreement).

In accordance with the REACH Directive (EC) no. 1907/2006, all seals in FAG main spindle bearings manufactured since 1.1.2015 are free from DEHP (bis(2-ethylhexyl) phthalate, CAS no. 117-81-7).

Coatings

Coatings are recommended in certain applications. In order to prevent current passage, to improve corrosion and/or wear protection or even to increase tribological characteristics under unfavourable lubrication conditions, coating is a proven method that can significantly optimise the performance capability of the bearings or increase their life.

In particular, thin dense chromium coating is used on many occasions in the case of main spindle bearings in order to prevent fretting corrosion of the outer ring. This option can be added using the suffix J24), other coating options are available by agreement.



Tolerances

Definitions and measurement principles

Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014

The definition of the tolerances and the associated measurement principles are described in the following chapter.



Symbol for nominal dimension ^{1) 2)} Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1: 2000
Width			
B	–	Nominal inner ring width	Nominal inner ring width
$t_{\Delta B_s}$	(LP)	Symmetrical rings Deviation of a two-point size of inner ring width from its nominal size $\Delta B_s = B_s - B$ $B_s =$ single two-point size of inner ring width	Deviation of a single inner ring width
	(GN)ALS (LP)	Asymmetrical rings, upper limit Deviation of a minimum circumscribed size of inner ring width, between two opposite lines, in any longitudinal section which includes the inner ring bore axis, from its nominal size	
		Asymmetrical rings, lower limit Deviation of a two-point size of inner ring width from its nominal size	
$t_{V B_s}$	(LP) (SR)	Symmetrical rings Range of two-point sizes of inner ring width $V B_s = B_s \text{ max} - B_s \text{ min}$	Variation of inner ring width
	(GN)ALS (SR)	Asymmetrical rings Range of minimum circumscribed sizes of inner ring width, between two opposite lines, obtained from any longitudinal section which includes the inner ring bore axis	

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).



Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014 (continued)

Symbol for nominal dimension¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Width			
C	–	Nominal outer ring width	Nominal outer ring width
$t_{\Delta Cs}$	(LP)	Symmetrical rings Deviation of a two-point size of outer ring width from its nominal size $\Delta Cs = Cs - C$ Cs = single two-point size of inner ring width	Deviation of a single outer ring width
	(GN) ALS  (LP)	Asymmetrical rings, upper limit Deviation of a minimum circumscribed size of outer ring width, between two opposite lines, in any longitudinal section which includes the outer ring outside surface axis, from its nominal size	
		Asymmetrical rings, lower limit Deviation of a two-point size of outer ring width from its nominal size	
t_{VCs}	(LP) (SR)	Symmetrical rings Range of two-point sizes of outer ring width $VCs = Cs_{max} - Cs_{min}$	Variation of outer ring width
	(GN) ALS (SR) 	Asymmetrical rings Range of minimum circumscribed sizes of outer ring width, between two opposite lines, obtained from any longitudinal section which includes the outer ring outside surface axis	

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).

Tolerances

Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014 (continued)

Symbol for nominal dimension ¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Diameter			
d	–	Nominal bore diameter of a cylindrical bore or at the theoretical small end of a tapered bore	Nominal bore diameter
$t_{\Delta ds}$	(LP)	Deviation of a two-point size of the bore diameter from its nominal size $\Delta ds = ds - d$	Deviation of a single bore diameter
t_{Vdsp}	(LP)(SR)ACS	Range of two-point sizes of bore diameter in any cross-section of a cylindrical or tapered bore $Vdsp = ds_{max} - ds_{min}$	Variation of single bore diameter in a single plane
$t_{\Delta dmp}$	(LP)(SD)ACS	Cylindrical bore Deviation of a mid-range size (out of two-point sizes) of bore diameter in any cross-section from its nominal size $dmp = (d_{max} + d_{min})/2$ $\Delta dmp = dmp - d$	Deviation of mean bore diameter in a single plane
	(LP)(SD)SCS	Tapered bore Deviation of a mid-range size (out of two-point sizes) of bore diameter at the theoretical small end from its nominal size	

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).



Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014 (continued)

Symbol for nominal dimension ¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Diameter			
t_{Vdmp}	$\textcircled{LP} \textcircled{SD} \textcircled{ACS} \textcircled{SR}$	Range of mid-range sizes (out of two-point sizes) of bore diameter obtained from any cross-section of a cylindrical bore $Vdmp = dmp \text{ max} - dmp \text{ min}$	Variation of mean bore diameter
d_1	–	Nominal diameter at the theoretical large end of a tapered bore	–
$t_{\Delta d1mp}$	$\textcircled{LP} \textcircled{SD} \textcircled{SCS}$	Deviation of a mid-range size (out of two-point sizes) of bore diameter at the theoretical large end of a tapered bore from its nominal size	–
D	–	Nominal size of outside diameter	Nominal outside diameter
$t_{\Delta Ds}$	\textcircled{LP}	Deviation of a two-point size of outside diameter from its nominal size	Deviation of a single outside diameter
t_{VDsp}	$\textcircled{LP} \textcircled{SR} \textcircled{ACS}$	Range of two-point sizes of outside diameter in any cross-section	Variation of a single outside diameter in a single plane

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).

Tolerances

Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014 (continued)

Symbol for nominal dimension ¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Diameter			
$t_{\Delta Dmp}$	(LP) (SD) ACS	Deviation of a mid-range size (out of two-point sizes) of outside diameter in any cross-section from its nominal size $Dmp = (D_{max} + D_{min})/2$ $\Delta Dmp = Dmp - D$	Deviation of mean outside diameter in a single plane
t_{VDmp}	(LP) (SD) ACS (SR)	Range of mid-range sizes (out of two-point sizes) of outside diameter obtained from any cross-section $VDmp = Dmp_{max} - Dmp_{min}$	Variation of mean outside diameter
Running accuracy			
t_{Kea}	\nearrow ³⁾	Circular radial run-out of outer ring outside surface of assembled bearing with respect to datum, i.e. axis, established from the inner ring bore surface	Radial run-out of outer ring of assembled bearing
t_{Kia}	\nearrow ³⁾	Circular radial run-out of inner ring bore of assembled bearing with respect to datum, i.e. axis, established from the outer ring outside surface	Radial run-out of inner ring of assembled bearing
t_{Sd}	\nearrow ³⁾	Circular axial run-out of inner ring face with respect to datum, i.e. axis, established from the inner ring bore surface	Perpendicularity of inner ring face with respect to the bore
t_{SD}	\perp	Perpendicularity of outer ring outside surface axis with respect to datum established from the outer ring face	Perpendicularity of outer ring outside surface with respect to the face

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).

3) Specification modifiers for the direction of action of the mass, as well as fixed and movable parts necessary in accordance with ISO/TS 17863.



Symbols for nominal dimensions, characteristics and specification modifiers for radial rolling bearings in accordance with ISO 492:2014
(continued)

Symbol for nominal dimension¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for radial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 492:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Running accuracy			
t_{Sea}	↗ ³⁾	Circular axial run-out of outer ring face of assembled bearing with respect to datum, i.e. axis, established from the inner ring bore surface	Axial run-out of outer ring of assembled bearing
t_{Sia}	↗ ³⁾	Circular axial run-out of inner ring face of assembled bearing with respect to datum, i.e. axis, established from the outer ring outside surface	Axial run-out of inner ring of assembled bearing
Tapered bore			
SL	–	Taper slope: The difference between nominal diameters at the theoretical large end and small end of a tapered bore $SL = d1 - d$ $SL = \text{spacing}$	–
$t_{\Delta SL}$	–	Deviation of taper slope of a tapered bore from its nominal size (description based on DIN EN ISO 1119) $\Delta SL = \Delta d1mp - \Delta dmp$	–
α	–	Frustum angle of tapered inner ring bore	–
Width of assembled bearing			
T	–	Nominal assembled bearing width	Nominal bearing width
$t_{\Delta Ts}$	(GN) ³⁾	Deviation of minimum circumscribed size of assembled bearing width from its nominal size	Deviation of the actual bearing width
T₁	–	Nominal effective width of inner subunit assembled with a master outer ring	Nominal effective width of inner subunit
$t_{\Delta T1s}$	(GN) ³⁾	Deviation of minimum circumscribed size of effective width (inner subunit assembled with a master outer ring) from its nominal size	Deviation of the actual effective width of inner subunit

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 15241 (exception: font).

3) Specification modifiers for the direction of action of the mass, as well as fixed and movable parts necessary in accordance with ISO/TS 17863.

Tolerances

Symbols for nominal dimensions, characteristics and specification modifiers for axial rolling bearings in accordance with ISO 199:2014

Symbol for nominal dimension ¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for axial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 199:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Diameter			
d	–	Nominal bore diameter of shaft washer, single-direction bearing	Nominal bore diameter of shaft washer
$t_{\Delta dmp}$	(LP) (SD) ACS	Deviation of a mid-range size (out of two-point sizes) of shaft washer bore diameter in any cross-section from its nominal size $dmp = (d_{max} + d_{min})/2$ $\Delta dmp = dmp - d$	Deviation of mean bore diameter in a single plane
t_{Vdsp}	(LP) (SR) ACS	Range of two-point sizes of shaft washer bore diameter in any cross-section $Vdsp = ds_{max} - ds_{min}$	Variation of single bore diameter in a single plane
D	–	Nominal outside diameter of housing washer	Nominal outside diameter of bore (housing washer)
$t_{\Delta Dmp}$	(LP) (SD) ACS	Deviation of a mid-range size (out of two-point sizes) of housing washer outside diameter in any cross-section from its nominal size $Dmp = (D_{max} + D_{min})/2$ $\Delta Dmp = Dmp - D$	Deviation of mean outside diameter in a single plane
t_{VDsp}	(LP) (SR) ACS	Range of two-point sizes of housing washer outside diameter in any cross-section $VDsp = Ds_{max} - Ds_{min}$	Variation of a single outside diameter in a single plane

1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.

2) Symbols in accordance with ISO 1101 and ISO 14405-1.




Symbols for nominal dimensions, characteristics and specification modifiers for axial rolling bearings in accordance with ISO 199:2014 (continued)

Symbol for nominal dimension¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for axial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 199:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1:2000
Height			
T	–	Nominal assembled bearing height, single-direction bearing	Nominal bearing height
$t_{\Delta Ts}$	(GN) ³⁾	Deviation of minimum circumscribed size of assembled bearing height from its nominal size, single-direction bearing	Deviation of the actual bearing height
T₁	–	Nominal assembled bearing height, double-direction bearing	–
$t_{\Delta T1s}$	(GN) ³⁾	Deviation of minimum circumscribed size of assembled bearing height from its nominal size, double-direction bearing	–
t_{Se} ⁴⁾	(LP) (SR)	Axial cylindrical roller bearings Range of two-point sizes of thickness between housing washer raceway and the back face	Variation in thickness between housing washer raceway and back face
	(LS) (SN) ALS (SR)	Axial ball bearings Range of minimum spherical sizes between the raceway and the opposite back face of the housing washer, obtained from any longitudinal section which includes the housing washer outside surface axis	

- 1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.
- 2) Symbols in accordance with ISO 1101 and ISO 14405-1.
- 3) Specification modifiers for the direction of action of the mass in accordance with ISO/TS 17863.
- 4) Valid only for axial ball bearings and axial cylindrical roller bearings with a 90° contact angle.

Tolerances

Symbols for nominal dimensions, characteristics and specification modifiers for axial rolling bearings in accordance with ISO 199:2014 (continued)

Symbol for nominal dimension¹⁾²⁾ Tolerance symbol for characteristic ²⁾	GPS symbol and specification modifier	Description for axial bearings	Old term
	Symbols in accordance with ISO 1101 and ISO 14405-1	In accordance with ISO 199:2014 (based on ISO 1101, ISO 5459 and ISO 14405-1)	In accordance with ISO 1132-1: 2000
Height			
t_{Si} ³⁾	(LP) (SR)	Axial cylindrical roller bearings Range of two-point sizes of thickness between shaft washer raceway and the back face	Variation in thickness between shaft washer raceway and back face
	(LS) (SN) ALS (SR) < 	Axial ball bearings Range of minimum spherical sizes between the raceway and the opposite back face of the shaft washer, obtained from any longitudinal section which includes the shaft washer bore axis	

- 1) Symbols for the nominal dimension are printed bold; they indicate size dimensions and spacings.
- 2) Symbols in accordance with ISO 1101 and ISO 14405-1.
- 3) Valid only for axial ball bearings and axial cylindrical roller bearings with a 90° contact angle.

Tolerances of super precision bearings

Rolling bearing tolerances are standardised in accordance with ISO 492: 2014 for radial rolling bearings and in accordance with ISO 199: 2014 for axial rolling bearings. Definitions for the meanings of dimensions and tolerances are regulated in DIN ISO 1132.

In order to ensure full use of the bearing performance capacity and a high machining accuracy, the dimensional, geometrical and running accuracy of super precision bearings is produced within very narrow tolerance ranges.

In general, super precision spindle bearings (including BAX) are manufactured to the accuracy standard P4S. P4S means: main deviations at least in accordance with ISO tolerance class 4; all geometrical and running tolerances in accordance with ISO tolerance class 2.

All cylindrical roller bearings and axial angular contact ball bearings (2344) are manufactured in standard cases in accordance with the Schaeffler internal accuracy requirement SP, see tables, page 38 and page 39. In this case, the roundness and running tolerances correspond to at least ISO tolerance class 4. For higher accuracy requirements, super precision cylindrical roller bearings are also available to the accuracy class UP, see tables, page 42 and page 43.



Dimensional, geometrical and positional tolerances of spindle bearings and BAX

In order to ensure full use of the bearing performance capability and a high machining accuracy, the dimensional, geometrical and positional accuracy of FAG spindle bearings is produced within very narrow tolerance ranges. The bearing tolerances conform to P4, the running accuracy and parallelism conform to P2.

P4S is a Schaeffler standard that is better than P4 in accordance with DIN 620.

The radial runout tolerance of the inner ring for P4S, P4, P5 is shown in *Figure 1*.

The tolerances of the inner and outer ring for tolerance class P4S are shown in the tables from page 34 to page 35.

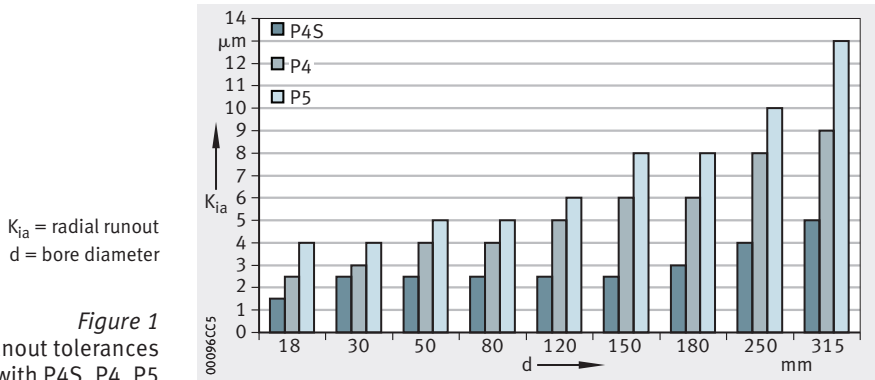


Figure 1
Radial runout tolerances of the inner ring with P4S, P4, P5

Restricted diameter tolerance to P4S-K5

Spindle bearings are also available by agreement with a restricted diameter tolerance. The tolerance range is at the centre of the diameter tolerance, while the tolerance width is 1/3 of the diameter tolerance. The diameter tolerances stated are thus narrower than P2. Tolerances for K5, see tables, page 36.

Actual value codes and actual deviation

The actual value codes for the bore and the outside diameter as well as the actual deviation of the bearing width from the nominal dimension are stated on the end faces of the inner and outer rings, *Figure 9* and *Figure 10*, page 147.

Tolerances

Tolerances of inner and outer ring

Tolerances of the inner and outer ring in spindle bearings and BAX, see tables.

Tolerances of the inner ring (tolerance class P4S)

Nominal bearing bore diameter		Deviation		Variation of width	Width deviation	
d mm		$t_{\Delta dmp}^{1)}$, $t_{\Delta ds}$ μm		t_{VBs} μm	$t_{\Delta Bs}$ μm	
over	incl.					
–	10	0	–4	1,5	0	–100
10	18	0	–4	1,5	0	–100
18	30	0	–5	1,5	0	–120
30	50	0	–6	1,5	0	–120
50	80	0	–7	1,5	0	–150
80	120	0	–8	2,5	0	–200
120	150	0	–10	2,5	0	–250
150	180	0	–10	4	0	–250
180	250	0	–12	5	0	–300
250	315	0	–15	6	0	–350
315	400	0	–19	7	0	–400
400	500	0	–23	8	0	–450
500	630	0	–26	10	0	–500
630	800	0	–32	12	0	–750

1) For series 719.

Tolerances of the inner ring (tolerance class P4S) (continued)

Nominal bearing bore diameter		Variation (out of roundness)		Variation of mean diameter	Radial runout	Axial runout	
d mm		t_{Vdsp} μm		t_{Vdmp} μm	$t_{\kappa ia}$ μm	t_{Sd} μm	t_{Sia} μm
over	incl.	Series 9	Series 0,2				
–	10	2,5	2	1,5	1,5	1,5	1,5
10	18	2,5	2	1,5	1,5	1,5	1,5
18	30	2,5	2	1,5	2,5	1,5	2,5
30	50	3	2,5	2	2,5	1,5	2,5
50	80	3,5	3	2	2,5	1,5	2,5
80	120	4	3	2,5	2,5	2,5	2,5
120	150	5	3	3	2,5	2,5	2,5
150	180	5	4	3	3	4	5
180	250	6	4	4	4	5	5
250	315	8	5	5	5	6	7
315	400	10	6	6	7	7	9
400	500	12	8	8	8	8	11
500	630	13	10	8	9	10	13
630	800	16	10	10	10	12	15



Tolerances of the outer ring (tolerance class P4S)

Nominal size of outside diameter		Deviation		Variation (out of roundness)	
D mm		$t_{\Delta Ds}^{1)}, t_{\Delta Dmp}^{2)}$ μm		$t_{VDsp}^{3)}$ μm	
over	incl.			Series 9	Series 0,2
10	18	0	-4	2,5	2
18	30	0	-5	2,5	2
30	50	0	-6	3	2,5
50	80	0	-7	3,5	3
80	120	0	-8	4	3
120	150	0	-9	5	4
150	180	0	-10	5	4
180	250	0	-11	6	5
250	315	0	-13	7	6
315	400	0	-15	8	6
400	500	0	-18	9	7
500	630	0	-22	11	9
630	800	0	-26	13	10
800	1000	0	-33	17	14

The width deviation $t_{\Delta Cs}$ is identical to $t_{\Delta Bs}$ of the corresponding inner ring.

- 1) For BAX, the tolerance position is displaced by 50 μm . Example: for BAX70, the tolerance range is -50 ... -58.
- 2) For series 719.
- 3) Valid for open bearings;
for sealed bearings and DLR bearings, the values apply before assembly.

Tolerances of the outer ring (tolerance class P4S) (continued)

Nominal size of outside diameter		Variation of mean diameter	Variation of width	Radial runout	Axial runout	
D mm		t_{VDmp} μm	t_{Cs} μm	t_{Kea} μm	t_{SD} μm	t_{Se} μm
over	incl.					
10	18	1,5	1,5	1,5	0,75	1,5
18	30	1,5	1,5	2,5	0,75	2,5
30	50	2	1,5	2,5	0,75	2,5
50	80	2	1,5	3	0,75	4
80	120	2,5	2,5	4	1,25	5
120	150	3	2,5	4	1,25	5
150	180	3	2,5	5	1,25	5
180	250	4	4	7	2	7
250	315	4	5	7	2,5	7
315	400	5	7	8	3,5	8
400	500	6	7	9	4	10
500	630	7	8	11	4,5	12
630	800	8	9	13	5	14
800	1000	11	11	15	6	17

Tolerances

Tolerances of the bearing bore (tolerance class P4S-K5)

Nominal bearing bore diameter d mm		Deviation $t_{\Delta D_S}, t_{\Delta D_{mp}}^{1)}$ μm	
over	incl.		
–	10	–1,5	–3
10	18	–1,5	–3
18	30	–1,5	–3,5
30	50	–2	–4
50	80	–2,5	–5
80	120	–2,5	–5,5
120	150	–3	–7
150	180	–3	–7
180	250	–4	–8
250	315	–5	–10
315	400	–6	–13
400	500	–7	–16
500	630	–8	–18
630	800	–11	–21

1) For series 719.

Tolerances of the outside diameter (tolerance class P4S-K5)

Nominal size of outside diameter D mm		Deviation $t_{\Delta D_S}, t_{\Delta D_{mp}}$ μm	
over	incl.		
10	18	–1,5	–3
18	30	–1,5	–3,5
30	50	–2	–4
50	80	–2,5	–5
80	120	–2,5	–5,5
120	150	–3	–6
150	180	–3	–7
180	250	–3,5	–7,5
250	315	–4	–9
315	400	–5	–10
400	500	–6	–12
500	630	–7	–15
630	800	–8	–18
800	1000	–11	–22



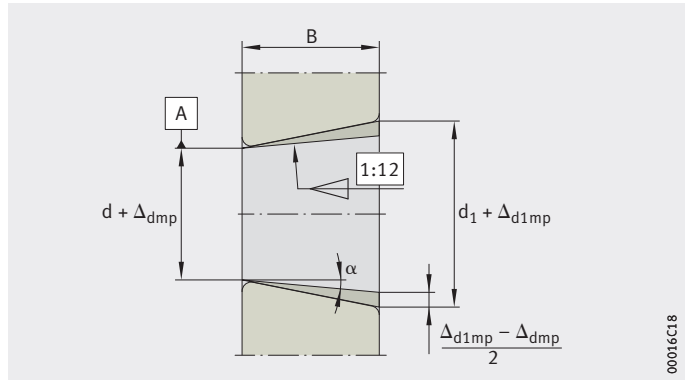
Dimensional, geometrical and positional tolerances of super precision cylindrical roller bearings

Deviation of the tapered bore Δ_{dmp} , see *Figure 2* and tables, page 38 topage 43.

- α = inclination angle at end of taper
= $2^{\circ} 23' 9,4''$
- 2α = taper angle at end of taper
= $4^{\circ} 46' 18,8''$
- B = width of inner ring
- d = nominal bearing bore diameter
- d_1 = bore diameter at large end of taper
- Δ_{dmp} = deviation of bore diameter from nominal dimension in a single radial plane

Figure 2

Tolerances for tapered bores



Tolerances

Tolerances of class SP for single row bearings

The following values are valid for the series N10 and HCN10.

Tolerances of the inner ring (tolerance class SP)

Nominal bore diameter		Deviation of cylindrical bore		Deviation of tapered bore		Variation of width	Width deviation	
d mm		$t_{\Delta d}, t_{\Delta dmp}$ μm		$t_{\Delta dmp}$ μm		t_{VBs} μm	$t_{\Delta Bs}$ μm	
over	incl.							
18	30	0	-6	10	0	1,5	0	-120
30	50	0	-8	12	0	2	0	-120
50	80	0	-9	15	0	3	0	-150
80	120	0	-10	20	0	3	0	-200
120	180	0	-13	25	0	4	0	-250
180	250	0	-15	30	0	5	0	-300
250	315	0	-18	35	0	6	0	-350
315	400	0	-23	40	0	7	0	-400
400	500	0	-27	45	0	8	0	-450
500	630	0	-30	50	0	10	0	-500
630	800	0	-40	65	0	12	0	-750

Tolerances of the inner ring (tolerance class SP) (continued)

Nominal bore diameter		Variation (out of roundness)		Variation of mean diameter	Deviation	Radial runout	Axial runout	
d mm		t_{Vdsp} μm Bore		t_{Vdmp} μm	$t_{\Delta d1mp} - t_{\Delta dmp}$ μm	t_{Kia} μm	t_{Sd} μm	t_{Sia} μm
over	incl.	cylindrical	tapered					
18	30	3	3	3	4 0	3	3	4
30	50	4	4	4	4 0	4	3	4
50	80	5	5	5	5 0	4	4	5
80	120	5	5	5	6 0	5	4	5
120	180	7	7	7	8 0	6	5	7
180	250	8	8	8	9 0	8	6	8
250	315	9	9	9	11 0	9	7	10
315	400	12	12	12	12 0	10	9	12
400	500	14	14	14	14 0	12	11	15
500	630	15	15	15	15 0	14	13	18
630	800	20	20	20	18 0	17	15	21



**Tolerances of the outer ring
(tolerance class SP)**

Nominal outside diameter		Deviation of outside diameter		Variation (out of roundness)
D mm		$t_{\Delta Ds}, t_{\Delta Dmp}$ μm		t_{VDsp} μm
over	incl.			
30	50	0	-7	4
50	80	0	-9	5
80	120	0	-10	5
120	150	0	-11	6
150	180	0	-13	7
180	250	0	-15	8
250	315	0	-18	9
315	400	0	-20	10
400	500	0	-23	12
500	630	0	-28	14
630	800	0	-35	18
800	1000	0	-40	20

The width deviation $t_{\Delta Cs}$ is identical to $t_{\Delta Bs}$ of the corresponding inner ring.

**Tolerances of the outer ring
(tolerance class SP)
(continued)**

Nominal outside diameter		Variation of mean diameter	Variation of width	Radial runout	Inclination variation	Axial runout
D mm		t_{VDmp} μm	t_{Cs} μm	t_{ke} μm	t_{SD} μm	t_{Se} μm
over	incl.					
30	50	4	2,5	5	2	5
50	80	5	3	5	2	5
80	120	5	4	6	2,5	6
120	150	6	5	7	2,5	7
150	180	7	5	8	2,5	8
180	250	8	7	10	3,5	10
250	315	9	7	11	4	10
315	400	10	8	13	5	13
400	500	12	9	15	5,5	15
500	630	14	11	17	6,5	18
630	800	18	13	20	7,5	22
800	1000	20	15	23	8,5	26

Tolerances

Tolerances of class SP for double row cylindrical roller bearings

The following values are valid for the series NN30 and NNU49.

Tolerances of the inner ring (tolerance class SP)

Nominal bore diameter		Deviation of cylindrical bore		Deviation of tapered bore		Variation of width	Width deviation	
d mm		$t_{\Delta Ds}, t_{\Delta Dmp}$ μm		$t_{\Delta dmp}$ μm		t_{VBs} μm	$t_{\Delta Bs}$ μm	
over	incl.							
18	30	0	-6	10	0	2,5	0	-120
30	50	0	-8	12	0	3	0	-120
50	80	0	-9	15	0	4	0	-150
80	120	0	-10	20	0	4	0	-200
120	180	0	-13	25	0	5	0	-250
180	250	0	-15	30	0	6	0	-300
250	315	0	-18	35	0	8	0	-350
315	400	0	-23	40	0	10	0	-400
400	500	0	-27	45	0	12	0	-450
500	630	0	-30	50	0	14	0	-500
630	800	0	-40	65	0	17	0	-750

Tolerances of the inner ring (tolerance class SP) (continued)

Nominal bore diameter		Variation (out of roundness)		Variation of mean diameter	Deviation	Radial runout	Axial runout		
d mm		t_{Vdsp} μm Bore		t_{Vdmp} μm	$t_{\Delta d1mp} - t_{\Delta dmp}$ μm	t_{Kia} μm	t_{Sd} μm	t_{Sia} μm	
over	incl.	cylindrical	tapered						
18	30	3	3	3	4	0	3	4	4
30	50	4	4	4	4	0	4	4	4
50	80	5	5	5	5	0	4	5	5
80	120	5	5	5	6	0	5	5	5
120	180	7	7	7	8	0	6	6	7
180	250	8	8	8	9	0	8	7	8
250	315	9	9	9	11	0	8	8	10
315	400	12	12	12	12	0	10	10	12
400	500	14	14	14	14	0	10	12	15
500	630	15	15	15	15	0	12	14	18
630	800	20	20	20	18	0	15	17	21



**Tolerances of the outer ring
(tolerance class SP)**

Nominal outside diameter		Deviation of outside diameter		Variation (out of roundness)
D mm		$t_{\Delta Ds}, t_{\Delta Dmp}$ μm		t_{VDsp} μm
over	incl.			
30	50	0	-7	4
50	80	0	-9	5
80	120	0	-10	5
120	150	0	-11	6
150	180	0	-13	7
180	250	0	-15	8
250	315	0	-18	9
315	400	0	-20	10
400	500	0	-23	12
500	630	0	-28	14
630	800	0	-35	18
800	1000	0	-40	20

The width deviation $t_{\Delta Cs}$ is identical to $t_{\Delta Bs}$ of the corresponding inner ring.

**Tolerances of the outer ring
(tolerance class SP)
(continued)**

Nominal outside diameter		Variation of mean diameter	Variation of width	Radial runout	Inclination variation	Axial runout
D mm		$t_{v\Delta Dmp}$ μm	t_{vCs} μm	t_{Kea} μm	t_{SD} μm	t_{Se} μm
over	incl.					
30	50	4	2,5	5	2	5
50	80	5	3	5	2	5
80	120	5	4	6	2,5	6
120	150	6	5	7	2,5	7
150	180	7	5	8	2,5	8
180	250	8	7	10	3,5	10
250	315	9	7	11	4	10
315	400	10	8	13	5	13
400	500	12	9	15	5,5	15
500	630	14	11	17	6,5	18
630	800	18	13	20	7,5	22
800	1000	20	15	23	8,5	26

Tolerances

Tolerances of class UP for single and double row cylindrical roller bearings

The following values are valid for single and double row cylindrical roller bearings.

Tolerances of the inner ring (tolerance class UP)

Nominal bore diameter		Deviation of cylindrical bore		Deviation of tapered bore		Variation of width		Width deviation	
d mm		$t_{\Delta Ds}, t_{\Delta Dmp}$ μm		$t_{\Delta dmp}$ μm		t_{VBs} μm		$t_{\Delta Bs}$ μm	
over	incl.								
18	30	0	-5	6	0	1,5	0	-25	
30	50	0	-6	7	0	2	0	-30	
50	80	0	-7	8	0	2,5	0	-40	
80	120	0	-8	10	0	3	0	-50	
120	180	0	-10	12	0	4	0	-60	
180	250	0	-12	14	0	5	0	-75	
250	315	0	-15	15	0	5	0	-100	
315	400	0	-19	17	0	6	0	-100	
400	500	0	-23	19	0	7	0	-100	
500	630	0	-26	20	0	8	0	-125	
630	800	0	-34	22	0	11	0	-125	

Tolerances of the inner ring (tolerance class UP) (continued)

Nominal bore diameter		Variation (out of roundness)		Variation of mean diameter	Deviation		Radial runout	Axial runout	
d mm		t_{Vdsp} μm		t_{Vdmp} μm	$t_{\Delta d1mp} - t_{\Delta dmp}$ μm		t_{kia} μm	t_{sd} μm	t_{sia} μm
over	incl.	cylindrical	tapered						
18	30	2,5	2,5	2,5	2	0	1,5	3	3
30	50	3	3	3	3	0	2	3	3
50	80	3,5	3,5	3,5	3	0	2	4	3
80	120	4	4	4	4	0	3	4	4
120	180	5	5	5	4	0	3	5	6
180	250	6	6	6	5	0	4	6	7
250	315	8	8	8	6	0	4	6	8
315	400	10	10	10	6	0	5	7	9
400	500	12	12	12	7	0	5	8	10
500	630	13	13	13	8	0	6	9	12
630	800	17	17	17	9	0	7	11	18



**Tolerances of the outer ring
(tolerance class UP)**

Nominal outside diameter		Deviation of outside diameter		Variation (out of roundness)
D mm		$t_{\Delta Ds}, t_{\Delta Dmp}$ μm		t_{VDsp} μm
over	incl.			
30	50	0	-5	3
50	80	0	-6	3
80	120	0	-7	4
120	150	0	-8	4
150	180	0	-9	5
180	250	0	-10	5
250	315	0	-12	6
315	400	0	-14	7
400	500	0	-17	9
500	630	0	-20	10
630	800	0	-25	13
800	1000	0	-30	15

The width deviation $t_{\Delta Cs}$ is identical to $t_{\Delta Bs}$ of the corresponding inner ring.

**Tolerances of the outer ring
(tolerance class UP)
(continued)**

Nominal outside diameter		Variation of mean diameter	Variation of width	Radial runout	Inclination variation	Axial runout
D mm		t_{VDmp} μm	t_{Cs} μm	t_{Kea} μm	t_{SD} μm	t_{Se} μm
over	incl.					
30	50	3	1,5	3	1	3
50	80	3	2	3	1	4
80	120	4	3	3	1,5	5
120	150	4	4	4	1,5	5
150	180	5	4	4	1,5	5
180	250	5	5	5	2	7
250	315	6	5	6	2	7
315	400	7	6	7	2,5	8
400	500	9	7	8	2,5	10
500	630	10	8	9	3	12
630	800	13	11	11	3,5	14
800	1000	15	12	12	5	17

Tolerances

Dimensional, geometrical and positional tolerances of axial angular contact ball bearings

The dimensional, geometrical and running tolerances correspond to tolerance class SP in accordance with Schaeffler Group. Bearings of tolerance class UP are available by agreement.

Tolerances of the shaft locating washer (tolerance class SP)

Nominal bore diameter		Deviation		Variation (out of roundness)	Wall thickness variation	Height deviation	
d mm		$t_{\Delta dmp}$ μm		t_{Vdsp} μm	t_{Si} μm	$t_{\Delta Hs}$ μm	
over	incl.						
18	30	0	-8	6	3	50	-150
30	50	0	-10	8	3	75	-200
50	80	0	-12	9	4	100	-250
80	120	0	-15	11	4	125	-300
120	150	0	-18	14	5	150	-350
150	180	0	-18	14	5	150	-350
180	250	0	-22	17	5	175	-400
250	315	0	-25	19	7	200	-450
315	400	0	-30	22	7	250	-600
400	500	0	-35	26	9	300	-750

Tolerances of the shaft locating washer (tolerance class UP)

Nominal bore diameter		Deviation		Variation (out of roundness)	Wall thickness variation	Height deviation	
d mm		$t_{\Delta dmp}$ μm		t_{Vdsp} μm	t_{Si} μm	$t_{\Delta Hs}$ μm	
over	incl.						
18	30	0	-6	5	1,5	50	-150
30	50	0	-8	6	1,5	75	-200
50	80	0	-9	7	2	100	-250
80	120	0	-10	8	2	125	-300
120	150	0	-13	10	3	150	-350
150	180	0	-13	10	3	150	-350
180	250	0	-15	12	3	175	-400
250	315	0	-18	14	4	200	-450
315	400	0	-23	18	4	250	-600
400	500	0	-27	20	5	300	-750



The machining tolerances of the housing locating washer (bearings of tolerance class SP or UP) are shown in the tables.

**Tolerances
of the housing locating washer
(tolerance class SP)**

Nominal outside diameter		Deviation of outside diameter		Variation (out of roundness)	Wall thickness variation	Width deviation
D mm		$t_{\Delta Dmp}$ μm		t_{VDsp} μm	t_{Se} μm	$t_{\Delta Cs}$ μm
over	incl.					
30	50	-20	-36	5	3	-120
50	80	-24	-43	6	4	-120
80	120	-28	-50	8	4	-125
120	150	-33	-58	9	5	-125
150	180	-33	-58	9	5	-125
180	250	-37	-66	10	5	-125
250	315	-41	-73	12	7	-150
315	400	-46	-82	13	7	-150
400	500	-50	-90	15	9	-200
500	630	-55	-99	16	11	-200
630	800	-60	-110	18	13	-250

**Tolerances
of the housing locating washer
(tolerance class UP)**

Nominal outside diameter		Deviation of outside diameter		Variation (out of roundness)	Wall thickness variation	Width deviation
D mm		$t_{\Delta Dmp}$ μm		t_{VDsp} μm	t_{Se} μm	$t_{\Delta Cs}$ μm
over	incl.					
30	50	-20	-36	5	1,5	-120
50	80	-24	-43	6	2	-120
80	120	-28	-50	8	2	-125
120	150	-33	-58	9	3	-125
150	180	-33	-58	9	3	-125
180	250	-37	-66	10	3	-125
250	315	-41	-73	12	4	-150
315	400	-46	-82	13	4	-150
400	500	-50	-90	15	5	-200
500	630	-55	-99	16	6	-200
630	800	-55	-99	18	7	-250

Tolerances

Chamfer dimensions

The tables describe the chamfer dimensions for:

- radial bearings with a cylindrical bore
- radial bearings with a tapered bore, see table, page 47
- axial bearings, see table, page 48.

For r_{\min} , $r_{1 \min}$, r_{\max} , $r_{s \max}$, $r_{\max a}$, $r_{1 \max a}$ and measurement spacing a , see *Figure 3*, page 48.

Chamfer dimension of radial bearings with cylindrical bore

Bore		Chamfer dimension			Measurement spacing a mm
d mm		r_{\min} $r_{1 \min}$ mm	radial $r_{\max r}$ $r_{s \max r}$ mm	axial $r_{\max a}$ $r_{1 \max a}$ mm	
over	incl.				
–	25	0,1	0,2	0,4	0,9
–	25	0,15	0,3	0,6	1,1
–	40	0,2	0,5	0,8	1,3
–	40	0,3	0,6	1	1,5
40	120	0,3	0,8	1	1,5
120	250	0,3	1	1,7	2,2
–	40	0,6	1	2	2,5
40	250	0,6	1,3	2	2,5
250	400	0,6	1,5	2,6	3,1
–	50	1	1,5	3	3,6
50	400	1	1,9	3	3,6
400	500	1	2,5	3,5	4,2
–	120	1,1	2	3,5	4,2
120	400	1,1	2,5	4	4,8
400	500	1,1	2,7	4,5	5,4
–	120	1,5	2,3	4	4,8
120	400	1,5	3	5	6
400	800	1,5	3,5	5	6
–	80	2	3	4,5	5,4
80	220	2	3,5	5	6
220	800	2	3,8	6	7,2
–	280	2,1	4	6,5	7,8
280	1200	2,1	4,5	7	8,4
–	100	2,5	3,8	6	7,2
100	280	2,5	4,5	6	7,2
280	800	2,5	5	7	8,4
800	1200	2,5	5	7,5	9
–	280	3	5	8	9,6
280	1200	3	5,5	8	9,6
–	1200	4	6,5	9	10,8
–	2000	5	8	10	12
–	3000	6	10	13	15,6
–	3000	7,5	12,5	17	20,4



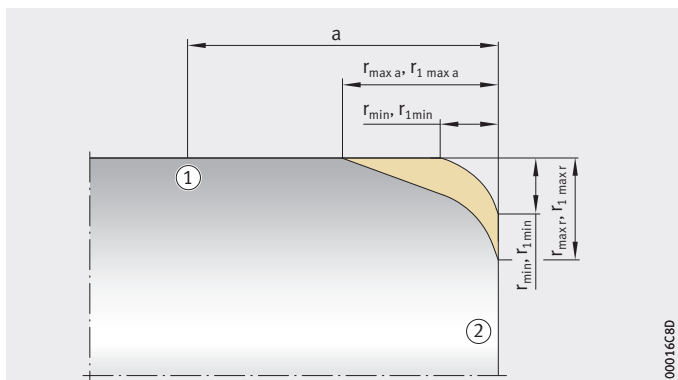
**Chamfer dimension
of radial bearings
with tapered bore**

Bore		Chamfer dimension			Measurement spacing
d mm		r _{min} r _{1 min} mm	radial r _{max r} r _{s max r} mm	axial r _{max a} r _{1 max a} mm	a mm
–	25	0,05	0,15	0,25	0,8
–	25	0,1	0,3	0,5	1
–	40	0,1	0,3	0,5	1
–	40	0,15	0,45	0,75	1,3
40	120	0,15	0,45	0,75	1,3
120	250	0,2	0,6	1	1,5
–	40	0,25	0,75	1,25	1,8
40	250	0,3	0,9	1,5	2
250	400	0,35	1,05	1,75	2,3
–	50	0,4	1,2	2	2,5
50	400	0,45	1,35	2,25	2,8
400	500	0,5	1,5	2,5	3
–	120	0,5	1,5	2,5	3
120	400	0,55	1,65	2,75	3,3
400	500	0,6	1,8	3	3,5
–	120	0,6	1,8	3	3,5
120	400	0,7	2,1	3,5	4,2
400	800	0,7	2,1	3,5	4,2
–	80	0,7	2,1	3,5	4,2
80	220	0,8	2,4	4	4,8
220	800	0,9	2,7	4,5	5,4
–	280	0,9	2,7	4,5	5,4
280	1200	1	3	5	6
–	100	0,9	2,7	4,5	5,4
100	280	1	3	5	6
280	800	1,1	3,3	5,5	6,6
800	1200	1,1	3,3	5,5	6,6
–	280	1,2	3,6	6	7,2
280	1200	1,2	3,6	6	7,2
–	1200	1,5	4,5	7,5	9
–	2000	1,8	5,5	9	10,8
–	3000	2,2	6,5	11	13,2
–	3000	3	9	15	18

Tolerances

- ① Bore or outside diameter
- ② Lateral face

Figure 3
Limit chamfer dimensions



Chamfer dimension of axial bearings

Bore		Chamfer dimension			Measurement spacing
d		r _{min} r _{1 min} mm	radial	axial	a mm
over	incl.		r _{max r} r _{s max r} mm	r _{max a} r _{1 max a} mm	
–	25	0,1	0,2	0,2	0,7
–	25	0,15	0,3	0,3	0,8
–	40	0,2	0,5	0,5	1
–	120	0,3	0,8	0,8	1,3
120	250	0,3	1	1	1,5
–	400	0,6	1,5	1,5	2
–	500	1	2,2	2,2	2,6
500	800	1	2,6	2,6	3,1
–	800	1,1	2,7	2,7	3,2
–	1200	1,5	3,5	3,5	4,2
–	1200	2	4	4	4,8
–	1200	2,1	4,5	4,5	5,4
–	2 000	3	5,5	5,5	6,6
–	2 000	4	6,5	6,5	7,8
–	3 000	5	8	8	9,6
–	3 000	6	10	10	12
–	3 000	7,5	12,5	12,5	15

Legend

- r_{min}, r_{1 min} mm
Symbol for smallest chamfer dimension in radial and axial direction
- r_{max r}, r_{1 max r} mm
Largest chamfer dimension in radial direction
- r_{max a}, r_{1 max a} mm
Largest chamfer dimension in axial direction
- a mm
Measurement spacing: this spacing is used for inspection of the bore or outside diameter tolerances.



Machining tolerances of adjacent parts

The performance capacity of super precision bearings in relation to speed suitability and running accuracy continues to increase. However, this increased performance capacity is only effective and can only be used to the full if the precision of the adjacent parts is in harmony with the precision of the bearings.

In order to facilitate better and faster selection of fits as well as secure functioning and interchangeability of the super precision bearing, the dimensional, geometrical and positional tolerances that have proved effective in many applications are compiled in tables. For spindle bearings, see page 51 and tables, page 61, for cylindrical roller bearings, see page 52 to 59, for axial angular contact ball bearings, see page 56.



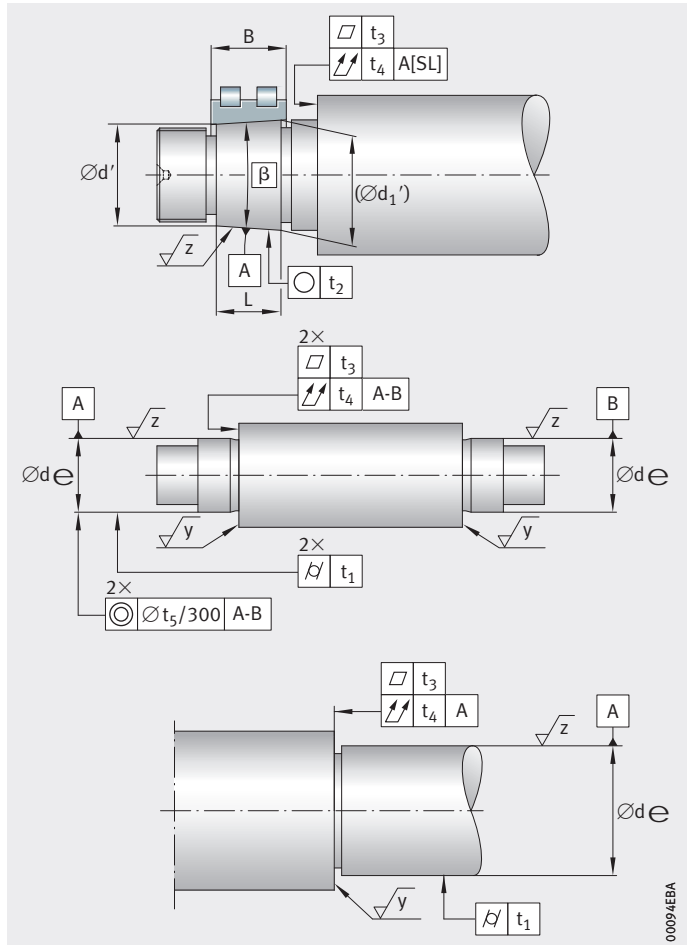
The mean roughness values R_a of the bearing seats must not be exceeded, in order that the recommended fits remain within a restricted change (burnishing). The generally valid rules of rolling bearing engineering that take account of the direction and action of loading, the rotation of the inner or outer ring and changes in the fit due to temperature and centrifugal force must also be observed.

Tolerances

Geometrical and positional tolerances of the shaft

- d = nominal shaft diameter
- d' = small taper diameter
(= d + lower deviation, see tables, page 53 and page 54)
- d₁' = large taper diameter
d₁' = d' + 1/12 · L
- L = taper length L = 0,95 · B
(bearing width)
- t₁ = cylindricity tolerance according to DIN ISO 1101
- t₂ = roundness tolerance according to DIN ISO 1101
- t₃ = flatness tolerance according to DIN ISO 1101
- t₄ = axial runout tolerance according to DIN ISO 1101
- t₅ = coaxiality tolerance according to DIN ISO 1101
- AT_D = taper angle tolerance according to DIN 7178
- y, z, Ra = mean roughness according to DIN ISO 1302

Figure 4
Geometrical and positional tolerances of the shaft





Spindle bearings and axial bearings BAX



In order to make comprehensive use of the performance capability of spindle bearings and axial bearings BAX, the adjacent construction must be of an appropriate design.

Recommendations for the machining tolerances of the shaft are shown in the table.

Machining tolerances of the shaft

Nominal shaft diameter d mm		Deviation for d μm		Cylindricity μm t ₁	Flatness μm t ₃	Axial runout μm t ₄	Co-axiality μm t ₅	Mean roughness μm Ra
over	incl.							
–	10	2	–2	0,6	0,6	1	2,5	0,2
10	18	2,5	–2,5	0,8	0,8	1,2	3	0,2
18	30	3	–3	1	1	1,5	4	0,2
30	50	3,5	–3,5	1	1	1,5	4	0,2
50	80	4	–4	1,2	1,2	2	5	0,4
80	120	5	–5	1,5	1,5	2,5	6	0,4
120	180	6	–6	2	2	3,5	8	0,4
180	250	7	–7	3	3	4,5	10	0,4
250	315	8	–8	4	4	6	12	0,8
315	400	9	–9	5	5	7	13	0,8
400	500	10	–10	6	6	8	15	0,8
500	630	11	–11	7	7	9	16	0,8
630	800	12	–12	8	8	10	18	0,8

Tolerances

Super precision
cylindrical roller bearings



In order to make comprehensive use of the performance capacity of super precision cylindrical roller bearings, the adjacent construction must be of an appropriate design.

Recommendations for the machining tolerances of the cylindrical shaft (for super precision cylindrical roller bearings of tolerance class SP or UP) are shown in the tables.

**Tolerances of the cylindrical shaft
for tolerance class SP**

Nominal shaft diameter d mm		Deviation for d μm		Cylin- dricity μm	Flat- ness μm	Axial runout μm	Co- axiality μm	Mean rough- ness μm
over	incl.			t_1	t_3	t_4	t_5	Ra
18	30	3	-3	1	1	1,5	4	0,2
30	50	3,5	-3,5	1	1	1,5	4	0,2
50	80	4	-4	1,2	1,2	2	5	0,4
80	120	5	-5	1,5	1,5	2,5	6	0,4
120	180	6	-6	2	2	3,5	8	0,4
180	250	7	-7	3	3	4,5	10	0,4
250	315	8	-8	4	4	6	12	0,8
315	400	9	-9	5	5	7	13	0,8
400	500	10	-10	6	6	8	15	0,8
500	630	11	-11	7	7	9	16	0,8
630	800	12	-12	8	8	10	18	0,8

**Tolerances of the cylindrical shaft
for tolerance class UP**

Nominal shaft diameter d mm		Deviation for d μm		Cylin- dricity μm	Flat- ness μm	Axial runout μm	Co- axiality μm	Mean rough- ness μm
over	incl.			t_1	t_3	t_4	t_5	Ra
18	30	2	-2	0,6	0,6	1	2,5	0,2
30	50	2	-2	0,6	0,6	1	2,5	0,2
50	80	2,5	-2,5	0,8	0,8	1,2	3	0,2
80	120	3	-3	1	1	1,5	4	0,2
120	180	4	-4	1,2	1,2	2	5	0,2
180	250	5	-5	2	2	3	7	0,2
250	315	6	-6	2,5	2,5	4	8	0,4
315	400	6,5	-6,5	3	3	5	9	0,4
400	500	7,5	-7,5	4	4	6	10	0,4
500	630	8	-8	5	5	7	11	0,4
630	800	9	-9	5	5	8	12	0,4



Recommendations for the machining tolerances of the tapered shaft (for super precision cylindrical roller bearings of tolerance class SP or UP) are shown in the tables.

**Tolerances of the tapered shaft
for tolerance class SP**

Nominal shaft diameter (bearing bore) d mm		Deviation of small taper diameter ¹⁾ μm		Roundness μm t ₂	Flatness μm t ₃	Axial runout μm t ₄	Mean roughness μm Ra
over	incl.						
18	30	+73	+64	1	1	1,5	0,2
30	40	+91	+80	1	1	1,5	0,2
40	50	+108	+97	1	1	1,5	0,2
50	65	+135	+122	1,2	1,2	2	0,2
65	80	+159	+146	1,2	1,2	2	0,2
80	100	+193	+178	1,5	1,5	2,5	0,2
100	120	+225	+210	1,5	1,5	2,5	0,2
120	140	+266	+248	2	2	3,5	0,2
140	160	+298	+280	2	2	3,5	0,2
160	180	+328	+310	2	2	3,5	0,2
180	200	+370	+350	3	3	4,5	0,2
200	225	+405	+385	3	3	4,5	0,2
225	250	+445	+425	3	3	4,5	0,2
250	280	+498	+475	4	4	6	0,4
280	315	+548	+525	4	4	6	0,4
315	355	+615	+590	5	5	7	0,4
355	400	+685	+660	5	5	7	0,4
400	450	+767	+740	6	6	8	0,4
450	500	+847	+820	6	6	8	0,4
500	560	+928	+900	7	7	9	0,4
560	630	+1008	+980	7	7	9	0,4
630	710	+1092	+1060	8	8	10	0,4

¹⁾ In relation to the nominal shaft diameter d, see page 55.

Tolerances

Tolerances of the tapered shaft for tolerance class UP

Nominal shaft diameter (bearing bore) d mm		Deviation of small taper diameter ¹⁾ μm		Roundness μm	Flatness μm	Axial runout μm	Mean roughness μm
over	incl.			t ₂	t ₃	t ₄	Ra
18	30	+73	+64	0,6	0,6	1	0,2
30	40	+91	+80	0,6	0,6	1	0,2
40	50	+108	+97	0,6	0,6	1	0,2
50	65	+135	+122	0,8	0,8	1,2	0,2
65	80	+159	+146	0,8	0,8	1,2	0,2
80	100	+193	+178	1	1	1,5	0,2
100	120	+225	+210	1	1	1,5	0,2
120	140	+266	+248	1,2	1,2	2	0,2
140	160	+298	+280	1,2	1,2	2	0,2
160	180	+328	+310	1,2	1,2	2	0,2
180	200	+370	+350	2	2	3	0,2
200	225	+405	+385	2	2	3	0,2
225	250	+445	+425	2	2	3	0,2
250	280	+498	+475	2,5	2,5	4	0,4
280	315	+548	+525	2,5	2,5	4	0,4
315	355	+615	+590	3	3	5	0,4
355	400	+685	+660	3	3	5	0,4
400	450	+767	+740	4	4	6	0,4
450	500	+847	+820	4	4	6	0,4
500	560	+928	+900	5	5	7	0,4
560	630	+1008	+980	5	5	7	0,4
630	710	+1092	+1060	5	5	8	0,4

¹⁾ In relation to the nominal shaft diameter d, see section Calculation example.



For cylindrical roller bearings, the tolerance of the tapered shaft can be calculated according to the following example.

Calculation example	Bearing bore	70 mm
	Tolerance class	SP
	Small taper diameter d'	= d + lower deviation = 70 mm + 0,146 mm = 70,146 mm
	Tolerance	= upper deviation – lower deviation = 0,159 mm – 0,146 mm = (+) 0,013 mm

The taper angle tolerance AT_D applies vertical to the axis and is defined as the differential diameter.

When using FAG taper gauges MGK132, the AT_D values stated should be halved (inclination angle tolerance).

For taper lengths with nominal dimensions between the values stated in the table, the taper angle tolerance AT_D is determined by means of interpolation.

The deviation of the taper angle of the shaft seat for super precision cylindrical roller bearings of tolerance class SP is shown in the table.

Deviation of taper angle

Nominal taper length L mm		Taper angle tolerance AT_D μm			
L_U over	L_O incl.	AT_{DU}		AT_{DO}	
16	25	+2	0	+3,2	0
25	40	+2,5	0	+4	0
40	63	+3,2	0	+5	0
63	100	+4	0	+6,3	0
100	160	+5	0	+8	0
160	250	+6,3	0	+10	0

Calculation example of the taper length of a shaft seat 50 mm, tolerance class SP.

$$AT_D = \frac{AT_{DO} - AT_{DU}}{L_o - L_u} \cdot L$$

$$AT_D = \frac{5 - 3,2}{63 - 40} \cdot 50 = 3,91 \mu\text{m}$$

Taper angle tolerance $AT_D = +4 \mu\text{m}$.

Tolerances

Axial angular contact ball bearings
(2344)



In order to make comprehensive use of the performance capacity of double direction axial angular contact ball bearings, the adjacent construction must be of an appropriate design.

Recommendations for the machining tolerances of the shaft (for axial angular contact ball bearings of tolerance class SP or UP) are shown in the tables.

Shaft design for tolerance class SP

Nominal shaft diameter d mm		Deviation for d μm		Cylin- dricity μm t_1	Flatness μm t_3	Axial runout μm t_4	Mean roughness μm Ra
over	incl.						
18	30	0	-6	1	1	1,5	0,2
30	50	0	-7	1	1	1,5	0,2
50	80	0	-8	1,2	1,2	2	0,4
80	120	0	-10	1,5	1,5	2,5	0,4
120	180	0	-12	2	2	3,5	0,4
180	250	0	-14	3	3	4,5	0,4
250	315	0	-16	4	4	6	0,8
315	400	0	-18	5	5	7	0,8
400	500	0	-20	6	6	8	0,8

Shaft design for tolerance class UP

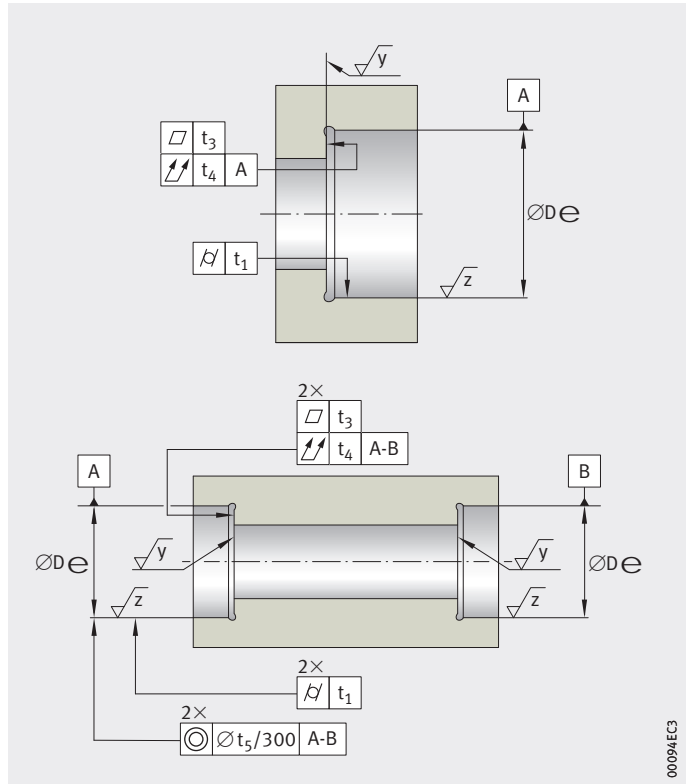
Nominal shaft diameter d mm		Deviation for d μm		Cylin- dricity μm t_1	Flatness μm t_3	Axial runout μm t_4	Mean roughness μm Ra
over	incl.						
18	30	0	-4	0,6	0,6	1	0,2
30	50	0	-4	0,6	0,6	1	0,2
50	80	0	-5	0,8	0,8	1,2	0,2
80	120	0	-6	1	1	1,5	0,2
120	180	0	-8	1,2	1,2	2	0,2
180	250	0	-10	2	2	3	0,2
250	315	0	-12	2,5	2,5	4	0,4
315	400	0	-13	3	3	5	0,4
400	500	0	-15	4	4	6	0,4



Geometrical and positional tolerances of the housing

- D = nominal housing bore diameter
- t_1 = cylindricity tolerance according to DIN ISO 1101
- t_3 = flatness tolerance according to DIN ISO 1101
- t_4 = axial runout tolerance according to DIN ISO 1101
- t_5 = coaxiality tolerance according to DIN ISO 1101
- y, z, Ra = mean roughness according to DIN ISO 1302

Figure 5
Geometrical and positional tolerances of the housing



Tolerances

Spindle bearings

Recommendations for the machining tolerance of the housing are shown in the table. The tolerances are matched to bearing tolerance class P4S.

Tolerances of the housing

Nominal housing bore diameter D mm		Deviation for D μm				Cylin- dricity μm t ₁	Flat- ness μm t ₃	Axial run- out μm t ₄	Co- axiality μm t ₅	Mean rough- ness μm Ra
over	incl.	Locating bearing		Non-locating bearing						
10	18	+3	-2	+7	+2	1,2	1,2	2	3	0,4
18	30	+4	-2	+8	+2	1,5	1,5	2,5	4	0,4
30	50	+4	-3	+10	+3	1,5	1,5	2,5	4	0,4
50	80	+5	-3	+11	+3	2	2	3	5	0,4
80	120	+6	-4	+14	+4	2,5	2,5	4	6	0,8
120	180	+8	-4	+17	+5	3,5	3,5	5	8	0,8
180	250	+10	-4	+21	+7	4,5	4,5	7	10	0,8
250	315	+12	-4	+24	+8	6	6	8	12	1,6
315	400	+13	-5	+27	+9	7	7	9	13	1,6
400	500	+15	-5	+30	+10	8	8	10	15	1,6
500	630	+16	-6	+33	+11	9	9	11	16	1,6
630	800	+18	-6	+36	+12	10	10	12	18	1,6
800	1000	+21	-7	+42	+14	11	11	14	21	1,6



Super precision cylindrical roller bearings and axial angular contact ball bearings

Recommendations for the machining tolerances of the housing (for super precision cylindrical roller bearings and axial angular contact ball bearings (2344) of tolerance class SP or UP) are shown in the tables.

Housing design for tolerance class SP

Nominal housing bore diameter D mm		Deviation for D μm		Cylindricity μm	Flatness μm	Axial runout μm	Co-axiality μm	Mean roughness μm
over	incl.			t_1	t_3	t_4	t_5	Ra
30	50	+2	-9	1,5	1,5	2,5	4	0,4
50	80	+3	-10	2	2	3	5	0,4
80	120	+2	-13	2,5	2,5	4	6	0,8
120	180	+3	-15	3,5	3,5	5	8	0,8
180	250	+2	-18	4,5	4,5	7	10	0,8
250	315	+3	-20	6	6	8	12	1,6
315	400	+3	-22	7	7	9	13	1,6
400	500	+2	-25	8	8	10	15	1,6
500	630	0	-29	9	9	11	16	1,6
630	800	0	-32	10	10	12	18	1,6
800	1000	0	-36	11	11	14	21	1,6

Housing design for tolerance class UP

Nominal housing bore diameter D mm		Deviation for D μm		Cylindricity μm	Flatness μm	Axial runout μm	Co-axiality μm	Mean roughness μm
over	incl.			t_1	t_3	t_4	t_5	Ra
30	50	+1	-6	1	1	1,5	2,5	0,2
50	80	+1	-7	1,2	1,2	2	3	0,4
80	120	+1	-9	1,5	1,5	2,5	4	0,4
120	180	+1	-11	2	2	3,5	5	0,4
180	250	0	-14	3	3	4,5	7	0,4
250	315	0	-16	4	4	6	8	0,8
315	400	+1	-17	5	5	7	9	0,8
400	500	0	-20	6	6	8	10	0,8
500	630	0	-22	7	7	9	11	1,6
630	800	0	-24	8	8	10	12	1,6
800	1000	0	-27	9	9	11	14	1,6

Axial bearings BAX

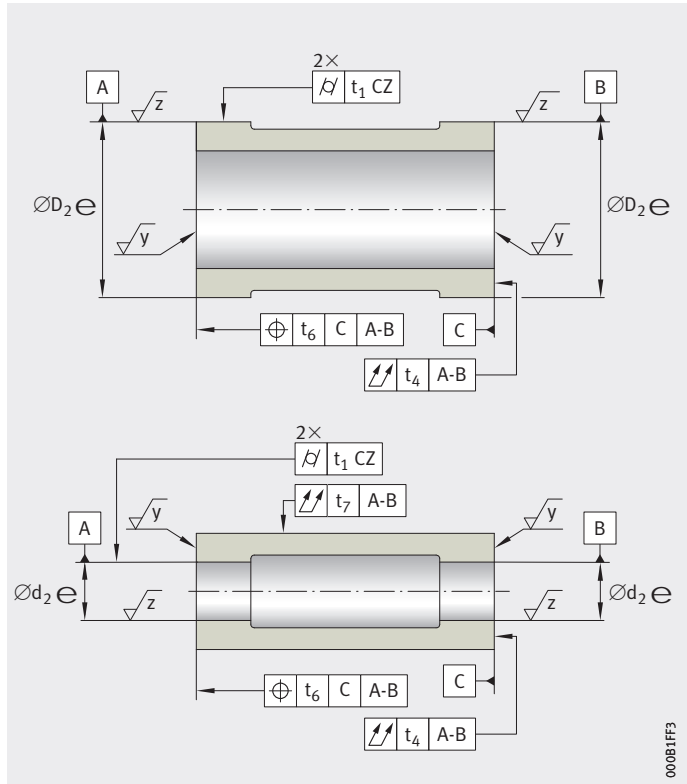
The machining tolerances of the housing are based on the cylindrical roller bearing used, see tables, page 59.

Tolerances

Geometrical and positional tolerances of spacer sleeves

- d_2 = nominal spacer sleeve bore diameter
- D_2 = nominal spacer sleeve outside diameter
- t_1 = cylindricity tolerance according to DIN ISO 1101
- t_4 = total runout tolerance according to DIN ISO 1101
- t_6 = positional tolerance according to DIN ISO 1101
- t_7 = total runout tolerance according to DIN ISO 1101
- y, z, Ra = mean roughness according to DIN ISO 1302

Figure 6
Geometrical and positional tolerances of spacer sleeves



Recommendations for the machining tolerances of the inner and outer spacer sleeve, see tables.

Unless stated otherwise in the drawing, both spacer sleeves should be of the same length. The end faces of both sleeves should therefore be finish ground in a single clamping operation.



Tolerances of the inner spacer sleeve

Nominal sleeve bore diameter d_2 mm		Deviation for d_2		Cylin- dricity	Axial runout	Paral- lelism	Radial runout	Mean rough- ness ¹⁾
over	incl.	μm		μm	μm	μm	μm	μm
				t_1	t_4	t_6	t_7	Ra
-	10	9	0	2,5	1	1	2,5	0,4
10	18	11	0	3	1,2	1,2	3	0,4
18	30	13	0	4	1,5	1,5	4	0,4
30	50	16	0	4	1,5	1,5	4	0,4
50	80	19	0	5	2	2	5	0,4
80	120	22	0	6	2,5	2,5	6	0,8
120	180	25	0	8	3,5	3,5	8	0,8
180	250	29	0	10	4,5	4,5	10	0,8
250	315	32	0	12	6	6	12	1,6
315	400	36	0	13	7	7	13	1,6
400	500	40	0	15	8	8	15	1,6
500	630	44	0	16	9	9	16	1,6
630	800	50	0	18	10	10	18	1,6

¹⁾ Including end faces.

Tolerances of the outer spacer sleeve

Nominal sleeve outside diameter D_2 mm		Deviation for D_2		Cylin- dricity	Axial runout	Parallelism	Mean rough- ness ¹⁾
over	incl.	μm		μm	μm	μm	μm
				t_1	t_4	t_6	Ra
10	18	-6	-17	3	2	1,2	0,4
18	30	-7	-20	4	2,5	1,5	0,4
30	50	-9	-25	4	2,5	1,5	0,4
50	80	-10	-29	5	3	2	0,4
80	120	-12	-34	6	4	2,5	0,8
120	180	-14	-39	8	5	3,5	0,8
180	250	-15	-44	10	7	4,5	0,8
250	315	-17	-49	12	8	6	1,6
315	400	-18	-54	13	9	7	1,6
400	500	-20	-60	15	10	8	1,6
500	630	-22	-66	16	11	9	1,6
630	800	-24	-74	18	12	10	1,6
800	1000	-27	-83	21	14	11	1,6

¹⁾ Including end faces.

Tolerances

Spindle bearings

Fit as a function of speed

FAG spindle bearings are suitable for the highest speeds. If grease lubrication is used, it is possible to achieve speed parameters of $n \cdot d_m$ to $2 \cdot 10^6$ mm/min and, in the case of oil lubrication, even $3 \cdot 10^6$ mm/min and higher.

These speeds induce high centrifugal forces that act on the inner rings and cause their expansion. Such expansion of the ring leads to the inner ring lifting off the shaft and thus to clearance between the inner ring and shaft.

This may have the following consequences:

- fretting corrosion
- rotation of the ring on the shaft
- poor shaft guidance with an increased tendency towards vibration
- reduced bearing performance due to possible tilting.

Calculation of the interference

This can be prevented by correspondingly tight fits on the shaft. The necessary interference can be taken from the diagram or calculated using BEARINX, *Figure 7*, page 63. The values calculated in this way will give a fit under which there will still be interference of 1 μm at the highest speed.

The value f_w can be taken from the following diagrams. For the bearing types B, HCB, RS and HCRS, see *Figure 8*, page 63. For the bearing types HS, HC and XC, see *Figure 9*, page 63.

High interference leads, particularly in the case of rigidly adjusted bearings, to an increase in preload. In turn, this leads to increased temperature in the bearing arrangement and to impaired speed capacity. The increase in preload must be compensated by means of appropriate measures.



At values $f_w \cdot n^2 > 1,2$ (red area), *Figure 7*, page 63, it is recommended that advice should be obtained from the Application Engineering facilities of the Schaeffler Group.



U = interference,
as a function of speed
n = speed
 f_W = factor for determining the fit

- ① Solid shaft
- ② Hollow shaft 50%
- ③ Hollow shaft 75%

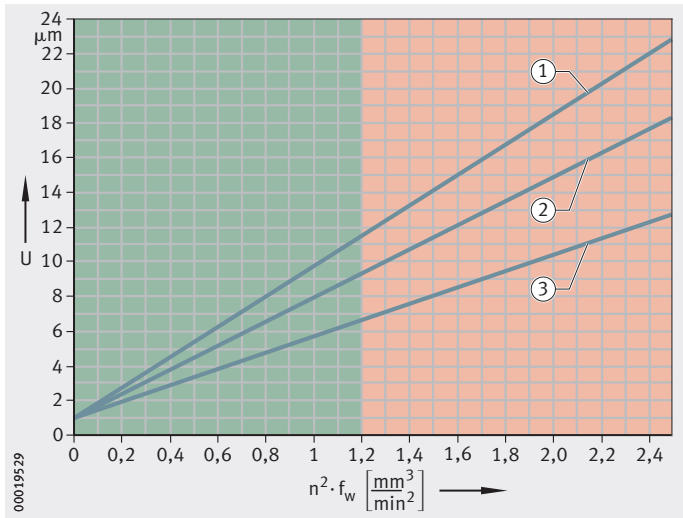


Figure 7
Calculation of the interference
between the shaft and inner ring

f_W = factor for determining the fit
between the inner ring and shaft,
as a function of speed
d = bearing bore

- ① B70, RS70, HCRS70
- ② B719, RS719, HCRS719
- ③ B72, HCB72

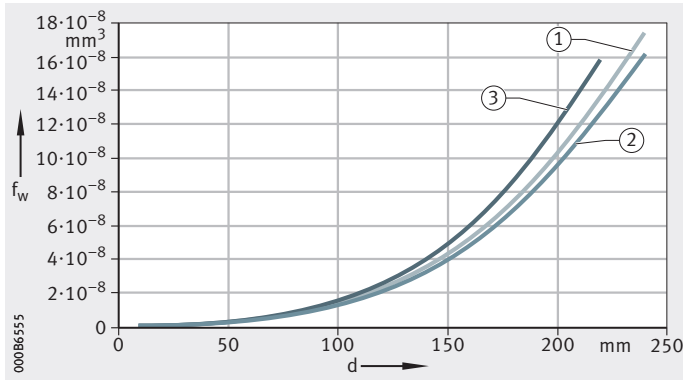


Figure 8
Factor f_W for B, HCB, RS, HCRS

f_W = factor for determining the fit
between the inner ring and shaft,
as a function of speed
d = bearing bore

- ① HC70, HS70, XC70
- ② HC719, HS719, XC719

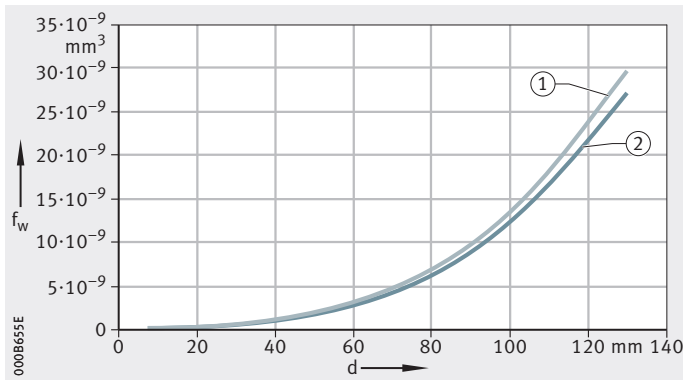


Figure 9
Factor f_W for HS, HC, XC

Tolerances

Example If $f_w \cdot n^2 < 1,2$, the shaft dimension is calculated as follows:

Given data

- Spindle bearing
 - HCS71914-E-T-P4S-UL
- Speed n
 - $16\,000\text{ min}^{-1}$
- Inner ring actual dimension (the deviation from the actual dimension is indicated on the bearing ring)
 - $70\text{ mm} - 3\text{ }\mu\text{m} = 69,997\text{ mm}$
- Bore of hollow shaft
 - 35 mm (\triangleq 50% of bore diameter)
- Factor for determining the fit, as a function of the speed for bearing types HS, HC and XC, *Figure 9*, page 63
 - $f_w = 4,30 \cdot 10^{-9}$.

Calculation

$$n^2 \cdot f_w = 1,1$$

With the value 1,1 and the curve ②, *Figure 7*, page 63, the necessary interference is calculated as $9\text{ }\mu\text{m}$.

The actual dimension of the shaft must thus be $70,006\text{ mm}$, in order that the inner ring is still firmly seated on the shaft at a speed of $n = 16\,000\text{ min}^{-1}$.



**Super precision
cylindrical roller bearings and
axial bearings (2344)
Radial internal clearance**

The values in the table are valid for single and double row cylindrical roller bearings with a tapered or cylindrical bore.

The internal clearance groups conform to DIN 620-4.

**Radial internal clearance
of bearings with tapered bore**

Nominal bore diameter		Internal clearance group							
d mm		C1 ¹⁾ μm		C2 ²⁾ μm		CN ²⁾ μm		C3 ²⁾ μm	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.
24	30	15	25	20	45	35	60	45	70
30	40	15	25	20	45	40	65	55	80
40	50	17	30	25	55	45	75	60	90
50	65	20	35	30	60	50	80	70	100
65	80	25	40	35	70	60	95	85	120
80	100	35	55	40	75	70	105	95	130
100	120	40	60	50	90	90	130	115	155
120	140	45	70	55	100	100	145	130	175
140	160	50	75	60	110	110	160	145	195
160	180	55	85	75	125	125	175	160	210
180	200	60	90	85	140	140	195	180	235
200	225	60	95	95	155	155	215	200	260
225	250	65	100	105	170	170	235	220	285
250	280	75	110	115	185	185	255	240	310
280	315	80	120	130	205	205	280	265	340
315	355	90	135	145	225	225	305	290	370
355	400	100	150	165	255	255	345	330	420
400	450	110	170	185	285	285	385	370	470
450	500	120	190	205	315	315	425	410	520
500	560	130	210	230	350	350	470	455	575
560	630	140	230	260	380	380	500	500	620
630	710	160	260	295	435	435	575	565	705

Radial internal clearance without measurement load.

- 1) Bearings of accuracy SP and UP have a radial internal clearance C1.
The bearing rings are not interchangeable (NA).
- 2) The internal clearance groups C2, CN and C3 can be ordered using suffixes for the accuracy SP and UP.
The bearing rings are interchangeable.

Tolerances

Radial internal clearance of bearings with cylindrical bore

Nominal bore diameter d mm		Internal clearance group							
		C1 ¹⁾ μm		C2 ²⁾ μm		CN ²⁾ μm		C3 ²⁾ μm	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.
24	30	5	15	0	25	20	45	35	60
30	40	5	15	5	30	25	50	45	70
40	50	5	18	5	35	30	60	50	80
50	65	5	20	10	40	40	70	60	90
65	80	10	25	10	45	40	75	65	100
80	100	10	30	15	50	50	85	75	110
100	120	10	30	15	55	50	90	85	125
120	140	10	35	15	60	60	105	100	145
140	160	10	35	20	70	70	120	115	165
160	180	10	40	25	75	75	125	120	170
180	200	15	45	35	90	90	145	140	195
200	225	15	50	45	105	105	165	160	220
225	250	15	50	45	110	110	175	170	235
250	280	20	55	55	125	125	195	190	260
280	315	20	60	55	130	130	205	200	275
315	355	20	65	65	145	145	225	225	305
355	400	25	75	100	190	190	280	280	370
400	450	25	85	110	210	210	310	310	410
450	500	25	95	110	220	220	330	330	440
500	560	25	100	120	240	240	360	360	480
560	630	30	110	140	260	260	380	380	500
630	710	30	130	145	285	285	425	425	565

Radial internal clearance without measurement load.

- 1) Bearing of accuracy SP and UP have a radial internal clearance C1.
The bearing rings are not interchangeable (NA).
- 2) The internal clearance groups C2, CN and C3 can be ordered using suffixes for the accuracy SP and UP.
The bearing rings are interchangeable.



Speeds

The achievable speeds are dependent on the overall energy balance in the system.

The decisive factors are:

- the number of bearings
- the arrangement of the bearings
- the internal load (preload class)
- the external load
- the lubrication
- the heat dissipation.

Spindle bearings



The limiting speeds in the dimension tables are based on elastically preloaded single bearings and are guide values that may deviate up or down depending on the operating conditions. However, they give an indication of the speed capacity under relatively low load and when using elastically preloaded single bearings with good heat dissipation.

The data for grease lubrication are valid when using the high speed grease in the correct quantity.

Reduction factors

The speed limits stated are reduced in the case of bearings fitted with rigid preload or high preload (in order to achieve better rigidity of the spindle) as well as in bearing pairs and bearing groups. The speeds in the dimension tables must therefore be multiplied by reduction factors. The factors f_r to be used here are shown in the table.

Speed reduction for spindle bearing sets

Arrangement of bearings	Bearing preload		
	L	M	H
	Factor f_r		
Bearing spacing greater than twice bearing bore			
	0,85	0,75	0,5
	0,8	0,7	0,5
	0,75	0,65	0,45
Bearing spacing 0 to bearing bore			
	0,75	0,6	0,35
	0,65	0,5	0,3
	0,65	0,5	0,3
	0,72	0,57	0,37
	0,54	0,4	0,25

Speeds

Super precision cylindrical roller bearings

The limiting speeds n_G given in the dimension tables are valid for grease lubrication or minimal quantity oil lubrication and must not be exceeded.

In the case of cylindrical roller bearings, the radial internal clearance after mounting must be selected in accordance with the maximum operating speed. Guide values are shown in the table.

Speeds n_G grease and n_G oil, see dimension tables.

Achievable speeds

Single row cylindrical roller bearings		
Clearance or preload		Maximum achievable speed
μm		min^{-1}
-5 to 0		$< 0,75 \cdot n_G$ grease
0 (clearance-free)		$0,75$ to $1,0 \cdot n_G$ grease
0 to 5		1 to $1,1 \cdot n_G$ grease
0 to 5		$1,0 \cdot n_G$ oil
Double row cylindrical roller bearings		
Clearance or preload		Achievable speed
μm	mm	min^{-1}
-5 to 0	-	$< 0,50 \cdot n_G$ grease
-	$2 \cdot 10^{-5} \cdot d_M$	$0,50$ to $0,75 \cdot n_G$ grease
-	$4 \cdot 10^{-5} \cdot d_M$	$0,75$ to $1,0 \cdot n_G$ grease
-	$1 \cdot 10^{-4} \cdot d_M$	$1,0 \cdot n_G$ oil

$$d_M = (d + D)/2$$

These values are guide values for ΔT up to 5 K between the inner and outer ring. For use in applications with larger temperature differentials, for example in motor spindles, please consult Schaeffler Application Engineering.



Axial angular contact ball bearings

Double direction axial angular contact ball bearings are suitable for moderate speeds.

For higher speeds, single row angular contact ball bearings of the design BAX with a contact angle of 30° or optionally 40°, are available, see TPI 202, Axial Bearings BAX. These bearings are fitted in pairs and subjected to axial load only.

The speeds given in the dimension tables are valid for bearing pairs with light preload. The speed reduction factor for the preload M is 0,80.

- ① Speed parameter
- ② Grease lubrication
- ③ Minimal quantity oil lubrication

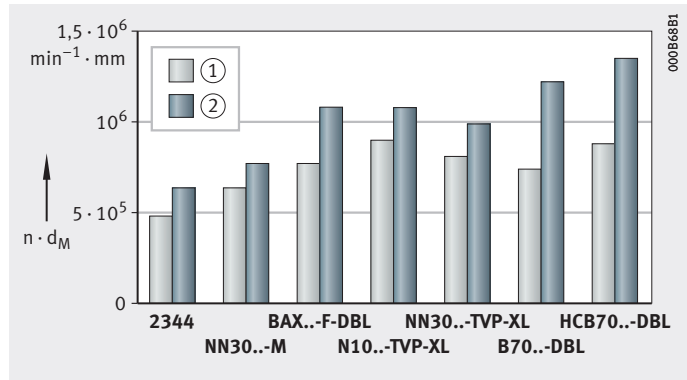


Figure 1 Comparison of speed suitability

Rigidity

The axial and radial rigidity of a bearing arrangement is dependent on the arrangement of the bearings and the preload. The rigidity of the complete system is determined not only by the rigidity of the bearing arrangement but also significantly by the rigidity of the shaft and housing. In the application, the rigidity can be increased by means of the mounting and operating conditions.

Axial rigidity

The axial rigidity c_a is the quotient of the axial load and axial displacement.






$$c_a = \frac{F_a}{\delta_a}$$

c_a Axial rigidity N/ μ m
 F_a Axial force N
 δ_a Axial displacement μ m

Values for the axial rigidity: see dimension tables in section Spindle bearings, page 134, and section Axial angular contact ball bearings, page 236.

The axial rigidity c_a and the lift-off force K_{aE} of a bearing set under concentrically acting axial force is shown in the table.

Axial rigidity of spindle bearing sets

Arrangement of bearings	Axial rigidity c_a ¹⁾ N/ μ m	Lift-off force K_{aE} N
	c_a	$3 \cdot F_V$
	$1,64 \cdot c_a$	$6 \cdot F_V$
	$2 \cdot c_a$	$6 \cdot F_V$
	$2,24 \cdot c_a$	$9 \cdot F_V$
	$2,64 \cdot c_a$	$9 \cdot F_V$

¹⁾ Values, see dimension tables.



The deflection of a spindle bearing set is almost linear up to the lift-off force under which a bearing becomes free of load. The values stated in the dimension tables for the axial rigidity c_a are valid for bearing pairs in an O or X arrangement.

The radial rigidity c_r can be calculated approximately from the axial rigidity c_a using the following factors:

- $c_r \approx 6 \cdot c_a$ for $\alpha = 15^\circ$
- $c_r \approx 3,5 \cdot c_a$ for $\alpha = 20^\circ$
- $c_r \approx 2 \cdot c_a$ for $\alpha = 25^\circ$.

In sets with more than two bearings, there is an increase in the rigidity values and the lift-off force. The approximation values for the axial rigidity and lift-off force under a concentrically acting axial force are shown in the table Axial rigidity of spindle bearing sets.

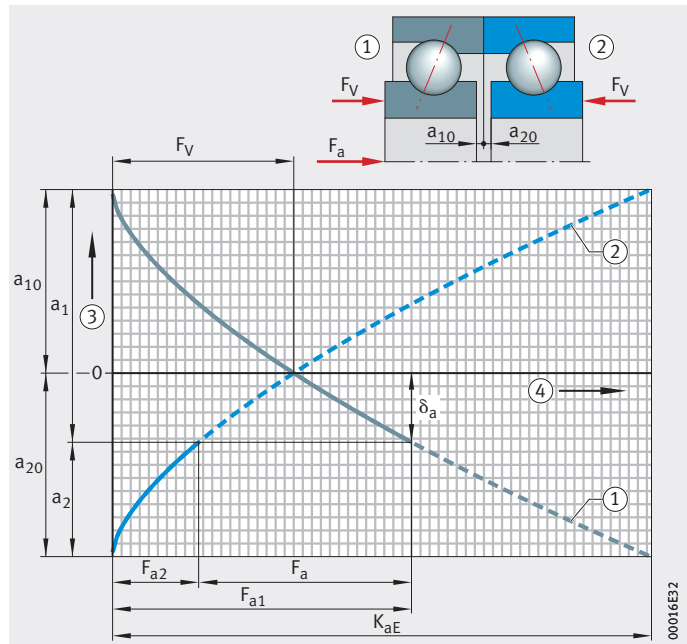
Lift-off force

The lift-off force K_{aE} corresponds to an external axial load F_a above which the preload ceases to have an effect. In the example, bearing 2 is relieved of load and is thus free of preload, *Figure 1*.

- F_V = preload force
- F_a = axial force
- F_{a1} = axial load on bearing 1
- a_1 = deflection of bearing 1
- a_{10} = initial deflection of bearing 1
- F_{a2} = axial load on bearing 2
- a_2 = deflection of bearing 2
- a_{20} = initial deflection of bearing 2
- K_{aE} = lift-off force
- δ_a = axial displacement

- ① Bearing 1
- ② Bearing 2
- ③ Deflection
- ④ Axial load

Figure 1
Preload force,
axial load, lift-off force



00016EE3

Rigidity






Radial rigidity

$$c_r = \frac{F_r}{\delta_r}$$

c_r Radial rigidity, see dimension tables $\text{N}/\mu\text{m}$
 F_r Radial force N
 δ_r Radial displacement μm

The radial rigidity c_r for sets under a radial force acting at the centre of the set is calculated approximately from the radial rigidity of the bearing pair according to the following table.

Radial rigidity of spindle bearing sets

Arrangement of bearings	Radial rigidity c_r $\text{N}/\mu\text{m}$
	c_r
	$1,36 \cdot c_r$
	$2 \cdot c_r$
	$1,6 \cdot c_r$
	$2,72 \cdot c_r$



Load carrying capacity and operating life

Operating life of super precision bearings

Super precision bearings must guide machine parts with high precision and must support forces securely at very high speeds. The bearings are therefore selected predominantly according to the criteria of accuracy, rigidity and running behaviour.

In order that they can fulfil these tasks securely, they must run without wear. This requires the formation of a load-bearing hydrodynamic lubricant film at the contact points of the rolling contact partners. Under these conditions, the bearings will achieve their fatigue life in a large number of applications.

If the design is appropriate to the fatigue life, the operating life of the bearing is normally restricted by the lubricant operating life, see also page 86.

The decisive factors for the operating life from the perspective of load are the Hertzian pressures occurring at the contact points and the bearing kinematics. For high performance spindle bearings, it is therefore advisable to design the bearing arrangement individually using specific calculation programs.

In practice, failure due to fatigue is not significant for these bearings. Calculation of the rating life L_{10} in accordance with DIN ISO 281 is therefore not an appropriate means of determining the operating life. If the load ratio of super precision cylindrical roller bearings is $S_0^* \geq 8$, this fulfils the essential precondition for fatigue strength.

Fatigue strength

In order to check fatigue strength, the load ratio S_0^* is calculated in accordance with the following equation:

$$S_0^* = \frac{C_0}{P_0^*}$$

S_0^* – Load ratio for fatigue strength (dynamic load safety factor)

C_0 N – Basic static load rating

P_0^* – The equivalent load P_0^* is calculated from the dynamic load forces in accordance with the equation for the equivalent static load.

The minimum value for the load ratio S_0^* at which the essential precondition for fatigue strength is fulfilled is dependent on the bearing type and the material used for the components, see table.

Load carrying capacity and operating life

Load ratio S_0^*

Bearing type	Contact angle $\alpha = 15^\circ$		Contact angle $\alpha = 20^\circ$		Contact angle $\alpha = 25^\circ$	
	$\frac{F_{0a}}{F_{0r}} \leq 1,09$	$\frac{F_{0a}}{F_{0r}} > 1,09$	$\frac{F_{0a}}{F_{0r}} \leq 1,20$	$\frac{F_{0a}}{F_{0r}} > 1,09$	$\frac{F_{0a}}{F_{0r}} \leq 1,30$	$\frac{F_{0a}}{F_{0r}} > 1,30$
B/HCB	8	12	–	–	8	10
HS/HC	8	12	–	–	8	10
RS/HCRS	–	–	8	11	–	–
XC	3	4	–	–	3	4

A more precise method is individual calculation of the Hertzian pressures, see table, page 98, and checking of the bearing kinematics using a calculation program, see page 99.

If the other preconditions for an effective separating lubricant film (viscosity ratio $\kappa \geq 2$) and very high cleanliness are fulfilled, calculation of the rating life is not necessary.

If these preconditions are not fulfilled, the influence of lubrication and contamination on the operating life can be estimated by carrying out manual calculation using an expanded rating life calculation in accordance with ISO 281 or in accordance with DIN ISO 281, Appendix 4, for computer-aided methods.

Static load safety factor

In super precision bearings, static loading such as the tool ejection force is rarely checked.

Whether the static load carrying capacity of a bearing is sufficient for a given static load can be checked with the aid of the static load safety factor S_0 .

The parameter for static loading is the static load safety factor S_0 .

$$S_0 = \frac{C_0}{P_0}$$

S_0 –
Static load safety factor

C_0 N
Basic static load rating

P_0 N
Equivalent dynamic bearing load for combined load,
see section Equivalent static bearing load.



In order to utilise the high accuracy of the bearings, the static load safety factor S_0 must be as follows:

- spindle bearings: $S_0 > 2$
 - for hybrid bearings, $S_0 \geq 1$ is only possible with an extremely short-lived and concentrically acting axial load (tool ejection force)
- super precision cylindrical roller bearings: $S_0 > 3$
- axial angular contact ball bearings: $S_0 > 2,5$
- axial bearings BAX: $S_0 > 2$.



Equivalent static bearing load

The equivalent static bearing load P_0 is determined from the axial and radial loads acting on the bearing.

It induces the same load at the centre point of the most heavily loaded contact point between the rolling element and raceway as the combined bearing load occurring in practice. The load carrying capacity of the most heavily loaded bearing must be checked.

Spindle bearings

Universal bearings can support axial loads in one direction as well as radial loads.

For bearings under static loading, the following applies:

Spindle bearings with contact angle 15°

Load ratio	Equivalent static load
$\frac{F_{0a}}{F_{0r}} \leq 1,09$	$P_0 = F_{0r}$
$\frac{F_{0a}}{F_{0r}} > 1,09$	$P_0 = 0,5 \cdot F_{0r} + 0,46 \cdot F_{0a}$

Spindle bearings with contact angle 20°

Load ratio	Equivalent static load
$\frac{F_{0a}}{F_{0r}} \leq 1,2$	$P_0 = F_{0r}$
$\frac{F_{0a}}{F_{0r}} > 1,2$	$P_0 = 0,5 \cdot F_{0r} + 0,42 \cdot F_{0a}$

Spindle bearings with contact angle 25°

Load ratio	Equivalent static load
$\frac{F_{0a}}{F_{0r}} \leq 1,3$	$P_0 = F_{0r}$
$\frac{F_{0a}}{F_{0r}} > 1,3$	$P_0 = 0,5 \cdot F_{0r} + 0,38 \cdot F_{0a}$

F_{0a} N

Axial static bearing load

F_{0r} N

Radial static bearing load

P_0 N

Equivalent static bearing load for combined load.

Super precision cylindrical roller bearings

Super precision cylindrical roller bearings can support radial forces only.

For bearings under static loading, the following applies:

$$P_0 = F_{0r}$$

P_0 N

Equivalent static bearing load

F_{0r} N

Radial static bearing load.

Load carrying capacity and operating life

Axial angular contact ball bearings

Axial angular contact ball bearings can support axial forces only. For bearings under static loading, the following applies:

$$P_{0a} = F_{0a}$$

P_{0a} N
Equivalent static bearing load
 F_{0a} N
Axial static bearing load.

Axial bearings BAX

Axial bearings BAX can support axial forces only.

For bearings under static loading, the following applies: $P_0 = F_a$.

Contact angle

Description	Load	Equivalent static load
Bearings with contact angle 30°	F_a	$P_0 = 0,33 \cdot F_a$
Bearings with contact angle 40°	F_a	$P_0 = 0,26 \cdot F_a$

F_a N
Axial bearing load
 P_0 N
Equivalent static bearing load for combined load.

Distribution of load over several bearings

Where there are several bearings at one bearing position, the external load is distributed over the individual bearings, see table. The load carrying capacity of the most heavily loaded bearing must be checked.



This must be based on the radial and axial loads acting on the specific bearing position, which must be calculated from the external loads and the spacings between the loading point and bearing positions.

Distribution of load

Arrangement	Proportion of load on most heavily loaded bearing	
	F_a %	F_r %
	100	60
	100	60
	50	60
	50	60
	33	60
	33	60



Lubrication

Principles

Lubrication and maintenance are important in order to achieve reliable function, an adequate operating life, wear-free running and a low vibration level in super precision bearings. An essential precondition here is the formation of a lubricant film that separates the rolling contact partners at their contact points.

In order to achieve this:

- It must be ensured that lubricant is present at all contact points and at all times.
- The lubrication method defined must be appropriate to the required speed.
- A lubricant with the correct characteristics must be selected.

Selection of the type of lubrication

It should be determined as early as possible in the design process whether bearings should be lubricated using grease or oil. The decisive factor is the maximum operating speed required.

This catalogue states, for each bearing, the maximum speeds for the two most important lubrication methods used with super precision bearings, grease lubrication and minimal quantity oil lubrication, see dimension tables. These speeds are valid for single bearings and must be recalculated in the case of rigidly preloaded bearing arrangements by multiplication with the reduction factors, see table, page 67.

Criteria for grease lubrication

Grease lubrication is predominantly used for super precision bearings.

This is a simple means of providing advantages such as:

- low friction
- lubrication “for life”
- very little design work required
- low system costs.

Criteria for oil lubrication

Minimal quantity oil lubrication is used when the spindle speed is too high for grease lubrication. If high speed parameters are to be applied over long intervals, it may be advisable to use minimal quantity oil lubrication in order to achieve the required lubricant operating life. This may also be appropriate in those cases where grease lubrication would still be possible according to the achievable speed parameter for lubrication since the achievable grease operating life decreases with increasing speed, *Figure 3*, page 86.

Lubrication

Optimised lubricants

In consideration of the bearing as a complete system, the lubricant plays an important role. The decision between grease and oil lubrication has a significant influence on the system costs.

The objective of Schaeffler is to facilitate and as appropriate drive forward the reliable application of grease lubrication up to very high speeds. Before a lubricant is approved for use in the bearing, it is subjected to a very stringent approval process. The calculations and suitability tests relating to the application-specific requirements, such as a spindle running at high speed, are particularly important for the temperature and running-in behaviour.

The result of this demanding process is an approved product specification for the particular lubricant and precise compliance with the specification is ensured by ongoing assessments.

Lubricant viscosity

The condition of the lubricant film is determined by the viscosity ratio κ , which is defined as the quotient of the operating viscosity ν and the reference viscosity ν_1 .

$$\kappa = \frac{\nu}{\nu_1}$$

κ —
Viscosity ratio

ν $\text{mm}^2 \cdot \text{s}^{-1}$

Kinematic viscosity of the lubricant at operating temperature

ν_1 $\text{mm}^2 \cdot \text{s}^{-1}$

Reference viscosity of the lubricant at operating temperature.

The reference viscosity ν_1 is a function of the bearing size and speed.

Calculation of the value: *Figure 1, page 79.*

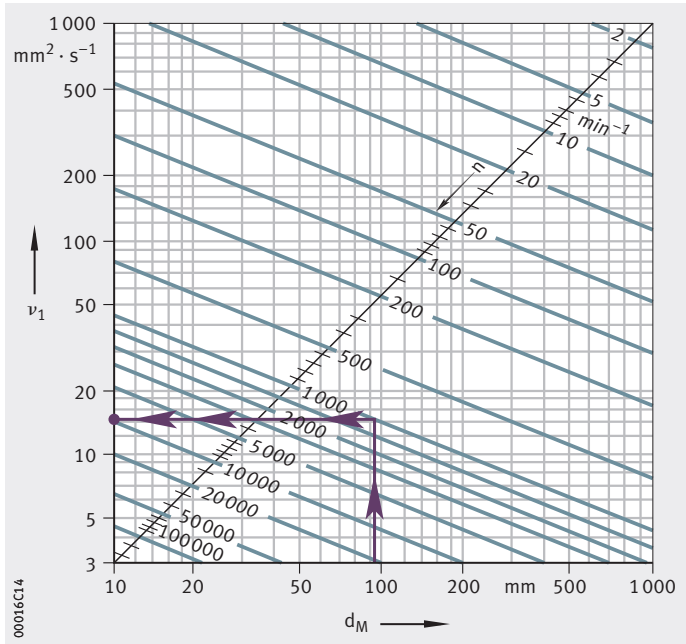
The operating viscosity is the actual viscosity of the lubricant during operation. It is a function of the operating temperature and the basic viscosity of the lubricant and can be determined from the V/T diagram, *Figure 2, page 79.*

In the case of greases, the viscosity of the base oil is used. For successful operation, the aim should be to achieve a viscosity at operating temperature that is at least twice as high as the reference viscosity, $\kappa = \nu/\nu_1 \geq 2$. Higher viscosity ratios do not give any further improvement in the lubricant film but do have the effect of increasing friction.



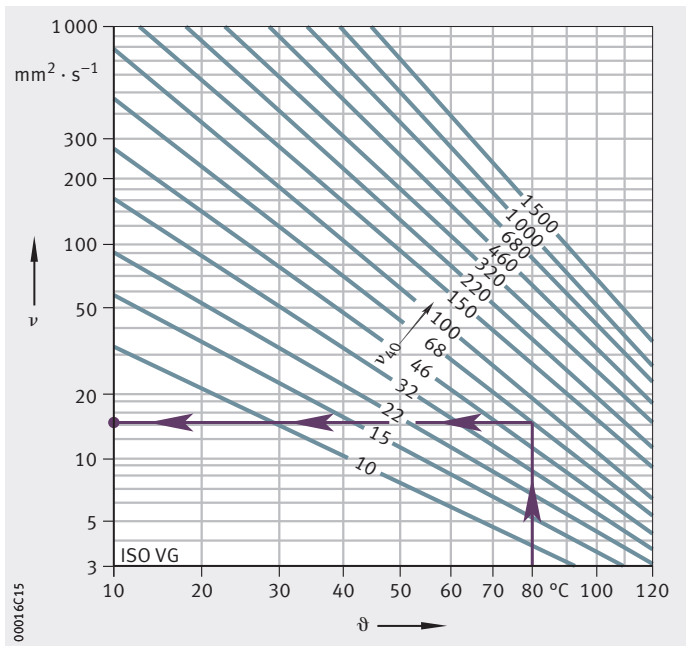
ν_1 = reference viscosity
 d_M = mean bearing diameter
 n = speed

Figure 1
 Reference viscosity ν_1



ν = operating viscosity
 ϑ = operating temperature
 ν_{40} = viscosity at +40 °C

Figure 2
 V/T diagram



Lubrication

Grease lubrication

Development in greases and bearings has led to an enormous improvement in performance, principally in relation to the achievable speeds. It is now possible to achieve speed parameters $n \cdot d_M$ of up to $2\,000\,000 \text{ min}^{-1} \cdot \text{mm}$.

The use of spindle bearings already greased “for life” and sealed brings further advantages, such as very high cleanliness, since the interior of the bearing is protected. It also gives simplified mounting.

Greases with special suitability

Many of the rolling bearings supplied by Schaeffler Technologies have a grease filling. In mechanical-dynamic tests, the greases used have proved particularly suitable for the application. An overview of suitable FAG greases for super precision bearings is shown in the table.

Greases for super precision bearings

Lubricating greases	Designation		
	L252	L055	L298
Identifier according to DIN 51825	KHCP2/3K-40	KPHC2N-30	KPHCP3P-40
Thickener	Lithium complex	Lithium	Polycarbamide
Base oil	PAO and ester oil	PAO and mineral oil	PAO and ester oil
Base oil viscosity at	+40 °C	25	85
	+100 °C	5	12,5
NLGI grade	2 to 3	2	3
Maximum operating temperature ¹⁾ °C	80	80	110
Speed parameter $n \cdot d_M$ ²⁾ $\text{min}^{-1} \cdot \text{mm}$	2 000 000	800 000	1 300 000
Specific mass $\approx \text{g/cm}^3$	0,94	0,9	0,86
Application as	high speed grease	high pressure grease	high temperature grease

1) Without minimisation of service life.

2) The speed parameter $n \cdot d_M$ is the product of the mean bearing diameter and the speed (values apply for point contact).



- L252** High speed greases have been developed for operation in spindles for machine tools. This class of greases includes the FAG high speed grease L252. This grease is the current standard grease for spindle bearings, due to the achievable speeds and the suitability for the typical temperature range in machine tools.
- L298** L298 is a high temperature grease that, due to its higher base oil viscosity, is used at continuous temperatures up to approx. +110 °C.
- L055** L055 is a high pressure grease that has proved extremely effective in the end bearings of ball screw drives, in indexing table bearings and for example also in tailstock lathe centre bearing arrangements.

Standard greasing In the case of sealed bearings supplied with standard greasing, the grease grade is not stated on the packaging or on the bearing. Open bearings supplied greased with high speed grease are identified by the application-oriented grease group GA21 on the bearing and on the packaging. In the case of these bearings, Schaeffler Technologies reserves the right to change the grease grade without a change in designation on the precondition that the grease fulfils the requirements of the application-oriented grease group GA21 in relation to speed capacity, operating temperature and life.

Lubrication

Grease quantities

The individual bearing series require different grease quantities. The recommendations are matched to the space within the bearing that is not disturbed by rotating parts, see tables. Guidelines on greasing, see page 109.

Recommended grease quantities for spindle bearings

Bore code	Bearing series				
	Grease quantity cm ³				
	HS719 HC719 XC719	HS70 HC70 XC70	B719 HCB719 RS719 HCRS719	B70 HCB70 RS70 HCRS70	B72 HCB72
6	–	0,12	–	0,04	–
7	–	0,13	–	0,06	–
8	–	0,17	–	0,11	–
9	–	0,21	–	0,10	–
00	0,17	0,26	0,09	0,17	0,26
01	0,18	0,28	0,10	0,21	0,36
02	0,28	0,46	0,17	0,32	0,48
03	0,32	0,58	0,17	0,42	0,68
04	0,58	0,98	0,36	0,76	1,12
05	0,68	1,14	0,40	0,86	1,44
06	0,92	1,72	0,42	1,12	2,10
07	1,18	2,20	0,64	1,74	3,00
08	1,62	2,60	1,36	2,35	3,80
09	2,10	3,65	1,60	3,00	4,55
10	2,35	4,00	1,74	3,30	5,45
11	3,40	5,95	2,20	4,60	6,50
12	3,60	6,40	2,50	4,95	8,00
13	3,90	6,80	2,65	5,30	9,35
14	5,80	9,20	4,35	7,10	10,80
15	6,10	9,70	4,60	7,50	12,90
16	7,00	12,80	4,90	9,65	12,30
17	8,55	13,40	6,80	10,30	18,30
18	9,40	17,70	7,10	13,30	19,10
19	9,85	18,40	7,45	13,90	26,10
20	12,80	19,20	9,70	14,60	27,20

The spindle bearings HS, HC and XC are available greased and sealed as HSS, HCS and XCS.

The spindle bearings B719, B70 and some bearings of series B72 are also available greased and sealed, design 2RSD, see dimension tables.



**Recommended grease quantities
for spindle bearings
(continued)**

Bore code	Bearing series				
	Grease quantity cm ³				
	HS719 HC719 XC719	HS70 HC70 XC70	B719 HCB719 RS719 HCRS719	B70 HCB70 RS70 HCRS70	B72 HCB72
21	13,30	24,60	10,10	15,00	36,30
22	14,70	28,20	10,40	21,90	43,90
24	17,90	30,30	14,20	23,60	38,80
26	24,00	43,70	18,10	36,10	41,90
28	25,60	46,30	19,30	38,30	58,60
30	37,80	57,10	28,40	44,70	81,30
32	39,90	69,70	30,00	58,20	102,90
34	–	–	31,70	65,30	120,40
36	–	–	47,40	94,90	125,70
38	–	–	50,00	99,10	155,40
40	–	–	70,60	118,30	187,80
44	–	–	68,30	172,60	250,10
48	–	–	73,70	185,30	–
52	–	–	118,20	267,00	–
56	–	–	126,00	283,90	–
60	–	–	204,50	–	–

The spindle bearings HS, HC and XC are available greased and sealed as HSS, HCS and XCS.

The spindle bearings B719, B70 and some bearings of series B72 are also available greased and sealed, design 2RSD, see dimension tables.

Lubrication

Recommended grease quantities for cylindrical roller bearings

Bore code	Bearing series Grease quantity cm ³		
	N10	NN30	NNU49
06	0,69	0,76	–
07	0,91	0,95	–
08	1,15	1,14	–
09	1,44	1,61	–
10	1,56	1,74	–
11	2,25	2,55	–
12	2,45	2,70	–
13	2,60	2,85	–
14	3,10	4,20	2,90
15	3,30	4,45	3,10
16	4,30	6,10	3,25
17	4,50	6,40	4,50
18	5,75	7,85	4,75
19	6,00	8,20	4,95
20	6,20	8,50	6,25
21	7,75	10,60	6,50
22	8,50	13,70	6,75
24	9,05	15,90	10,10
26	14,90	21,20	13,60
28	15,70	24,10	12,10
30	19,00	29,30	21,20
32	23,00	37,20	22,40
34	30,80	48,80	23,60
36	38,30	63,50	32,70
38	55,80	67,40	34,20
40	67,90	86,70	54,50
44	72,50	110,10	59,00
48	112,50	127,50	63,60
52	119,10	177,30	109,50
56	157,70	196,70	116,60



**Recommended grease quantities
for axial bearings BAX
with hard fabric cage (suffix T)
and double direction axial
angular contact ball bearings**

Grease quantities only valid for greases in accordance with GA21:

Bore code	Bore diameter mm	Bearing series Grease quantity cm ³	
		BAX	2344
06	30	–	3,90
07	35	–	5,00
08	40	–	6,10
09	45	–	7,80
10	50	3,26	8,35
11	55	4,84	12,20
12	60	5,22	12,20
13	65	5,6	13,30
14	70	7,34	17,80
15	75	7,78	18,90
16	80	10,76	25,60
17	85	11,3	27,80
18	90	14,14	38,90
19	95	15,1	38,90
20	100	15,76	44,40
21	105	21,1	61,10
22	110	26,3	61,10
24	120	28,35	66,70
26	130	41,5	105,60
28	140	44,25	116,70
30	150	54,7	138,90
32	160	68,2	172,20
34	170	92,3	227,80
36	180	119	316,70
38	190	124,6	311,10
40	200	166,3	411,10
44	220	–	522,20
48	240	–	622,20
52	260	–	833,30
56	280	–	850,00

Lubrication

Grease operating life

The grease operating life is the period during which the bearing function is maintained by the lubricant introduced.

It is dependent on the following factors:

- the grease quantity
- the grease type
- the bearing type
- the speed
- the temperature
- the mounting, operating and environmental conditions.

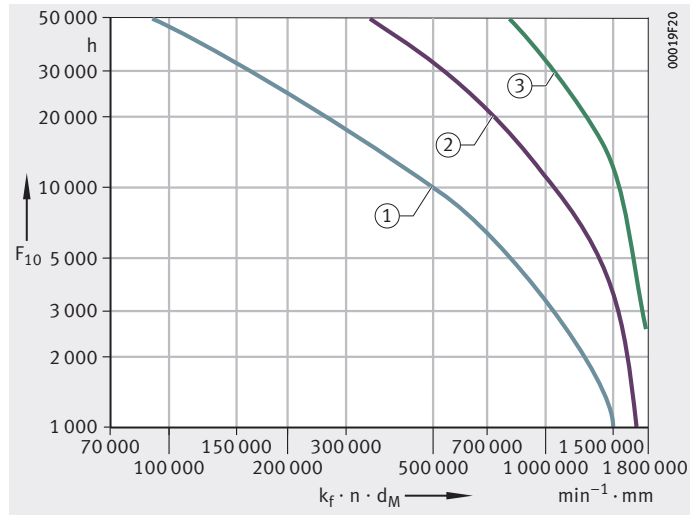
The grease operating life F_{10} must be taken into consideration as the decisive factor in many applications instead of the fatigue life.

The grease operating life is dependent on the bearing-specific speed parameter $k_f \cdot n \cdot d_M$, *Figure 3*.

F_{10} = grease operating life
 $k_f \cdot n \cdot d_M$ = bearing-specific speed parameter
 k_f = factor for bearing type
 n = operating speed or equivalent speed
 d_M = mean bearing diameter

- ① Steel bearing
- ② Hybrid bearing
- ③ Cronidur bearing

Figure 3
Grease operating life F_{10}





**Factor k_f ,
as a function of bearing type**

Bearing type		Factor k_f
Spindle bearings with contact angle	15°	0,75
	20°	0,8
	25°	0,9
Super precision cylindrical roller bearings	Single row	1
	Double row	2
Double direction axial angular contact ball bearings		2,5

Unfavourable operating and environmental conditions such as moisture, vibrations and air flows through the bearings must be taken into consideration as appropriate.

Where operation is at varying speeds for known time periods, the total grease operating life can be calculated according to the following formula:

$$F_{10 \text{ tot}} = \frac{100}{\sum_{i=1}^n \frac{q_i}{F_{10 i}}}$$

$F_{10 \text{ tot}}$ Total grease operating life h

n Number of load cases -

q_i Time periods %

$F_{10 i}$ Grease operating life for individual speeds in speed duty cycle. h



If a grease operating life >3 is required, this should be discussed with the lubricant manufacturer.

Grease distribution cycle

In order to distribute the grease, start/stop operation is recommended. This prevents high detrimental temperatures at the contact point. During the stop phase, the temperatures of the individual bearing components are levelled out, preventing detrimental increases in preload.

It is recommended that the temperature should be monitored during the grease distribution cycle as well as during the subsequent continuous running. The temperature sensor should be mounted as close as possible to the outer ring.



A progressive increase in temperature must be avoided at all costs. This will occur, for example, if there is an excessive increase in preload.

Lubrication

Running-in process

Grease distribution is completed once a stable bearing temperature has been achieved.

Recommendations for the grease distribution cycle of super precision bearings, *Figure 4*.

The running-in process comprises several cycles of start/stop operation at different speeds and for different running times, while the stationary times after each cycle are very important. The number of cycles required may vary according to the bearing size, the number of bearings, the maximum speed and the bearing environment.



Further cycles should be carried out for an increased running time and with a shortened stationary time until the equilibrium temperature is achieved.

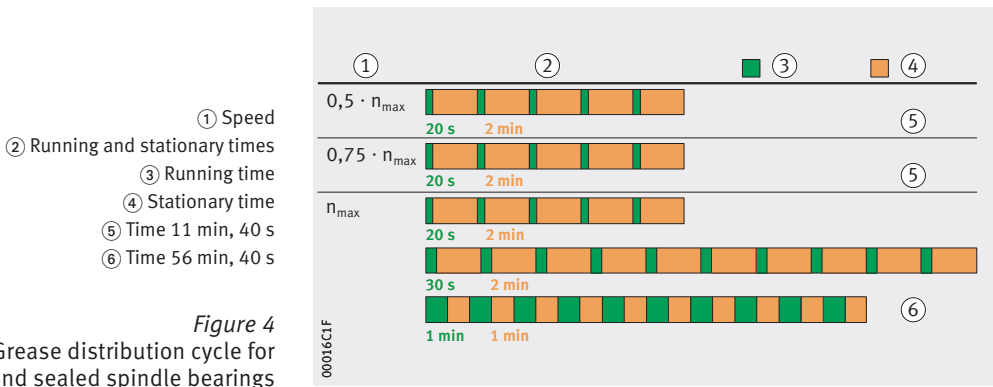


Figure 4

Grease distribution cycle for open and sealed spindle bearings

Oil lubrication

For the lubrication of super precision bearings, fully synthetic oils with high pressure capacity are essentially suitable.

Oils in accordance with the designation ISO VG 68 + EP have proved effective here. This means that the oil has a nominal viscosity of $68 \text{ mm}^2/\text{s}$ at $+40 \text{ }^\circ\text{C}$ and Extreme Pressure additives.



Lubrication methods

Minimal quantity oil lubrication

Lubrication of FAG spindle bearings requires very little oil. Quantities of the order of magnitude of approx. $100 \text{ mm}^3/\text{h}$ are sufficient if it can be ensured that all the rolling and sliding surfaces are coated with oil. Such minimal quantity lubrication gives only small friction losses.

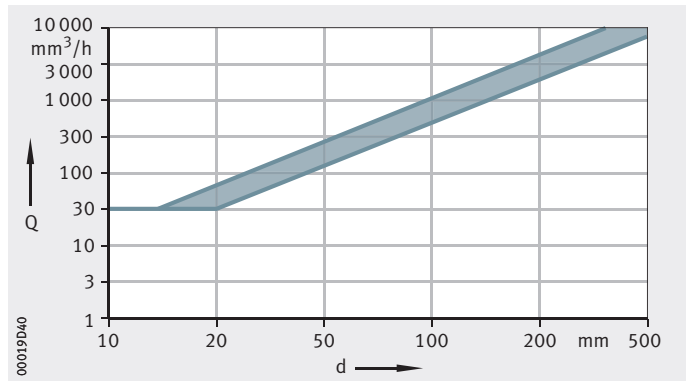
Minimal quantity oil lubrication is used when the spindle speed is too high for grease lubrication. The standard method is now pneumatic oil lubrication. Speeds achieved with minimal quantity lubrication, see dimension tables.

Guide values for the oil quantity in pneumatic oil lubrication are shown in *Figure 5*. Specific flow conditions in the bearing arrangement can have a significant influence on the oil quantity. For hybrid bearings, the upper part of the range is always more applicable, while steel bearings tend to fall within the lower part of the range.

Oil quantities for super precision cylindrical roller bearings with pneumatic oil lubrication are shown in *Figure 6*.

Q = oil quantity
 d = bearing bore

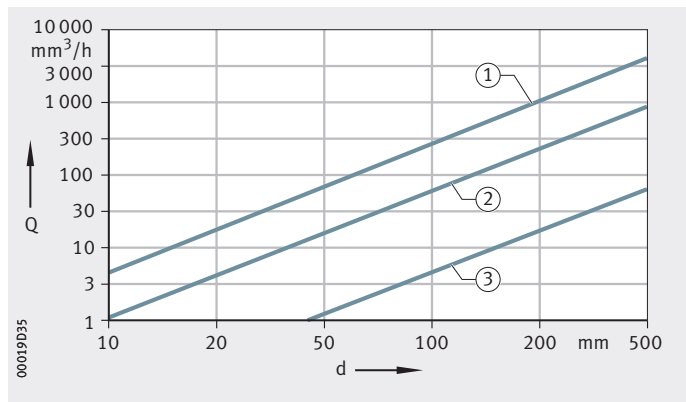
Figure 5
 Oil quantity
 for spindle bearings
 with pneumatic oil lubrication



Q = oil quantity
 d = bearing bore

- ① Oil quantity for cylindrical roller bearings with ceramic rollers and ribs on the inner ring
- ② Bearing with ribs on inner ring and $n \cdot d_M \leq 10^6 \text{ min}^{-1} \cdot \text{mm}$
- ③ Bearing with ribs on outer ring and $n \cdot d_M \leq 600\,000 \text{ min}^{-1} \cdot \text{mm}$

Figure 6
 Oil quantity
 for cylindrical roller bearings
 with pneumatic oil lubrication



Spindle bearings B, HCB, HS, HC, XC, RS and HCRS are also available in the Direct Lube design.

Lubrication

Recommendations for pneumatic oil lubrication

Characteristic	Recommendation
Air cleanliness	Particle size max. 1 μm
Dryness of air	Dew point at +2 °C
Air pressure in the feed pipe	\approx 3 bar

- Nozzle design
- Recommendation for nozzle diameter = 0,5 mm to 1 mm
 - Provide individual nozzles for each bearing
 - One nozzle per 150 mm pitch circle circumference
 - Feed parallel to the spindle axis between the inner ring rib and cage bore.

- Injection pitch circle diameter
- Injection pitch circle diameter E_{tk} , see dimension tables
 - In cylindrical roller bearings with a PVPA1 cage, there are two injection pitch circle diameters, depending on the injection side, see page 212.

- Feed pipes
- Inside diameter 2 mm to 2,5 mm
 - Flexible and transparent plastic pipe, allowing visible oil flow on the inner wall of the pipe.

- Length
- At least 1 m, optimally 4 m, up to approx. 10 m
 - Coiling with approx. five turns
 - Centre axis horizontal or inclined at an angle up to 30°
 - Not more than approx. 500 mm to the nozzle
 - When lubrication is stopped, oil collects in the bottom of the turns and is rapidly available at restart. As a result, there is only a short delay when starting the spindle.

- Oil outlets
- On both sides of each bearing
 - Accumulation of oil can cause hot running
 - In the case of vertical spindles, provide an outlet under each bearing so that the other bearings arranged below are not overlubricated. Diameter of outlet hole preferably \geq 5 mm.
 - All outlet holes from all bearings on one spindle must be linked to each other in order to equalise pressures.

Further information can be obtained from the manufacturers of pneumatic oil lubrication devices.

Pneumatic oil lubrication devices

Oil quantities per injection cycle mm^3	Injection cycles per hour
3, 5, 10, (30, 60, 100)	6 to 10 times



Requisite cleanliness

In super precision bearings, cleanliness at the contact surfaces plays an important role since contaminants strongly promote wear and thus reduce the operating life.

Guide values for lubricant cleanliness in bearings with oil lubrication are derived from hydraulic conditions and can be seen in the tables.

In bearings with grease lubrication, the highest level of cleanliness is present in practice if the bearings are already greased by the manufacturer and sealed by means of sealing washers.

Recommended oil purity classes with point contact

(D - d)/2 mm	Requisite oil purity class in accordance with ISO 4406	Requisite filter retention rate in accordance with ISO 4572	Maximum size of overrolled particles ¹⁾ µm
up to 12,5	11/8	$\beta_3 \geq 200$	10
over 12,5 incl. 20	12/9	$\beta_3 \geq 200$	15
over 20 incl. 35	13/10	$\beta_3 \geq 75$	25
over 35	14/11	$\beta_3 \geq 75$	40

¹⁾ The data are correct if, in the heavily loaded raceway area, no large particles with a hardness > 50 HRC are overrolled.

Recommended oil purity classes with line contact

(D - d)/2 mm	Requisite oil purity class in accordance with ISO 4406	Requisite filter retention rate in accordance with ISO 4572	Maximum size of overrolled particles µm
up to 12,5	12/9	$\beta_3 \geq 200$	20
over 12,5 incl. 20	13/10	$\beta_3 \geq 75$	25
over 20 incl. 35	14/11	$\beta_3 \geq 75$	40
over 35	14/11	$\beta_3 \geq 75$	75

The oil purity class as an indicator of the probability of overrolling by life-reducing particles in the bearing can be determined using tests, for example by filter manufacturers and institutes. The purity classes are achieved when the total circulating oil quantity runs once through the filter in a few minutes.

A filter retention rate of $\beta_3 \geq 200$ means, for example, that only one out of 200 particles > 3 µm passes the filter in the so-called multi-pass test.



Filters coarser than $\beta_3 \geq 75$ can have detrimental consequences for the other subassemblies in the oil circuit.

Before mounting of the bearing arrangement, the feed lines must be flushed in order to ensure good cleanliness.

Operating temperature

Spindle bearings

Spindle bearings are suitable for operating temperatures of $-30\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$, restricted by the lubricant as well as the seal and cage material.

The FAG high performance grease for sealed spindle bearings is suitable up to a continuous temperature of $+80\text{ }^{\circ}\text{C}$.

Super precision cylindrical roller bearings

The bearings can be used at operating temperatures of $-30\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$ (or higher depending on the cage design).

Axial angular contact ball bearings

Axial angular contact ball bearings can be used at operating temperatures of $-30\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$ (or higher depending on the cage design).



Note the information on the operating temperatures of greases, see page 77.



Design and examples of bearing arrangements

Design and applications

In practical application, a large number of different spindle bearing arrangements are used. The selection and arrangement are determined by their specific use in turning, milling and grinding or in high frequency motor spindles. The design of the bearing arrangement is also influenced in relation to the bearing size and bearing type by the operating conditions. Finally, consideration of the cost-effectiveness of various technical design possibilities also plays a major role.

The bearing arrangement must run clearance-free and normally with preload in operation in order to fulfil the high accuracy requirements (P4 and above). In addition, very high speeds are required (with grease lubrication, up to $n \cdot d_M = 2 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$ and with pneumatic oil lubrication up to $n \cdot d_M = 3,1 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$) at the lowest possible operating temperatures. This requires the use of super precision bearings and correspondingly accurate adjacent parts.

The following guidelines are intended to assist in the selection of bearings and bearing arrangements.

The following aspects are considered:

- preload
- rigidity
- bearing contact angle
- ball size and material
- distance between the bearings
- sealing
- stages in bearing arrangement design
- comparison of bearing arrangements
- examples of bearing arrangements.

Preload

Rigidly adjusted bearing arrangements, especially those with a short spacing between the bearings, react with a high degree of sensitivity to temperatures between the shaft and housing, since the preload within the bearing set may increase sharply and the bearing sets may brace against each other if the sliding seat does not function.

Radial bracing may occur in particular with spindle bearings having a contact angle of 15° . This also applies to cylindrical roller bearings or non-locating bearing pairs with a sliding seat.

In contrast, rigid bearing arrangements with a large spacing between the bearings, elastically adjusted bearing arrangements and bearings with a contact angle of 20° or 25° are less sensitive.

Design and examples of bearing arrangements

Bearings with ceramic rolling elements generally have lower operating temperatures. Furthermore, the increase in the preload in the rigid system with increasing ΔT is smaller in this case than with steel balls.

For rigidly preloaded bearing arrangements, speed reduction factors must be applied, see page 67.

In bearing arrangements adjusted by springs or hydraulic means, the stated speeds are achieved due to the lower thermal sensitivity, see dimension tables. In bearings with a contact angle of 15° , the ΔT between the shaft and housing may restrict the speed.

For the springs, a preload force is selected that corresponds to at least the mean bearing preload M , see table, page 67.

Axial angular contact ball bearings

In axial angular contact ball bearings, the preload is determined by the spacer ring arranged between the two shaft locating washers.

Rigidity

The rigidity of the bearing arrangement system is influenced by the shaft diameter, the number of bearings, the bearing size, the preload and the contact angle.

Contact angle and rigidity

The rigidity of a bearing set is dependent on the arrangement of the bearings and the preload. The rigidity of the complete system is determined not only by the rigidity of the bearing arrangement but also significantly by the rigidity of the shaft and housing.

Bearings with a 15° contact angle have only 45% of the axial rigidity of bearings with a 25° contact angle but their radial rigidity is higher by only 10%. Calculation of the radial and axial rigidity, see page 70.

If the spindle bearing arrangement and boom is considered as a complete system, the total rigidity of a bearing arrangement with 25° bearings is normally better in a radial direction due to the wider support spacing than in one with 15° bearings. A bearing arrangement with 20° bearings offers a good intermediate value in this case.

Rigidity of a preloaded bearing arrangement

The rigidity of a rigidly preloaded bearing arrangement increases during mounting due to the influence of fit compared with the catalogue data. In operation, it generally increases further due to the expansion of the ring as a result of centrifugal force at high speeds and due to the thermally induced radial expansion of the shaft and inner ring.



Bearing contact angle

The available contact angles of the spindle bearings have different advantages and areas of application, see table.

Contact angles, advantages and applications

Advantages and applications	Contact angle		
	15°	20°	25°
Advantages	<ul style="list-style-type: none"> ■ Radial rigidity ■ Radial load carrying capacity ■ Somewhat higher speed at small ΔT 	<ul style="list-style-type: none"> ■ Good axial and radial rigidity ■ Combined loads ■ Very high speeds at high ΔT 	<ul style="list-style-type: none"> ■ Axial rigidity ■ Radial system rigidity ■ Axial load carrying capacity ■ Combined axial and radial load carrying capacity ■ High permissible ΔT between inner ring and outer ring
Applications	<ul style="list-style-type: none"> ■ Grinding machines ■ Precision machining equipment ■ Bearing arrangement on belt side 	<ul style="list-style-type: none"> ■ Milling at high output ■ Machining centres ■ Motor spindles 	<ul style="list-style-type: none"> ■ Lathes ■ Milling machines ■ Drilling machines ■ Machining centres ■ Motor spindles

Bearing selection according to ball size and material

Spindle bearings with a B or RS in the designation are filled with large balls while the other types have small balls.

Bearings with large balls have a higher load carrying capacity and are therefore more suitable for high loads than bearings with small balls. The latter should be selected in preference for high speeds.

Ceramic

Bearings with ceramic rolling elements have additional speed advantages.

Bearing rings made from Cronidur

Bearings with rings made from Cronidur 30 and ceramic rolling elements are available in the design XC with small balls.

Specifications for bearing selection

Bearing selection is aided by a comparison of the specifications and performance data of spindle bearings, see table.

Design and examples of bearing arrangements

Comparison of bearing designs

Ball material	Ball size	Bearing type	Load carrying capacity	Speed suitability	Service life
Steel	Large	B	High	Medium	Good
Steel	Large	RS	High	High	Good
Steel	Small	HS	Medium	High	Better
Ceramic	Large	HCB	Medium	High	Much better
Ceramic	Large	HCRS	Medium	Highest	Much better
Ceramic	Small	HC	Low	Highest	Best
Ceramic	Small	XC	Premium	Premium	Premium

Selection of the optimum bearing spacing

In rigidly preloaded bearing arrangements, it is recommended that a thermally neutral bearing spacing is selected at which the effects of the radial and axial thermal expansion of the shaft in relation to the influence on preload are compensated.

This thermally optimum bearing spacing L corresponds for spindle bearings with a 25° contact angle to approx. three times and with a 20° contact angle to four times the shaft diameter d ; in bearings with a 15° contact angle, L is approx. $5 \cdot d$, where the axial thermal expansion often takes effect too slowly due to the long bearing spacing. Such an approach is not very advisable in practice.

Sealing

Main spindle bearing arrangements must be effectively sealed, especially at the spindle nose. If a non-contact labyrinth seal with a protective collar, narrow radial gaps (to $h8/C9$), wide axial gaps (gap width ≥ 3 mm) and outlet holes is required due to the high speeds, complete sealing integrity against cooling lubricant, swarf and dust must be ensured during rotation and standstill.

When using grease lubrication, sealed bearings assist the effect of the labyrinth and prevent air flows through the bearing arrangement. Solutions with labyrinth seals for horizontal and vertical spindles are shown in *Figure 1*, page 97, and *Figure 2*, page 97.

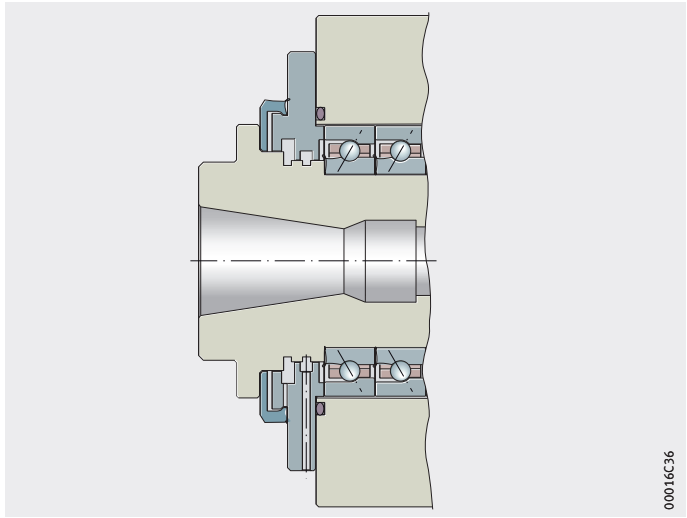


Figure 1
Labyrinth seal
for horizontal spindle

00016C36

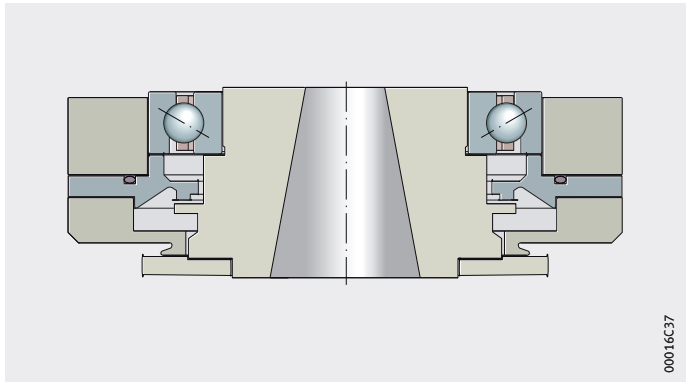


Figure 2
Labyrinth seal
for vertical spindle

00016C37

Design and examples of bearing arrangements

Stages in bearing arrangement design

In the design of a spindle bearing arrangement, the following stages must be performed:

1. Define the operating conditions (speeds, forces, time periods, spacings and diameters, temperatures, environmental influences).
2. Select the arrangement of bearings on the basis of the application and the requirements, see table, page 101.
3. Determine the lubrication, see page 77.
4. Select the bearing type and bearing size on the basis of speed suitability, design envelope and lubrication.
5. Check the grease operating life, *Figure 3*, page 86.
6. Calculate the load distribution on the bearings.
7. Check the fatigue strength of the bearing arrangement, see page 73.

Bearing design using a calculation program

If a calculation program is available, the following stages can also be performed:

- Calculate the bearing kinematics (spin/roll ratio, ball advance and retardation) and pressures (p_0) and compare with the design limits.
- Assess the rating life taking account of lubrication and cleanliness.
- Calculate the bending line, deflections and rigidity.
- Calculate the natural frequencies or critical whirling speeds.
- Optimise the bearing arrangement.

Schaeffler also offers calculations by agreement as a service.

It is advisable in this case to submit the complete bearing arrangement data using the template for bearing arrangement calculations in the appendix of the catalogue. This form is also available for download at www.fag.de.

Design limits

Criteria	Limit values
Spin/roll ratio	max. 0,5
Maximum ball advance and ball retardation	Dependent on the internal design of the bearing
Hertzian pressures	Fatigue strength limits: Point contact with 100Cr6: 2 000 MPa with Cronidur 30: 2 500 MPa Line contact with 100Cr6: 1 500 MPa with Cronidur 30: 1 900 MPa



Design of main spindles using BEARINX

Assistance in rolling bearing design

As early as the development phase, Schaeffler offers its customers the support they require for the reliable application of super precision bearings.

A key component in design work is the design of the rolling bearings. For this purpose, Schaeffler has been successfully using calculation programs for more than thirty years.

The computer-aided examination of rolling bearing behaviour under realistically modelled operating conditions in the design phase helps to speed up development work and contributes to higher operational security.

BEARINX – a leading calculation program

In BEARINX, Schaeffler Technologies has developed one of the leading programs for the calculation of rolling bearings. It facilitates the detailed analysis of rolling bearing arrangements, from individual bearings to complex shaft systems, transmissions and linear guidance systems. The complete calculation is carried out in a consistent calculation model. Even for extensive applications, the contact pressure at each individual rolling element is included in the calculation.

The current version of BEARINX includes a special module for calculation of spindle bearings. The functional scope of BEARINX incorporates the influences of centrifugal force on load distribution and the running behaviour of rolling elements in angular contact ball bearings.

BEARINX takes account of factors including:

- the non-linear elastic deflection behaviour of the bearings
- the elasticity of shafts and axes
- the influence of fit, temperature and speed on the operating clearance or preload of the bearings and on their contact angle
- the profiling of rollers and raceways and raceway osculations
- load-induced displacements in contact angle in ball bearings and angular contact ball bearings
- the influence of lubrication conditions, contamination and actual contact pressure on the fatigue life.

BEARINX offers the option of determining the actual load on spindle bearings.

Design and examples of bearing arrangements

Spindle calculation using BEARINX

Spindle calculation by means of BEARINX, *Figure 3* and *Figure 4*, offers:

- recommendations for mounting fits as a function of the specified speed
- calculation of design parameters for contact pressure and kinematics in the bearing
- kinematic bearing frequencies for vibration analyses
- calculation of the rigidity of the bearing arrangement at the operating point taking account of all relevant influences
- diagrammatic shaft responses such as shaft deflection and shaft inclination
- critical whirling speeds and the diagrammatic representation of the natural mode
- calculation of the fatigue life in accordance with DIN ISO 281, Appendix 4
- many other pieces of additional information.

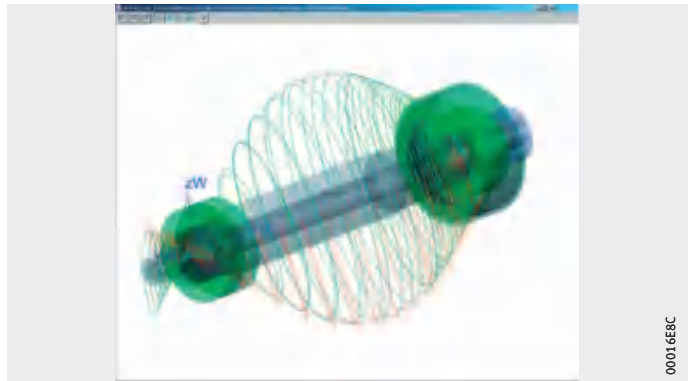


Figure 3
Deflection of the shaft

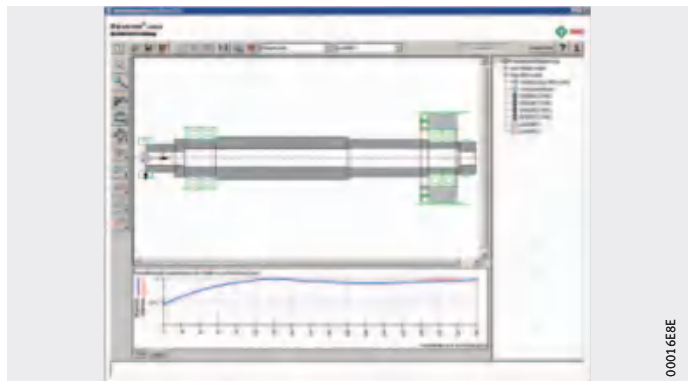


Figure 4
Calculation of the load distribution



Comparison of bearing arrangements

The data are guide values, based on a spindle with:

- shaft diameter $d = 70 \text{ mm}$
- bearing spacing $L = 3 \cdot d$
- boom $A = L/2$.

Comparison of applications and performance data

Arrangement of bearings		Typical application	Speed suitability %	System rigidity		Load carrying capacity		Temperature behaviour	
front	rear			%		%		Load	
				axial	radial	axial	radial	Operating temperature	Sensitivity
==≅	==	Universal	50	100	100	60	100	+	+
<<>>	==	Grinding	72	65	100	75	50	+++	+++
<<>	==	Turning	65	44	86	75	47	+	+++
<<>	<>	Turning, grinding	65	44	84	75	44	+++	+
<>	=	Wood, motor	75	32	79	35	42	+++	+++
<>	<>	Drilling, motor	75	32	77	35	40	+++	+++
<	>	Milling, drilling	85	30	62	35	22	+++++	+++++
<<	>>	Milling, drilling, universal	80	61	95	75	44	++++	+++++
<<<	>>	Milling, drilling, universal	75	76	98	100	46	+++	++++
<	≈>	Motor	100	23	60	30	27	+++++	+++++
<<	≈>>	Motor	100	46	92	60	52	+++++	+++++
<≈>	≈>	Motor	100	25	89	25	60	+++++	+++++
<≈>	=	Motor	80	23	82	30	46	+++++	++++
<<≈>	≈>	Motor	100	46	93	50	65	+++++	++++
<<≈>>	≈>>	Motor	100	48	98	48	65	++++	++++

- 100 Optimum
- + Very unfavourable
- +++++ Very good
- < Spindle bearings
- = Single row cylindrical roller bearing
- == Double row cylindrical roller bearing
- ≅ Double direction axial angular contact ball bearing
- ≈ Spring

Design and examples of bearing arrangements

Comparison between different spindle bearing arrangements

Design of bearing arrangements

A comparison is presented of three different spindle bearing arrangements in relation to radial and axial rigidity, see page 103, and speed suitability, see page 104.

Bearing combination and arrangement:

- four spindle bearings in a tandem-O-tandem arrangement and a double row cylindrical roller bearing, *Figure 5*
- one double direction axial angular contact bearing and two double row cylindrical roller bearings, *Figure 6*
- two axial bearings and two double row cylindrical roller bearings, *Figure 7*.

- ① Spindle bearing B7014-E-T-P4S-UL
- ② Cylindrical roller bearing NN3011-D-K-TVP-SP-XL

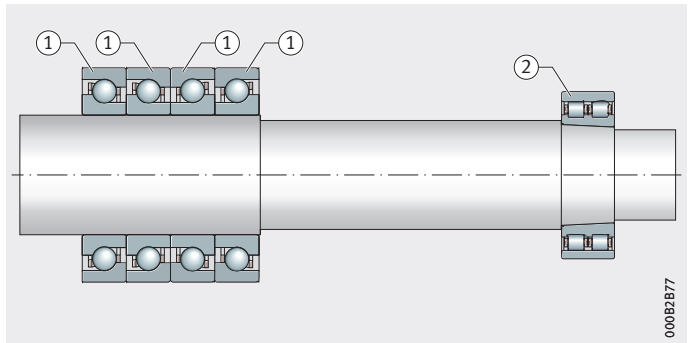


Figure 5
Bearing arrangement with spindle bearings B70

- ① Cylindrical roller bearing NN3014-D-K-TVP-SP-XL
- ② Double direction axial angular contact ball bearing 234414-M-SP
- ③ Cylindrical roller bearing NN3011-D-K-TVP-SP-XL

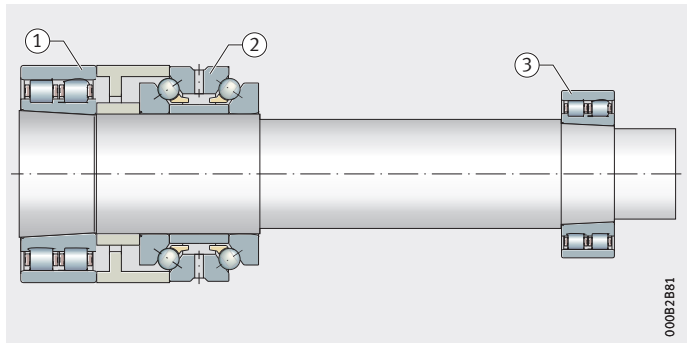


Figure 6
Bearing arrangement with axial angular contact ball bearing 2344

- ① Cylindrical roller bearing NN3014-D-K-TVP-SP-XL
- ② Axial bearing BAX70-F-T-P4S-DBL
- ③ Cylindrical roller bearing NN3011-D-K-TVP-SP-XL

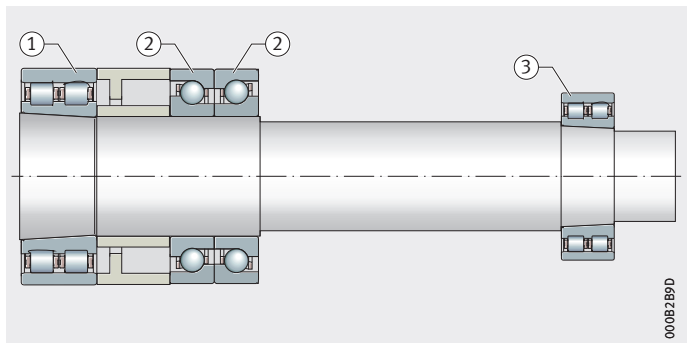


Figure 7
Bearing arrangement with axial bearings BAX



- Axial and radial rigidity** The bearing arrangement in machine tools is subjected to frequently changing requirements. In order to achieve the highest possible machining accuracy, the aim must be to achieve high basic rigidity values.

- Increased radial rigidity** When cylindrical roller bearings NN30 are used, the arrangement with an axial angular contact ball bearing 2344 and the arrangement with axial bearings BAX has a rigidity that is approx. 2,5 times higher than in the case of four spindle bearings B70 of the same size, *Figure 8*.

- Consistent axial rigidity** The axial rigidity with axial bearings BAX is at the level of the bearing arrangement variants with the spindle bearings. The advantage when using the double direction axial angular contact ball bearings is 60%, *Figure 8*.

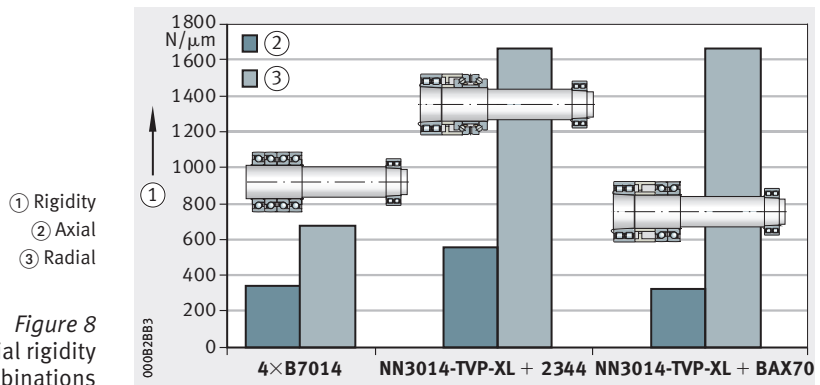


Figure 8
Axial and radial rigidity of bearing combinations

Design and examples of bearing arrangements

Speed suitability

In order that machine tools can achieve high cutting output, the bearing arrangement of the main spindle must be suitable for high speeds.

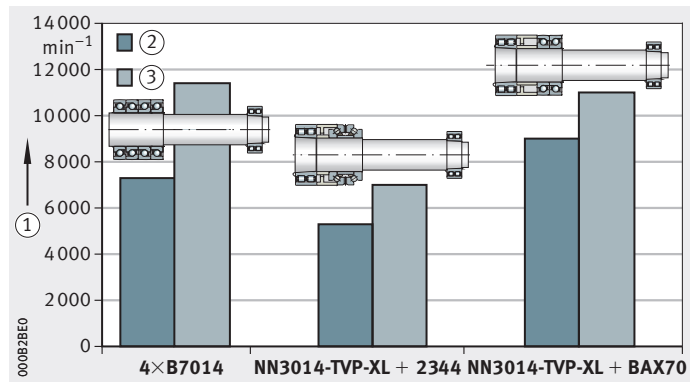
Increased maximum speed

The bearing design with axial bearings (NN30 + BAX70) gives, in comparison with the bearing design with the axial angular contact ball bearing (NN30 + 2344), significantly higher maximum speeds. This is valid in the case of grease lubrication as well as in the case of minimal quantity oil lubrication.

In comparison with the design with spindle bearings (4×B70), the maximum speed of the bearing design with axial bearings (NN30 + BAX70) with grease lubrication is at a higher level. If minimal quantity oil lubrication is used, the achievable speed capacity is comparatively lower. This is due to the lower speed suitability of the cylindrical roller bearings NN30, *Figure 9*.

- ① Speed
- ② Grease
- ③ Minimal oil quantity

Figure 9
Maximum speeds of bearing combinations





Examples of bearing arrangements

Machining centre

Figure 10
Milling spindle for high loads

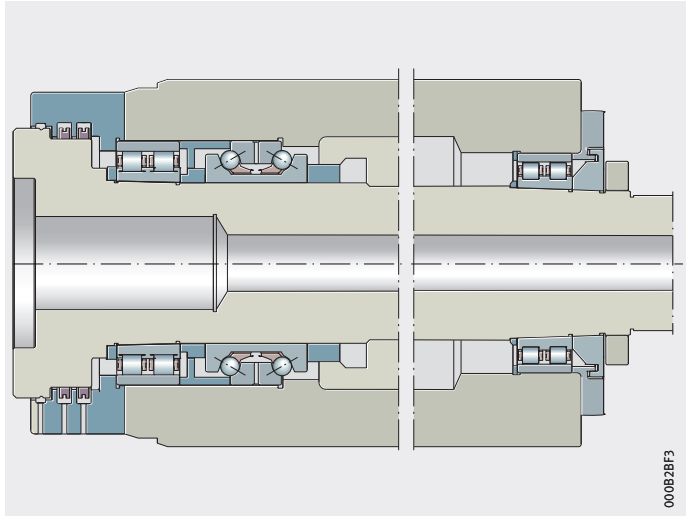
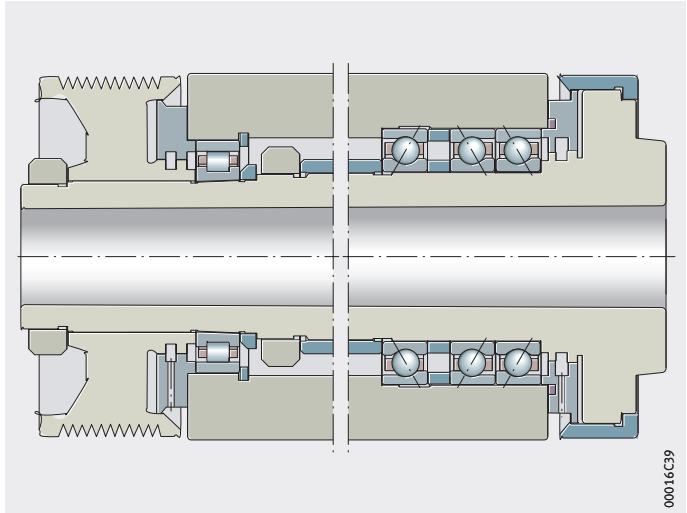
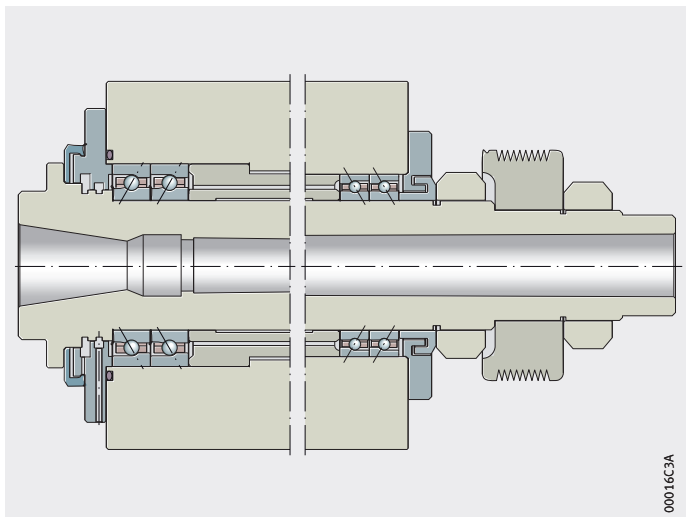


Figure 11
Turning spindle



Machining centre

Figure 12
Milling spindle for high speeds



Design and examples of bearing arrangements

Machining centre

Figure 13
Milling spindle
for very high speeds

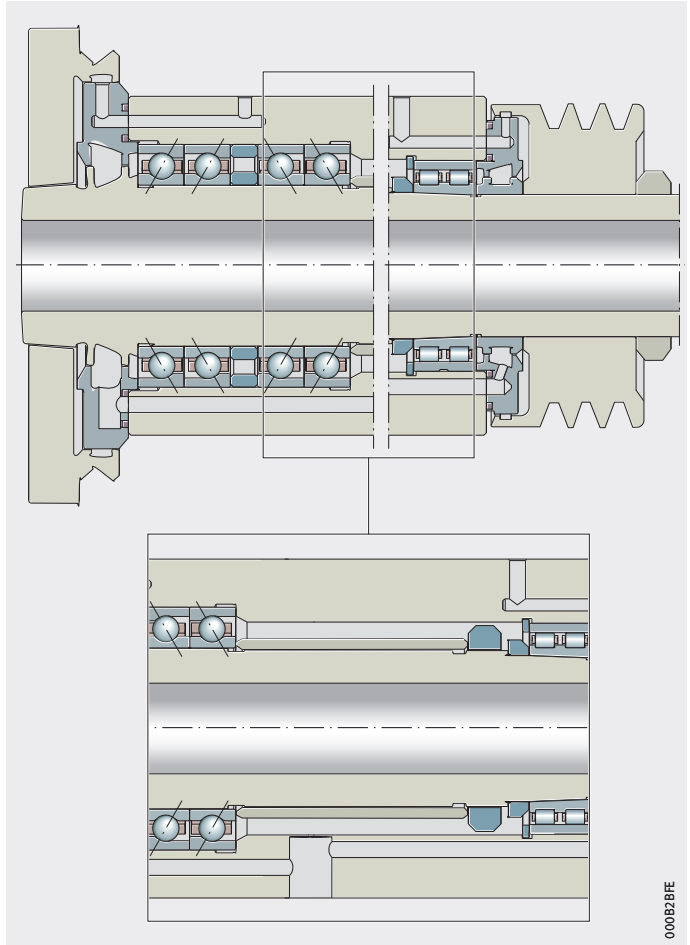
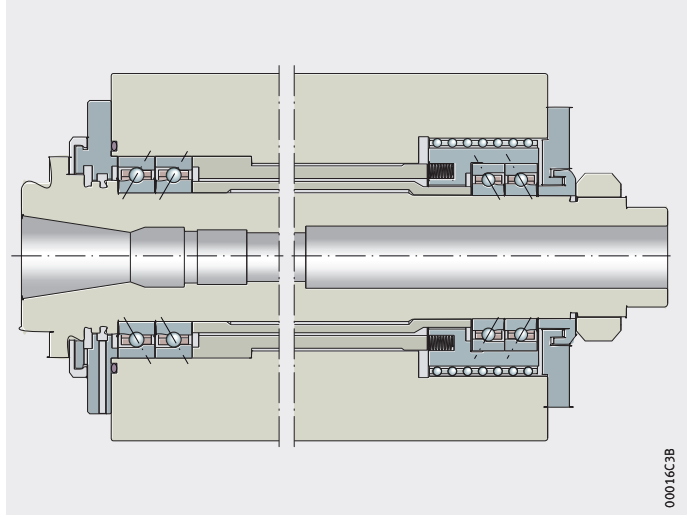


Figure 14
Grinding spindle

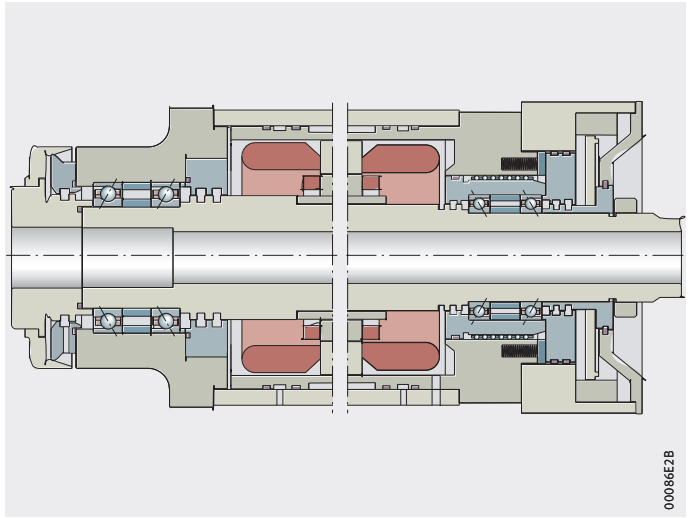


Figure 15
High frequency motor spindle

Mounting

- Handling and use** FAG super precision bearings are manufactured in extremely clean conditions, closely inspected and protected by high quality packaging. In order to maintain the full performance capacity of the bearings, they must be handled with great care during mounting. This can best be achieved by the use of a separate, clean room for mounting purposes.
- Provision of parts** Only approved parts should be used for mounting. Depending on the part, approval comprises dimensional inspection, optical inspection or even prebalancing.
- Allocation of parts** Fits have a major influence on the function of a bearing arrangement. It is advisable in certain cases to allocate bearings to the spindle or housing diameter. Spindle bearings are subdivided by bore and outside diameter tolerance into groups whose mean deviation is indicated on the packaging and the bearing. The width of a spindle bearing is also marked on the bearing as a deviation from the nominal dimension. These indications are, depending on the size of the bearing, subject to tolerances.



Mounting Guidelines for mounting

The following guidelines must always be taken into account:

- The assembly area must be kept clean and free from dust.
- Protect bearings from dust, contaminants and moisture. Contaminants have a detrimental influence on the running and operating life of rolling bearings.
- Before mounting work is started, familiarise yourself with the design by means of the final assembly drawing.
- Before mounting, check whether the bearing presented for mounting corresponds to the data in the drawing.
- Check the housing bore and shaft seat for dimensional, geometrical and positional accuracy and cleanliness.
- Check that no edges are present which could hamper the mounting of bearing rings on the shaft or in the housing bore. A lead chamfer of 10° to 15° is advantageous in this case.
- Wipe away any corrosion protection from the seating and locating surfaces.
- Rub cylindrical seating surfaces of the bearing rings with a very thin layer of Arcanol mounting paste.
- Do not cool the bearings excessively. Moisture due to condensation can lead to corrosion in the bearings and bearing seats.
- After mounting, supply the rolling bearings with lubricant.
- Observe the values for axial clamping by means of precision nuts. Use appropriate tools for this purpose. Always tighten the retaining screws of the precision locknuts fully in accordance with the manufacturer's data.
- The covers used for clamping must be matched to the bearings.
- Check the correct functioning of the bearing arrangement.

Mounting

Mounting record

In order to ensure quality, it is recommended that measurement values are recorded, such as:

- seat diameter, interference
- differences in intermediate ring dimensions
- equilibrium temperatures
- radial and axial runout.

The use of a checklist may be helpful here. The appendix to the catalogue includes a specimen and a template, which are also available to download from the Internet at www.fag.de.

Matching operations

In order to maintain optimum performance or achieve precise positioning of the spindle in relation to the housing, it is often necessary to carry out special matching operations on the components. This applies, for example, to the covers used to clamp the bearings. Before clamping, a gap should be present, *Figure 1*.

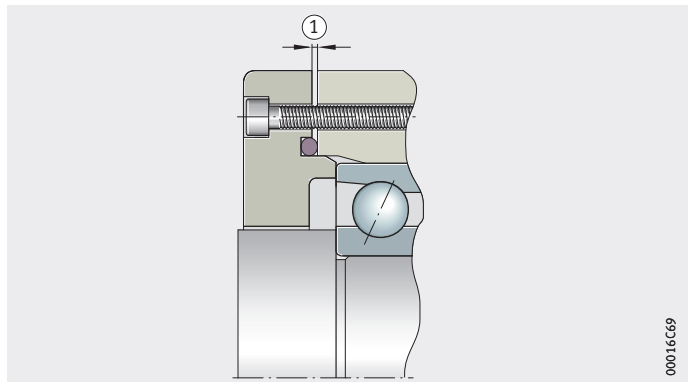
Matching of the intermediate rings may be advisable in the case of high speed spindles in order to compensate the influence of fit and ring expansion on the preload.

Bearing bore $d \leq 100$ mm:
0,01 to 0,02 mm

Bearing bore $d > 100$ mm:
0,015 to 0,03 mm

① Gap before tightening
of the end cover fixing screws

Figure 1
Matching end cover
(recommendation)





Greasing Suitable rolling bearing greases and grease quantities: see page 80 to page 85. The setting of the grease quantity places high requirements on the greasing and measurement equipment used. It is recommended that bearings already greased and sealed from Schaeffler are used.



Greasing must be carried out under extremely clean conditions.

Test run and grease distribution

In bearings with grease lubrication, a grease distribution cycle must be carried out on the bearings before the test run on the spindle. Information on the grease distribution cycle, see *Figure 4*, page 88. The information on the grease distribution cycle is available for download at www.fag.de and can also be ordered from Schaeffler as a laminated overview card.

Axial clamping of inner rings

Values for axial clamping of inner rings on the shaft using a precision nut, see tables, page 112 and page 113.

In order to eliminate or reduce settling effects, the nut should first be tightened to three times the stated torque, loosened and then finally tightened to the nominal torque. The retaining screws should then be fully tightened in accordance with the manufacturer's data.

Mounting

Spindle bearings

For spindle bearings B, HS, HC and XC of diameter series 719, 70 and 72, the applicable values are in accordance with the table. The stated values correspond to an end face pressure of approx. 10 MPa.

Recommended clamping forces and nut tightening torques for spindle bearings

Bore/ bore code	Clamping force kN			Tightening torque Nm			Thread
	719	70/BAX	72	719	70/BAX	72	
6	–	1,49	–	–	1,52	–	M6×0,5
7	–	1,51	–	–	1,70	–	M7×0,5
8	–	1,53	–	–	1,89	–	M8×0,75
9	–	1,55	–	–	2,09	–	M9×0,75
00	0,66	1,58	1,36	0,96	2,30	1,99	M10×0,75
01	0,71	1,64	1,45	1,19	2,75	2,43	M12×1
02	0,79	1,75	1,60	1,60	3,52	3,23	M15×1
03	0,86	1,84	1,73	1,93	4,11	3,87	M17×1
04	0,99	1,99	1,96	2,54	5,13	5,04	M20×1
05	1,24	2,32	2,45	3,87	7,25	7,65	M25×1,5
06	1,55	2,73	3,07	5,96	10,0	11,3	M30×1,5
07	1,91	3,22	3,83	8,10	13,6	16,2	M35×1,5
08	2,34	3,79	4,74	11,2	18,2	22,7	M40×1,5
09	2,82	4,45	5,79	15,1	23,8	31,0	M45×1,5
10	3,36	5,19	7,00	19,8	30,6	41,3	M50×1,5
11	3,96	6,02	8,36	25,6	38,9	54,0	M55×2
12	4,62	6,94	9,88	32,4	48,6	69,3	M60×2
13	5,34	7,94	11,6	40,4	60,1	87,5	M65×2
14	6,12	9,04	13,4	49,7	73,4	109	M70×2
15	6,95	10,2	15,4	60,3	88,7	134	M75×2
16	7,85	11,5	17,6	72,4	106	163	M80×2
17	8,81	12,9	20,0	86,2	126	195	M85×2
18	9,82	14,3	22,5	102	148	233	M90×2
19	10,9	15,9	25,2	119	173	275	M95×2
20	12,0	17,5	28,1	138	201	322	M100×2
21	13,2	19,3	31,2	159	231	374	M105×2
22	14,5	21,1	34,4	182	265	433	M110×2
24	17,2	25,0	41,5	235	342	567	M120×2
26	20,1	29,4	49,3	297	434	729	M130×2
28	23,3	34,1	57,9	370	541	920	M140×2
30	26,7	39,1	67,3	454	666	1144	M150×2
32	30,4	44,6	77,4	550	808	1402	M160×3
34	34,3	50,5	88,4	659	971	1699	M170×3
36	38,4	56,8	100,2	781	1154	2036	M180×3
38	42,8	63,4	112,7	918	1360	2417	M190×3
40	47,4	70,5	126,2	1070	1589	2845	M200×3
44	57,5	85,8	155,5	1423	2125	3853	Tr220×4
48	68,4	103	–	1847	2773	–	Tr240×4
52	80,4	–	–	2349	–	–	Tr260×4
56	93,4	–	–	2935	–	–	Tr280×4
60	107	–	–	3612	–	–	Tr300×4



Axial angular contact ball bearings

For double direction axial angular contact ball bearings 2344, the applicable values are in accordance with the table.

Recommended clamping forces for axial angular contact ball bearings

Hole mm	Bore code	Clamping force kN		Tightening torque Nm		Thread
		from	to	from	to	
25	05	1,2	2,5	3,8	7,8	M25×1,5
30	06	1,4	2,8	5,2	10,3	M30×1,5
35	07	1,7	3,1	7,2	13,1	M35×1,5
40	08	2,4	3,8	11,3	18,2	M40×1,5
45	09	2,3	3,7	12,3	19,8	M45×1,5
50	10	2,6	4,0	15,3	23,6	M50×1,5
55	11	3,0	4,3	19,4	27,8	M55×2
60	12	3,3	4,7	23,1	32,9	M60×2
65	13	3,7	5,1	28,0	38,6	M65×2
70	14	4,1	5,4	33,3	43,8	M70×2
75	15	4,4	5,8	38,2	50,3	M75×2
80	16	4,8	6,2	44,3	57,2	M80×2
85	17	5,3	6,6	51,9	64,6	M85×2
90	18	5,7	7,1	58,9	73,4	M90×2
95	19	6,1	7,5	66,5	81,7	M95×2
100	20	6,5	7,9	74,4	90,5	M100×2
105	21	7,0	8,4	84,0	101	M105×2
110	22	7,4	8,8	92,9	111	M110×2
120	24	8,4	9,8	115	134	M120×2
130	26	9,3	10,8	137	160	M130×2
140	28	10,3	11,8	164	188	M140×2
150	30	11,3	12,8	192	218	M150×2
160	32	12,4	13,8	225	250	M160×3
170	34	13,4	14,9	258	286	M170×3
180	36	14,5	16,0	295	325	M180×3
190	38	15,7	17,2	337	369	M190×3
200	40	16,8	18,3	379	413	M200×3
220	44	19,2	20,7	476	513	Tr220×4
240	48	21,6	23,3	583	629	Tr240×4
260	52	24,2	25,8	707	754	Tr260×4
280	56	26,8	28,4	842	893	Tr280×4
300	60	29,5	31,1	993	1047	Tr300×4
320	64	32,2	33,9	1155	1216	Tr320×5
340	68	35,0	36,8	1333	1402	Tr340×5
360	72	37,9	39,7	1528	1600	Tr360×5
380	76	40,9	42,7	1739	1816	Tr380×5
400	80	32,9	45,8	1472	2050	Tr400×5

Mounting

Recommendations for shaft nuts

Spindle bearing sets are generally clamped on the shaft using shaft nuts. Nuts with axial holes are to be used in preference over locknuts for tightening on the shaft, since they minimise the air turbulence that occurs at high speeds.

The contact faces of the nuts should be ground in a single clamping operation together with the thread. The recommended maximum axial runout tolerance is 2 μm .

In order to prevent impairment of the axial runout during the clamping operation, the clamping inserts should be ground together with the thread and the axial face.

Clearance adjustment of cylindrical roller bearings

Cylindrical roller bearings with a tapered bore are fitted with clearance, clearance-free or with preload, see table, page 68. This can be carried out with the aid of an FAG enveloping circle gauge to an accuracy of $\pm 1 \mu\text{m}$.

Mounting procedure for cylindrical roller bearings

As an example, a description is given below of the mounting procedure for cylindrical roller bearings with a tapered bore and a separable outer ring, N10 and NN30, and the enveloping circle gauge MGA 31. The FAG gauge can be used to precisely set the radial internal clearance or preload of the cylindrical roller bearings. The user manual must be read before the using the gauge.



- Measure the raceway diameter of the mounted outer ring using a conventional internal gauge, *Figure 2*.



Figure 2
Measuring the raceway diameter
of the outer ring

- Transfer this dimension to the two hardened and precision ground measuring surfaces of the enveloping circle gauge, *Figure 3*.



Figure 3
Transferring the raceway diameter
to the enveloping circle gauge

Mounting

- Then position the gauge on the inner ring and roller and cage assembly premounted on the tapered shaft, *Figure 4*.



Figure 4
Positioning
the enveloping circle gauge



- Drive up the bearing axially until the precision indicator of the enveloping circle gauge shows the required radial internal clearance or preload.
- Then determine the spacing between the bearing inner ring and the shaft shoulder using gauge blocks at four measurement points offset by 90°, *Figure 5*. For larger bearings, the spacing must be measured at a minimum of 6 points.
- After dismounting the bearing inner ring, grind the width of a gauge ring to match the spacing determined and slide this over the cylindrical section of the shaft.
- Finally, mount the bearing inner ring again and secure using a nut. If stated in the drawing, mount the adjacent bearings and secure them by means of a precision locknut.



Figure 5
Measuring the spacing
from the shaft shoulder

0 001704A

Mounting

Setting the clearance without a gauge

If an enveloping circle gauge is not available, the clearance can be set to a fairly precise value by measuring the axial drive-up distance of the inner ring on the tapered shaft seat, taper 1:12.

This drive-up distance is approx. 13 to 19 times (factor F, see table) larger than the radial expansion induced in this way. Surface bur- nishing and the elastic expansion of the inner ring and the contrac- tion of the shaft are contributory factors here.

Drive-up distance A:

$$A = F \cdot \Delta G$$

A mm
Drive-up distance

F –
Factor, see table

ΔG μm
Change in radial clearance.

Hollow shaft ratio and drive-up factor

Hollow shaft ratio $d_B/d'^{1)}$	Drive-up factor F
0 to 0,2	13
0,2 to 0,3	14
0,3 to 0,4	15
0,4 to 0,5	16
0,5 to 0,6	17
0,6 to 0,8	18
0,8 to 0,9	19

¹⁾ d_B = bore of hollow shaft
 d' = tapered seat diameter, measured at the centre of the taper.



Example The cylindrical roller bearing is to be clearance-free after mounting.

- Procedure
- Insert the outer ring in the housing bore.
 - Mount the inner ring with the spindle in the housing, rotating the spindle back and forth in order to avoid scraping marks.
 - Slide the inner ring onto the taper until the radial clearance reaches a value, for example, of 20 μm , rotating the spindle back and forth.

The measurement itself is carried out through radial displacement of the inner ring relative to the outer ring, for example by raising the spindle, while the dial gauge should be positioned as close as possible to the bearing.

Scraping marks can be avoided in the mounting of cylindrical roller bearings if the inner ring is not tilted relative to the outer ring and the spindle is rotated back forth while it is being slid into place.

Mounting can be made easier by heating of the housing and outer ring.

- Determine the spacing between the inner ring and the locating shoulder, for example by means of gauge blocks at four measurement points offset by 90°.
- Grind the gauge ring to width and insert in place.
- Mount the bearing and check for freedom from clearance.

The mounting procedure as described ensures that, after mounting, the bearing has the required radial internal clearance and the position of the bearing inner ring on the shaft is not altered by vibrations during operation.

Calculation of the drive-up distance A Drive-up distance $A = \text{factor } F \cdot \text{change in radial clearance } \Delta G$

Given data

Hollow shaft ratio d_B/d'	=	0,55
Drive-up factor F , see table, page 118	=	17
Change in radial clearance ΔG	=	20 μm

Calculation Drive-up distance $A = 17 \cdot 20 \mu\text{m} = 340 \mu\text{m} = 0,34 \text{ mm}$

Mounting

PrecisionDesk

The free-of-charge Schaeffler app PrecisionDesk for super precision bearings includes services for rotary and linear bearings of a high precision design, *Figure 6*. It assists fitters and engineers in the selection and mounting of bearing arrangement components in machine tools, textile and printing machinery, in food and packaging equipment and all other applications that require high precision bearing arrangements.



Figure 6
PrecisionDesk
for super precision bearings

The advantage for the user is that the data can be accessed from any smartphone, tablet, PC or at a local mounting station. In future, it will for example be possible to call off bearing-specific spindle and rotary table bearings directly and store or send these with the aid of the app for the purposes of documentation. For spindle bearings, it is possible to create electronic bearing-specific data sets in the .csv format and use these, for example, for a logistics system. The app offers Schaeffler customers the possibility of monitoring their own inventory and improving quality in mounting. With such a service tool, Schaeffler is a pioneer in the market.

Reading off the data matrix code (DMC) on the bearing or the bearing packaging gives access to the scope of performance of the program.



Scope of performance

The scope of performance of the app comprises, *Figure 7*:

- checking of data matrix codes (anti-piracy protection)
- measurement records for spindle bearings
- recommendations for mounting
- performance data
- service.



Figure 7
Scope of performance of
PrecisionDesk

Anti-piracy protection

- Checking of data matrix code (DMC), *Figure 8*.



Figure 8
Data matrix code on rolling bearing

Mounting

Measurement records for spindle bearings

The creatable measurement records contain the following:

- bearing
- designation
- date of manufacture
- actual value codes (bore diameter, outside diameter)
- width deviation
- contact angle
- projection.



Figure 9
Measurement record for spindle bearings

Recommendations for mounting

- Correct grease quantity
- Grease distribution cycle
- Universal bearing sets
- Permissible heating temperatures
- Designation and marking.

Performance data

- Catalogue information
- Additional product information
- Direct access to Schaeffler Library.

The app can be used on Android and IOS operating systems and can be downloaded from the corresponding app stores. Enter “PrecisionDesk” as the search term.

Mounting and dismounting

The Schaeffler Industrial Service experts offer mounting and dismounting services for rolling bearings that are applicable across industrial sectors. They have detailed knowledge and extensive experience in all industrial sectors.

The experts in the Industrial Service function are trained and skilled personnel who can provide reliable, rapid and competent assistance. The services are provided either at the customer’s location or in the Schaeffler workshop facilities.



The mounting and dismounting services include:

- mounting and dismounting of rolling bearings and bearing systems of all types
- measurement and condition analyses
- problem solving and preparation of concept solutions
- design and manufacture of special tools
- rental of tools
- emergency service
- training courses on products and mounting
- certification of mounting and dismounting processes.

Advantages

The mounting services give the following advantages:

- rapid availability worldwide of experts in bearing arrangement technology with extensive experience in almost every application
- rapid mounting or dismounting by means of professional preparation and implementation
- increased plant availability and productivity as a result of reduced unplanned downtime
- optimisation of mounting and dismounting processes
- professional mounting and dismounting using special high-quality tools
- training and awareness measures for employees relating to the correct handling of bearings of all types.

Rental of tools

Customers who require special mounting and dismounting tools or measuring equipment only infrequently can rent these from Schaeffler for a fee.

Our service includes:

- prompt rental in Europe
- free-of-charge, rapid delivery to the installation site
- checked quality products in keeping with the latest technological developments
- delivery of the tools, including all add-on parts
- user manuals available in several languages.

If one of our qualified experts in the Industrial Service function is commissioned to carry out the particular activity, rental costs are not generally incurred.

Mounting

Devices for the mounting of super precision bearings

FAG enveloping circle gauge MGI 21

Gauges and heating devices for the mounting of spindle bearings can be obtained via Schaeffler.

The enveloping circle gauge is used to set the radial internal clearance of cylindrical roller bearings with a separable inner ring. It is suitable for cylindrical roller bearings NNU4920-K to NNU4948-K and NNU4920 to NNU4948. Bearings with a bore diameter of 100 to 240 mm have separable inner rings.

In the FAG enveloping circle gauge MGI 21, the inner enveloping circle of the roller and cage assembly is measured by two hardened and precision ground surfaces, one of which is movable.

After mounting of the outer ring, the gauge is set to the internal enveloping circle of the roller and cage assembly. This dimension is measured using a snap gauge, for example the SNAP-GAUGE. It is then possible to set the inner ring to the diameter that gives the required radial internal clearance.

Bearings with a tapered bore are displaced on the tapered seat of the shaft in order to set the preload or bearing clearance. For bearings with a cylindrical bore, preground inner rings are used (suffix F12) and finish ground to the required raceway diameter.

Ordering example for NNU4920: **MGI21-NN4920**

FAG enveloping circle gauge MGI 21

Figure 10
Gauge for cylindrical roller bearings with separable inner ring





FAG enveloping circle gauge MGA 31

The MGA 31 is used to set the radial clearance of cylindrical roller bearings with a tapered bore and separable outer ring. It is suitable for cylindrical roller bearings NN3006-K to NN3048-K and N1006-K to N1048-K. The gauge is used to precisely set the radial clearance or preload of cylindrical roller bearings.

The raceway diameter of the mounted outer ring is measured using a conventional internal gauge. This dimension is transferred to the two hardened and precision ground measuring surfaces of the enveloping circle gauge. The tapered shaft with the pre-mounted inner ring and roller and cage assembly can then be inserted in the gauge. The shaft is moved axially by the hydraulic method until the precision indicator of the enveloping circle gauge shows the required radial internal clearance or preload.

Ordering example for NN3006-K: **MGA31-NN3006**

FAG enveloping circle gauge MGA 31

Figure 11
Gauge for cylindrical roller bearings with separable outer ring



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Mounting

FAG snap gauge SNAP-GAUGE

This gauge is used for checking the diameter of cylindrical shafts and workpieces of all types directly on the machine tool and for setting of the enveloping circle gauge MGI 21.

The actual dimension of the workpiece can be determined precisely. The snap gauge functions as a comparator gauge. Its setting is checked using master shims that can be obtained for each diameter.

Ordering example for shaft diameter 120 mm:

SNAP-GAUGE-100/150 (snap gauge)

SNAP-GAUGE.MASTER120 (master shim)

Ordering designation SNAP-GAUGE

Ordering designation	Diameter range mm
SNAP-GAUGE-30/60	30 – 60
SNAP-GAUGE-60/100	60 – 100
SNAP-GAUGE-100/150	100 – 150

FAG snap gauge SNAP-GAUGE

Figure 12
Snap gauge





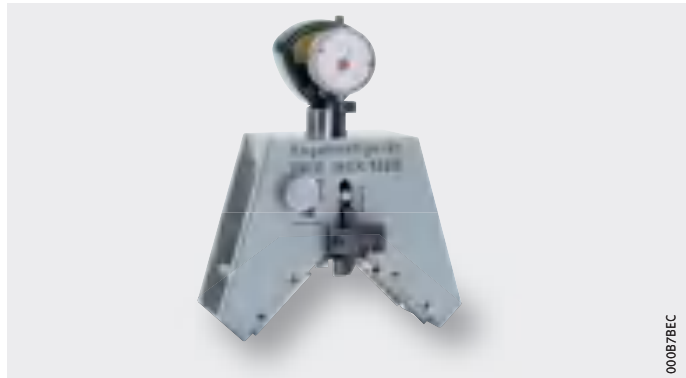
FAG taper gauge MGK 132

For measuring outer tapers with a taper angle of 0° to 6° and taper diameters of 90 mm to 510 mm, the FAG taper gauge MGK 132 is recommended.

With this gauge, the reproducibility of measurement results is within $1\ \mu\text{m}$. The MGK 132 rests on the workpiece with four hardened, ground and lapped ledges. The ledges form an angle of 90° . A stop on the front or rear precisely defines the position of the gauge on the taper. Between the support ledges, the measurement slide runs on preloaded roller bearings. A dial gauge fixed in the housing acts against the measurement slide and indicates the deviation of the taper diameter from the nominal value. The gauge is set using a reference taper, which is available by agreement.

FAG taper gauge MGK 132

Figure 13
Taper gauge



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Mounting

FAG taper gauge MGK 133

The taper gauge MGK 133 is suitable for outer tapers 1:12 and 1:30 and taper diameters of 27 mm to 205 mm.

It rests on the taper with four hardened and polished support pins. The position of the gauge on the taper is defined by these pins and one stop. The stop can be attached to either the front or back of the gauge. The gauge contains two movable measuring brackets, one of which is in contact with the smaller taper diameter while the other, at a fixed distance, is in contact with the larger taper diameter. The deviation of the taper diameter from the nominal value is displayed in both measurement planes by a precision indicator.

The reproducibility of the measurement results is less than 1 μm . The gauge is set using a reference taper corresponding to the taper diameter, which is available by agreement.

FAG taper gauge MGK 133

Figure 14
Taper gauge



In order to prepare a proposal for taper gauge and the corresponding setting taper, we require from the customer a mounting drawing of the taper to be produced.



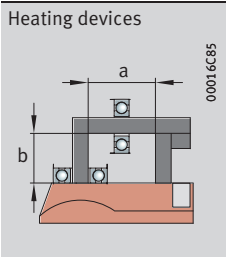


Induction heating devices

Many rolling bearings and other rotationally symmetrical parts made from steel have tight fits on the shaft. This applies in particular to high speed spindle bearings, since very high interference values must be selected here in order to prevent the inner rings lifting off under centrifugal force. Rapid and clean induction heating is superior to the conventional methods. It is therefore particularly suitable for batch mounting. The induction heating devices HEATER10 to HEATER150 are suitable for workpieces up to 150 kg and can be used in either a mobile or stationary capacity.

Detailed information, including information on larger designs, is given in brochure TPI 200.

Induction heating devices and their characteristics are shown in the following tables.

Characteristics of heating devices

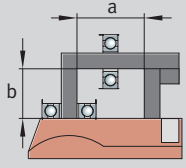


Heating devices	HEATER10	HEATER20
		
Power consumption max. ¹⁾	2,3 kVA	3,6 kVA
Operating voltage	230 V	230 V
Frequency ²⁾	50 Hz	50 Hz
Current rating	10 A	16 A
Mass	7 kg	17 kg
Length	240 mm	345 mm
Width	200 mm	205 mm
Height	255 mm	230 mm
Dimension a	65 mm	120 mm
Dimension b	100 mm	100 mm
Ledges (incl.) for workpieces with bore min.	15 mm	20 mm
	30 mm	35 mm
	45 mm	60 mm
	Stepped stand	
Ledges (accessories) for workpieces with bore min.	10 mm	10 mm
	20 mm	15 mm
		45 mm

¹⁾ If lower voltage is used, the power will be reduced.

²⁾ Heating devices with other rated voltages and frequencies and higher power ratings are available on request.

Mounting

Characteristics of heating devices continued

Heating devices	HEATER40	HEATER150
 00016C85	 00019F74	 00019F76
Power consumption max. ¹⁾	3,6 kVA	12,8 kVA
stress	230 V	400 V
Frequency ²⁾	50 Hz	50 Hz
Current	16 A	25 A
Mass	26 kg	57 kg
Length	340 mm	500 mm
Width	240 mm	290 mm
Height	295 mm	480 mm
Dimension a	180 mm	210 mm
Dimension b	160 mm	210 mm
Ledges (incl.) for workpieces with bore min.	20 mm 45 mm 70 mm	45 mm 70 mm 100 mm
Ledges (accessories) for workpieces with bore min.	15 mm – 35 mm – 60 mm	20 mm 30 mm – 60 mm – 85 mm

1) If lower voltage is used, the power will be reduced.

2) Heating devices with other rated voltages and frequencies and higher power ratings are available on request.



Training courses For the maintenance of machine tool main spindles, Schaeffler regularly offers a one-day training course on mounting, especially for supervisors and fitters at machine tool operators and manufacturers. The content of this training course covers utilisation of the full performance capacity of FAG super precision bearings, reduction of costs through the use of modern bearing arrangement concepts and the mounting and monitoring of FAG super precision bearings. The training course covers not only new spindle designs but also options for achieving improvements in existing spindles. The spindle bearing training course is divided into a theoretical section and a practical section.

Theoretical principles The following theoretical principles are covered:

- types, designs and performance characteristics of FAG super precision bearings
- tolerances for the adjacent parts and their influence on bearing performance
- lubrication of rolling bearings and rolling bearing failures
- monitoring of bearings in operation
- failure analysis of FAG super precision bearings.

Practical handling The practical section of the training course covers the following aspects:

- mounting of spindle bearings
- mounting of cylindrical roller bearings with a tapered shaft seat
- use of induction heating devices
- use of special gauges such as enveloping circle gauges and taper gauges.

Training courses can also be held on site at the customer's premises upon request.

Other products and services Catalogue IS 1 contains a complete overview of the portfolio offered by the Industrial Services Division. The catalogue and further information on all the services described here can be obtained at www.schaeffler.de/services.

Bearing monitoring

Factors in bearing monitoring

The measurement values to be considered for bearing monitoring are all the factors that respond to changes in the bearing or in the operating conditions. These can include forces, vibrations, temperatures or drive power.

In relation to the monitoring of bearings, however, it should be noted that the absolute values of a measurement parameter are of little significance in themselves. Greater importance should be attached to the occurrence of any changes. For example, a constant temperature of +40 °C is not detrimental to a rolling bearing. However, an increase in the temperature over a short period from +35 °C to +40 °C may well be an early indication of bearing damage.

Types of monitoring Periodic monitoring

When selecting a suitable monitoring method, it must be noted that continuous progress in damage over an extended period can only be expected at low and moderate speeds. In such cases, periodic monitoring may be appropriate.

Continuous monitoring

In the range of high to very high speeds, abrupt failure must be included in the risk assessment, which means that continuous monitoring is the only method that should be used in order to limit damage.

One-off monitoring

One-off monitoring is only used for quality assurance in the case of newly manufactured or repaired spindles. For example, measurement of run-down time or natural frequency measurement can be considered here. These methods can be used for the rapid and reliable detection of preload errors.

Temperature measurement and the measurement of vibration velocities and accelerations are also methods commonly used for quality assurance. As is the case with measurement of run-down time, however, these can only be used as comparative methods.



Temperature monitoring

In many cases, temperature is highly significant as an indicator of the operating behaviour of a bearing. In the case of bearings with grease lubrication, it can generally be used to detect damage or forthcoming failure in good time.

Where changes in preload or malfunction of non-locating bearings occur, there are relatively stable specimens of typical temperature curves.

The temperature is generally measured on the stationary ring, which is normally the outer ring. Assessment is generally based on the change in temperature over time.

In order to achieve reliable temperature measurement, the following rules must be observed:

- carry out measurement as close as possible to the bearing
- carry out measurement as continuously as possible
- prevent bearing deformation by means of measurement sensors.



A bearing will normally show a stable temperature behaviour. Towards the end of the grease operating life, however, the temperature will fluctuate. Intervention is necessary at the latest when a progressive pattern becomes apparent.

t = time
 ϑ = temperature

① Normal
 ② End of grease operating life

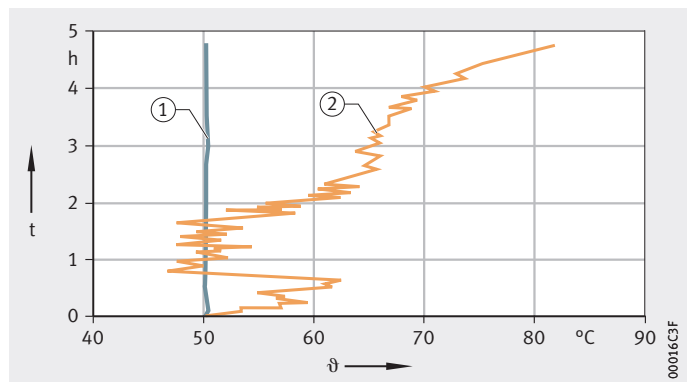
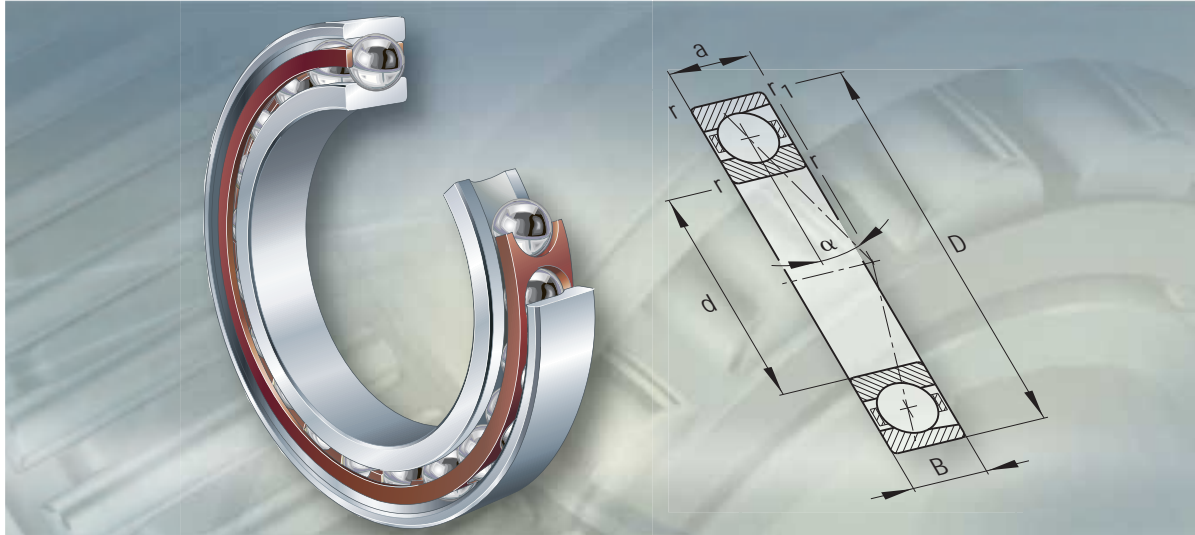


Figure 1
Bearing temperature behaviour

FAG



Spindle bearings

Single row

For main spindles in machine tools

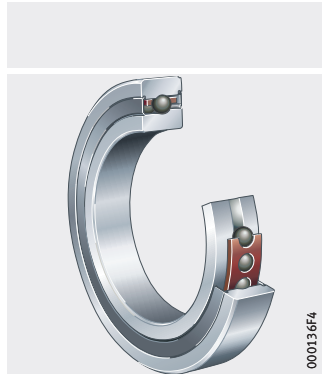
Spindle bearings

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	Cage 144
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Dimension tables	Spindle bearings With large or small balls, steel or ceramic balls, steel or Cronidur rings, open or sealed 148



Product overview Spindle bearings

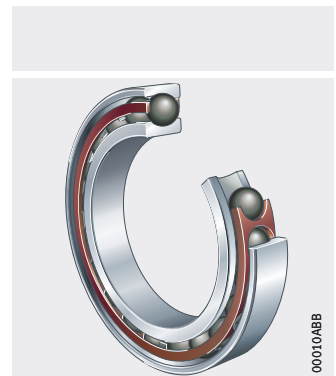
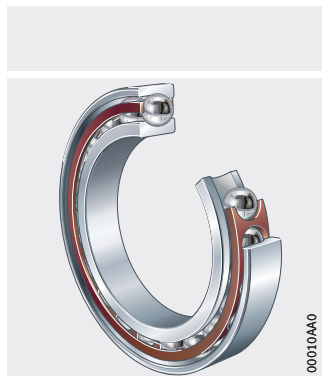
Universal bearings
With small or large balls



Steel or ceramic balls



Bearing rings
Standard rolling bearing steel or
Cronidur 30



Open or sealed
Direct Lube bearings
For pneumatic oil lubrication



Spindle bearings

Features FAG spindle bearings are super precision single row angular contact ball bearings with solid outer and inner rings, ball and cage assemblies and solid window cages, *Figure 1*. The dimensions are standardised.

Due to their very narrow tolerances, the spindle bearings are particularly suitable for applications involving the highest requirements for guidance accuracy, such as bearing arrangements for main spindles in machine tools.

Extensive range of product variants

The bearings are available in all the designs that are relevant to bearing arrangements for main spindles in machine tools. This extensive range of variants is presented in the dimension tables. In addition to the products listed therein, further designs are available by agreement.

This extensive product range gives the designer all possible scope for developing technically innovative, operationally secure and economical bearing arrangements. This results in significant performance improvements and cost savings in machine tools.

In new designs, this can allow the machine manufacturer to achieve a unique position in the market. In existing designs too, refitting with FAG spindle bearings can still give further increases in the performance and profitability of machines.



Figure 1
FAG spindle bearings



Spindle bearings

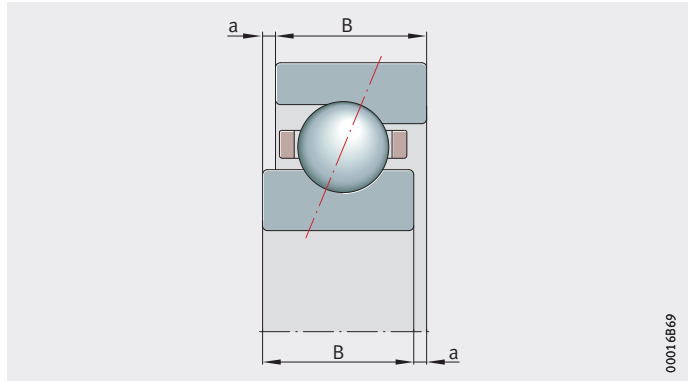
Universal bearings

FAG spindle bearings are always designed as universal bearings, which means that:

- The bearing rings are of the same width
- The projection on both sides of the bearing is of the same size, *Figure 2*.

B = bearing width
a = projection

Figure 2
Universal preload system



Advantages

Single bearings can be fitted in any arrangement required, such as a rigid X, O or tandem arrangement or with spring preloading, or can be combined in different sets. Universal bearing sets, see page 139.

In order to ensure uniform load-bearing in the tandem arrangement, the bearings used should have the same deviation in the inner ring bore and the outside diameter.

In an O arrangement and with rigid adjustment, sorting through checking of the interference between the shaft and bearing bore or the housing and bearing outside diameter can help to control the differences in the actual preload after mounting.

Arrangement of the bearings can be carried out in accordance with the arrow on the cylindrical surface of the outer ring, *Figure 3*, page 139. This provides logistical advantages for the customer, especially in spare parts procurement and stockholding of bearings.

Universal bearing sets

Bearing sets comprise universal bearings with the same deviation in the inner ring bore and the same deviation in the outside diameter.

The deviation stands as the actual value code for the inner ring bore or the outside diameter on the bearing ring.

The sets are of identical technical quality to single bearings with the same deviation in the inner ring bore and the outside diameter.

Marking of bearing sets

The first letter indicates the number of bearings in the set:

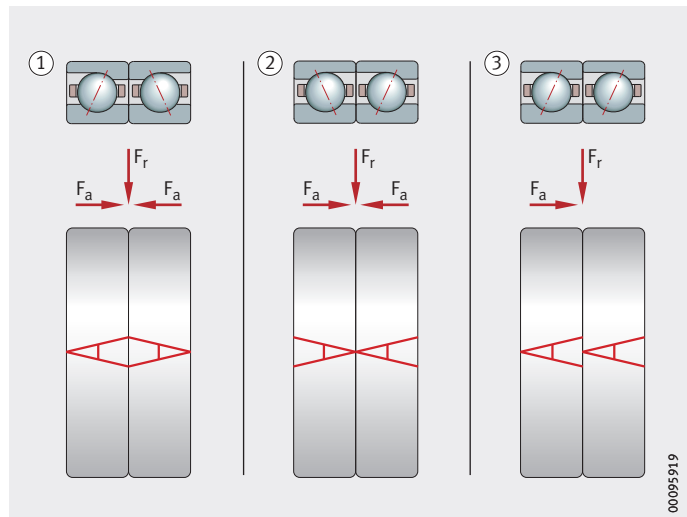
- D = 2 bearings (duplex)
- T = 3 bearings (triplex)
- Q = 4 bearings (quadruplex).

A “U” stands for “Universal”, for example in DU. After these letters, the preload class is then indicated, for example “L” for light preload, in this case DUL. Bearing designations, see also page 145.

Universal bearing sets can be mounted in any arrangement required. Possible bearing arrangements are shown in *Figure 3*.

- F_r = radial load
 F_a = axial load
- ① DU becomes DB, 2 bearing set in O arrangement
 - ② DU becomes DF, 2 bearing set in X arrangement
 - ③ DU becomes DT, 2 bearing set in tandem arrangement

Figure 3
 Bearing arrangements
 of a DU set



Ready-to-fit bearing sets

Ready-to-fit bearing sets are also available by agreement. In this case, the fitting sequence is indicated by a large arrow.

Ready-to-fit bearing sets correspond in technical terms to the universal bearing sets. However, the latter offer significant logistical advantages over the ready-to-fit sets, especially in spare parts procurement and stockholding.

Spindle bearings

Load carrying capacity and contact angle

Universal bearings can support axial loads in one direction as well as radial loads.

If bearings are used in an O or X arrangement, they can support axial forces in both directions as well as moments. Bearings in a tandem arrangement can support axial loads in one direction only, *Figure 3*, page 139.

Contact angle

The contact angle indicates the axial load carrying capacity of the bearing. As the contact angle increases, so does the axial load carrying capacity.

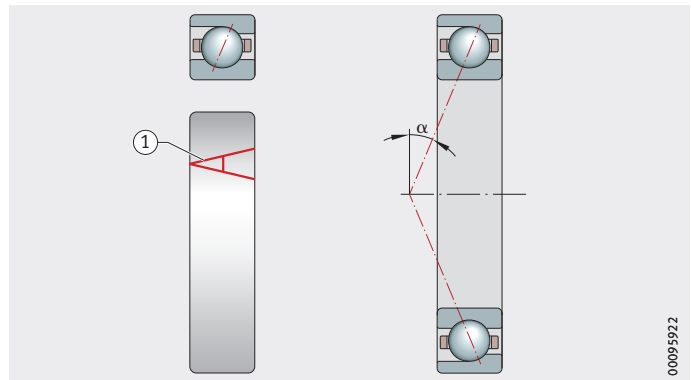
FAG spindle bearings are available with the contact angle:

- $\alpha = 15^\circ$ (suffix C)
- $\alpha = 20^\circ$ (suffix D)
- $\alpha = 25^\circ$ (suffix E).

The load direction of the outer ring is marked on the cylindrical surface of the outer ring, *Figure 4*. The open side of the symbol indicates the side of the outer ring capable of supporting axial load (the large shoulder).

α = contact angle
① Marking

Figure 4
Symbol indicating the load direction of the outer ring



00095922

Bearing types and product characteristics

Universal spindle bearings are available in the following designs: B, RS and H bearings.

B spindle bearings

- Classical spindle bearing
- With large size balls
- Contact angle 15° and 25°
- High load carrying capacity and high rigidity
- For moderate speed level.

RS spindle bearings

- With large size balls
- Contact angle 20°
- Suitable for high to very high speeds due to bearing internal design with optimised friction
- Kinematic insensitivity to tilting
- High load carrying capacity especially under combined axial and radial load
- Particularly suitable for high speed milling spindles and motor spindles.

H spindle bearings (high speed design)

- With small size balls
- Contact angle 15° and 25°
- Suitable for very high speeds due to internal design with optimised friction and very low centrifugal forces on the rolling elements
- Very high rigidity at high speeds
- Particularly suitable for very high speed spindles and grinding spindles.

Design of bearing types

The bearings are available with steel and ceramic balls and in an open, sealed and DLR design.

H spindle bearings are also available with Cronidur rings.

Bearing selection according to ball size and bearing arrangement, see page 14.



Spindle bearings

Hybrid bearings

Hybrid spindle bearings have bearing rings made from steel and, in contrast to standard spindle bearings, rolling elements made from ceramic (silicon nitride Si_3N_4), *Figure 5*.

- ① Ceramic rolling elements
- ② Direct Lube design with circumferential annular grooves



Figure 5
Hybrid spindle bearings

Advantages

Hybrid spindle bearings achieve very high speeds, have lower friction and heat generation, a longer operating life, place less strain on the lubricant and are insensitive to lubricant starvation.

Through the use of hybrid bearings, the operating limits of bearings with grease lubrication have been shifted to significantly higher speed ranges. This results in considerable savings on overall machine system costs, see page 18.

Cronidur bearings

Cronidur bearings are suitable for very high speeds and have very high load carrying capacity. Cronidur bearings are always designed as hybrid bearings, with bearing rings made from Cronidur 30 and rolling elements made from ceramic (Si_3N_4). Cronidur 30 is a highly nitrided, corrosion-resistant steel, see page 18.

Advantages

Cronidur 30 has, in comparison with the normal rolling bearing steel 100Cr6, a significantly finer structure. As a result, less heat is generated in the bearing and the permissible contact pressure is higher.

In the mixed friction range, Cronidur 30 has proved highly effective in comparison with the standard material 100Cr6.

It is also significantly superior to the conventional rolling bearing steels on the criteria of corrosion resistance and high temperature hardness.

The longer life of Cronidur bearings compared to conventional bearings makes a considerable contribution to reducing system costs.

Open and sealed spindle bearings

Spindle bearings are super precision machine elements that react with high sensitivity to harmful influences from the environment (for example ingress of contamination or air streams).

Sealing

In sealed designs, the rolling element system is protected by gap seals on both sides of the bearings, *Figure 6*.

Due to their particular advantages, these non-contact seals have long been the state of the art for sealed main spindle bearings.

Suffixes

Sealed bearings with small balls have the letter S (Sealed) in the designation. Spindle bearings with large balls have the suffix 2RSD.



① Gap seals

Figure 6
Sealed spindle bearings



Lubrication

Since the grease operating life can generally be equated to the bearing operating life, machine life values are also directly influenced by the correct grease quantity and selection of the lubricant. Sealed bearings are therefore supplied already greased with the correct quantity of a high performance grease.

Furthermore, the increase in the use of sealed bearings reflects the change from oil lubrication to economical grease lubrication with ready-to-fit, maintenance-free bearings with lifetime lubrication.



When selecting a lubricant, the operating temperature of the lubricant must be taken into consideration.

Further information on lubrication, see page 14.

Spindle bearings

Direct Lube bearings

These bearings are designed for extremely high speeds. They are used where pneumatic oil lubrication is necessary and a reliable supply of lubricant must be ensured, *Figure 7*. They are thus an ideal addition to the spindle bearing range.

Direct Lube bearings provide reliable feed of lubricant directly to the contact point. This is achieved by means of circumferential annular grooves and radial feed holes.

The bearing is sealed off from the spindle housing by means of integrated high precision O rings.

In addition, the adjacent construction can be simplified since the bearing design means that it no longer has to include certain expensive elements. This reduces both the design envelope and the costs.



① Circumferential annular grooves

Figure 7
Direct Lube bearing

Cage



Spindle bearings have solid window cages made from laminated fabric (suffix T). The cage is guided on the outer ring, see page 213.

Check the chemical resistance of the seal and cage material when using synthetic greases and lubricants with EP additives.

Additives in the oil can impair the operating life of the cages at high temperatures.

Bearing designations The structure for spindle bearings is shown in *Figure 8*.

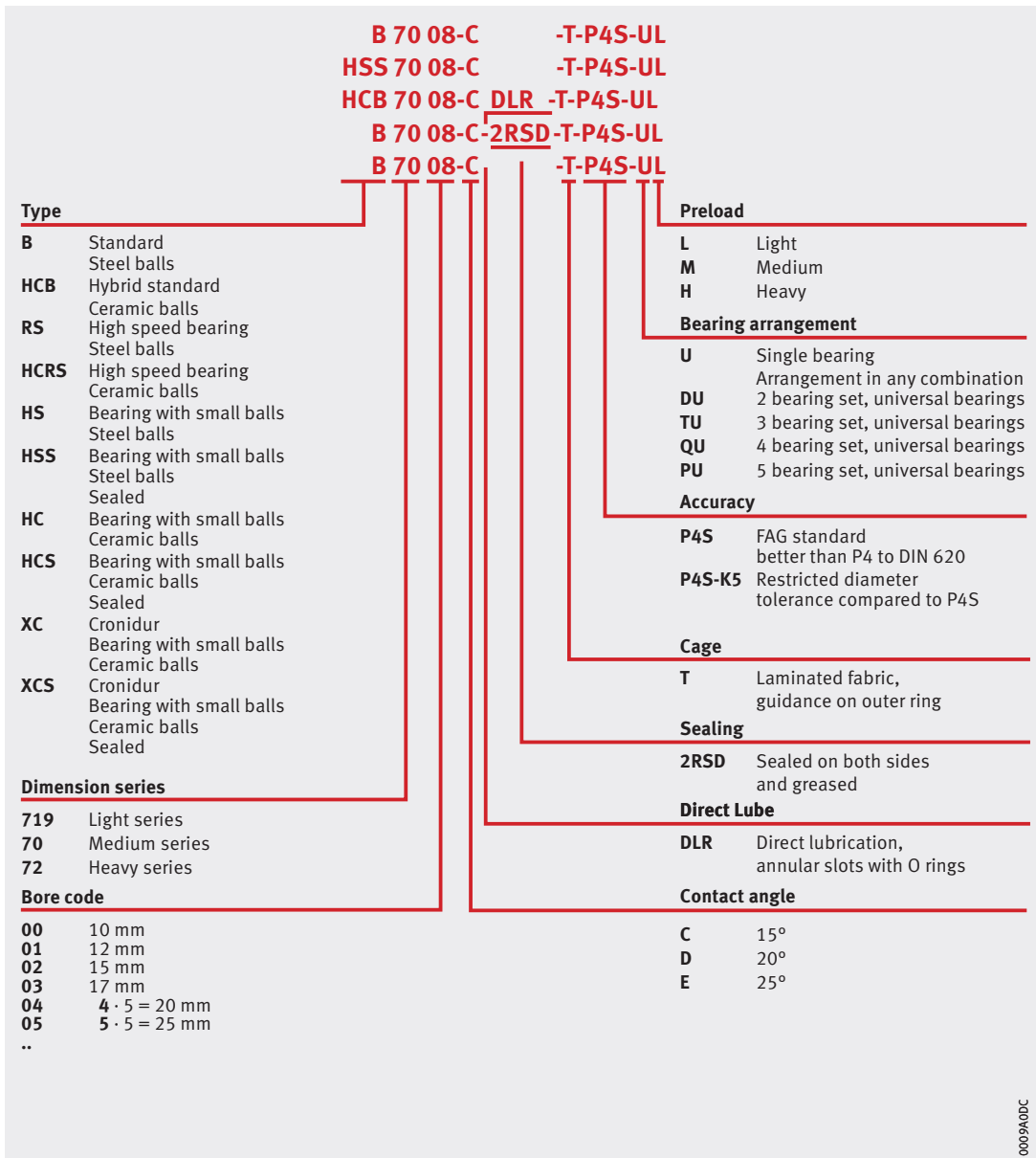


Figure 8
Bearing designations

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Spindle bearings

Marking of bearings

FAG spindle bearings for machine tools have a uniform designation system.

In addition to the actual bearing designation, this also contains information on the:

- tolerances and actual value codes (bore/outside diameter/width/projection¹⁾/contact angle¹⁾)
- mounting position indicated by the marking on the outside surface of the outer ring (symbol indicating the load direction of the outer ring), *Figure 4*, page 140.

These indications are, depending on the size of the bearing, subject to tolerances. Marking on the end faces of the bearing rings is shown in *Figure 9* and *Figure 10*, page 147.

- ① Data matrix code
- ② Symbol indicating the load direction of the outer ring
- ③ Trademark
- ④ Short designation
- ⑤ Country of manufacture
- ⑥ Internal code
- ⑦ Internal code
- ⑧ Special material for outer ring
- ⑨ Actual value code for outside diameter/actual deviation of width in μm /actual deviation from nominal projection in μm /actual contact angle¹⁾
- ⑩ Actual value code for bore
- ⑪ Special material for inner ring
- ⑫ Symbol for largest wall thickness of inner ring

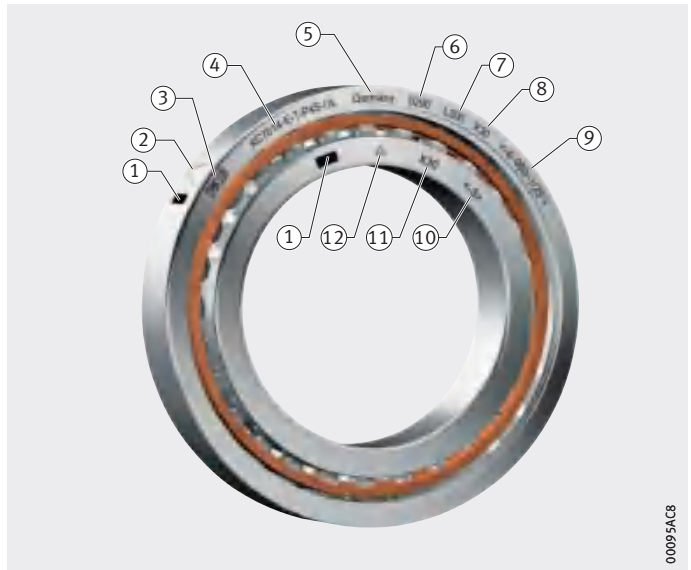
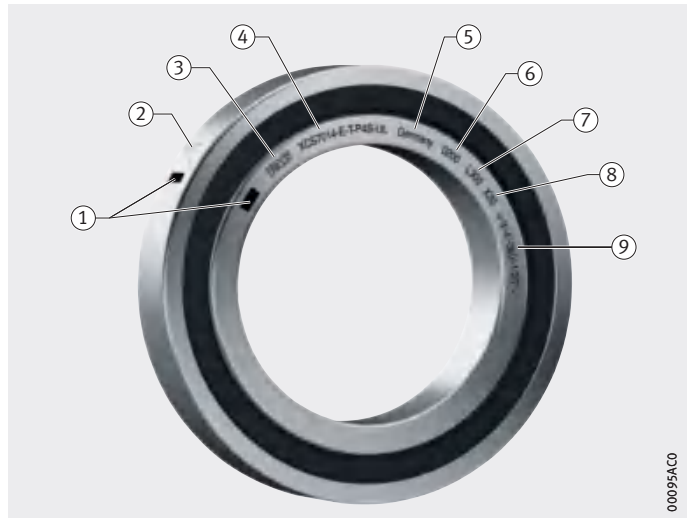


Figure 9
Example of marking
for open spindle bearings

- ① Data matrix code
- ② Symbol indicating the load direction of the outer ring
- ③ Trademark
- ④ Short designation
- ⑤ Country of manufacture
- ⑥ Internal code
- ⑦ Internal code
- ⑧ Special material for the inner ring
- ⑨ Value code for bore/actual value code for outside diameter/actual deviation of width in μm /actual deviation from nominal projection in μm /actual contact angle¹⁾

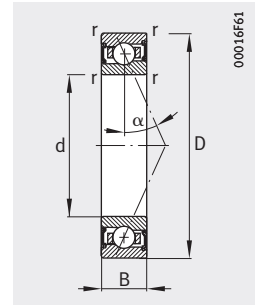
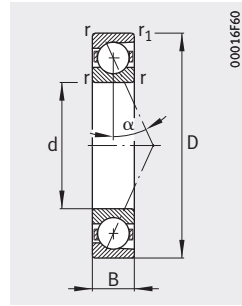
Figure 10
Example of marking
for sealed spindle bearings



¹⁾ Deviation from nominal projection and actual contact angle: to be introduced progressively together with new spindle bearing packaging starting in 01/2016.

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed



Dimension table - Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71900-C-T-P4S	–	–	0,01	10	22	6	0,3	0,3	15	13	19,5
B71900-E-T-P4S	–	–	0,01	10	22	6	0,3	0,3	25	13	19,5
HCB71900-C-T-P4S	–	–	0,009	10	22	6	0,3	0,3	15	13	19,5
HCB71900-E-T-P4S	–	–	0,009	10	22	6	0,3	0,3	25	13	19,5
HS71900-C-T-P4S	–	–	0,011	10	22	6	0,3	–	15	13	19,5
HS71900-E-T-P4S	–	–	0,01	10	22	6	0,3	–	25	13	19,5
HC71900-E-T-P4S	–	–	0,012	10	22	6	0,3	–	25	13	19,5
XC71900-E-T-P4S	–	–	0,012	10	22	6	0,3	–	25	13	19,5
–	B7000-C-T-P4S	–	0,02	10	26	8	0,3	0,3	15	14	22
–	B7000-E-T-P4S	–	0,02	10	26	8	0,3	0,3	25	14	22
–	HCB7000-C-T-P4S	–	0,018	10	26	8	0,3	0,3	15	14	22
–	HCB7000-E-T-P4S	–	0,018	10	26	8	0,3	0,3	25	14	22
–	HS7000-C-T-P4S	–	0,022	10	26	8	0,3	–	15	14	22
–	HS7000-E-T-P4S	–	0,022	10	26	8	0,3	–	25	14	22
–	HC7000-E-T-P4S	–	0,023	10	26	8	0,3	–	25	14	22
–	XC7000-E-T-P4S	–	0,023	10	26	8	0,3	–	25	14	22
–	–	B7200-C-T-P4S	0,032	10	30	9	0,6	0,6	15	14,5	25,5
–	–	B7200-E-T-P4S	0,032	10	30	9	0,6	0,6	25	14,5	25,5
–	–	HCB7200-C-T-P4S	0,029	10	30	9	0,6	0,6	15	14,5	25,5
–	–	HCB7200-E-T-P4S	0,029	10	30	9	0,6	0,6	25	14,5	25,5

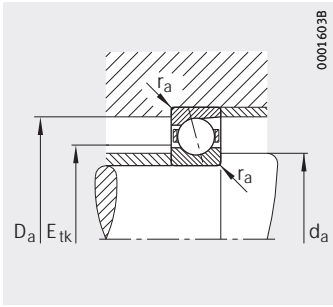
1) Explanation of short designations, see page 145.

2) The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7000-C-2RSD-T-P4S-UL and HSS7000-E-T-P4S-UL.

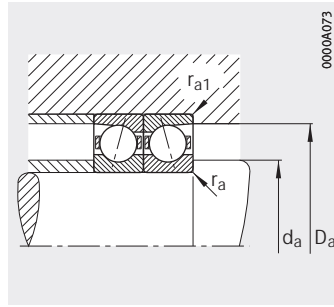
3) The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

4) Explanation, see page 70.

5) Minimal quantity oil lubrication.



Mounting dimensions



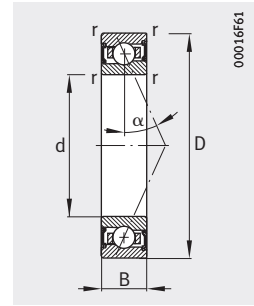
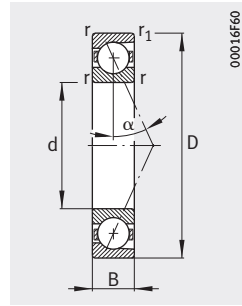
Mounting dimensions



			Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾ F _v			Lift-off force ⁴⁾ K _{aE}			Axial rigidity ⁴⁾ c _a		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
0,3	0,3	15	3	1,07	75 000	120 000	10	41	87	31	141	320	11	21,1	31,2
0,3	0,3	15	2,9	1,02	70 000	110 000	17	74	163	50	226	521	27,1	47,7	67
0,3	0,3	15	3	1,02	110 000	160 000	6	25	54	17	79	185	9,8	18,2	26,5
0,3	0,3	15	2,9	0,98	95 000	150 000	5	35	85	16	104	260	20,4	39,9	56,5
0,3	0,3	15	1,79	0,65	100 000	160 000	7	20	39	20	63	132	8,8	14,1	19,6
0,3	0,3	15	1,7	0,62	95 000	140 000	11	32	64	31	96	196	21,7	32,7	43
0,3	0,3	15	1,7	0,6	120 000	180 000	7	22	45	21	65	133	21,6	32	41,7
0,3	0,3	15	2,6	0,6	130 000	200 000	7	22	45	21	65	133	21,6	32	41,7
0,3	0,1	16,4	4,1	1,47	67 000	100 000	18	65	136	54	220	490	12,7	23	33,53
0,3	0,1	16,4	3,95	1,41	60 000	95 000	21	99	223	61	298	698	27,6	49,2	69,1
0,3	0,1	16,4	4,1	1,4	95 000	140 000	7	33	74	21	104	248	9,9	18,5	26,9
0,3	0,1	16,4	3,95	1,35	85 000	130 000	12	57	130	33	167	392	25,1	44,6	61,6
0,3	0,1	16,8	2,47	0,94	90 000	140 000	9	28	55	28	89	185	10,9	17,4	24,1
0,3	0,1	16,8	2,35	0,89	85 000	130 000	15	45	90	43	133	273	26,8	40,3	53
0,3	0,1	16,8	2,35	0,86	110 000	160 000	10	31	62	30	91	185	26,6	39,5	51,4
0,3	0,1	16,8	3,6	0,86	120 000	180 000	10	31	62	30	91	185	26,6	39,5	51,4
0,6	0,6	18,8	6,9	2,95	56 000	85 000	25	91	185	79	311	684	16,4	29,8	43,5
0,6	0,6	18,8	6,6	2,8	50 000	75 000	32	141	314	94	429	995	35,8	63,2	88,8
0,6	0,6	18,8	6,9	2,8	67 000	100 000	11	47	103	32	150	352	12,9	23,9	34,9
0,6	0,6	18,8	6,6	2,7	60 000	90 000	18	82	185	52	243	564	32,8	57,2	71,7

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
							min.				
B71901-C-T-P4S	–	–	0,011	12	24	6	0,3	0,3	15	15	21,5
B71901-E-T-P4S	–	–	0,011	12	24	6	0,3	0,3	25	15	21,5
HCB71901-C-T-P4S	–	–	0,01	12	24	6	0,3	0,3	15	15	21,5
HCB71901-E-T-P4S	–	–	0,01	12	24	6	0,3	0,3	25	15	21,5
HS71901-C-T-P4S	–	–	0,011	12	24	6	0,3	–	15	15	21,5
HS71901-E-T-P4S	–	–	0,011	12	24	6	0,3	–	25	15	21,5
HC71901-E-T-P4S	–	–	0,013	12	24	6	0,3	–	25	15	21,5
XC71901-E-T-P4S	–	–	0,013	12	24	6	0,3	–	25	15	21,5
–	B7001-C-T-P4S	–	0,023	12	28	8	0,3	0,3	15	16,5	24,5
–	B7001-E-T-P4S	–	0,023	12	28	8	0,3	0,3	25	16,5	24,5
–	HCB7001-C-T-P4S	–	0,02	12	28	8	0,3	0,3	15	16,5	24,5
–	HCB7001-E-T-P4S	–	0,02	12	28	8	0,3	0,3	25	16,5	24,5
–	HS7001-C-T-P4S	–	0,024	12	28	8	0,3	–	15	16,5	24,5
–	HS7001-E-T-P4S	–	0,024	12	28	8	0,3	–	25	16,5	24,5
–	HC7001-E-T-P4S	–	0,025	12	28	8	0,3	–	25	16,5	24,5
–	XC7001-E-T-P4S	–	0,025	12	28	8	0,3	–	25	16,5	24,5
–	–	B7201-C-T-P4S	0,04	12	32	10	0,6	0,6	15	16,5	27,5
–	–	B7201-E-T-P4S	0,037	12	32	10	0,6	0,6	25	16,5	27,5
–	–	HCB7201-C-T-P4S	0,032	12	32	10	0,6	0,6	15	16,5	27,5
–	–	HCB7201-E-T-P4S	0,032	12	32	10	0,6	0,6	25	16,5	27,5

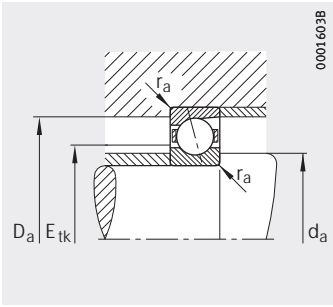
¹⁾ Explanation of short designations, see page 145.

²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7001-C-2RSD-T-P4S-UL and HSS7001-E-T-P4S-UL.

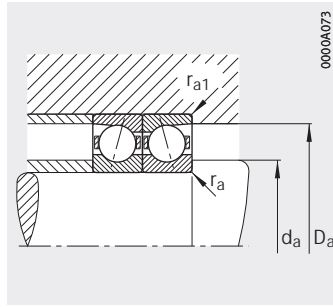
³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.



Mounting dimensions



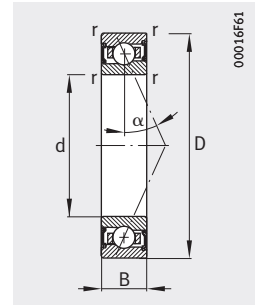
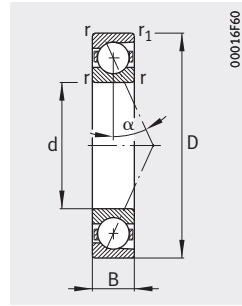
Mounting dimensions



			Basic load ratings			Limiting speeds ³⁾		Preload force ⁴⁾ F _v			Lift-off force ⁴⁾ K _{aE}			Axial rigidity ⁴⁾ c _a		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H	
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm	
0,3	0,3	17,2	3,4	1,31	67 000	100 000	11	46	97	34	155	355	12,6	24,1	35,7	
0,3	0,3	17,2	3,25	1,25	60 000	95 000	18	80	179	53	245	567	30,8	54,4	76,5	
0,3	0,3	17,2	3,4	1,25	95 000	140 000	6	27	60	18	87	205	11,2	20,8	30,3	
0,3	0,3	17,2	3,25	1,19	85 000	130 000	5	38	92	16	111	281	22,7	45,5	64,5	
0,3	0,3	17	1,85	0,72	90 000	140 000	7	21	41	21	66	137	9,4	15	20,8	
0,3	0,3	17	1,76	0,69	85 000	130 000	11	33	67	32	99	203	23,1	34,7	45,6	
0,3	0,3	17	1,76	0,66	110 000	160 000	8	23	46	22	68	138	22,9	34,1	44,3	
0,3	0,3	17	2,7	0,66	120 000	180 000	8	23	46	22	68	138	22,9	34,1	44,3	
0,3	0,1	18,6	4,65	1,83	60 000	90 000	19	73	152	59	242	543	14,6	26,5	38,71	
0,3	0,1	18,6	4,45	1,75	53 000	85 000	23	109	248	66	328	775	31,8	57,2	80,3	
0,3	0,1	18,6	4,65	1,75	85 000	130 000	8	36	82	22	114	274	11,3	21,4	31,1	
0,3	0,1	18,6	4,45	1,67	75 000	120 000	12	63	145	35	184	436	29	51,9	71,7	
0,3	0,1	18,8	2,45	0,96	80 000	130 000	9	27	54	27	87	181	10,8	17,3	23,9	
0,3	0,1	18,8	2,32	0,91	75 000	110 000	15	44	88	43	131	268	26,7	40	52,6	
0,3	0,1	18,8	2,32	0,87	95 000	140 000	10	30	61	29	89	181	26,4	39,2	50,9	
0,3	0,1	18,8	3,55	0,87	100 000	160 000	10	30	61	29	89	181	26,4	39,2	50,9	
0,6	0,6	21,1	9,1	3,9	50 000	75 000	35	123	248	109	420	916	19,3	34,6	50,3	
0,6	0,6	21,1	8,8	3,75	45 000	67 000	47	193	423	137	588	1342	42,8	73,9	103,1	
0,6	0,6	21,1	9,1	3,7	63 000	95 000	16	65	142	47	210	483	15,6	28,2	40,9	
0,6	0,6	21,1	8,8	3,6	53 000	80 000	26	112	248	76	332	757	39,2	66,8	84,3	

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71902-C-T-P4S	–	–	0,016	15	28	7	0,3	0,3	15	18	25,5
B71902-E-T-P4S	–	–	0,016	15	28	7	0,3	0,3	25	18	25,5
HCB71902-C-T-P4S	–	–	0,014	15	28	7	0,3	0,3	15	18	25,5
HCB71902-E-T-P4S	–	–	0,014	15	28	7	0,3	0,3	25	18	25,5
HS71902-C-T-P4S	–	–	0,017	15	28	7	0,3	–	15	18	25,5
HS71902-E-T-P4S	–	–	0,017	15	28	7	0,3	–	25	18	25,5
HC71902-E-T-P4S	–	–	0,018	15	28	7	0,3	–	25	18	25,5
XC71902-E-T-P4S	–	–	0,018	15	28	7	0,3	–	25	18	25,5
–	B7002-C-T-P4S	–	0,03	15	32	9	0,3	0,3	15	19	29
–	B7002-E-T-P4S	–	0,03	15	32	9	0,3	0,3	25	19	29
–	HCB7002-C-T-P4S	–	0,027	15	32	9	0,3	0,3	15	19	29
–	HCB7002-E-T-P4S	–	0,027	15	32	9	0,3	0,3	25	19	29
–	HS7002-C-T-P4S	–	0,033	15	32	9	0,3	–	15	19	29
–	HS7002-E-T-P4S	–	0,033	15	32	9	0,3	–	25	19	29
–	HC7002-E-T-P4S	–	0,035	15	32	9	0,3	–	25	19	29
–	XC7002-E-T-P4S	–	0,035	15	32	9	0,3	–	25	19	29
–	–	B7202-C-T-P4S	0,044	15	35	11	0,6	0,6	15	19,5	30,5
–	–	B7202-E-T-P4S	0,044	15	35	11	0,6	0,6	25	19,5	30,5
–	–	HCB7202-C-T-P4S	0,038	15	35	11	0,6	0,6	15	19,5	30,5
–	–	HCB7202-E-T-P4S	0,038	15	35	11	0,6	0,6	25	19,5	30,5

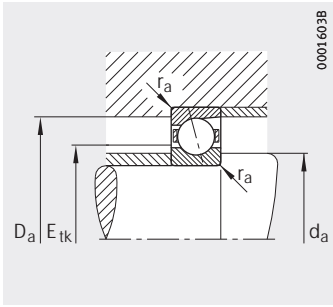
1) Explanation of short designations, see page 145.

2) The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7002-C-2RSD-T-P4S-UL and HSS7002-E-T-P4S-UL.

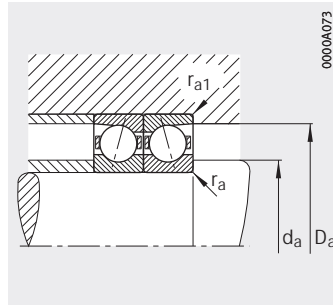
3) The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

4) Explanation, see page 70.

5) Minimal quantity oil lubrication.



Mounting dimensions



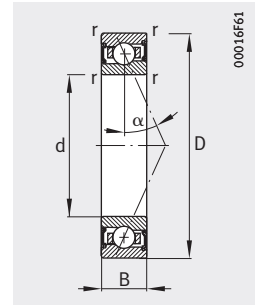
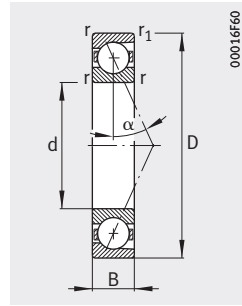
Mounting dimensions



			Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾ F_V			Lift-off force ⁴⁾ K_{aE}			Axial rigidity ⁴⁾ c_a		
r_a	r_{a1}	E_{tk}	dyn. C_r	stat. C_{0r}	n_G grease	n_G oil ⁵⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min^{-1}	min^{-1}	N	N	N	N	N	N	N/ μm	N/ μm	N/ μm
0,3	0,3	20,9	5,1	2,03	56 000	85 000	19	73	153	59	249	559	16,4	30,5	44,9
0,3	0,3	20,9	4,85	1,94	50 000	75 000	22	111	255	64	336	805	35	64,7	91,9
0,3	0,3	20,9	5,1	1,94	75 000	120 000	7	37	84	21	117	285	12,5	24,4	35,9
0,3	0,3	20,9	4,85	1,86	70 000	110 000	12	64	150	34	190	457	31,9	58,7	82
0,3	0,3	20,3	2,55	1,04	75 000	110 000	9	28	56	28	90	188	11,4	18,2	25,2
0,3	0,3	20,3	2,41	0,99	67 000	100 000	15	46	91	44	136	278	28,3	42,4	55,6
0,3	0,3	20,3	2,41	0,95	85 000	130 000	11	32	63	30	92	188	28	41,5	53,9
0,3	0,3	20,3	3,7	0,95	95 000	150 000	11	32	63	30	92	188	28	41,5	53,9
0,3	0,1	22,3	6,1	2,41	53 000	80 000	27	99	204	84	332	733	16,6	29,7	43,04
0,3	0,1	22,3	5,9	2,31	45 000	70 000	36	154	341	104	464	1066	37,2	64,6	89,8
0,3	0,1	22,3	6,1	2,31	70 000	110 000	12	52	114	35	164	381	13,4	24,3	35,1
0,3	0,1	22,3	5,9	2,21	63 000	100 000	20	88	199	57	260	600	34,1	58,6	80,2
0,3	0,1	22,2	3,45	1,48	70 000	110 000	13	38	75	38	120	251	13,7	21,8	30,2
0,3	0,1	22,2	3,25	1,41	63 000	95 000	20	61	122	59	182	372	34	50,9	66,8
0,3	0,1	22,2	3,25	1,35	80 000	120 000	14	42	85	41	124	252	33,7	49,9	64,8
0,3	0,1	22,2	5	1,35	90 000	140 000	14	42	85	41	124	252	33,7	49,9	64,8
0,6	0,6	23,3	11,6	5	45 000	67 000	46	158	319	144	543	1177	22,1	39,3	57
0,6	0,6	23,3	11,1	4,85	40 000	60 000	64	252	546	187	768	1732	49,7	84,4	117,3
0,6	0,6	23,3	11,6	4,8	56 000	85 000	22	86	183	65	275	626	18,1	32,3	46,5
0,6	0,6	23,3	11,1	4,65	48 000	70 000	24	126	291	70	371	884	39,7	72	89,1

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71903-C-T-P4S	–	–	0,018	17	30	7	0,3	0,3	15	20	27,5
B71903-E-T-P4S	–	–	0,018	17	30	7	0,3	0,3	25	20	27,5
HCB71903-C-T-P4S	–	–	0,015	17	30	7	0,3	0,3	15	20	27,5
HCB71903-E-T-P4S	–	–	0,015	17	30	7	0,3	0,3	25	20	27,5
HS71903-C-T-P4S	–	–	0,019	17	30	7	0,3	–	15	20	27,5
HS71903-E-T-P4S	–	–	0,019	17	30	7	0,3	–	25	20	27,5
HC71903-E-T-P4S	–	–	0,021	17	30	7	0,3	–	25	20	27,5
XC71903-E-T-P4S	–	–	0,021	17	30	7	0,3	–	25	20	27,5
–	B7003-C-T-P4S	–	0,039	17	35	10	0,3	0,3	15	21	32
–	B7003-E-T-P4S	–	0,038	17	35	10	0,3	0,3	25	21	32
–	HCB7003-C-T-P4S	–	0,033	17	35	10	0,3	0,3	15	21	32
–	HCB7003-E-T-P4S	–	0,032	17	35	10	0,3	0,3	25	21	32
–	HS7003-C-T-P4S	–	0,043	17	35	10	0,3	–	15	21	32
–	HS7003-E-T-P4S	–	0,043	17	35	10	0,3	–	25	21	32
–	HC7003-E-T-P4S	–	0,046	17	35	10	0,3	–	25	21	32
–	XC7003-E-T-P4S	–	0,046	17	35	10	0,3	–	25	21	32
–	–	B7203-C-T-P4S	0,063	17	40	12	0,6	0,6	15	22,5	34,5
–	–	B7203-E-T-P4S	0,062	17	40	12	0,6	0,6	25	22,5	34,5
–	–	HCB7203-C-T-P4S	0,056	17	40	12	0,6	0,6	15	22,5	34,5
–	–	HCB7203-E-T-P4S	0,055	17	40	12	0,6	0,6	25	22,5	34,5

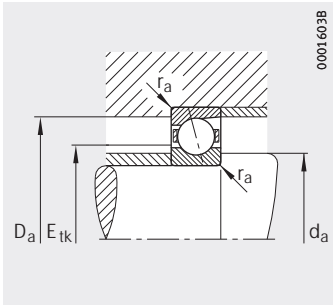
¹⁾ Explanation of short designations, see page 145.

²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7003-C-2RSD-T-P4S-UL and HSS7003-E-T-P4S-UL.

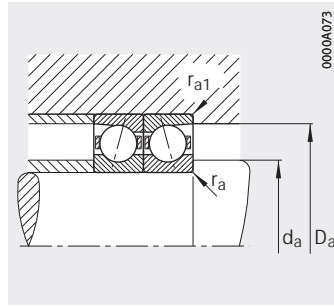
³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.



Mounting dimensions



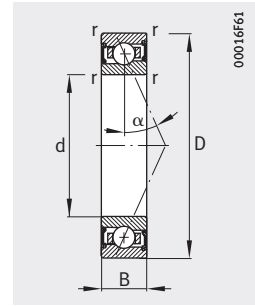
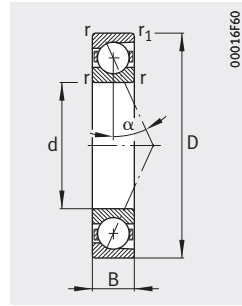
Mounting dimensions



			Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾ F_v			Lift-off force ⁴⁾ K_{aE}			Axial rigidity ⁴⁾ c_a		
r_a	r_{a1}	E_{tk}	dyn. C_r	stat. C_{0r}	n_G grease	n_G oil ⁵⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min^{-1}	min^{-1}	N	N	N	N	N	N	N/ μm	N/ μm	N/ μm
0,3	0,3	22,2	5,3	2,23	50 000	80 000	20	78	162	62	263	592	17,5	32,6	47,9
0,3	0,3	22,2	5,1	2,12	45 000	70 000	22	115	265	65	346	833	36,9	68,5	97,3
0,3	0,3	22,2	5,3	2,13	70 000	110 000	8	39	89	22	123	300	13,3	26	38,3
0,3	0,3	22,2	5,1	2,03	63 000	100 000	12	65	154	34	193	466	33,4	61,9	86,4
0,3	0,3	22,3	2,6	1,13	70 000	110 000	10	29	58	29	93	194	12	19,2	26,5
0,3	0,3	22,3	2,48	1,07	63 000	95 000	16	47	93	45	138	283	29,6	44,4	58,3
0,3	0,3	22,3	2,48	1,03	80 000	120 000	11	33	66	31	96	195	29,6	43,9	56,9
0,3	0,3	22,3	3,8	1,03	90 000	140 000	11	33	66	31	96	195	29,6	43,9	56,9
0,3	0,1	24,1	8,6	3,5	45 000	70 000	40	142	291	124	474	1 042	21,1	37,1	53,61
0,3	0,1	24,1	8,2	3,35	43 000	63 000	54	220	483	156	663	1 504	47,6	81	111,9
0,3	0,1	24,1	8,6	3,35	63 000	100 000	18	75	164	54	237	546	17,3	30,7	43,9
0,3	0,1	24,1	8,2	3,25	56 000	90 000	30	126	279	85	370	840	43,5	73,4	99,7
0,3	0,1	24,7	3,55	1,6	63 000	95 000	13	38	76	38	121	253	14,3	22,7	31,3
0,3	0,1	24,7	3,35	1,52	56 000	85 000	21	63	126	61	187	382	35,7	53,4	70
0,3	0,1	24,7	3,35	1,46	75 000	110 000	14	43	86	41	126	256	35,3	52,2	67,7
0,3	0,1	24,7	5,1	1,46	80 000	120 000	14	43	86	41	126	256	35,3	52,2	67,7
0,6	0,6	26,7	13	5,8	38 000	56 000	53	179	360	165	614	1 327	23,6	41,8	60,6
0,6	0,6	26,7	12,4	5,6	36 000	53 000	74	286	616	216	871	1 954	53,3	89,9	124,6
0,6	0,6	26,7	13	5,6	50 000	75 000	25	97	208	75	313	708	19,5	34,4	49,5
0,6	0,6	26,7	12,4	5,4	43 000	63 000	29	145	332	84	428	1 011	43,2	77,2	95,9

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
							min.					
B71904-C-T-P4S	–	–	0,037	20	37	9	0,3	0,3	–	–	–	15
B71904-E-T-P4S	–	–	0,037	20	37	9	0,3	0,3	–	–	–	25
HCB71904-C-T-P4S	–	–	0,033	20	37	9	0,3	0,3	–	–	–	15
HCB71904-E-T-P4S	–	–	0,033	20	37	9	0,3	0,3	–	–	–	25
HS71904-C-T-P4S	–	–	0,04	20	37	9	0,3	–	–	–	–	15
HS71904-E-T-P4S	–	–	0,04	20	37	9	0,3	–	–	–	–	25
HC71904-E-T-P4S	–	–	0,045	20	37	9	0,3	–	–	–	–	25
XC71904-E-T-P4S	–	–	0,045	20	37	9	0,3	–	–	–	–	25
–	B7004-C-T-P4S	–	0,067	20	42	12	0,6	0,6	–	–	–	15
–	B7004-E-T-P4S	–	0,067	20	42	12	0,6	0,6	–	–	–	25
–	HCB7004-C-T-P4S	–	0,061	20	42	12	0,6	0,6	2,2	6,6	1,4	15
–	HCB7004-E-T-P4S	–	0,06	20	42	12	0,6	0,6	2,2	6,6	1,4	25
–	RS7004-D-T-P4S	–	0,07	20	42	12	0,6	0,6	–	–	–	20
–	HS7004-C-T-P4S	–	0,077	20	42	12	0,6	–	–	–	–	15
–	HS7004-E-T-P4S	–	0,077	20	42	12	0,6	–	–	–	–	25
–	HC7004-E-T-P4S	–	0,079	20	42	12	0,6	–	2,2	6,6	1,4	25
–	XC7004-E-T-P4S	–	0,079	20	42	12	0,6	–	2,2	6,6	1,4	25
–	–	B7204-C-T-P4S	0,103	20	47	14	1	1	–	–	–	15
–	–	B7204-E-T-P4S	0,103	20	47	14	1	1	–	–	–	25
–	–	HCB7204-C-T-P4S	0,092	20	47	14	1	1	–	–	–	15
–	–	HCB7204-E-T-P4S	0,091	20	47	14	1	1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).

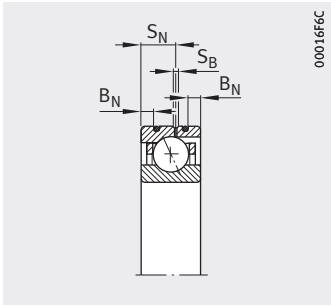
Ordering examples: B7004-C-2RSD-T-P4S-UL and HSS7004-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

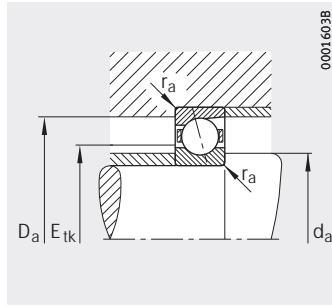
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

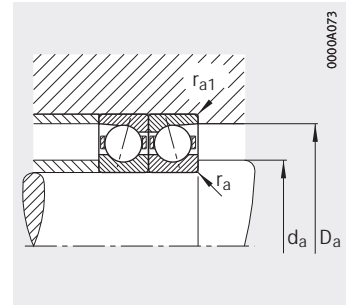
⁶⁾ Ordering examples for Direct Lube design: HCB7004-EDLR-T-P4S-UL and HC7004-EDLR-T-P4S-UL.
DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



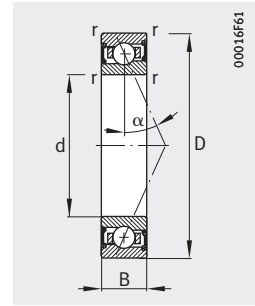
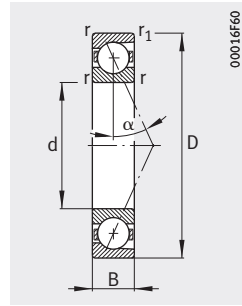
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _v			K _{aE}			c _a		
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H
									N	N	N	N	N	N	N/μm	N/μm	N/μm
24	33,5	0,3	0,3	26,8	7,4	3,2	43 000	63 000	31	113	233	95	384	851	21,6	39,3	57,4
24	33,5	0,3	0,3	26,8	7	3,05	38 000	60 000	37	170	384	108	516	1 208	46,7	83,3	117,1
24	33,5	0,3	0,3	26,8	7,4	3,1	60 000	90 000	12	57	128	37	182	431	16,8	31,5	46
24	33,5	0,3	0,3	26,8	7	2,95	53 000	80 000	20	98	223	58	289	678	42,5	75,3	104,1
24	33,5	0,3	0,3	27,2	3,6	1,73	56 000	90 000	13	39	78	39	124	259	15	23,7	32,7
24	33,5	0,3	0,3	27,2	3,4	1,63	53 000	80 000	22	65	129	62	191	392	37,4	55,9	73,2
24	33,5	0,3	0,3	27,2	3,4	1,56	67 000	100 000	15	44	88	42	128	261	36,9	54,6	70,7
24	33,5	0,3	0,3	27,2	5,2	1,56	75 000	110 000	15	44	88	42	128	261	36,9	54,6	70,7
25	37	0,6	0,3	28,8	10,3	4,25	38 000	60 000	51	175	356	157	586	1 276	22,6	39,4	56,8
25	37	0,6	0,3	28,8	9,8	4,05	34 000	53 000	71	275	595	205	829	1 857	51,6	86,3	118,7
25	37	0,6	0,3	28,8	10,3	4,05	53 000	80 000	24	94	202	72	297	673	18,7	32,7	46,6
25	37	0,6	0,3	28,8	9,8	3,9	48 000	75 000	28	140	321	80	410	966	42	74,7	102,9
25	37	0,6	0,3	28,8	9,5	3,6	45 000	70 000	46	139	278	137	427	883	32,8	50,5	67,9
25	37	0,6	0,3	29,3	5,7	2,7	53 000	80 000	21	62	125	63	198	413	19,8	31,5	43,5
25	37	0,6	0,3	29,3	5,4	2,6	48 000	75 000	34	101	202	97	299	611	49,1	73,6	96,4
25	37	0,6	0,3	29,3	5,4	2,47	60 000	95 000	23	70	140	67	204	415	48,8	72,3	93,7
25	37	0,6	0,3	29,3	8,3	2,47	67 000	100 000	23	70	140	67	204	415	48,8	72,3	93,7
26,5	40,5	1	1	31,7	17,2	8	32 000	48 000	75	248	496	234	851	1 828	28,1	49,3	71,1
26,5	40,5	1	1	31,7	16,5	7,7	30 000	45 000	107	398	848	313	1 212	2 686	63,7	106	146,2
26,5	40,5	1	1	31,7	17,2	7,6	40 000	60 000	36	135	284	109	432	967	23,3	40,5	57,9
26,5	40,5	1	1	31,7	16,5	7,3	36 000	53 000	46	205	460	131	606	1 400	53	91,6	114,9

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
B71905-C-T-P4S	–	–	0,043	25	42	9	0,3	0,3	–	–	–	15
B71905-E-T-P4S	–	–	0,043	25	42	9	0,3	0,3	–	–	–	25
HCB71905-C-T-P4S	–	–	0,039	25	42	9	0,3	0,3	–	–	–	15
HCB71905-E-T-P4S	–	–	0,039	25	42	9	0,3	0,3	–	–	–	25
RS71905-D-T-P4S	–	–	0,045	25	42	9	0,3	0,3	–	–	–	20
HS71905-C-T-P4S	–	–	0,046	25	42	9	0,3	–	–	–	–	15
HS71905-E-T-P4S	–	–	0,046	25	42	9	0,3	–	–	–	–	25
HC71905-E-T-P4S	–	–	0,051	25	42	9	0,3	–	–	–	–	25
XC71905-E-T-P4S	–	–	0,051	25	42	9	0,3	–	–	–	–	25
–	B7005-C-T-P4S	–	0,071	25	47	12	0,6	0,6	–	–	–	15
–	B7005-E-T-P4S	–	0,07	25	47	12	0,6	0,6	–	–	–	25
–	HCB7005-C-T-P4S	–	0,065	25	47	12	0,6	0,6	2,2	6,6	1,4	15
–	HCB7005-E-T-P4S	–	0,065	25	47	12	0,6	0,6	2,2	6,6	1,4	25
–	RS7005-D-T-P4S	–	0,075	25	47	12	0,6	0,6	–	–	–	20
–	HS7005-C-T-P4S	–	0,088	25	47	12	0,6	–	–	–	–	15
–	HS7005-E-T-P4S	–	0,088	25	47	12	0,6	–	–	–	–	25
–	HC7005-E-T-P4S	–	0,092	25	47	12	0,6	–	2,2	6,6	1,4	25
–	XC7005-E-T-P4S	–	0,092	25	47	12	0,6	–	2,2	6,6	1,4	25
–	–	B7205-C-T-P4S	0,126	25	52	15	1	1	–	–	–	15
–	–	B7205-E-T-P4S	0,126	25	52	15	1	1	–	–	–	25
–	–	HCB7205-C-T-P4S	0,113	25	52	15	1	1	–	–	–	15
–	–	HCB7205-E-T-P4S	0,113	25	52	15	1	1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

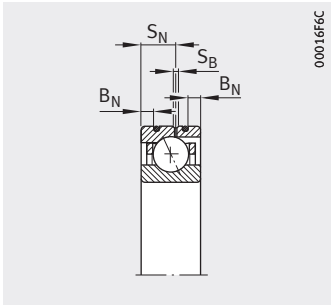
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7005-C-2RSD-T-P4S-UL and HSS7005-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

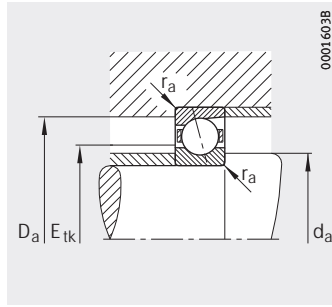
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

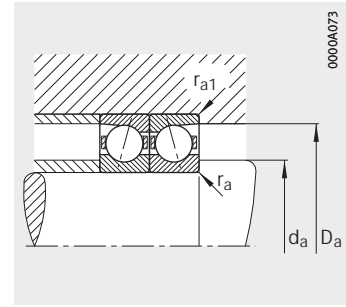
⁶⁾ Ordering examples for Direct Lube design: HCB7005-EDLR-T-P4S-UL and HC7005-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



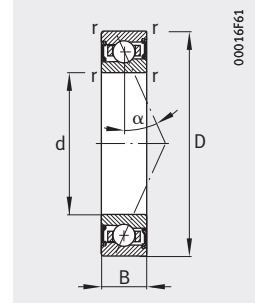
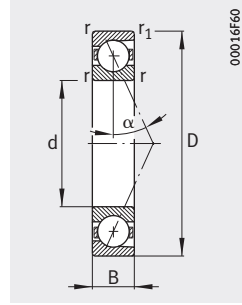
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
29	38,5	0,3	0,3	31,8	8,3	4,05	36 000	56 000	33	124	258	102	418	934	24,9	45,4	66,3
29	38,5	0,3	0,3	31,8	7,9	3,85	32 000	50 000	40	188	426	115	566	1 335	54,1	97,3	136,8
29	38,5	0,3	0,3	31,8	8,3	3,9	50 000	75 000	13	63	142	39	199	475	19,4	36,6	53,4
29	38,5	0,3	0,3	31,8	7,9	3,7	45 000	67 000	21	105	243	60	310	735	48,7	87,4	120,9
29	38,5	0,3	0,3	31,8	7,4	3,4	43 000	63 000	36	109	218	107	333	689	36,5	56,1	75,2
29	38,5	0,3	0,3	32,2	3,9	2,06	48 000	75 000	14	43	85	43	135	282	17	26,8	36,9
29	38,5	0,3	0,3	32,2	3,65	1,95	43 000	67 000	23	69	138	66	204	416	42,2	63,1	82,4
29	38,5	0,3	0,3	32,2	3,65	1,87	56 000	85 000	16	47	95	45	138	281	41,8	61,9	80,1
29	38,5	0,3	0,3	32,2	5,6	1,87	63 000	95 000	16	47	95	45	138	281	41,8	61,9	80,1
30	42	0,6	0,3	33,5	14,3	6,5	34 000	50 000	74	249	507	226	831	1 807	29,6	51,2	73,54
30	42	0,6	0,3	33,5	13,6	6,2	30 000	45 000	100	383	823	290	1 150	2 560	67,2	111,5	152,7
30	42	0,6	0,3	33,5	14,3	6,2	45 000	70 000	35	133	285	104	419	944	24,6	42,5	60,2
30	42	0,6	0,3	33,5	13,6	5,9	40 000	63 000	41	196	446	117	573	1 338	55,4	96,9	132,8
30	42	0,6	0,3	33,5	13,6	5,8	38 000	60 000	65	195	390	192	597	1 234	42,5	65,4	87,7
30	42	0,6	0,3	34,3	5,8	2,95	45 000	70 000	21	63	127	64	201	419	20,6	32,7	45
30	42	0,6	0,3	34,3	5,5	2,8	40 000	63 000	35	104	207	100	306	626	51,2	76,7	100,4
30	42	0,6	0,3	34,3	5,5	2,65	53 000	80 000	23	70	140	67	204	415	50,4	74,7	96,7
30	42	0,6	0,3	34,3	8,4	2,65	56 000	90 000	23	70	140	67	204	415	50,4	74,7	96,7
31,5	45,5	1	1	36,5	18,3	9,2	28 000	43 000	80	265	531	248	906	1 949	30,4	53,4	77
31,5	45,5	1	1	36,5	17,5	8,8	26 000	40 000	114	425	907	333	1 293	2 868	69,2	115,2	158,8
31,5	45,5	1	1	36,5	18,3	8,8	36 000	53 000	39	145	306	117	465	1 042	25,3	44,1	63,1
31,5	45,5	1	1	36,5	17,5	8,5	32 000	48 000	49	220	495	140	650	1 504	57,6	99,8	125

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions							Contact angle α °	
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N		S _B
B71906-C-T-P4S	–	–	0,05	30	47	9	0,3	0,3	–	–	–	15
B71906-E-T-P4S	–	–	0,05	30	47	9	0,3	0,3	–	–	–	25
HCB71906-C-T-P4S	–	–	0,045	30	47	9	0,3	0,3	1,1	5,3	1,4	15
HCB71906-E-T-P4S	–	–	0,045	30	47	9	0,3	0,3	1,1	5,3	1,4	25
RS71906-D-T-P4S	–	–	0,055	30	47	9	0,3	0,3	–	–	–	20
HCRS71906-D-T-P4S	–	–	0,045	30	47	9	0,3	0,3	1,1	5,3	1,4	20
HS71906-C-T-P4S	–	–	0,05	30	47	9	0,3	–	–	–	–	15
HS71906-E-T-P4S	–	–	0,05	30	47	9	0,3	–	–	–	–	25
HC71906-E-T-P4S	–	–	0,054	30	47	9	0,3	–	1,1	5,3	1,4	25
XC71906-E-T-P4S	–	–	0,054	30	47	9	0,3	–	1,1	5,3	1,4	25
–	B7006-C-T-P4S	–	0,108	30	55	13	1	1	–	–	–	15
–	B7006-E-T-P4S	–	0,108	30	55	13	1	1	–	–	–	25
–	HCB7006-C-T-P4S	–	0,103	30	55	13	1	1	2,8	7,2	1,4	15
–	HCB7006-E-T-P4S	–	0,102	30	55	13	1	1	2,8	7,2	1,4	25
–	RS7006-D-T-P4S	–	0,115	30	55	13	1	1	–	–	–	20
–	HCRS7006-D-T-P4S	–	0,115	30	55	13	1	1	2,8	7,2	1,4	20
–	HS7006-C-T-P4S	–	0,124	30	55	13	1	–	–	–	–	15
–	HS7006-E-T-P4S	–	0,124	30	55	13	1	–	–	–	–	25
–	HC7006-E-T-P4S	–	0,133	30	55	13	1	–	2,8	7,2	1,4	25
–	XC7006-E-T-P4S	–	0,133	30	55	13	1	–	2,8	7,2	1,4	25
–	–	B7206-C-T-P4S	0,202	30	62	16	1	1	–	–	–	15
–	–	B7206-E-T-P4S	0,201	30	62	16	1	1	–	–	–	25
–	–	HCB7206-C-T-P4S	0,171	30	62	16	1	1	–	–	–	15
–	–	HCB7206-E-T-P4S	0,171	30	62	16	1	1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

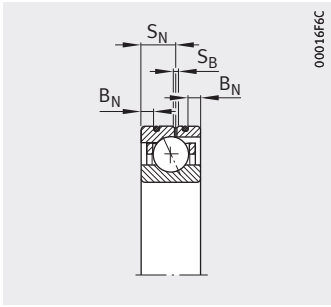
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7006-C-2RSD-T-P4S-UL and HSS7006-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

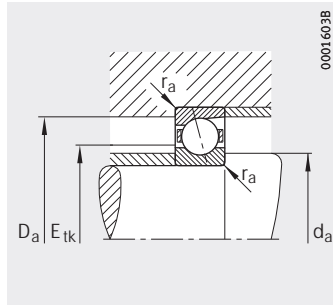
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

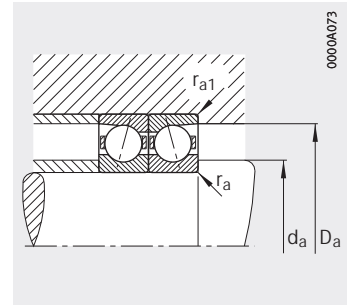
⁶⁾ Ordering examples for Direct Lube design: HCB7006-EDLR-T-P4S-UL and HC7006-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



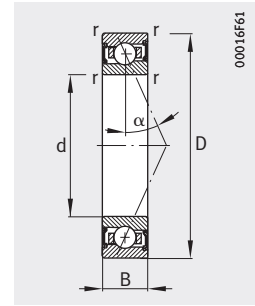
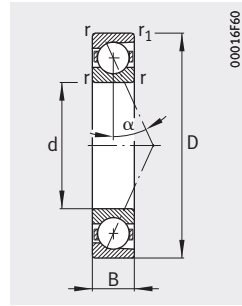
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a	D _a	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _v			K _{aE}			c _a		
h12	H12	max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H
									N	N	N	N	N	N	N/μm	N/μm	N/μm
34	43,5	0,3	0,3	36,8	8,8	4,65	30 000	48 000	34	131	274	106	439	985	27	49,3	72,1
34	43,5	0,3	0,3	36,8	8,4	4,4	28 000	43 000	39	193	441	114	580	1 377	58	105,2	147,9
34	43,5	0,3	0,3	36,8	8,8	4,45	43 000	67 000	14	67	151	40	210	504	21,1	40	58,3
34	43,5	0,3	0,3	36,8	8,4	4,25	38 000	60 000	21	109	254	60	322	768	52,5	95,1	131,7
34	43,5	0,3	0,3	36,8	7,9	3,9	36 000	56 000	39	116	232	114	353	730	40,1	61,4	82,2
34	43,5	0,3	0,3	36,8	7,9	3,7	45 000	70 000	27	80	160	77	238	489	39,4	59,4	65,8
34	43,5	0,3	0,3	36,75	5,9	3,1	43 000	63 000	21	64	129	65	204	425	21,3	33,8	46,5
34	43,5	0,3	0,3	36,75	5,6	2,95	38 000	60 000	35	104	207	100	306	625	52,9	79,1	103,4
34	43,5	0,3	0,3	36,75	5,6	2,85	48 000	75 000	24	72	143	69	209	425	52,5	77,7	100,6
34	43,5	0,3	0,3	36,75	8,5	2,85	53 000	85 000	24	72	143	69	209	425	52,5	77,7	100,6
36	49	1	0,3	40,4	15,4	7,3	28 000	43 000	74	252	511	228	848	1 844	32,4	56,7	81,79
36	49	1	0,3	40,4	14,6	7	24 000	38 000	101	394	850	294	1 188	2 661	73,5	123,2	169,7
36	49	1	0,3	40,4	15,4	7	38 000	60 000	35	136	291	104	431	976	26,9	47	67,1
36	49	1	0,3	40,4	14,6	6,7	34 000	53 000	41	201	463	117	592	1 395	60,1	106,9	147,3
36	49	1	0,3	40,4	14,3	6,5	32 000	50 000	68	205	410	201	625	1 293	45,3	69,6	93,4
36	49	1	0,3	40,4	14,3	6,3	40 000	63 000	46	139	278	135	416	855	44,4	66,9	88,4
36	49	1	0,3	40,5	8,2	4,25	38 000	56 000	29	88	177	89	280	584	24,4	38,7	53,2
36	49	1	0,3	40,5	7,8	4,05	34 000	53 000	48	143	286	138	423	865	60,6	90,6	118,6
36	49	1	0,3	40,5	7,8	3,85	43 000	67 000	33	98	197	94	287	583	60	88,8	115
36	49	1	0,3	40,5	12	3,85	48 000	75 000	33	98	197	94	287	583	60	88,8	115
37,5	54,5	1	1	43,7	28,5	14,7	24 000	38 000	123	404	806	385	1 375	2 945	39,6	68,8	98,9
37,5	54,5	1	1	43,7	27	14,1	22 000	36 000	177	641	1 355	518	1 946	4 271	90,4	148,3	203,3
37,5	54,5	1	1	43,7	28,5	14,1	30 000	45 000	62	222	465	185	711	1 576	33,3	57,1	81,1
37,5	54,5	1	1	43,7	27	13,5	26 000	40 000	80	339	749	231	1 001	2 273	76,8	129,7	163,6

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions							Contact angle α °	
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N		S _B
							min.					
B71907-C-T-P4S	–	–	0,077	35	55	10	0,6	0,6	–	–	–	15
B71907-E-T-P4S	–	–	0,077	35	55	10	0,6	0,6	–	–	–	25
HCB71907-C-T-P4S	–	–	0,067	35	55	10	0,6	0,6	1,6	5,8	1,4	15
HCB71907-E-T-P4S	–	–	0,067	35	55	10	0,6	0,6	1,6	5,8	1,4	25
RS71907-D-T-P4S	–	–	0,08	35	55	10	0,6	0,6	–	–	–	20
HCRS71907-D-T-P4S	–	–	0,068	35	55	10	0,6	0,6	1,6	5,8	1,4	20
HS71907-C-T-P4S	–	–	0,081	35	55	10	0,6	–	–	–	–	15
HS71907-E-T-P4S	–	–	0,081	35	55	10	0,6	–	–	–	–	25
HC71907-E-T-P4S	–	–	0,086	35	55	10	0,6	–	1,6	5,8	1,4	25
XC71907-E-T-P4S	–	–	0,086	35	55	10	0,6	–	–	–	–	25
–	B7007-C-T-P4S	–	0,153	35	62	14	1	1	–	–	–	15
–	B7007-E-T-P4S	–	0,152	35	62	14	1	1	–	–	–	25
–	HCB7007-C-T-P4S	–	0,135	35	62	14	1	1	2,8	8	1,4	15
–	HCB7007-E-T-P4S	–	0,135	35	62	14	1	1	2,8	8	1,4	25
–	RS7007-D-T-P4S	–	0,155	35	62	14	1	1	–	–	–	20
–	HCRS7007-D-T-P4S	–	0,155	35	62	14	1	1	2,8	8	1,4	20
–	HS7007-C-T-P4S	–	0,169	35	62	14	1	–	–	–	–	15
–	HS7007-E-T-P4S	–	0,169	35	62	14	1	–	–	–	–	25
–	HC7007-E-T-P4S	–	0,178	35	62	14	1	–	2,8	8	1,4	25
–	XC7007-E-T-P4S	–	0,178	35	62	14	1	–	2,8	8	1,4	25
–	–	B7207-C-T-P4S	0,301	35	72	17	1,1	1,1	–	–	–	15
–	–	B7207-E-T-P4S	0,3	35	72	17	1,1	1,1	–	–	–	25
–	–	HCB7207-C-T-P4S	0,265	35	72	17	1,1	1,1	–	–	–	15
–	–	HCB7207-E-T-P4S	0,264	35	72	17	1,1	1,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

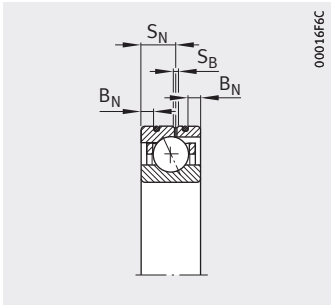
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7007-C-2RSD-T-P4S-UL and HSS7007-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

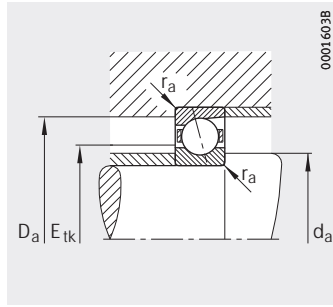
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

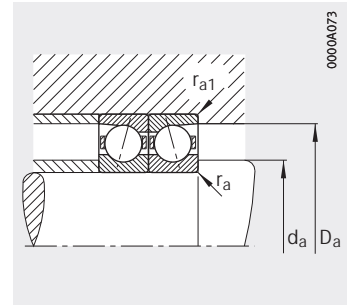
⁶⁾ Ordering examples for Direct Lube design: HCB7007-EDLR-T-P4S-UL and HC7007-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



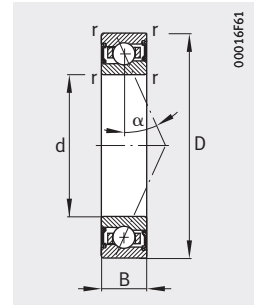
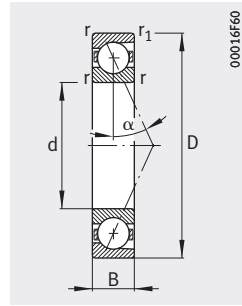
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a max.	r _{a1} nom.	E _{tk}	dyn. C _r kN	stat. C _{0r} kN	n _G grease min ⁻¹	n _G oil ⁵⁾ min ⁻¹	F _V			K _{aE}			C _a		
									L N	M N	H N	L N	M N	H N	L N/μm	M N/μm	H N/μm
40	51,5	0,6	0,6	44	12,1	6,8	26 000	40 000	50	185	384	155	619	1 377	33,5	60,2	87,5
40	51,5	0,6	0,6	44	11,5	6,5	24 000	36 000	60	273	613	174	820	1 910	72,9	128,5	179,3
40	51,5	0,6	0,6	44	12,1	6,5	36 000	56 000	21	96	213	63	301	709	26,7	49,1	71
40	51,5	0,6	0,6	44	11,5	6,2	32 000	50 000	33	158	359	95	463	1 081	66,7	117	160,7
40	51,5	0,6	0,6	44	11,3	6,1	30 000	48 000	52	156	311	153	474	980	49	75,2	100,7
40	51,5	0,6	0,6	44	11,3	5,8	38 000	60 000	36	109	218	106	326	670	48,5	73,2	82,7
40	51,5	0,6	0,6	43,3	6,4	3,8	36 000	56 000	23	70	140	70	220	459	24,5	38,6	53
40	51,5	0,6	0,6	43,3	6,1	3,6	32 000	50 000	38	113	226	109	333	680	61	91,1	119
40	51,5	0,6	0,6	43,3	6,1	3,45	40 000	63 000	26	78	155	74	226	459	60,5	89,4	115,6
40	51,5	0,6	0,6	43,3	9,3	3,45	45 000	70 000	26	78	155	74	226	459	60,5	89,4	115,6
41	56	1	0,3	45,6	19	9,6	24 000	38 000	96	324	656	296	1 087	2 357	38,3	66,6	95,76
41	56	1	0,3	45,6	18,1	9,2	22 000	34 000	135	514	1 102	394	1 551	3 446	87,9	145,9	200,3
41	56	1	0,3	45,6	19	9,2	34 000	53 000	47	176	375	138	558	1 255	32	55,5	78,9
41	56	1	0,3	45,6	18,1	8,8	30 000	45 000	55	259	588	157	761	1 771	72,1	125,9	172,6
41	56	1	0,3	45,6	18,1	8,7	28 000	43 000	85	254	508	249	776	1 605	53,8	82,7	111
41	56	1	0,3	45,6	18,1	8,7	36 000	56 000	59	176	352	171	527	1 083	53	80,1	105,8
41	56	1	0,3	46,5	8,9	5	34 000	50 000	31	93	187	94	295	614	27,1	42,8	58,8
41	56	1	0,3	46,5	8,4	4,7	30 000	45 000	51	152	304	146	448	915	67,7	101,1	132,1
41	56	1	0,3	46,5	8,4	4,5	38 000	60 000	35	105	210	101	307	623	67,3	99,5	128,7
41	56	1	0,3	46,5	12,8	4,5	43 000	67 000	35	105	210	101	307	623	67,3	99,5	128,7
44	63	1	1	50,7	31,5	17,9	20 000	34 000	134	443	887	418	1 500	3 223	44,8	77,8	111,8
44	63	1	1	50,7	30	17,1	19 000	32 000	195	710	1 504	570	2 152	4 730	103,2	169,4	232,2
44	63	1	1	50,7	31,5	17,2	26 000	40 000	67	243	510	200	774	1 720	37,7	64,7	91,8
44	63	1	1	50,7	30	16,4	22 000	36 000	84	363	806	242	1 069	2 438	86,2	146,4	184,1

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
B71908-C-T-P4S	–	–	0,1	40	62	12	0,6	0,6	–	–	–	15
B71908-E-T-P4S	–	–	0,099	40	62	12	0,6	0,6	–	–	–	25
HCB71908-C-T-P4S	–	–	0,092	40	62	12	0,6	0,6	2,2	6,6	1,4	15
HCB71908-E-T-P4S	–	–	0,092	40	62	12	0,6	0,6	2,2	6,6	1,4	25
RS71908-D-T-P4S	–	–	0,105	40	62	12	0,6	0,6	–	–	–	20
HCRS71908-D-T-P4S	–	–	0,09	40	62	12	0,6	0,6	2,2	6,6	1,4	20
HS71908-C-T-P4S	–	–	0,125	40	62	12	0,6	–	–	–	–	15
HS71908-E-T-P4S	–	–	0,125	40	62	12	0,6	–	–	–	–	25
HC71908-E-T-P4S	–	–	0,129	40	62	12	0,6	–	2,2	6,6	1,4	25
XC71908-E-T-P4S	–	–	0,129	40	62	12	0,6	–	2,2	6,6	1,4	25
–	B7008-C-T-P4S	–	0,188	40	68	15	1	1	–	–	–	15
–	B7008-E-T-P4S	–	0,188	40	68	15	1	1	–	–	–	25
–	HCB7008-C-T-P4S	–	0,168	40	68	15	1	1	2,8	8,5	1,4	15
–	HCB7008-E-T-P4S	–	0,168	40	68	15	1	1	2,8	8,5	1,4	25
–	RS7008-D-T-P4S	–	0,19	40	68	15	1	1	–	–	–	20
–	HCRS7008-D-T-P4S	–	0,19	40	68	15	1	1	2,8	8,5	1,4	20
–	HS7008-C-T-P4S	–	0,211	40	68	15	1	–	–	–	–	15
–	HS7008-E-T-P4S	–	0,211	40	68	15	1	–	–	–	–	25
–	HC7008-E-T-P4S	–	0,221	40	68	15	1	–	2,8	8,5	1,4	25
–	XC7008-E-T-P4S	–	0,221	40	68	15	1	–	2,8	8,5	1,4	25
–	–	B7208-C-T-P4S	0,372	40	80	18	1,1	1,1	–	–	–	15
–	–	B7208-E-T-P4S	0,371	40	80	18	1,1	1,1	–	–	–	25
–	–	HCB7208-C-T-P4S	0,322	40	80	18	1,1	1,1	–	–	–	15
–	–	HCB7208-E-T-P4S	0,321	40	80	18	1,1	1,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

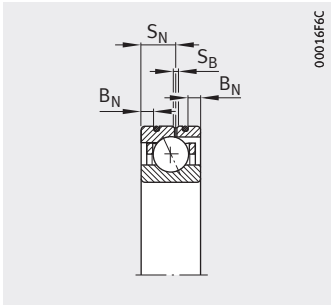
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7008-C-2RSD-T-P4S-UL and HSS7008-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

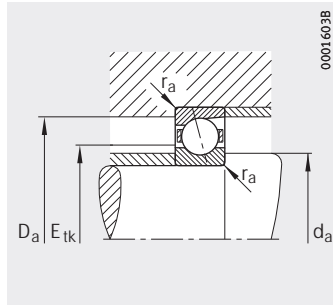
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

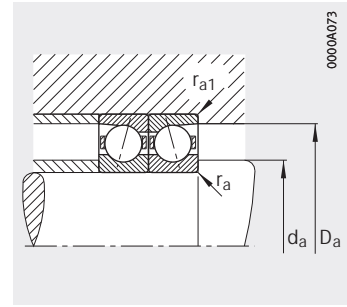
⁶⁾ Ordering examples for Direct Lube design: HCB7008-EDLR-T-P4S-UL and HC7008-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



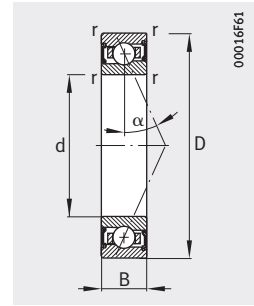
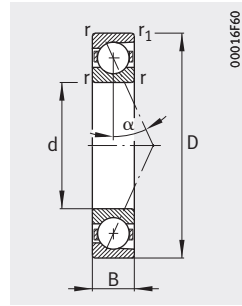
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
45	58,5	0,6	0,6	49,1	18	9,9	24 000	36 000	84	292	594	259	979	2 140	40,7	71,6	103,4
45	58,5	0,6	0,6	49,1	17,1	9,4	20 000	32 000	111	447	974	324	1 348	3 043	91,3	154,5	213,4
45	58,5	0,6	0,6	49,1	18	9,4	32 000	50 000	39	156	337	116	494	1 127	33,5	59,2	84,7
45	58,5	0,6	0,6	49,1	17,1	9	28 000	45 000	41	220	514	117	645	1 548	72,4	132,2	183,2
45	58,5	0,6	0,6	49,1	16,7	8,7	26 000	40 000	79	236	472	232	720	1 489	57,2	87,7	117,6
45	58,5	0,6	0,6	49,1	16,7	8,4	34 000	53 000	54	161	322	156	481	988	56	84,4	98,9
45	58,5	0,6	0,6	49,3	6,8	4,3	32 000	48 000	24	72	145	72	227	473	26,6	41,8	57,2
45	58,5	0,6	0,6	49,3	6,4	4,05	28 000	43 000	39	117	235	113	345	704	66,6	99,2	129,3
45	58,5	0,6	0,6	49,3	6,4	3,9	36 000	56 000	27	82	164	78	238	484	66,4	98	126,6
45	58,5	0,6	0,6	49,3	9,7	3,9	40 000	63 000	27	82	164	78	238	484	66,4	98	126,6
46	62	1	0,3	50,8	20,9	11,2	22 000	34 000	101	344	698	312	1 157	2 515	43,2	75,6	108,9
46	62	1	0,3	50,8	19,9	10,6	20 000	30 000	141	543	1 170	410	1 640	3 663	98,6	164,8	226,8
46	62	1	0,3	50,8	25,5	10,7	30 000	45 000	49	188	402	146	597	1 350	36,1	63,1	89,9
46	62	1	0,3	50,8	24,4	10,2	28 000	43 000	55	271	622	159	797	1 875	80	141,7	195,1
46	62	1	0,3	50,8	19,5	10,1	26 000	40 000	91	273	546	268	833	1 721	59,8	91,7	122,9
46	62	1	0,3	50,8	19,5	10,1	32 000	50 000	64	191	382	185	571	1 173	59,1	89,2	117,8
46	62	1	0,3	52	9,4	5,7	30 000	45 000	34	101	201	100	316	659	30,1	47,4	64,9
46	62	1	0,3	52	8,9	5,4	26 000	40 000	53	160	321	154	472	964	74,7	111,4	145,4
46	62	1	0,3	52	8,9	5,2	34 000	53 000	37	110	221	106	321	652	74,2	109,5	141,5
46	62	1	0,3	52	13,7	5,2	38 000	60 000	37	110	221	106	321	652	74,2	109,5	141,5
48	72	1	1	56,7	32,5	16,1	18 000	30 000	175	566	1 128	544	1 920	4 102	49,2	84,7	121,5
48	72	1	1	56,7	31	15,4	17 000	28 000	257	906	1 903	750	2 748	5 985	113,5	184,3	251,6
48	72	1	1	56,7	32,5	15,4	24 000	38 000	89	312	650	266	996	2 193	41,6	70,6	99,8
48	72	1	1	56,7	31	14,7	20 000	34 000	121	485	1 059	347	1 432	3 208	97,6	162,1	205,4

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions							Contact angle α °	
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N		S _B
B71909-C-T-P4S	–	–	0,117	45	68	12	0,6	0,6	–	–	–	15
B71909-E-T-P4S	–	–	0,116	45	68	12	0,6	0,6	–	–	–	25
HCB71909-C-T-P4S	–	–	0,109	45	68	12	0,6	0,6	2,2	6,6	1,4	15
HCB71909-E-T-P4S	–	–	0,108	45	68	12	0,6	0,6	2,2	6,6	1,4	25
RS71909-D-T-P4S	–	–	0,12	45	68	12	0,6	0,6	–	–	–	20
HCRS71909-D-T-P4S	–	–	0,11	45	68	12	0,6	0,6	2,2	6,6	1,4	20
HS71909-C-T-P4S	–	–	0,136	45	68	12	0,6	–	–	–	–	15
HS71909-E-T-P4S	–	–	0,136	45	68	12	0,6	–	–	–	–	25
HC71909-E-T-P4S	–	–	0,14	45	68	12	0,6	–	2,2	6,6	1,4	25
XC71909-E-T-P4S	–	–	0,14	45	68	12	0,6	–	2,2	6,6	1,4	25
–	B7009-C-T-P4S	–	0,238	45	75	16	1	1	–	–	–	15
–	B7009-E-T-P4S	–	0,237	45	75	16	1	1	–	–	–	25
–	HCB7009-C-T-P4S	–	0,197	45	75	16	1	1	3,4	9,3	1,4	15
–	HCB7009-E-T-P4S	–	0,197	45	75	16	1	1	3,4	9,3	1,4	25
–	RS7009-D-T-P4S	–	0,24	45	75	16	1	1	–	–	–	20
–	HCRS7009-D-T-P4S	–	0,24	45	75	16	1	1	–	–	–	20
–	HS7009-C-T-P4S	–	0,262	45	75	16	1	–	–	–	–	15
–	HS7009-E-T-P4S	–	0,261	45	75	16	1	–	–	–	–	25
–	HC7009-E-T-P4S	–	0,277	45	75	16	1	–	3,4	9,3	1,4	25
–	XC7009-E-T-P4S	–	0,277	45	75	16	1	–	3,4	9,3	1,4	25
–	–	B7209-C-T-P4S	0,423	45	85	19	1,1	1,1	–	–	–	15
–	–	B7209-E-T-P4S	0,422	45	85	19	1,1	1,1	–	–	–	25
–	–	HCB7209-C-T-P4S	0,37	45	85	19	1,1	1,1	–	–	–	15
–	–	HCB7209-E-T-P4S	0,369	45	85	19	1,1	1,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

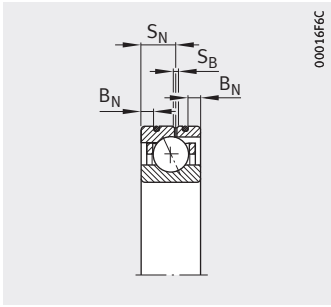
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7009-C-2RSD-T-P4S-UL and HSS7009-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

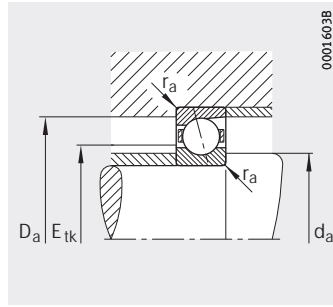
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

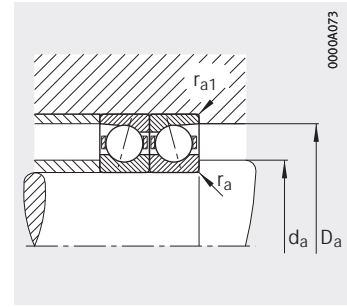
⁶⁾ Ordering examples for Direct Lube design: HCB7009-EDLR-T-P4S-UL and HC7009-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



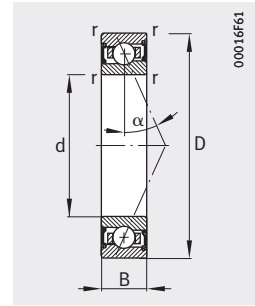
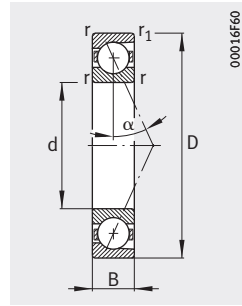
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾ F _v			Lift-off force ⁴⁾ K _{aE}			Axial rigidity ⁴⁾ c _a		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.	nom.		kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
50	63,5	0,6	0,6	54,5	19,1	11,2	20 000	32 000	88	307	628	270	1 027	2 251	44	77,5	111,8
50	63,5	0,6	0,6	54,5	18,2	10,6	19 000	28 000	116	470	1 028	336	1 415	3 203	99	168	231,9
50	63,5	0,6	0,6	54,5	19,1	10,7	28 000	45 000	40	164	355	120	516	1 182	36,2	64,1	91,7
50	63,5	0,6	0,6	54,5	18,2	10,2	26 000	40 000	42	233	547	121	682	1 643	78,5	144,2	200
50	63,5	0,6	0,6	54,5	17,7	9,9	24 000	38 000	82	246	491	241	748	1 544	62	94,9	126,9
50	63,5	0,6	0,6	54,5	17,7	9,5	32 000	48 000	57	171	341	165	509	1 044	61,1	92,1	107,4
50	63,5	0,6	0,6	54,5	9,6	6	28 000	43 000	34	101	201	100	316	657	30,8	48,4	66,2
50	63,5	0,6	0,6	54,5	9,1	5,6	26 000	40 000	55	164	328	158	482	984	77,2	115	150
50	63,5	0,6	0,6	54,5	9,1	5,4	32 000	50 000	38	113	226	108	329	667	76,6	113,1	146,1
50	63,5	0,6	0,6	54,5	13,9	5,4	36 000	56 000	38	113	226	108	329	667	76,6	113,1	146,1
51	69	1	0,3	56,2	28	14,9	19 000	30 000	144	476	958	445	1 606	3 461	49,8	86,3	123,91
51	69	1	0,3	56,2	26,5	14,2	17 000	26 000	208	763	1 622	606	2 308	5 082	115	188,9	258,7
51	69	1	0,3	56,2	28	14,3	26 000	40 000	71	261	549	212	827	1 843	41,9	71,9	101,9
51	69	1	0,3	56,2	26,5	13,6	24 000	38 000	89	389	869	254	1 145	2 622	95,8	163,4	223
51	69	1	0,3	56,2	26,5	13,7	22 000	36 000	123	369	737	361	1 124	2 323	67,4	103,4	138,6
51	69	1	0,3	56,2	26,5	13,7	30 000	45 000	85	254	508	246	758	1 557	66,3	100	131,9
51	69	1	0,3	57,7	12,3	7,5	26 000	40 000	43	130	259	130	409	853	34,3	54,1	74,3
51	69	1	0,3	57,7	11,6	7,1	24 000	36 000	70	210	421	203	621	1 269	85,4	127,6	166,7
51	69	1	0,3	57,7	11,6	6,8	30 000	48 000	48	143	286	137	417	848	84,4	124,7	161,3
51	69	1	0,3	57,7	17,8	6,8	34 000	53 000	48	143	286	137	417	848	84,4	124,7	161,3
52,5	78	1	1	61,8	34	17,7	17 000	28 000	182	592	1 182	567	2 003	4 286	52,2	90	128,9
52,5	78	1	1	61,8	32,5	16,9	15 000	24 000	268	948	1 994	782	2 873	6 261	120,8	196,1	267,8
52,5	78	1	1	61,8	34	17	22 000	36 000	93	329	685	279	1 047	2 307	44,4	75,3	106,4
52,5	78	1	1	61,8	32,5	16,2	18 000	30 000	123	500	1 095	354	1 475	3 312	103,2	171,7	217,2

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
B71910-C-T-P4S	–	–	0,117	50	72	12	0,6	0,6	–	–	–	15
B71910-E-T-P4S	–	–	0,083	50	72	12	0,6	0,6	–	–	–	25
HCB71910-C-T-P4S	–	–	0,108	50	72	12	0,6	0,6	2,2	6,6	1,4	15
HCB71910-E-T-P4S	–	–	0,108	50	72	12	0,6	0,6	2,2	6,6	1,4	25
RS71910-D-T-P4S	–	–	0,13	50	72	12	0,6	0,6	–	–	–	20
HCRS71910-D-T-P4S	–	–	0,115	50	72	12	0,6	0,6	2,2	6,6	1,4	20
HS71910-C-T-P4S	–	–	0,138	50	72	12	0,6	–	–	–	–	15
HS71910-E-T-P4S	–	–	0,138	50	72	12	0,6	–	–	–	–	25
HC71910-E-T-P4S	–	–	0,143	50	72	12	0,6	–	2,2	6,6	1,4	25
XC71910-E-T-P4S	–	–	0,143	50	72	12	0,6	–	2,2	6,6	1,4	25
–	B7010-C-T-P4S	–	0,257	50	80	16	1	1	–	–	–	15
–	B7010-E-T-P4S	–	0,256	50	80	16	1	1	–	–	–	25
–	HCB7010-C-T-P4S	–	0,214	50	80	16	1	1	3,4	9,3	1,4	15
–	HCB7010-E-T-P4S	–	0,213	50	80	16	1	1	3,4	9,3	1,4	25
–	RS7010-D-T-P4S	–	0,25	50	80	16	1	1	–	–	–	20
–	HCRS7010-D-T-P4S	–	0,25	50	80	16	1	1	3,4	9,3	1,4	20
–	HS7010-C-T-P4S	–	0,283	50	80	16	1	–	–	–	–	15
–	HS7010-E-T-P4S	–	0,282	50	80	16	1	–	–	–	–	25
–	HC7010-E-T-P4S	–	0,3	50	80	16	1	–	3,4	9,3	1,4	25
–	XC7010-E-T-P4S	–	0,3	50	80	16	1	–	3,4	9,3	1,4	25
–	–	B7210-C-T-P4S	0,448	50	90	20	1,1	1,1	–	–	–	15
–	–	B7210-E-T-P4S	0,446	50	90	20	1,1	1,1	–	–	–	25
–	–	HCB7210-C-T-P4S	0,384	50	90	20	1,1	1,1	–	–	–	15
–	–	HCB7210-E-T-P4S	0,382	50	90	20	1,1	1,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

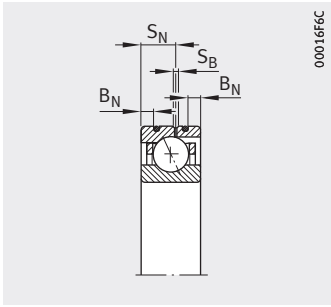
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7010-C-2RSD-T-P4S-UL and HSS7010-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

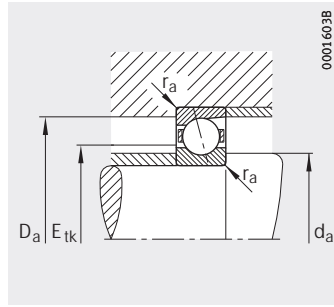
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

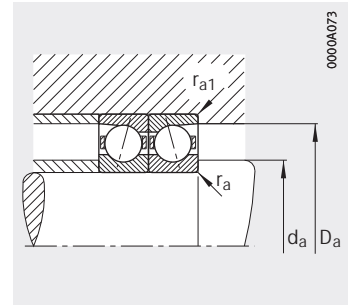
⁶⁾ Ordering examples for Direct Lube design: HCB7010-EDLR-T-P4S-UL and HC7010-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



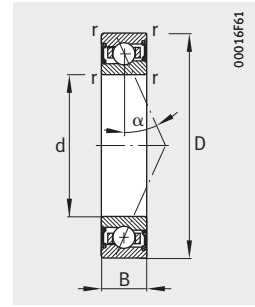
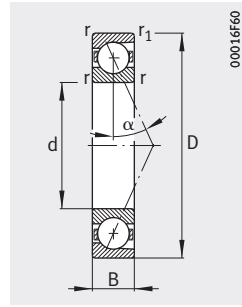
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾ F _V			Lift-off force ⁴⁾ K _{aE}			Axial rigidity ⁴⁾ c _a		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
55	67,5	0,6	0,6	58,9	19,6	11,9	19 000	30 000	89	313	642	274	1 044	2 293	45,6	80,2	115,7
55	67,5	0,6	0,6	58,9	18,6	11,3	17 000	26 000	117	479	1 049	340	1 439	3 263	102,5	174,3	240,5
55	67,5	0,6	0,6	58,9	19,6	11,4	26 000	40 000	41	167	362	121	525	1 205	37,5	66,4	95
55	67,5	0,6	0,6	58,9	18,6	10,8	24 000	36 000	40	229	542	115	671	1 626	79,7	147,9	205,3
55	67,5	0,6	0,6	58,9	18,1	10,5	22 000	34 000	85	254	508	249	772	1 594	64,7	99	132,4
55	67,5	0,6	0,6	58,9	18,1	10,1	28 000	45 000	58	173	347	168	516	1 059	63,4	95,5	111
55	67,5	0,6	0,6	59	9,9	6,5	26 000	40 000	35	105	209	104	328	682	32,6	51,2	70
55	67,5	0,6	0,6	59	9,4	6,1	24 000	36 000	56	169	338	163	497	1 014	81,7	121,7	158,6
55	67,5	0,6	0,6	59	9,4	5,8	30 000	48 000	39	116	231	110	336	682	80,9	119,4	154,1
55	67,5	0,6	0,6	59	14,3	5,8	34 000	53 000	39	116	231	110	336	682	80,9	119,4	154,1
56	74	1	0,3	61,2	29	16,1	18 000	28 000	148	493	994	459	1 659	3 579	52,3	90,5	129,93
56	74	1	0,3	61,2	27,5	15,3	16 000	24 000	209	774	1 648	610	2 336	5 151	119,8	197	269,6
56	74	1	0,3	61,2	29	15,4	24 000	38 000	73	268	566	217	848	1 894	43,9	75,3	106,6
56	74	1	0,3	61,2	27,5	14,7	22 000	34 000	90	400	895	259	1 175	2 697	100,2	171,4	234
56	74	1	0,3	61,2	27,5	14,8	20 000	32 000	127	382	764	375	1 164	2 406	71	108,8	145,7
56	74	1	0,3	61,2	27,5	14,1	26 000	43 000	88	263	527	255	786	1 614	69,8	105,3	138,8
56	74	1	0,3	62,7	12,8	8,2	24 000	38 000	45	135	269	135	424	884	36,4	57,4	78,8
56	74	1	0,3	62,7	12,1	7,7	22 000	34 000	72	216	431	208	635	1 297	90,6	135,1	176,3
56	74	1	0,3	62,7	12,1	7,4	28 000	43 000	50	149	298	143	435	883	90	132,9	171,9
56	74	1	0,3	62,7	18,4	7,4	32 000	48 000	50	149	298	143	435	883	90	132,9	171,9
57	83	1	1	66,2	43	22,4	16 000	26 000	240	771	1 534	746	2 606	5 556	59,9	102,6	146,8
57	83	1	1	66,2	41	21,4	14 000	22 000	352	1 221	2 553	1 027	3 697	8 006	138,3	222,9	303,3
57	83	1	1	66,2	43	21,4	20 000	34 000	126	434	898	377	1 383	3 027	51,4	86,5	121,8
57	83	1	1	66,2	41	20,4	17 000	28 000	168	656	1 420	484	1 933	4 292	119,9	196,5	249,7

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
B71911-C-T-P4S	–	–	0,174	55	80	13	1	1	–	–	–	15
B71911-E-T-P4S	–	–	0,173	55	80	13	1	1	–	–	–	25
HCB71911-C-T-P4S	–	–	0,15	55	80	13	1	1	2,8	7,2	1,4	15
HCB71911-E-T-P4S	–	–	0,149	55	80	13	1	1	2,8	7,2	1,4	25
RS71911-D-T-P4S	–	–	0,18	55	80	13	1	1	–	–	–	20
HCRS71911-D-T-P4S	–	–	0,15	55	80	13	1	1	2,8	7,2	1,4	20
HS71911-C-T-P4S	–	–	0,186	55	80	13	1	–	–	–	–	15
HS71911-E-T-P4S	–	–	0,186	55	80	13	1	–	–	–	–	25
HC71911-E-T-P4S	–	–	0,204	55	80	13	1	–	2,8	7,2	1,4	25
XC71911-E-T-P4S	–	–	0,204	55	80	13	1	–	2,8	7,2	1,4	25
–	B7011-C-T-P4S	–	0,377	55	90	18	1,1	1,1	–	–	–	15
–	B7011-E-T-P4S	–	0,376	55	90	18	1,1	1,1	–	–	–	25
–	HCB7011-C-T-P4S	–	0,312	55	90	18	1,1	1,1	4,3	9,7	1,4	15
–	HCB7011-E-T-P4S	–	0,311	55	90	18	1,1	1,1	4,3	9,7	1,4	25
–	RS7011-D-T-P4S	–	0,38	55	90	18	1,1	1,1	–	–	–	20
–	HCRS7011-D-T-P4S	–	0,38	55	90	18	1,1	1,1	4,3	9,7	1,4	20
–	HS7011-C-T-P4S	–	0,405	55	90	18	1,1	–	–	–	–	15
–	HS7011-E-T-P4S	–	0,404	55	90	18	1,1	–	–	–	–	25
–	HC7011-E-T-P4S	–	0,429	55	90	18	1,1	–	4,3	9,7	1,4	25
–	XC7011-E-T-P4S	–	0,429	55	90	18	1,1	–	4,3	9,7	1,4	25
–	–	B7211-C-T-P4S	0,619	55	100	21	1,5	1,5	–	–	–	15
–	–	B7211-E-T-P4S	0,617	55	100	21	1,5	1,5	–	–	–	25
–	–	HCB7211-C-T-P4S	0,546	55	100	21	1,5	1,5	–	–	–	15
–	–	HCB7211-E-T-P4S	0,544	55	100	21	1,5	1,5	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

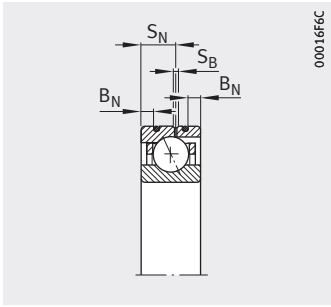
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7011-C-2RSD-T-P4S-UL and HSS7011-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

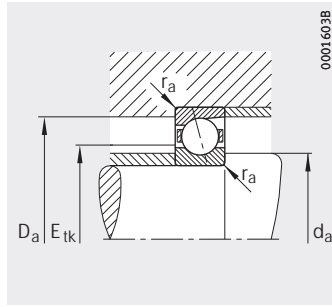
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

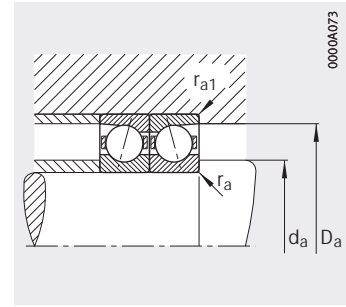
⁶⁾ Ordering examples for Direct Lube design: HCB7011-EDLR-T-P4S-UL and HC7011-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



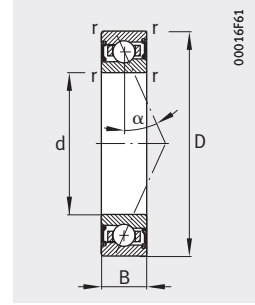
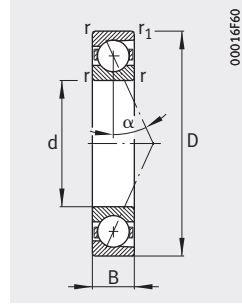
Mounting dimensions



Mounting dimensions					Basic load ratings			Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _v			K _{aE}			c _a			
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H	
									N	N	N	N	N	N	N/μm	N/μm	N/μm	
60	75,5	0,6	0,6	65,1	23,5	14,4	17 000	26 000	111	382	780	340	1 274	2 784	50,8	88,6	127,6	
60	75,5	0,6	0,6	65,1	22,2	13,7	15 000	24 000	149	588	1 278	431	1 768	3 973	115,1	193,3	265,7	
60	75,5	0,6	0,6	65,1	23,5	13,8	24 000	36 000	53	208	447	157	654	1 487	42,4	74,1	105,5	
60	75,5	0,6	0,6	65,1	22,2	13,1	22 000	32 000	57	296	686	164	867	2 058	93	167	230,4	
60	75,5	0,6	0,6	65,1	12,4	6,1	20 000	32 000	102	306	612	299	929	1 917	71,2	108,9	145,5	
60	75,5	0,6	0,6	65,1	21,9	12,5	26 000	40 000	70	209	418	202	622	1 275	69,9	105,1	123,6	
60	75,5	0,6	0,6	65,2	13	8,5	24 000	36 000	45	135	269	135	424	882	37,3	58,6	80,3	
60	75,5	0,6	0,6	65,2	12,3	8	22 000	32 000	73	219	438	211	645	1 317	93,2	139	181,4	
60	75,5	0,6	0,6	65,2	12,3	7,7	28 000	43 000	51	152	304	145	442	897	92,7	136,9	176,9	
60	75,5	0,6	0,6	65,2	18,8	7,7	30 000	48 000	51	152	304	145	442	897	92,7	136,9	176,9	
62	83	1	0,6	68,1	38,5	22,1	16 000	24 000	205	670	1 344	635	2 253	4 837	61,4	105,5	151,07	
62	83	1	0,6	68,1	37	21	14 000	22 000	296	1 059	2 234	862	3 197	6 983	141,7	230,3	314	
62	83	1	0,6	68,1	38,5	21,2	22 000	34 000	102	366	765	305	1 158	2 559	51,9	87,9	124	
62	83	1	0,6	68,1	37	20,1	20 000	30 000	136	562	1 236	390	1 653	3 728	121,2	202,5	274,6	
62	83	1	0,6	68,1	36	19,8	19 000	28 000	171	512	1 024	502	1 558	3 219	82,3	126,1	168,8	
62	83	1	0,6	68,1	36	18,9	24 000	38 000	116	348	696	337	1 038	2 130	80,6	121,4	160	
62	83	1	0,6	69,7	17,9	11,5	22 000	34 000	62	187	374	187	588	1 225	42,2	66,5	91,1	
62	83	1	0,6	69,7	16,9	10,9	20 000	30 000	101	304	607	292	895	1 826	105,6	157,4	205,5	
62	83	1	0,6	69,7	16,9	10,4	26 000	40 000	70	210	421	201	613	1 244	105	155,1	200,5	
62	83	1	0,6	69,7	26	10,4	28 000	43 000	70	210	421	201	613	1 244	105	155,1	200,5	
63	92	1,5	1,5	73,7	47	26,5	14 000	22 000	258	832	1 662	800	2 800	5 985	66,7	114	163	
63	92	1,5	1,5	73,7	45	25	13 000	20 000	378	1 321	2 767	1 103	3 991	8 652	154,6	249,2	338,8	
63	92	1,5	1,5	73,7	47	25	18 000	30 000	132	460	956	395	1 460	3 203	56,9	95,6	134,5	
63	92	1,5	1,5	73,7	45	24	15 000	24 000	180	709	1 540	518	2 088	4 646	133,8	219,9	279	

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
B71912-C-T-P4S	–	–	0,188	60	85	13	1	1	–	–	–	15
B71912-E-T-P4S	–	–	0,187	60	85	13	1	1	–	–	–	25
HCB71912-C-T-P4S	–	–	0,161	60	85	13	1	1	2,8	7,2	1,4	15
HCB71912-E-T-P4S	–	–	0,16	60	85	13	1	1	2,8	7,2	1,4	25
RS71912-D-T-P4S	–	–	0,195	60	85	13	1	1	–	–	–	20
HCRS71912-D-T-P4S	–	–	0,16	60	85	13	1	1	2,8	7,2	1,4	20
HS71912-C-T-P4S	–	–	0,2	60	85	13	1	–	–	–	–	15
HS71912-E-T-P4S	–	–	0,2	60	85	13	1	–	–	–	–	25
HC71912-E-T-P4S	–	–	0,22	60	85	13	1	–	2,8	7,2	1,4	25
XC71912-E-T-P4S	–	–	0,22	60	85	13	1	–	2,8	7,2	1,4	25
–	B7012-C-T-P4S	–	0,401	60	95	18	1,1	1,1	–	–	–	15
–	B7012-E-T-P4S	–	0,4	60	95	18	1,1	1,1	–	–	–	25
–	HCB7012-C-T-P4S	–	0,333	60	95	18	1,1	1,1	4,3	9,7	1,4	15
–	HCB7012-E-T-P4S	–	0,332	60	95	18	1,1	1,1	4,3	9,7	1,4	25
–	RS7012-D-T-P4S	–	0,4	60	95	18	1,1	1,1	–	–	–	20
–	HCRS7012-D-T-P4S	–	0,4	60	95	18	1,1	1,1	4,3	9,7	1,4	20
–	HS7012-C-T-P4S	–	0,433	60	95	18	1,1	–	–	–	–	15
–	HS7012-E-T-P4S	–	0,433	60	95	18	1,1	–	–	–	–	25
–	HC7012-E-T-P4S	–	0,458	60	95	18	1,1	–	4,3	9,7	1,4	25
–	XC7012-E-T-P4S	–	0,458	60	95	18	1,1	–	4,3	9,7	1,4	25
–	–	B7212-C-T-P4S	0,795	60	110	22	1,5	1,5	–	–	–	15
–	–	B7212-E-T-P4S	0,793	60	110	22	1,5	1,5	–	–	–	25
–	–	HCB7212-C-T-P4S	0,687	60	110	22	1,5	1,5	–	–	–	15
–	–	HCB7212-E-T-P4S	0,685	60	110	22	1,5	1,5	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

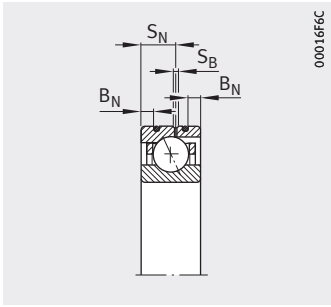
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7012-C-2RSD-T-P4S-UL and HSS7012-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

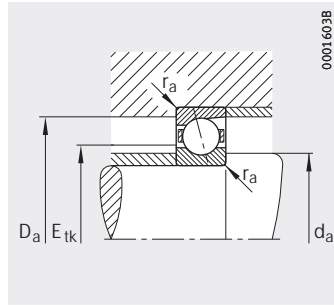
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

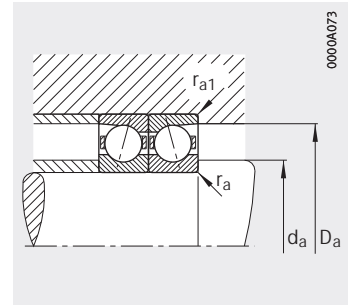
⁶⁾ Ordering examples for Direct Lube design: HCB7012-EDLR-T-P4S-UL and HC7012-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



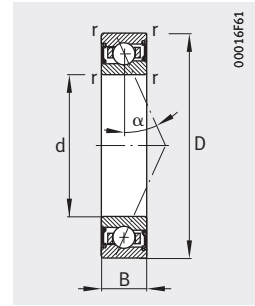
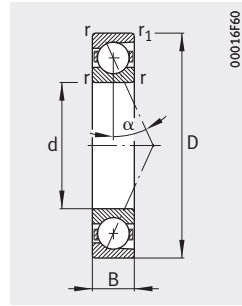
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
65	80,5	0,6	0,6	70,1	24,7	16	16 000	24 000	116	401	822	354	1 333	2 919	54,5	95,1	136,8
65	80,5	0,6	0,6	70,1	23,4	15,2	14 000	22 000	155	617	1 344	448	1 853	4 171	123,7	208,1	286,1
65	80,5	0,6	0,6	70,1	24,7	15,3	22 000	34 000	54	214	462	159	671	1 530	45,1	79	112,4
65	80,5	0,6	0,6	70,1	23,4	14,5	20 000	30 000	57	303	707	163	887	2 118	98,5	178,5	246,4
65	80,5	0,6	0,6	70,1	23,1	14,4	19 000	28 000	106	317	633	310	960	1 980	76,4	116,6	155,5
65	80,5	0,6	0,6	70,1	23,1	13,8	24 000	38 000	74	222	445	215	662	1 357	75,8	113,9	133,6
65	80,5	0,6	0,6	70,2	13,4	9,2	22 000	34 000	47	141	281	140	442	920	39,5	62,1	85
65	80,5	0,6	0,6	70,2	12,6	8,7	20 000	30 000	76	228	455	219	670	1 368	98,8	147,2	192
65	80,5	0,6	0,6	70,2	12,6	8,3	26 000	40 000	52	155	311	148	452	917	97,7	144,2	186,3
65	80,5	0,6	0,6	70,2	19,4	8,3	28 000	43 000	52	155	311	148	452	917	97,7	144,2	186,3
67	88	1	0,6	73,1	40	23,8	15 000	22 000	209	687	1 381	647	2 304	4 952	64	109,9	157,36
67	88	1	0,6	73,1	38	22,6	13 000	20 000	297	1 069	2 259	864	3 221	7 045	147,1	239,2	326
67	88	1	0,6	73,1	40	22,7	20 000	32 000	106	379	794	315	1 198	2 651	54,4	92,2	130
67	88	1	0,6	73,1	38	21,6	19 000	28 000	136	569	1 256	391	1 673	3 782	125,9	210,9	286
67	88	1	0,6	73,1	37	21,2	18 000	26 000	173	519	1 037	508	1 576	3 254	85,8	131,2	175,3
67	88	1	0,6	73,1	37	20,3	22 000	34 000	121	362	723	350	1 078	2 211	84,8	127,6	168,1
67	88	1	0,6	74,7	18,6	12,5	20 000	32 000	65	194	388	194	609	1 269	44,8	70,5	96,4
67	88	1	0,6	74,7	17,6	11,8	18 000	28 000	105	316	631	304	929	1 896	112,3	167,3	218,3
67	88	1	0,6	74,7	17,6	11,3	24 000	36 000	73	219	438	209	638	1 294	111,7	165	213,1
67	88	1	0,6	74,7	27	11,3	26 000	40 000	73	219	438	209	638	1 294	111,7	165	213,1
69,5	101,5	1,5	1,5	81,2	56	31	13 000	20 000	312	996	1 982	968	3 352	7 140	70,9	120,8	172,4
69,5	101,5	1,5	1,5	81,2	53	29,5	12 000	19 000	463	1 586	3 304	1 351	4 794	10 334	164,9	264,1	358,3
69,5	101,5	1,5	1,5	81,2	56	29,5	16 000	26 000	163	557	1 149	488	1 767	3 852	60,9	101,6	142,7
69,5	101,5	1,5	1,5	81,2	53	28,5	14 000	22 000	226	859	1 847	651	2 531	5 576	144	233,8	297,7

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
							min.					
B71913-C-T-P4S	–	–	0,2	65	90	13	1	1	–	–	–	15
B71913-E-T-P4S	–	–	0,199	65	90	13	1	1	–	–	–	25
HCB71913-C-T-P4S	–	–	0,172	65	90	13	1	1	2,8	7,2	1,4	15
HCB71913-E-T-P4S	–	–	0,171	65	90	13	1	1	2,8	7,2	1,4	25
RS71913-D-T-P4S	–	–	0,2	65	90	13	1	1	–	–	–	20
HCRS71913-D-T-P4S	–	–	0,175	65	90	13	1	1	2,8	7,2	1,4	20
HS71913-C-T-P4S	–	–	0,214	65	90	13	1	–	–	–	–	15
HS71913-E-T-P4S	–	–	0,214	65	90	13	1	–	–	–	–	25
HC71913-E-T-P4S	–	–	0,235	65	90	13	1	–	2,8	7,2	1,4	25
XC71913-E-T-P4S	–	–	0,235	65	90	13	1	–	2,8	7,2	1,4	25
–	B7013-C-T-P4S	–	0,426	65	100	18	1,1	1,1	–	–	–	15
–	B7013-E-T-P4S	–	0,425	65	100	18	1,1	1,1	–	–	–	25
–	HCB7013-C-T-P4S	–	0,354	65	100	18	1,1	1,1	4	10,4	1,4	15
–	HCB7013-E-T-P4S	–	0,353	65	100	18	1,1	1,1	4	10,4	1,4	25
–	RS7013-D-T-P4S	–	0,43	65	100	18	1,1	1,1	–	–	–	20
–	HCRS7013-D-T-P4S	–	0,43	65	100	18	1,1	1,1	4	10,4	1,4	20
–	HS7013-C-T-P4S	–	0,461	65	100	18	1,1	–	–	–	–	15
–	HS7013-E-T-P4S	–	0,461	65	100	18	1,1	–	–	–	–	25
–	HC7013-E-T-P4S	–	0,488	65	100	18	1,1	–	4	10,4	1,4	25
–	XC7013-E-T-P4S	–	0,488	65	100	18	1,1	–	4	10,4	1,4	25
–	–	B7213-C-T-P4S	1	65	120	23	1,5	1,5	–	–	–	15
–	–	B7213-E-T-P4S	0,998	65	120	23	1,5	1,5	–	–	–	25
–	–	HCB7213-C-T-P4S	0,866	65	120	23	1,5	1,5	–	–	–	15
–	–	HCB7213-E-T-P4S	0,863	65	120	23	1,5	1,5	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

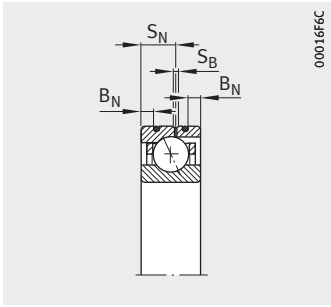
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7013-C-2RSD-T-P4S-UL and HSS7013-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

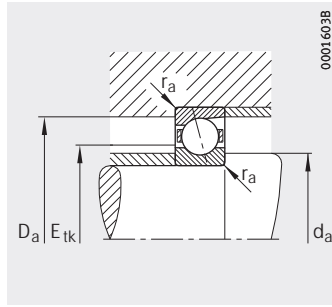
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

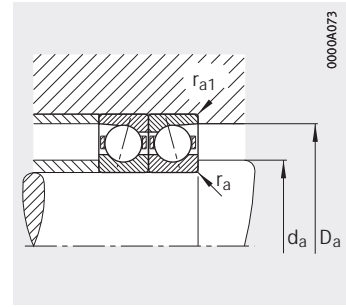
⁶⁾ Ordering examples for Direct Lube design: HCB7013-EDLR-T-P4S-UL and HC7013-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



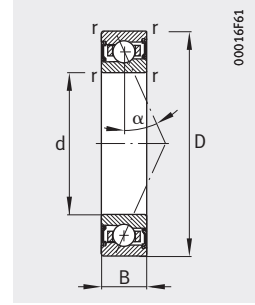
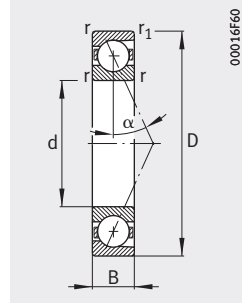
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
da	Da	ra	ra1	Etk	dyn. Cr	stat. Cor	nG grease	nG oil ⁵⁾	L	M	H	L	M	H	L	M	H
h12	H12	max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
70	85,5	0,6	0,6	75,1	25	16,9	15 000	22 000	117	409	839	360	1 356	2 973	56,2	98,1	141,1
70	85,5	0,6	0,6	75,1	23,7	16	13 000	20 000	152	613	1 339	440	1 837	4 145	126,4	213	292,7
70	85,5	0,6	0,6	75,1	25	16,1	20 000	32 000	55	219	473	161	684	1 562	46,6	81,7	116,1
70	85,5	0,6	0,6	75,1	23,7	15,3	19 000	28 000	58	309	723	165	904	2 165	101,6	184,7	255,1
70	85,5	0,6	0,6	75,1	23,3	15,1	18 000	26 000	113	339	678	330	1 021	2 101	86,4	131,1	173,9
70	85,5	0,6	0,6	75,1	23,3	14,5	22 000	34 000	78	234	468	226	693	1 417	85,3	127,6	148,2
70	85,5	0,6	0,6	75,2	13,8	9,9	20 000	32 000	48	144	287	143	450	937	41,5	65	88,8
70	85,5	0,6	0,6	75,2	13	9,3	18 000	28 000	77	231	462	222	680	1 386	103,6	154,2	200,9
70	85,5	0,6	0,6	75,2	13	8,9	24 000	36 000	53	160	321	153	466	946	103,1	152,1	196,3
70	85,5	0,6	0,6	75,2	19,9	8,9	26 000	40 000	53	160	321	153	466	946	103,1	152,1	196,3
72	93	1	0,6	78,1	41,5	25,5	14 000	22 000	214	704	1 417	660	2 354	5 068	66,7	114,4	163,62
72	93	1	0,6	78,1	39	24,1	13 000	19 000	308	1 111	2 350	896	3 347	7 323	154,3	251	341,9
72	93	1	0,6	78,1	41,5	24,3	19 000	30 000	107	385	808	318	1 213	2 688	56,4	95,6	134,8
72	93	1	0,6	78,1	39	23,1	17 000	26 000	137	577	1 276	392	1 694	3 836	130,5	219,2	297,3
72	93	1	0,6	78,1	38,5	22,7	16 000	26 000	177	532	1 065	521	1 616	3 335	89,6	136,9	182,8
72	93	1	0,6	78,1	38,5	21,7	22 000	32 000	123	369	737	357	1 097	2 250	88,4	132,9	174,9
72	93	1	0,6	79,7	19,3	13,4	19 000	30 000	67	201	402	200	630	1 312	47,4	74,4	101,7
72	93	1	0,6	79,7	18,2	12,7	17 000	26 000	109	328	656	315	964	1 967	119	177,2	231
72	93	1	0,6	79,7	18,2	12,2	22 000	34 000	74	223	445	213	647	1 313	117,5	173,4	223,8
72	93	1	0,6	79,7	28	12,2	24 000	38 000	74	223	445	213	647	1 313	117,5	173,4	223,8
75,5	109,5	1,5	1,5	88,2	68	38,5	12 000	19 000	386	1 224	2 431	1 198	4 118	8 752	78,9	133,9	190,9
75,5	109,5	1,5	1,5	88,2	65	36,5	11 000	18 000	585	1 977	4 100	1 709	5 978	12 828	184,8	294,5	399
75,5	109,5	1,5	1,5	88,2	68	36,5	15 000	24 000	205	690	1 419	614	2 192	4 757	68,2	113,2	158,6
75,5	109,5	1,5	1,5	88,2	65	35	13 000	20 000	290	1 071	2 286	834	3 157	6 901	162,1	260,7	333,1

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions							Contact angle		
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	α	°
							min.						
B71914-C-T-P4S	–	–	0,34	70	100	16	1	1	–	–	–	15	
B71914-E-T-P4S	–	–	0,339	70	100	16	1	1	–	–	–	25	
HCB71914-C-T-P4S	–	–	0,281	70	100	16	1	1	3,1	9,3	1,4	15	
HCB71914-E-T-P4S	–	–	0,28	70	100	16	1	1	3,1	9,3	1,4	25	
RS71914-D-T-P4S	–	–	0,33	70	100	16	1	1	–	–	–	20	
HCRS71914-D-T-P4S	–	–	0,28	70	100	16	1	1	3,1	9,3	1,4	20	
HS71914-C-T-P4S	–	–	0,354	70	100	16	1	–	–	–	–	15	
HS71914-E-T-P4S	–	–	0,353	70	100	16	1	–	–	–	–	25	
HC71914-E-T-P4S	–	–	0,379	70	100	16	1	–	3,1	9,3	1,4	25	
XC71914-E-T-P4S	–	–	0,379	70	100	16	1	–	3,1	9,3	1,4	25	
–	B7014-C-T-P4S	–	0,577	70	110	20	1,1	1,1	–	–	–	15	
–	B7014-E-T-P4S	–	0,575	70	110	20	1,1	1,1	–	–	–	25	
–	HCB7014-C-T-P4S	–	0,494	70	110	20	1,1	1,1	4	11,6	1,4	15	
–	HCB7014-E-T-P4S	–	0,492	70	110	20	1,1	1,1	4	11,6	1,4	25	
–	RS7014-D-T-P4S	–	0,59	70	110	20	1,1	1,1	–	–	–	20	
–	HCRS7014-D-T-P4S	–	0,59	70	110	20	1,1	1,1	4	11,6	1,4	20	
–	HS7014-C-T-P4S	–	0,644	70	110	20	1,1	–	–	–	–	15	
–	HS7014-E-T-P4S	–	0,643	70	110	20	1,1	–	–	–	–	25	
–	HC7014-E-T-P4S	–	0,67	70	110	20	1,1	–	4	11,6	1,4	25	
–	XC7014-E-T-P4S	–	0,67	70	110	20	1,1	–	4	11,6	1,4	25	
–	–	B7214-C-T-P4S	1,1	70	125	24	1,5	1,5	–	–	–	15	
–	–	B7214-E-T-P4S	1,09	70	125	24	1,5	1,5	–	–	–	25	
–	–	HCB7214-C-T-P4S	0,954	70	125	24	1,5	1,5	–	–	–	15	
–	–	HCB7214-E-T-P4S	0,951	70	125	24	1,5	1,5	–	–	–	25	

¹⁾ Explanation of short designations, see page 145.

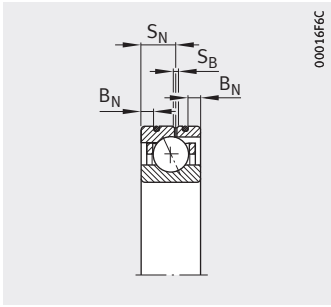
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7014-C-2RSD-T-P4S-UL and HSS7014-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

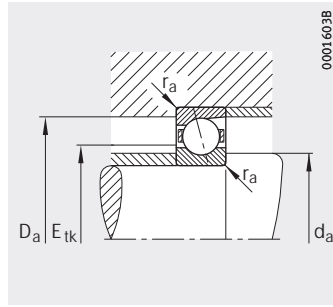
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

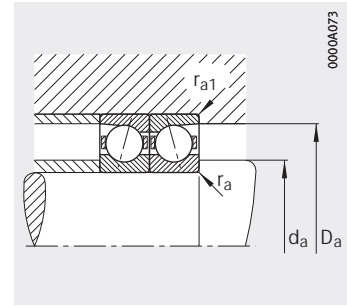
⁶⁾ Ordering examples for Direct Lube design: HCB7014-EDLR-T-P4S-UL and HC7014-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



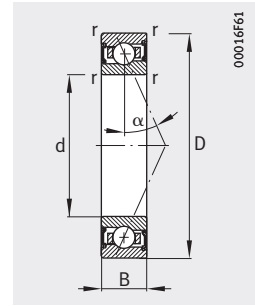
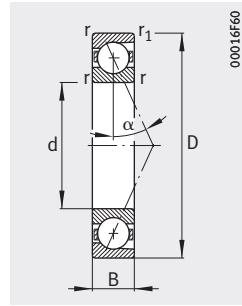
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.	nom.	nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
76	94,5	0,6	0,6	82,2	34,5	23	14 000	20 000	170	576	1 171	523	1 912	4 155	66	113,9	163,2
76	94,5	0,6	0,6	82,2	32,5	21,8	12 000	19 000	233	886	1 902	677	2 658	5 898	151	249,4	340,8
76	94,5	0,6	0,6	82,2	34,5	22	19 000	28 000	83	312	665	245	980	2 200	55,5	95,3	134,8
76	94,5	0,6	0,6	82,2	32,5	20,8	17 000	26 000	98	459	1 040	281	1 343	3 118	125,7	218,1	298,1
76	94,5	0,6	0,6	82,2	32	20,9	16 000	24 000	156	467	934	455	1 406	2 893	99,2	150,6	199,9
76	94,5	0,6	0,6	82,2	32	20	20 000	32 000	107	322	644	310	952	1 947	97,9	146,5	173,8
76	94,5	0,6	0,6	82,3	17,8	12,9	19 000	28 000	61	184	368	183	576	1 198	47	73,7	100,6
76	94,5	0,6	0,6	82,3	16,8	12,2	17 000	26 000	99	298	597	287	877	1 789	117,9	175,5	228,5
76	94,5	0,6	0,6	82,3	16,8	11,7	22 000	34 000	69	207	414	198	602	1 221	117,4	173,1	223,4
76	94,5	0,6	0,6	82,3	25,5	11,7	24 000	36 000	69	207	414	198	602	1 221	117,4	173,1	223,4
77	102	1	0,6	85	50	30,5	13 000	20 000	276	894	1 790	853	2 995	6 414	73,5	125,4	179,1
77	102	1	0,6	85	48	29	11 000	18 000	395	1 388	2 915	1 149	4 183	9 083	169,2	272,8	370,6
77	102	1	0,6	85	50	29,5	18 000	28 000	139	487	1 014	414	1 538	3 380	62,3	104,6	147
77	102	1	0,6	85	48	28	16 000	24 000	188	749	1 633	540	2 203	4 915	146,6	241,7	326,3
77	102	1	0,6	85	49,5	30	15 000	24 000	218	655	1 310	641	1 988	4 104	96,8	147,9	197,5
77	102	1	0,6	85	47,5	28	19 000	30 000	152	457	915	443	1 361	2 791	95,8	144	189,6
77	102	1	0,6	86,7	25	17,2	18 000	28 000	87	261	523	261	820	1 706	52,2	81,9	112
77	102	1	0,6	86,7	23,6	16,3	16 000	24 000	141	423	845	406	1 243	2 536	130,6	194,4	253,4
77	102	1	0,6	86,7	23,6	15,6	20 000	32 000	98	293	587	280	853	1 731	130	191,7	247,6
77	102	1	0,6	86,7	36	15,6	22 000	34 000	98	293	587	280	853	1 731	130	191,7	247,6
80	115	1,5	1,5	92,7	71	41,5	11 000	18 000	399	1 269	2 524	1 238	4 260	9 062	83,1	140,8	200,7
80	115	1,5	1,5	92,7	67	39,5	10 000	17 000	595	2 017	4 189	1 736	6 090	13 077	193,7	308,6	417,8
80	115	1,5	1,5	92,7	71	39,5	14 000	22 000	211	711	1 464	630	2 253	4 894	71,6	118,8	166,4
80	115	1,5	1,5	92,7	67	38	12 000	19 000	297	1 103	2 359	854	3 249	7 111	170,5	274,5	350,3

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions									Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B		
B71915-C-T-P4S	–	–	0,359	75	105	16	1	1	–	–	–	15	
B71915-E-T-P4S	–	–	0,358	75	105	16	1	1	–	–	–	25	
HCB71915-C-T-P4S	–	–	0,297	75	105	16	1	1	3,1	9,3	1,4	15	
HCB71915-E-T-P4S	–	–	0,296	75	105	16	1	1	3,1	9,3	1,4	25	
RS71915-D-T-P4S	–	–	0,355	75	105	16	1	1	–	–	–	20	
HCRS71915-D-T-P4S	–	–	0,3	75	105	16	1	1	3,1	9,3	1,4	20	
HS71915-C-T-P4S	–	–	0,374	75	105	16	1	–	–	–	–	15	
HS71915-E-T-P4S	–	–	0,373	75	105	16	1	–	–	–	–	25	
HC71915-E-T-P4S	–	–	0,4	75	105	16	1	–	3,1	9,3	1,4	25	
XC71915-E-T-P4S	–	–	0,4	75	105	16	1	–	3,1	9,3	1,4	25	
–	B7015-C-T-P4S	–	0,608	75	115	20	1,1	1,1	–	–	–	15	
–	B7015-E-T-P4S	–	0,606	75	115	20	1,1	1,1	–	–	–	25	
–	HCB7015-C-T-P4S	–	0,521	75	115	20	1,1	1,1	4	11,6	1,4	15	
–	HCB7015-E-T-P4S	–	0,519	75	115	20	1,1	1,1	4	11,6	1,4	25	
–	RS7015-D-T-P4S	–	0,61	75	115	20	1,1	1,1	–	–	–	20	
–	HCRS7015-D-T-P4S	–	0,61	75	115	20	1,1	1,1	4	11,6	1,4	20	
–	HS7015-C-T-P4S	–	0,679	75	115	20	1,1	–	–	–	–	15	
–	HS7015-E-T-P4S	–	0,678	75	115	20	1,1	–	–	–	–	25	
–	HC7015-E-T-P4S	–	0,707	75	115	20	1,1	–	4	11,6	1,4	25	
–	XC7015-E-T-P4S	–	0,707	75	115	20	1,1	–	4	11,6	1,4	25	
–	–	B7215-C-T-P4S	1,2	75	130	25	1,5	1,5	–	–	–	15	
–	–	B7215-E-T-P4S	1,2	75	130	25	1,5	1,5	–	–	–	25	
–	–	HCB7215-C-T-P4S	1,05	75	130	25	1,5	1,5	–	–	–	15	
–	–	HCB7215-E-T-P4S	1,04	75	130	25	1,5	1,5	–	–	–	25	

¹⁾ Explanation of short designations, see page 145.

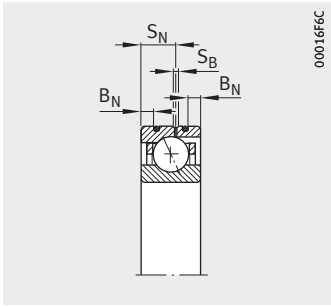
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7015-C-2RSD-T-P4S-UL and HSS7015-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

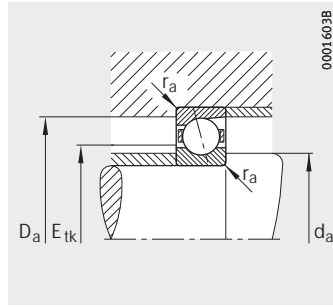
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

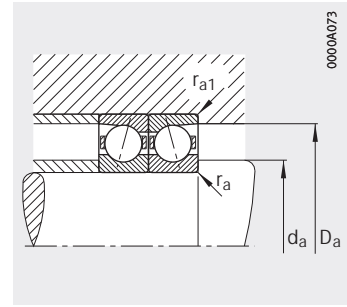
⁶⁾ Ordering examples for Direct Lube design: HCB7015-EDLR-T-P4S-UL and HC7015-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



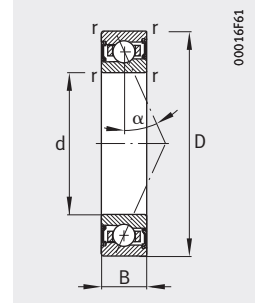
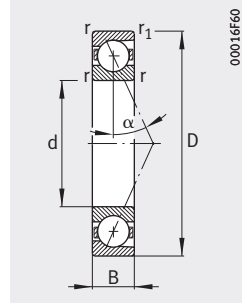
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
da	Da	ra	ra1	Etk	dyn. Cr	stat. Cor	nG grease	nG oil ⁵⁾	Fv			KaE			Ca		
h12	H12	max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H
									N	N	N	N	N	N	N	N	N
81	99,5	0,6	0,6	87,2	35	24,2	13 000	20 000	172	584	1 189	527	1 933	4 206	68	117,2	167,9
81	99,5	0,6	0,6	87,2	33	22,9	11 000	18 000	235	897	1 928	682	2 688	5 970	155,6	257,1	351,3
81	99,5	0,6	0,6	87,2	35	23,1	18 000	28 000	83	317	676	247	991	2 229	57,1	98,2	138,8
81	99,5	0,6	0,6	87,2	33	21,9	16 000	24 000	95	454	1 034	273	1 328	3 094	127,9	223,2	305,2
81	99,5	0,6	0,6	87,2	33	22	15 000	24 000	156	467	934	454	1 404	2 888	101,9	154,5	204,8
81	99,5	0,6	0,6	87,2	33	21	19 000	30 000	109	328	655	316	968	1 980	101,3	151,5	179,3
81	99,5	0,6	0,6	87,3	18,3	13,8	18 000	28 000	64	191	382	190	597	1 242	49,5	77,5	105,7
81	99,5	0,6	0,6	87,3	17,2	13	16 000	24 000	101	304	607	292	891	1 817	123,4	183,4	238,7
81	99,5	0,6	0,6	87,3	17,2	12,5	20 000	32 000	70	210	421	201	611	1 240	122,8	181	233,4
81	99,5	0,6	0,6	87,3	26,5	12,5	22 000	34 000	70	210	421	201	611	1 240	122,8	181	233,4
82	107	1	0,6	90	52	32,5	12 000	19 000	280	911	1 827	865	3 043	6 525	76,3	130,1	185,7
82	107	1	0,6	90	49,5	31	11 000	17 000	405	1 430	3 005	1 180	4 305	9 353	176,8	285,2	387,2
82	107	1	0,6	90	52	31,5	17 000	26 000	145	508	1 059	431	1 603	3 524	65,4	109,8	154,3
82	107	1	0,6	90	49,5	29,5	15 000	24 000	192	769	1 679	551	2 260	5 050	153	252,5	340,9
82	107	1	0,6	90	49	29,5	14 000	22 000	228	683	1 365	667	2 070	4 272	101,7	155,3	207,3
82	107	1	0,6	90	49	28,5	18 000	28 000	157	471	942	456	1 401	2 872	100,2	150,6	198,1
82	107	1	0,6	91,7	25,5	17,9	17 000	26 000	89	266	533	265	835	1 737	53,7	84,3	115,1
82	107	1	0,6	91,7	23,9	17	15 000	24 000	144	431	863	415	1 268	2 587	134,5	200,3	261
82	107	1	0,6	91,7	23,9	16,2	19 000	30 000	99	298	597	285	868	1 761	133,8	197,3	254,7
82	107	1	0,6	91,7	36,5	16,2	22 000	32 000	99	298	597	285	868	1 761	133,8	197,3	254,7
85	120	1,5	1,5	97,7	73	44,5	11 000	18 000	413	1 314	2 617	1 278	4 401	9 371	87,2	147,8	210,4
85	120	1,5	1,5	97,7	70	42,5	9 500	16 000	615	2 091	4 345	1 794	6 306	13 546	203,8	324,7	439,4
85	120	1,5	1,5	97,7	73	42,5	14 000	22 000	219	740	1 524	653	2 341	5 087	75,4	125,1	175,1
85	120	1,5	1,5	97,7	70	40,5	12 000	19 000	308	1 149	2 459	887	3 383	7 409	179,7	289,5	369,2

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾²⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719	Series 70	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
							min.					
B71916-C-T-P4S	–	–	0,376	80	110	16	1	1	–	–	–	15
B71916-E-T-P4S	–	–	0,375	80	110	16	1	1	–	–	–	25
HCB71916-C-T-P4S	–	–	0,312	80	110	16	1	1	3,1	9,3	1,4	15
HCB71916-E-T-P4S	–	–	0,311	80	110	16	1	1	3,1	9,3	1,4	25
RS71916-D-T-P4S	–	–	0,365	80	110	16	1	1	–	–	–	20
HCRS71916-D-T-P4S	–	–	0,32	80	110	16	1	1	3,1	9,3	1,4	20
HS71916-C-T-P4S	–	–	0,379	80	110	16	1	–	–	–	–	15
HS71916-E-T-P4S	–	–	0,379	80	110	16	1	–	–	–	–	25
HC71916-E-T-P4S	–	–	0,41	80	110	16	1	–	3,1	9,3	1,4	25
XC71916-E-T-P4S	–	–	0,41	80	110	16	1	–	3,1	9,3	1,4	25
–	B7016-C-T-P4S	–	0,836	80	125	22	1,1	1,1	–	–	–	15
–	B7016-E-T-P4S	–	0,833	80	125	22	1,1	1,1	–	–	–	25
–	HCB7016-C-T-P4S	–	0,699	80	125	22	1,1	1,1	4,7	12,2	2,2	15
–	HCB7016-E-T-P4S	–	0,696	80	125	22	1,1	1,1	4,7	12,2	2,2	25
–	RS7016-D-T-P4S	–	0,84	80	125	22	1,1	1,1	–	–	–	20
–	HCRS7016-D-T-P4S	–	0,84	80	125	22	1,1	1,1	4,7	12,2	2,2	20
–	HS7016-C-T-P4S	–	0,927	80	125	22	1,1	–	–	–	–	15
–	HS7016-E-T-P4S	–	0,925	80	125	22	1,1	–	–	–	–	25
–	HC7016-E-T-P4S	–	0,943	80	125	22	1,1	–	4,7	12,2	2,2	25
–	XC7016-E-T-P4S	–	0,943	80	125	22	1,1	–	4,7	12,2	2,2	25
–	–	B7216-C-T-P4S	1,43	80	140	26	2	2	–	–	–	15
–	–	B7216-E-T-P4S	1,42	80	140	26	2	2	–	–	–	25
–	–	HCB7216-C-T-P4S	1,18	80	140	26	2	2	–	–	–	15
–	–	HCB7216-E-T-P4S	1,18	80	140	26	2	2	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

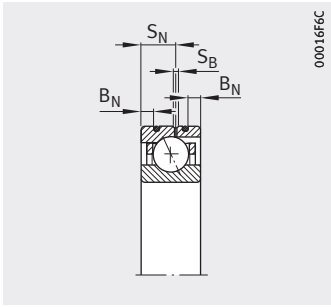
²⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7016-C-2RSD-T-P4S-UL and HSS7016-E-T-P4S-UL.

³⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

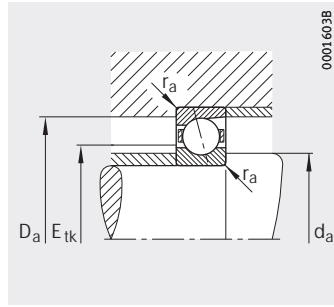
⁴⁾ Explanation, see page 70.

⁵⁾ Minimal quantity oil lubrication.

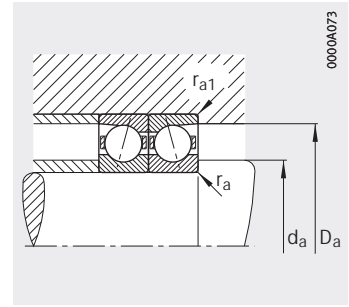
⁶⁾ Ordering examples for Direct Lube design: HCB7016-EDLR-T-P4S-UL and HC7016-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



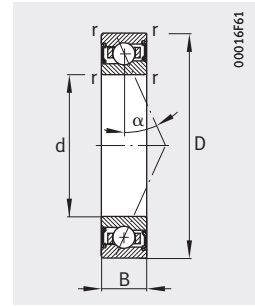
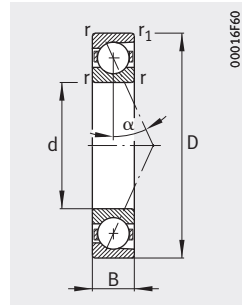
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ³⁾		Preload force ⁴⁾			Lift-off force ⁴⁾			Axial rigidity ⁴⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _v			K _{aE}			c _a		
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H
									N	N	N	N	N	N	N/μm	N/μm	N/μm
86	104	0,6	0,6	92,2	35,5	25,5	12 000	19 000	174	591	1 206	532	1 954	4 257	69,9	120,5	172,5
86	104	0,6	0,6	92,2	33,5	24	11 000	17 000	237	908	1 955	686	2 718	6 043	160,1	264,8	361,7
86	104	0,6	0,6	92,2	35,5	24,3	17 000	26 000	84	321	686	249	1 004	2 259	58,8	101,1	142,9
86	104	0,6	0,6	92,2	33,5	23	15 000	24 000	95	459	1 049	273	1 344	3 137	131,5	230,1	314,7
86	104	0,6	0,6	92,2	33,5	23,1	14 000	22 000	160	481	963	468	1 446	2 975	105,8	160,3	212,4
86	104	0,6	0,6	92,2	33,5	22,1	18 000	28 000	111	333	667	321	985	2 013	104,6	156,4	184,8
86	104	0,6	0,6	92,15	20,3	15,5	17 000	26 000	71	213	426	212	666	1 385	52,3	81,9	111,7
86	104	0,6	0,6	92,15	19,2	14,6	15 000	24 000	113	338	676	325	992	2 023	130,4	193,9	252,3
86	104	0,6	0,6	92,15	19,2	14	19 000	30 000	79	236	473	226	686	1 392	130,2	191,9	247,5
86	104	0,6	0,6	92,15	29,5	14	22 000	32 000	79	236	473	226	686	1 392	130,2	191,9	247,5
88	117	1	0,6	96,8	64	41	11 000	17 000	354	1 138	2 277	1 091	3 797	8 119	85,7	145,4	207,21
88	117	1	0,6	96,8	61	39	10 000	15 000	525	1 816	3 796	1 528	5 469	11 813	200,6	321,3	435,3
88	117	1	0,6	96,8	64	39	15 000	24 000	186	640	1 327	554	2 020	4 415	74	123,3	172,8
88	117	1	0,6	96,8	61	37,5	14 000	22 000	252	977	2 113	726	2 872	6 354	174,5	284,4	382,6
88	117	1	0,6	96,8	61	37,5	13 000	20 000	282	846	1 693	827	2 565	5 292	113,5	173,2	231,1
88	117	1	0,6	96,8	61	36	17 000	26 000	196	587	1 174	568	1 745	3 577	112,1	168,4	221,5
88	117	1	0,6	98,9	30,5	21,8	15 000	24 000	106	317	633	315	991	2 063	58,7	92	125,6
88	117	1	0,6	98,9	28,5	20,6	14 000	22 000	173	518	1 035	497	1 521	3 103	147,5	219,6	286,1
88	117	1	0,6	98,9	28,5	19,7	18 000	28 000	117	352	704	336	1 023	2 075	145,8	215	277,5
88	117	1	0,6	98,9	44	19,7	20 000	30 000	117	352	704	336	1 023	2 075	145,8	215	277,5
91	129	2	2	104,3	94	55	10 000	17 000	549	1 721	3 412	1 701	5 781	12 250	94,1	158,8	225,9
91	129	2	2	104,3	89	52	9 000	15 000	833	2 764	5 699	2 433	8 347	17 799	220,9	349,3	471,6
91	129	2	2	104,3	94	52	12 000	19 000	293	968	1 979	876	3 068	6 618	81,5	134,2	187,4
91	129	2	2	104,3	89	50	11 000	18 000	428	1 527	3 225	1 232	4 498	9 728	196,3	311,7	399,6

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions								Contact angle
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	α °
B71917-C-T-P4S	–	–	0,533	85	120	18	1,1	1,1	–	–	–	15
B71917-E-T-P4S	–	–	0,532	85	120	18	1,1	1,1	–	–	–	25
HCB71917-C-T-P4S	–	–	0,441	85	120	18	1,1	1,1	4	10,4	2,2	15
HCB71917-E-T-P4S	–	–	0,44	85	120	18	1,1	1,1	4	10,4	2,2	25
RS71917-D-T-P4S	–	–	0,53	85	120	18	1,1	1,1	–	–	–	20
HCRS71917-D-T-P4S	–	–	0,45	85	120	18	1,1	1,1	4	10,4	2,2	20
HS71917-C-T-P4S	–	–	0,572	85	120	18	1,1	–	–	–	–	15
HS71917-E-T-P4S	–	–	0,571	85	120	18	1,1	–	–	–	–	25
HC71917-E-T-P4S	–	–	0,604	85	120	18	1,1	–	4	10,4	2,2	25
XC71917-E-T-P4S	–	–	0,604	85	120	18	1,1	–	4	10,4	2,2	25
–	B7017-C-T-P4S	–	0,878	85	130	22	1,1	1,1	–	–	–	15
–	B7017-E-T-P4S	–	0,875	85	130	22	1,1	1,1	–	–	–	25
–	HCB7017-C-T-P4S	–	0,734	85	130	22	1,1	1,1	4,7	12,2	2,2	15
–	HCB7017-E-T-P4S	–	0,731	85	130	22	1,1	1,1	4,7	12,2	2,2	25
–	RS7017-D-T-P4S	–	0,87	85	130	22	1,1	1,1	–	–	–	20
–	HCRS7017-D-T-P4S	–	0,87	85	130	22	1,1	1,1	4,7	12,2	2,2	20
–	HS7017-C-T-P4S	–	0,97	85	130	22	1,1	–	–	–	–	15
–	HS7017-E-T-P4S	–	0,969	85	130	22	1,1	–	–	–	–	25
–	HC7017-E-T-P4S	–	0,989	85	130	22	1,1	–	4,7	12,2	2,2	25
–	XC7017-E-T-P4S	–	0,989	85	130	22	1,1	–	4,7	12,2	2,2	25
–	–	B7217-C-T-P4S	1,82	85	150	28	2	2	–	–	–	15
–	–	B7217-E-T-P4S	1,81	85	150	28	2	2	–	–	–	25
–	–	HCB7217-C-T-P4S	1,55	85	150	28	2	2	–	–	–	15
–	–	HCB7217-E-T-P4S	1,55	85	150	28	2	2	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

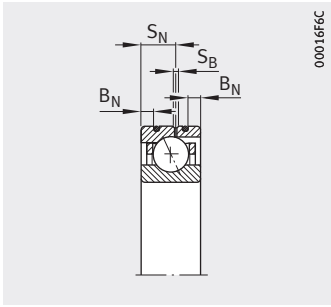
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

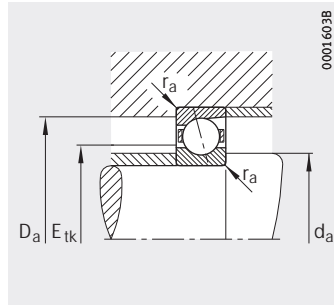
⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7017-C-2RSD-T-P4S-UL and HSS7017-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.

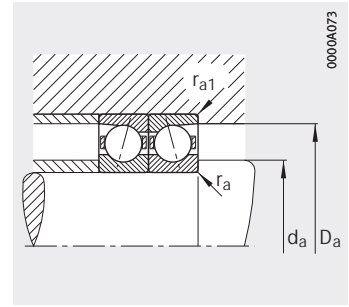
⁶⁾ Ordering examples for Direct Lube design: HCB7017-EDLR-T-P4S-UL and HC7017-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



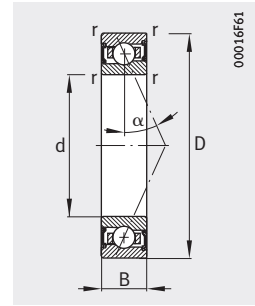
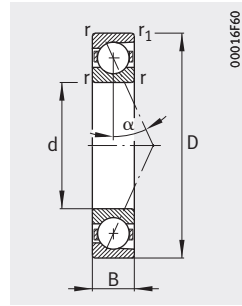
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾ F _v			Lift-off force ³⁾ K _{aE}			Axial rigidity ³⁾ c _a		
d _a h12	D _a H12	r _a max.	r _{a1} max.	E _{tk} nom.	dyn. C _r kN	stat. C _{0r} kN	n _G grease min ⁻¹	n _G oil ⁵⁾ min ⁻¹	L N	M N	H N	L N	M N	H N	L N/μm	M N/μm	H N/μm
92	114	0,6	0,6	99,2	47	33,5	11 000	17 000	237	788	1 597	726	2 609	5 644	79,7	136,3	194,5
92	114	0,6	0,6	99,2	44,5	31,5	10 000	15 000	333	1 226	2 609	968	3 675	8 074	184,3	300,5	408,8
92	114	0,6	0,6	99,2	47	32	15 000	24 000	117	428	906	346	1 341	2 985	67,4	114,3	160,8
92	114	0,6	0,6	99,2	44,5	30	14 000	22 000	143	627	1 403	409	1 837	4 197	154,3	261,9	355,6
92	114	0,6	0,6	99,2	43,5	29,5	13 000	20 000	211	632	1 265	615	1 900	3 908	118,7	179,9	238,4
92	114	0,6	0,6	99,2	43,5	28,5	17 000	26 000	144	431	862	415	1 273	2 602	116,8	174,5	209,2
92	114	0,6	0,6	99,7	21,2	17	15 000	24 000	74	221	442	220	689	1 433	55,9	87,4	118,9
92	114	0,6	0,6	99,7	20	16	14 000	22 000	117	352	704	338	1 032	2 102	139,7	207,6	269,9
92	114	0,6	0,6	99,7	20	15,3	18 000	28 000	82	247	493	236	716	1 452	139,7	205,7	265,2
92	114	0,6	0,6	99,7	30,5	15,3	20 000	30 000	82	247	493	236	716	1 452	139,7	205,7	265,2
93	122	1	0,6	101,8	66	43,5	11 000	16 000	367	1 183	2 368	1 132	3 942	8 434	89,7	152,1	216,72
93	122	1	0,6	101,8	63	41,5	9 500	15 000	540	1 874	3 919	1 573	5 639	12 184	209,4	335,5	454,4
93	122	1	0,6	101,8	66	41,5	15 000	22 000	189	653	1 356	562	2 058	4 501	76,9	128,1	179,3
93	122	1	0,6	101,8	63	39,5	13 000	20 000	256	997	2 159	736	2 927	6 484	181,3	295,9	398
93	122	1	0,6	101,8	63	40	13 000	19 000	291	874	1 747	853	2 645	5 457	118,6	180,9	241,3
93	122	1	0,6	101,8	63	38	16 000	24 000	200	601	1 201	581	1 784	3 656	116,8	175,4	230,5
93	122	1	0,6	103,9	30,5	22,7	15 000	22 000	107	322	643	320	1 006	2 093	60,3	94,4	128,8
93	122	1	0,6	103,9	29	21,4	13 000	20 000	173	518	1 035	497	1 520	3 099	150,8	224,3	292,1
93	122	1	0,6	103,9	29	20,5	17 000	26 000	120	359	718	343	1 042	2 115	150,1	221,3	285,5
93	122	1	0,6	103,9	44,5	20,5	19 000	30 000	120	359	718	343	1 042	2 115	150,1	221,3	285,5
98	138	2	2	112,3	97	59	9 000	15 000	568	1 786	3 544	1 759	5 983	12 688	99,1	167,1	237,5
98	138	2	2	112,3	93	57	8 000	13 000	864	2 869	5 921	2 520	8 657	18 466	233,1	368,5	497,4
98	138	2	2	112,3	97	57	11 000	18 000	306	1 012	2 071	915	3 205	6 915	86,2	141,9	198
98	138	2	2	112,3	93	54	10 000	17 000	438	1 572	3 325	1 262	4 626	10 015	206,4	328	420,1

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
									min.			
B71918-C-T-P4S	–	–	0,559	90	125	18	1,1	1,1	–	–	–	15
B71918-E-T-P4S	–	–	0,557	90	125	18	1,1	1,1	–	–	–	25
HCB71918-C-T-P4S	–	–	0,464	90	125	18	1,1	1,1	4	10,4	2,2	15
HCB71918-E-T-P4S	–	–	0,462	90	125	18	1,1	1,1	4	10,4	2,2	25
RS71918-D-T-P4S	–	–	0,55	90	125	18	1,1	1,1	–	–	–	20
HCRS71918-D-T-P4S	–	–	0,47	90	125	18	1,1	1,1	4	10,4	2,2	20
HS71918-C-T-P4S	–	–	0,58	90	125	18	1,1	–	–	–	–	15
HS71918-E-T-P4S	–	–	0,579	90	125	18	1,1	–	–	–	–	25
HC71918-E-T-P4S	–	–	0,629	90	125	18	1,1	–	4	10,4	2,2	25
XC71918-E-T-P4S	–	–	0,629	90	125	18	1,1	–	4	10,4	2,2	25
–	B7018-C-T-P4S	–	1,13	90	140	24	1,5	1,5	–	–	–	15
–	B7018-E-T-P4S	–	1,12	90	140	24	1,5	1,5	–	–	–	25
–	HCB7018-C-T-P4S	–	0,956	90	140	24	1,5	1,5	5,5	14,5	2,2	15
–	HCB7018-E-T-P4S	–	0,952	90	140	24	1,5	1,5	5,5	14,5	2,2	25
–	RS7018-D-T-P4S	–	1,14	90	140	24	1,5	1,5	–	–	–	20
–	HCRS7018-D-T-P4S	–	1,14	90	140	24	1,5	1,5	5,5	14,5	2,2	20
–	HS7018-C-T-P4S	–	1,27	90	140	24	1,5	–	–	–	–	15
–	HS7018-E-T-P4S	–	1,27	90	140	24	1,5	–	–	–	–	25
–	HC7018-E-T-P4S	–	1,31	90	140	24	1,5	–	5,5	14,5	2,2	25
–	XC7018-E-T-P4S	–	1,31	90	140	24	1,5	–	5,5	14,5	2,2	25
–	–	B7218-C-T-P4S	2,2	90	160	30	2	2	–	–	–	15
–	–	B7218-E-T-P4S	2,19	90	160	30	2	2	–	–	–	25
–	–	HCB7218-C-T-P4S	1,8	90	160	30	2	2	–	–	–	15
–	–	HCB7218-E-T-P4S	1,79	90	160	30	2	2	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

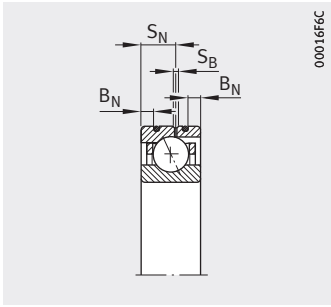
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

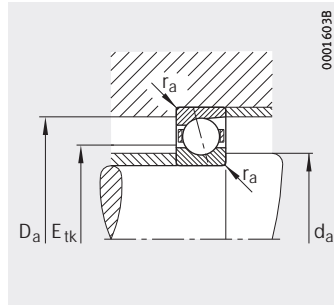
⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7018-C-2RSD-T-P4S-UL and HSS7018-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.

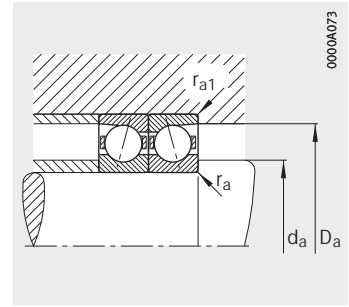
⁶⁾ Ordering examples for Direct Lube design: HCB7018-EDLR-T-P4S-UL and HC7018-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



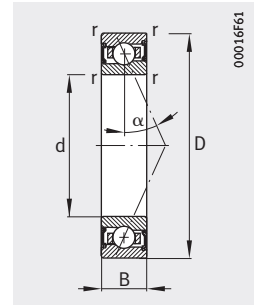
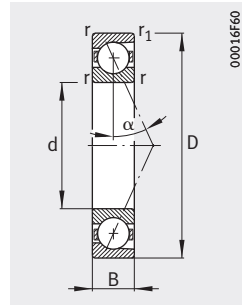
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
97	119	0,6	0,6	104,2	48	35	11 000	16 000	238	796	1 615	729	2 628	5 691	81,8	139,8	199,5
97	119	0,6	0,6	104,2	45	33	9 500	15 000	334	1 236	2 634	970	3 701	8 140	189,4	309	420,3
97	119	0,6	0,6	104,2	48	33,5	15 000	22 000	118	434	919	349	1 357	3 023	69,4	117,7	165,4
97	119	0,6	0,6	104,2	45	31,5	13 000	20 000	147	648	1 450	421	1 897	4 337	160,1	272	369,3
97	119	0,6	0,6	104,2	44	31	13 000	19 000	216	647	1 293	629	1 942	3 994	122,8	186	246,5
97	119	0,6	0,6	104,2	44	29,5	16 000	24 000	146	438	877	422	1 293	2 643	120,6	180,1	215,5
97	119	0,6	0,6	104,5	23,2	18,7	15 000	22 000	79	237	474	235	739	1 536	57,2	89,4	121,6
97	119	0,6	0,6	104,5	21,9	17,7	13 000	20 000	129	386	773	371	1 133	2 309	144,3	214,4	278,7
97	119	0,6	0,6	104,5	21,9	16,9	17 000	26 000	90	269	538	257	781	1 584	143,9	212	273,2
97	119	0,6	0,6	104,5	33,5	16,9	19 000	30 000	90	269	538	257	781	1 584	143,9	212	273,2
100	131	1,5	0,6	108,6	78	51	10 000	15 000	437	1 395	2 785	1 347	4 651	9 920	95,2	161	229,09
100	131	1,5	0,6	108,6	74	48,5	9 000	14 000	646	2 205	4 590	1 880	6 636	14 269	222,6	354,6	479,4
100	131	1,5	0,6	108,6	78	49	14 000	22 000	230	781	1 613	685	2 464	5 361	82,3	136,3	190,6
100	131	1,5	0,6	108,6	74	46,5	12 000	19 000	319	1 201	2 577	916	3 528	7 745	195,4	315,5	423,1
100	131	1,5	0,6	108,6	73	45,5	12 000	18 000	341	1 024	2 048	1 000	3 100	6 395	125,2	190,9	254,6
100	131	1,5	0,6	108,6	73	44	15 000	24 000	237	710	1 420	686	2 109	4 322	123,6	185,6	244
100	131	1,5	0,6	111	36	26,5	14 000	22 000	126	377	754	375	1 178	2 451	65,4	102,3	139,5
100	131	1,5	0,6	111	34	25	12 000	19 000	204	612	1 225	588	1 799	3 667	164,2	244,2	317,9
100	131	1,5	0,6	111	34	24	16 000	24 000	141	423	845	404	1 228	2 490	163,2	240,5	310,3
100	131	1,5	0,6	111	52	24	18 000	28 000	141	423	845	404	1 228	2 490	163,2	240,5	310,3
104	147	2	2	118,8	125	75	8 500	14 000	732	2 280	4 513	2 267	7 640	16 156	108,9	182,8	259,5
104	147	2	2	118,8	119	72	7 500	12 000	1 127	3 689	7 575	3 291	11 132	23 627	257,1	404,3	544,6
104	147	2	2	118,8	125	72	11 000	18 000	400	1 303	2 655	1 197	4 129	8 866	95,2	155,8	217
104	147	2	2	118,8	119	69	9 000	15 000	586	2 042	4 283	1 688	6 013	12 905	229,5	361,2	464,2

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions							Contact angle	
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	α °
B71919-C-T-P4S	–	–	0,583	95	130	18	1,1	1,1	–	–	–	15
B71919-E-T-P4S	–	–	0,581	95	130	18	1,1	1,1	–	–	–	25
HCB71919-C-T-P4S	–	–	0,484	95	130	18	1,1	1,1	4	10,4	2,2	15
HCB71919-E-T-P4S	–	–	0,482	95	130	18	1,1	1,1	4	10,4	2,2	25
RS71919-D-T-P4S	–	–	0,58	95	130	18	1,1	1,1	–	–	–	20
HCRS71919-D-T-P4S	–	–	0,48	95	130	18	1,1	1,1	4	10,4	2,2	20
HS71919-C-T-P4S	–	–	0,606	95	130	18	1,1	–	–	–	–	15
HS71919-E-T-P4S	–	–	0,605	95	130	18	1,1	–	–	–	–	25
HC71919-E-T-P4S	–	–	0,658	95	130	18	1,1	–	4	10,4	2,2	25
XC71919-E-T-P4S	–	–	0,658	95	130	18	1,1	–	4	10,4	2,2	25
–	B7019-C-T-P4S	–	1,19	95	145	24	1,5	1,5	–	–	–	15
–	B7019-E-T-P4S	–	1,18	95	145	24	1,5	1,5	–	–	–	25
–	HCB7019-C-T-P4S	–	0,999	95	145	24	1,5	1,5	5,5	14,5	2,2	15
–	HCB7019-E-T-P4S	–	0,995	95	145	24	1,5	1,5	5,5	14,5	2,2	25
–	RS7019-D-T-P4S	–	1,19	95	145	24	1,5	1,5	–	–	–	20
–	HCRS7019-D-T-P4S	–	1,19	95	145	24	1,5	1,5	5,5	14,5	2,2	20
–	HS7019-C-T-P4S	–	1,32	95	145	24	1,5	–	–	–	–	15
–	HS7019-E-T-P4S	–	1,32	95	145	24	1,5	–	–	–	–	25
–	HC7019-E-T-P4S	–	1,36	95	145	24	1,5	–	5,5	14,5	2,2	25
–	XC7019-E-T-P4S	–	1,36	95	145	24	1,5	–	5,5	14,5	2,2	25
–	–	B7219-C-T-P4S	2,73	95	170	32	2,1	2,1	–	–	–	15
–	–	B7219-E-T-P4S	2,72	95	170	32	2,1	2,1	–	–	–	25
–	–	HCB7219-C-T-P4S	2,3	95	170	32	2,1	2,1	–	–	–	15
–	–	HCB7219-E-T-P4S	2,29	95	170	32	2,1	2,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

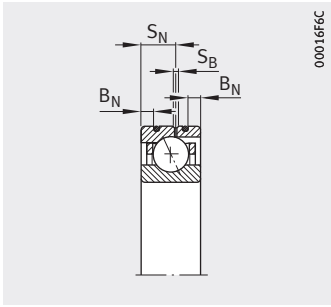
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

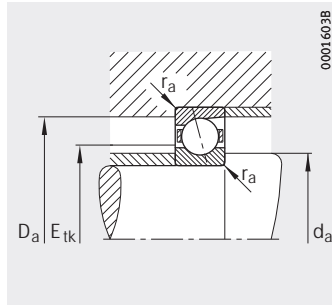
⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7019-C-2RSD-T-P4S-UL and HSS7019-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.

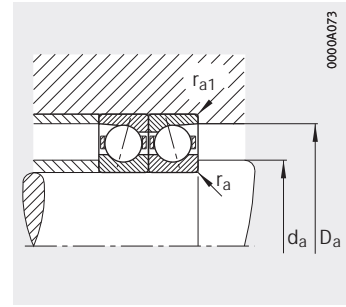
⁶⁾ Ordering examples for Direct Lube design: HCB7019-EDLR-T-P4S-UL and HC7019-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



Mounting dimensions



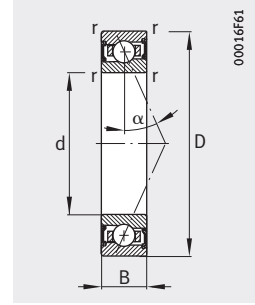
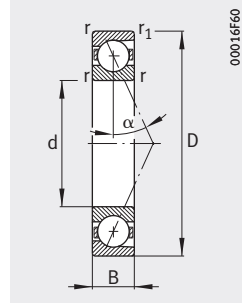
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
d _a h12	D _a H12	r _a max.	r _{a1} max.	E _{tk} nom.	dyn. C _r kN	stat. C _{0r} kN	n _G grease min ⁻¹	n _G oil ⁵⁾ min ⁻¹	L N	M N	H N	L N	M N	H N	L N/μm	M N/μm	H N/μm
102	124	0,6	0,6	109,2	48,5	36,5	10 000	16 000	243	813	1 651	743	2 679	5 806	84,4	144,1	205,6
102	124	0,6	0,6	109,2	46	34,5	9 000	14 000	341	1 262	2 693	988	3 777	8 313	195,5	319,1	433,9
102	124	0,6	0,6	109,2	48,5	35	14 000	22 000	119	440	932	352	1 373	3 061	71,3	121	170
102	124	0,6	0,6	109,2	46	33	13 000	19 000	148	656	1 470	423	1 918	4 393	164,4	280	380,3
102	124	0,6	0,6	109,2	45	32,5	12 000	18 000	218	654	1 308	635	1 961	4 033	126,4	191,3	253,3
102	124	0,6	0,6	109,2	45	31	15 000	24 000	148	445	891	429	1 314	2 684	124,4	185,7	221,9
102	124	0,6	0,6	109,5	23,9	19,9	14 000	22 000	82	246	492	244	766	1 593	60	93,7	127,4
102	124	0,6	0,6	109,5	22,5	18,7	13 000	19 000	131	393	787	377	1 153	2 347	150,4	223,3	290,1
102	124	0,6	0,6	109,5	22,5	17,9	16 000	24 000	92	276	552	263	801	1 623	150,4	221,4	285,3
102	124	0,6	0,6	109,5	34,5	17,9	18 000	28 000	92	276	552	263	801	1 623	150,4	221,4	285,3
105	136	1,5	0,6	113,6	81	54	9 500	15 000	444	1 421	2 842	1 367	4 726	10 091	98,8	166,8	237,2
105	136	1,5	0,6	113,6	77	52	8 500	13 000	671	2 295	4 780	1 955	6 904	14 849	233,2	371,6	502,3
105	136	1,5	0,6	113,6	81	52	13 000	20 000	233	794	1 643	693	2 499	5 442	85,3	141,3	197,4
105	136	1,5	0,6	113,6	77	49,5	12 000	18 000	322	1 220	2 622	924	3 581	7 871	202,7	327,7	439,4
105	136	1,5	0,6	113,6	75	48,5	11 000	17 000	348	1 044	2 088	1 019	3 158	6 512	130,2	198,5	264,4
105	136	1,5	0,6	113,6	75	46,5	14 000	22 000	241	723	1 447	699	2 148	4 400	128,6	193	253,5
105	136	1,5	0,6	116	36,5	27,5	13 000	20 000	127	382	764	380	1 192	2 480	67	104,8	142,9
105	136	1,5	0,6	116	34	26	12 000	18 000	204	612	1 225	588	1 797	3 663	167,7	249,3	324,4
105	136	1,5	0,6	116	34	25	15 000	24 000	141	423	845	404	1 227	2 488	166,7	245,6	316,7
105	136	1,5	0,6	116	52	25	17 000	26 000	141	423	845	404	1 227	2 488	166,7	245,6	316,7
110,5	154	2	2	125,8	130	81	8 000	13 000	760	2 373	4 703	2 353	7 935	16 792	114,9	192,7	273,4
110,5	154	2	2	125,8	124	78	7 000	11 000	1 184	3 876	7 964	3 454	11 693	24 820	272,7	428,7	577,3
110,5	154	2	2	125,8	130	78	10 000	17 000	413	1 348	2 748	1 234	4 261	9 153	100,3	163,9	228,1
110,5	154	2	2	125,8	124	74	8 500	14 000	605	2 113	4 437	1 741	6 219	13 355	241,9	381	489,1

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions								Contact angle α °
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁	B _N	S _N	S _B	
								min.				
B71920-C-T-P4S	–	–	0,772	100	140	20	1,1	1,1	–	–	–	15
B71920-E-T-P4S	–	–	0,769	100	140	20	1,1	1,1	–	–	–	25
HCB71920-C-T-P4S	–	–	0,658	100	140	20	1,1	1,1	4	12	2,2	15
HCB71920-E-T-P4S	–	–	0,655	100	140	20	1,1	1,1	4	12	2,2	25
RS71920-D-T-P4S	–	–	0,79	100	140	20	1,1	1,1	–	–	–	20
HCRS71920-D-T-P4S	–	–	0,66	100	140	20	1,1	1,1	4	12	2,2	20
HS71920-C-T-P4S	–	–	0,858	100	140	20	1,1	–	–	–	–	15
HS71920-E-T-P4S	–	–	0,856	100	140	20	1,1	–	–	–	–	25
HC71920-E-T-P4S	–	–	0,892	100	140	20	1,1	–	4	12	2,2	25
XC71920-E-T-P4S	–	–	0,892	100	140	20	1,1	–	4	12	2,2	25
–	B7020-C-T-P4S	–	1,24	100	150	24	1,5	1,5	–	–	–	15
–	B7020-E-T-P4S	–	1,23	100	150	24	1,5	1,5	–	–	–	25
–	HCB7020-C-T-P4S	–	1,04	100	150	24	1,5	1,5	5,5	14,5	2,2	15
–	HCB7020-E-T-P4S	–	1,04	100	150	24	1,5	1,5	5,5	14,5	2,2	25
–	RS7020-D-T-P4S	–	1,26	100	150	24	1,5	1,5	–	–	–	20
–	HCRS7020-D-T-P4S	–	1,26	100	150	24	1,5	1,5	5,5	14,5	2,2	20
–	HS7020-C-T-P4S	–	1,38	100	150	24	1,5	–	–	–	–	15
–	HS7020-E-T-P4S	–	1,37	100	150	24	1,5	–	–	–	–	25
–	HC7020-E-T-P4S	–	1,42	100	150	24	1,5	–	5,5	14,5	2,2	25
–	XC7020-E-T-P4S	–	1,42	100	150	24	1,5	–	5,5	14,5	2,2	25
–	–	B7220-C-T-P4S	3,35	100	180	34	2,1	2,1	–	–	–	15
–	–	B7220-E-T-P4S	3,34	100	180	34	2,1	2,1	–	–	–	25
–	–	HCB7220-C-T-P4S	2,89	100	180	34	2,1	2,1	–	–	–	15
–	–	HCB7220-E-T-P4S	2,88	100	180	34	2,1	2,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

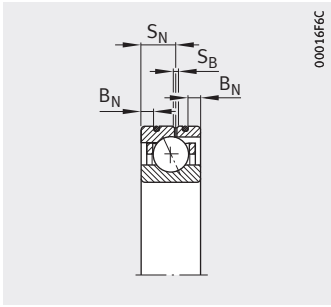
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

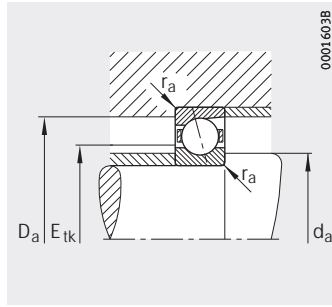
⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7020-C-2RSD-T-P4S-UL and HSS7020-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.

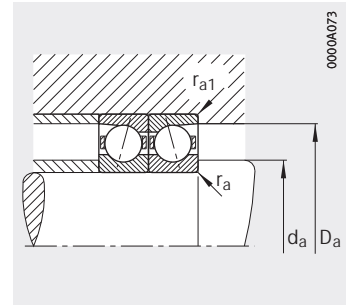
⁶⁾ Ordering examples for Direct Lube design: HCB7020-EDLR-T-P4S-UL and HC7020-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



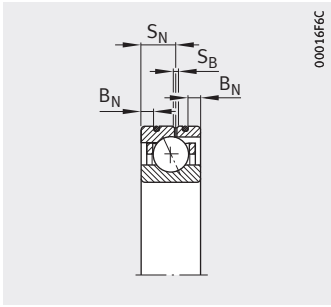
Mounting dimensions



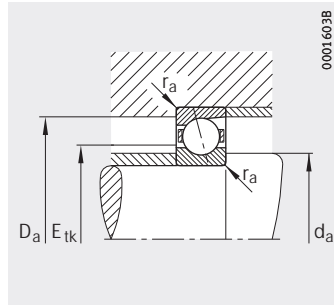
Mounting dimensions



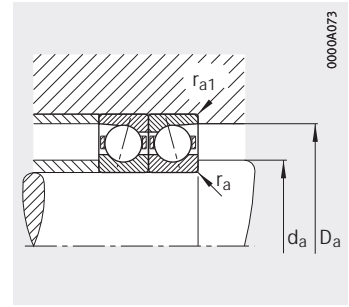
Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
d _a	D _a	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _V			K _{aE}			c _a		
h12	H12	max.		nom.	kN	kN	min ⁻¹	min ⁻¹	L	M	H	L	M	H	L	M	H
									N	N	N	N	N	N	N/μm	N/μm	N/μm
107	133	0,6	0,6	117,2	60	45	9 500	14 000	316	1 040	2 101	968	3 432	7 399	94,1	159,8	227,5
107	133	0,6	0,6	117,2	57	42,5	8 500	13 000	450	1 616	3 417	1 305	4 839	10 556	218,7	353,4	478,9
107	133	0,6	0,6	117,2	60	43	13 000	20 000	160	572	1 201	473	1 789	3 950	80,4	135	189,1
107	133	0,6	0,6	117,2	57	40,5	12 000	18 000	204	850	1 876	584	2 489	5 611	186,8	311,4	420,5
107	133	0,6	0,6	117,2	56	40,5	11 000	17 000	273	819	1 638	796	2 457	5 052	138,8	210,1	278,1
107	133	0,6	0,6	117,2	56	38,5	14 000	22 000	187	560	1 121	540	1 653	3 377	136,8	204,2	246,9
107	133	0,6	0,6	116,7	28,5	23,5	13 000	20 000	97	291	583	289	906	1 883	64,6	100,7	136,8
107	133	0,6	0,6	116,7	27	22,1	12 000	18 000	158	474	949	455	1 390	2 832	162,9	241,8	314,3
107	133	0,6	0,6	116,7	27	21,2	15 000	24 000	109	328	656	313	951	1 927	162	238,5	307,3
107	133	0,6	0,6	116,7	41	21,2	17 000	26 000	109	328	656	313	951	1 927	162	238,5	307,3
110	141	1,5	0,6	118,6	83	57	9 000	14 000	464	1 484	2 970	1 427	4 935	10 539	103,5	174,8	248,43
110	141	1,5	0,6	118,6	79	55	8 000	13 000	681	2 336	4 869	1 982	7 018	15 103	241,9	385,4	520,6
110	141	1,5	0,6	118,6	83	55	13 000	19 000	241	823	1 703	717	2 587	5 636	89,1	147,5	206
110	141	1,5	0,6	118,6	79	52	11 000	17 000	333	1 266	2 723	957	3 715	8 170	211,8	342,6	459,3
110	141	1,5	0,6	118,6	77	51,1	11 000	16 000	355	1 065	2 129	1 039	3 217	6 630	135,3	205,9	274,1
110	141	1,5	0,6	118,6	77	49	14 000	22 000	246	737	1 474	712	2 186	4 477	133,6	200,4	263
110	141	1,5	0,6	121	36,5	28,5	13 000	19 000	127	382	764	379	1 190	2 476	68,3	106,8	145,3
110	141	1,5	0,6	121	34,5	27	11 000	17 000	207	621	1 242	596	1 822	3 713	172	255,7	332,5
110	141	1,5	0,6	121	34,5	26	15 000	22 000	144	431	863	412	1 252	2 539	171,4	252,5	325,5
110	141	1,5	0,6	121	53	26	16 000	24 000	144	431	863	412	1 252	2 539	171,4	252,5	325,5
114,5	165,5	2,1	2,1	132,4	135	88	7 500	12 000	789	2 466	4 892	2 439	8 230	17 428	120,8	202,5	287,2
114,5	165,5	2,1	2,1	132,4	129	84	6 700	10 000	1 208	3 964	8 152	3 521	11 940	25 355	285,4	448,6	603,7
114,5	165,5	2,1	2,1	132,4	135	84	9 500	16 000	428	1 400	2 856	1 279	4 420	9 498	105,5	172,4	239,8
114,5	165,5	2,1	2,1	132,4	129	80	8 000	13 000	627	2 198	4 619	1 806	6 466	13 894	254,9	401,6	515,3



Design DLR⁶⁾



Mounting dimensions



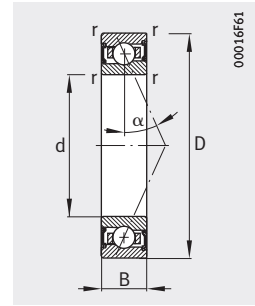
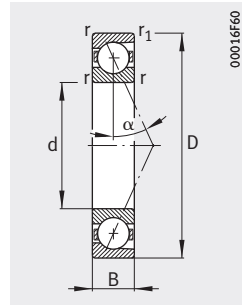
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
d _a h12	D _a H12	r _a max.	r _{a1} nom.	E _{tk} nom.	dyn. C _r kN	stat. C _{0r} kN	n _G grease min ⁻¹	n _G oil ⁵⁾ min ⁻¹	F _v			K _{aE}			c _a		
									L N	M N	H N	L N	M N	H N	L N/μm	M N/μm	H N/μm
112	138	0,6	0,6	121,2	60	45	9 000	14 000	316	1 040	2 101	968	3 432	7 399	94,1	159,8	227,5
112	138	0,6	0,6	121,2	57	42,5	8 000	13 000	450	1 616	3 417	1 305	4 839	10 556	218,7	353,4	478,9
112	138	0,6	0,6	121,2	60	43	13 000	19 000	157	564	1 185	466	1 763	3 895	80	134,2	187,9
112	138	0,6	0,6	121,2	57	41	11 000	17 000	204	850	1 876	584	2 489	5 611	186,8	311,4	420,5
112	138	0,6	0,6	121,2	56	40,5	11 000	16 000	268	805	1 609	782	2 412	4 959	137,9	208,6	276
112	138	0,6	0,6	121,2	56	39	14 000	22 000	187	560	1 121	540	1 653	3 377	136,8	204,2	246,9
112	138	0,6	0,6	121,7	29	24,8	13 000	19 000	101	302	603	299	937	1 946	67,6	105,3	143
112	138	0,6	0,6	121,7	27,5	23,4	11 000	17 000	161	483	966	463	1 414	2 880	169,6	251,7	326,8
112	138	0,6	0,6	121,7	27,5	22,4	15 000	22 000	113	338	676	323	980	1 987	169,5	249,5	321,3
112	138	0,6	0,6	121,7	42	22,4	16 000	24 000	113	338	676	323	980	1 987	169,5	249,5	321,3
116	150	2	1	125,8	85	61	8 500	13 000	471	1 511	3 027	1 447	5 010	10 710	107	180,5	256,48
116	150	2	1	125,8	80	58	7 500	12 000	691	2 377	4 959	2 010	7 133	15 359	250,5	399,1	538,9
116	150	2	1	125,8	85	58	12 000	18 000	244	836	1 732	725	2 623	5 718	92,1	152,5	212,8
116	150	2	1	125,8	80	55	11 000	16 000	336	1 285	2 768	966	3 768	8 297	219	354,7	475,5
116	150	2	1	125,8	79	54	10 000	16 000	364	1 092	2 184	1 065	3 296	6 793	140,6	213,9	284,6
116	150	2	1	125,8	79	52	13 000	20 000	255	764	1 529	738	2 267	4 641	139,5	209,1	274,4
116	150	2	1	127,9	47,5	36,5	12 000	18 000	164	492	985	489	1 536	3 194	75	117,3	159,7
116	150	2	1	127,9	45	34,5	11 000	16 000	267	802	1 604	770	2 354	4 797	189	280,9	365,4
116	150	2	1	127,9	45	33	14 000	22 000	184	552	1 104	527	1 602	3 250	187,7	276,5	356,5
116	150	2	1	127,9	69	33	15 000	24 000	184	552	1 104	527	1 602	3 250	187,7	276,5	356,5
120,5	174,5	2,1	2,1	139,9	164	104	7 000	11 000	989	3 069	6 072	3 060	10 252	21 655	131	219,1	310,5
120,5	174,5	2,1	2,1	139,9	156	99	6 300	9 500	1 545	5 006	10 249	4 508	15 092	31 918	311,5	487,7	655,6
120,5	174,5	2,1	2,1	139,9	164	99	9 000	15 000	536	1 733	3 524	1 603	5 476	11 721	114,4	186,1	258,4
120,5	174,5	2,1	2,1	139,9	156	95	7 500	12 000	800	2 742	5 723	2 303	8 067	17 220	277,7	434,3	558,7

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed
 Design DLR



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions							Contact angle α °	
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁	B _N	S _N		S _B
							min.					
B71922-C-T-P4S	–	–	0,834	110	150	20	1,1	1,1	–	–	–	15
B71922-E-T-P4S	–	–	0,832	110	150	20	1,1	1,1	–	–	–	25
HCB71922-C-T-P4S	–	–	0,715	110	150	20	1,1	1,1	4	12	2,2	15
HCB71922-E-T-P4S	–	–	0,713	110	150	20	1,1	1,1	4	12	2,2	25
RS71922-D-T-P4S	–	–	0,85	110	150	20	1,1	1,1	–	–	–	20
HCRS71922-D-T-P4S	–	–	0,7	110	150	20	1,1	1,1	4	12	2,2	20
HS71922-C-T-P4S	–	–	0,913	110	150	20	1,1	–	–	–	–	15
HS71922-E-T-P4S	–	–	0,912	110	150	20	1,1	–	–	–	–	25
HC71922-E-T-P4S	–	–	0,945	110	150	20	1,1	–	4	12	2,2	25
XC71922-E-T-P4S	–	–	0,945	110	150	20	1,1	–	4	12	2,2	25
–	B7022-C-T-P4S	–	1,95	110	170	28	2	2	–	–	–	15
–	B7022-E-T-P4S	–	1,95	110	170	28	2	2	–	–	–	25
–	HCB7022-C-T-P4S	–	1,62	110	170	28	2	2	6	16,2	2,2	15
–	HCB7022-E-T-P4S	–	1,62	110	170	28	2	2	6	16,2	2,2	25
–	RS7022-D-T-P4S	–	1,94	110	170	28	2	2	–	–	–	20
–	HCRS7022-D-T-P4S	–	1,94	110	170	28	2	2	6	16,2	2,2	20
–	HS7022-C-T-P4S	–	2,17	110	170	28	2	–	–	–	–	15
–	HS7022-E-T-P4S	–	2,17	110	170	28	2	–	–	–	–	25
–	HC7022-E-T-P4S	–	2,21	110	170	28	2	–	6	16,2	2,2	25
–	XC7022-E-T-P4S	–	2,21	110	170	28	2	–	6	16,2	2,2	25
–	–	B7222-C-T-P4S	4,6	110	200	38	2,1	2,1	–	–	–	15
–	–	B7222-E-T-P4S	4,59	110	200	38	2,1	2,1	–	–	–	25
–	–	HCB7222-C-T-P4S	3,97	110	200	38	2,1	2,1	–	–	–	15
–	–	HCB7222-E-T-P4S	3,96	110	200	38	2,1	2,1	–	–	–	25

¹⁾ Explanation of short designations, see page 145.

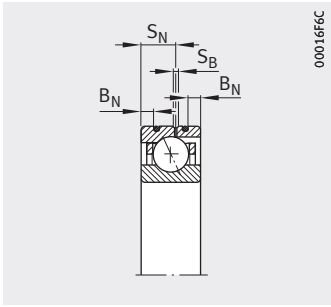
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

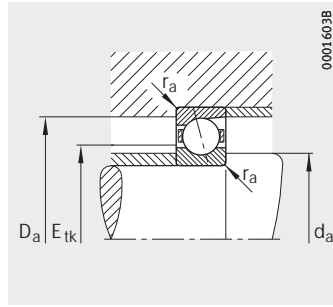
⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7022-C-2RSD-T-P4S-UL and HSS7022-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.

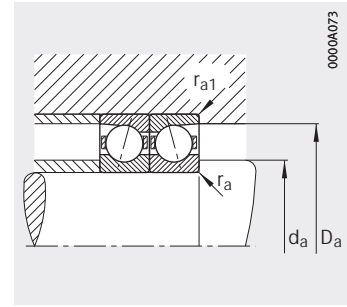
⁶⁾ Ordering examples for Direct Lube design: HCB7022-EDLR-T-P4S-UL and HC7022-EDLR-T-P4S-UL.
 DLR only up to bore code 22.



Design DLR⁶⁾



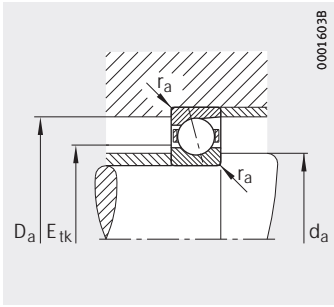
Mounting dimensions



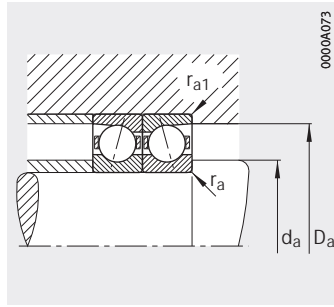
Mounting dimensions



Mounting dimensions					Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
d _a h12	D _a H12	r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	F _v			K _{aE}			c _a		
									L	M	H	L	M	H	L	M	H
		max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
117	143	0,6	0,6	126,2	61	47	8 500	13 000	314	1 038	2 102	961	3 415	7 373	96,1	163	231,8
117	143	0,6	0,6	126,2	58	44,5	8 000	12 000	455	1 642	3 475	1 321	4 913	10 722	225,3	364,1	493,4
117	143	0,6	0,6	126,2	61	45	12 000	19 000	158	570	1 199	468	1 777	3 931	82,1	137,8	192,8
117	143	0,6	0,6	126,2	58	42,5	11 000	17 000	208	871	1 923	596	2 547	5 747	192,9	322	434,9
117	143	0,6	0,6	126,2	57	42,5	10 000	16 000	273	819	1 638	795	2 454	5 043	142,3	215,1	284,5
117	143	0,6	0,6	126,2	57	40,5	13 000	20 000	192	575	1 150	553	1 695	3 462	141,5	211,2	255,2
117	143	0,6	0,6	126,4	34	28,5	12 000	19 000	116	347	693	344	1 077	2 238	70,6	109,9	149,3
117	143	0,6	0,6	126,4	32	27	11 000	17 000	187	561	1 121	538	1 642	3 344	177,7	263,7	342,5
117	143	0,6	0,6	126,4	32	26	14 000	22 000	131	393	787	375	1 141	2 312	177,7	261,6	337
117	143	0,6	0,6	126,4	49	26	16 000	24 000	131	393	787	375	1 141	2 312	177,7	261,6	337
121	159	2	1	133,3	112	77	8 000	12 000	643	2 033	4 052	1 981	6 757	14 370	118,8	199,6	283,13
121	159	2	1	133,3	106	73	7 500	12 000	968	3 242	6 709	2 820	9 745	20 814	280,1	442,5	596,2
121	159	2	1	133,3	112	74	12 000	18 000	337	1 126	2 314	1 004	3 540	7 655	102,6	168,5	234,4
121	159	2	1	133,3	106	70	11 000	16 000	490	1 779	3 778	1 409	5 224	11 341	248	395,1	527,4
121	159	2	1	133,3	105	71	9 500	15 000	491	1 474	2 948	1 439	4 455	9 185	155,2	236,3	314,6
121	159	2	1	133,3	105	68	12 000	19 000	334	1 003	2 007	969	2 975	6 092	152,3	228,3	299,6
121	159	2	1	135,4	48	38	12 000	18 000	168	503	1 005	499	1 566	3 257	77,2	120,5	164,1
121	159	2	1	135,4	45,5	35,5	11 000	16 000	267	802	1 604	770	2 352	4 792	193	286,7	372,8
121	159	2	1	135,4	46,5	34	13 000	20 000	187	561	1 121	535	1 627	3 299	192,8	283,9	366
121	159	2	1	135,4	69	34	14 000	22 000	187	561	1 121	535	1 627	3 299	192,8	283,9	366
126,5	183,5	2,1	2,1	147,4	164	105	6 700	10 000	989	3 069	6 072	3 060	10 252	21 655	131	219,1	310,5
126,5	183,5	2,1	2,1	147,4	156	100	6 000	9 000	1 512	4 905	10 048	4 410	14 777	31 257	309,1	483,8	650,1
126,5	183,5	2,1	2,1	147,4	164	101	8 500	14 000	536	1 733	3 524	1 603	5 476	11 721	114,4	186,1	258,4
126,5	183,5	2,1	2,1	147,4	156	96	7 000	10 000	800	2 742	5 723	2 303	8 067	17 220	277,7	434,3	558,7



Mounting dimensions



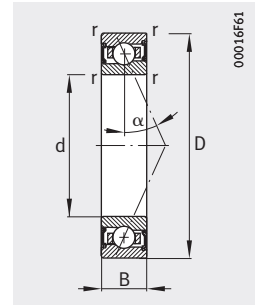
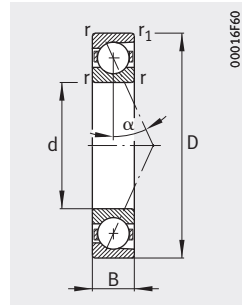
Mounting dimensions



			Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾ F _V			Lift-off force ³⁾ K _{aE}			Axial rigidity ³⁾ c _a		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
0,6	0,6	138,2	76	59	8 000	12 000	405	1 321	2 665	1 239	4 349	9 350	108,9	183,8	261,1
0,6	0,6	138,2	72	56	7 000	11 000	587	2 073	4 361	1 705	6 203	13 450	255,1	409,3	553,1
0,6	0,6	138,2	76	57	11 000	17 000	208	732	1 530	616	2 286	5 019	93,7	156	217,8
0,6	0,6	138,2	72	54	10 000	15 000	274	1 101	2 407	785	3 223	7 191	220,1	362,1	487,1
0,6	0,6	138,2	71	54	9 500	14 000	340	1 020	2 041	990	3 055	6 277	159,2	240,5	318
0,6	0,6	138,2	71	52	12 000	19 000	235	704	1 408	678	2 074	4 235	157,4	234,7	285,6
0,6	0,6	138,9	35,5	32	11 000	17 000	122	367	734	363	1 137	2 362	76,8	119,4	162
0,6	0,6	138,9	33,5	30	10 000	15 000	196	587	1 173	562	1 716	3 492	193	286,1	371,2
0,6	0,6	138,9	33,5	29	13 000	20 000	136	407	814	388	1 179	2 389	192,3	282,9	364,1
0,6	0,6	138,9	51	29	14 000	22 000	136	407	814	388	1 179	2 389	192,3	282,9	364,1
2	1	143,3	115	82	7 500	12 000	653	2 069	4 129	2 008	6 858	14 599	123	206,4	292,62
2	1	143,3	109	78	6 700	10 000	983	3 298	6 830	2 860	9 902	21 158	290,4	458,9	617,9
2	1	143,3	115	78	10 000	16 000	350	1 170	2 406	1 042	3 677	7 953	107,3	176,1	245
2	1	143,3	109	75	9 500	14 000	496	1 810	3 849	1 427	5 313	11 543	257,2	410	547,2
2	1	143,3	108	75	9 000	14 000	501	1 502	3 003	1 464	4 533	9 341	161,1	245,1	326
2	1	143,3	108	72	11 000	18 000	341	1 024	2 048	988	3 034	6 209	158,3	237,1	311
2	1	145,4	49,5	40,5	10 000	16 000	171	513	1 025	508	1 594	3 313	80,8	126	171,3
2	1	145,4	46,5	38,5	9 500	14 000	276	828	1 656	795	2 426	4 942	203,3	301,8	392,2
2	1	145,4	46,5	36,5	12 000	19 000	193	578	1 156	552	1 676	3 398	202,9	298,7	384,9
2	1	145,4	71	36,5	13 000	20 000	193	578	1 156	552	1 676	3 398	202,9	298,7	384,9
2,1	2,1	158	205	138	6 000	9 000	1 259	3 882	7 683	3 878	12 884	27 179	139	230,8	326
2,1	2,1	158	196	132	5 300	8 000	1 989	6 365	12 984	5 797	19 139	40 275	333,3	518,3	694,2
2,1	2,1	158	205	132	7 500	12 000	688	2 196	4 452	2 051	6 906	14 713	122	196,8	272,1
2,1	2,1	158	196	126	6 700	9 500	1 055	3 535	7 327	3 037	10 386	21 994	300	464,7	598,7

Spindle bearings

With large or small balls
 Steel or ceramic balls
 Steel or Cronidur rings
 Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719 ⁴⁾	Series 70 ⁴⁾	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
							min.				
B71926-C-T-P4S	–	–	1,52	130	180	24	1,5	1,5	15	139	171
B71926-E-T-P4S	–	–	1,51	130	180	24	1,5	1,5	25	139	171
HCB71926-C-T-P4S	–	–	1,34	130	180	24	1,5	1,5	15	139	171
HCB71926-E-T-P4S	–	–	1,33	130	180	24	1,5	1,5	25	139	171
RS71926-D-T-P4S	–	–	1,52	130	180	24	1,5	1,5	20	139	171
HCRS71926-D-T-P4S	–	–	1,34	130	180	24	1,5	1,5	20	139	171
HS71926-C-T-P4S	–	–	1,71	130	180	24	1,5	–	15	139	171
HS71926-E-T-P4S	–	–	1,71	130	180	24	1,5	–	25	139	171
HC71926-E-T-P4S	–	–	1,76	130	180	24	1,5	–	25	139	171
XC71926-E-T-P4S	–	–	1,76	130	180	24	1,5	–	25	139	171
–	B7026-C-T-P4S	–	3,16	130	200	33	2	2	15	142	189
–	B7026-E-T-P4S	–	3,15	130	200	33	2	2	25	142	189
–	HCB7026-C-T-P4S	–	2,63	130	200	33	2	2	15	142	189
–	HCB7026-E-T-P4S	–	2,61	130	200	33	2	2	25	142	189
–	RS7026-D-T-P4S	–	3,16	130	200	33	2	2	20	142	189
–	HCRS7026-D-T-P4S	–	3,16	130	200	33	2	2	20	142	189
–	HS7026-C-T-P4S	–	3,52	130	200	33	2	–	15	142	189
–	HS7026-E-T-P4S	–	3,51	130	200	33	2	–	25	142	189
–	HC7026-E-T-P4S	–	3,57	130	200	33	2	–	25	142	189
–	XC7026-E-T-P4S	–	3,57	130	200	33	2	–	25	142	189
–	–	B7226-C-T-P4S	6,11	130	230	40	3	3	15	148	211,5
–	–	B7226-E-T-P4S	6,09	130	230	40	3	3	25	148	211,5
–	–	HCB7226-C-T-P4S	4,94	130	230	40	3	3	15	148	211,5
–	–	HCB7226-E-T-P4S	4,92	130	230	40	3	3	25	148	211,5

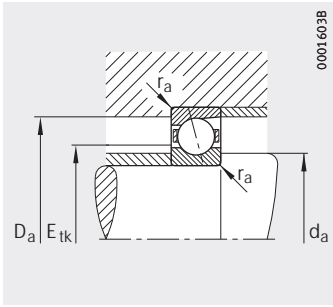
¹⁾ Explanation of short designations, see page 145.

²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

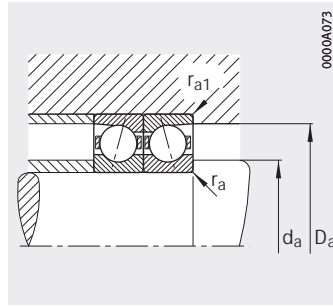
³⁾ Explanation, see page 70.

⁴⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering examples: B7026-C-2RSD-T-P4S-UL and HSS7026-E-T-P4S-UL.

⁵⁾ Minimal quantity oil lubrication.



Mounting dimensions



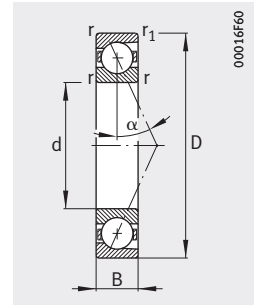
Mounting dimensions



			Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾ F _V			Lift-off force ³⁾ K _{aE}			Axial rigidity ³⁾ c _a		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁵⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
0,6	0,6	150,2	90	70	7 000	11 000	486	1 571	3 160	1 488	5 171	11 084	116,9	196,6	278,7
0,6	0,6	150,2	85	67	6 700	10 000	711	2 466	5 161	2 064	7 379	15 916	274,5	437,6	590,2
0,6	0,6	150,2	90	68	10 000	15 000	253	875	1 819	750	2 732	5 967	101,1	167,2	232,9
0,6	0,6	150,2	46,5	28,5	9 000	14 000	346	1 342	2 904	993	3 929	8 680	240,4	390,6	523,7
0,6	0,6	150,2	84	63	8 500	13 000	407	1 221	2 443	1 186	3 658	7 517	170,6	257,8	340,9
0,6	0,6	150,2	84	60	11 000	17 000	280	841	1 681	809	2 477	5 058	168,5	251,3	308,2
0,6	-	151	40,5	36,5	10 000	16 000	139	417	834	413	1 291	2 682	81,1	126	170,8
0,6	-	151	38,5	34,5	9 000	14 000	224	673	1 346	645	1 968	4 004	204,5	303,1	393,3
0,6	-	151	38,5	33	12 000	18 000	155	466	932	444	1 349	2 732	203,7	299,5	385,4
0,6	-	151	59	33	13 000	20 000	155	466	932	444	1 349	2 732	203,7	299,5	385,4
2	1	157,2	149	107	6 700	10 000	850	2 669	5 314	2 616	8 846	18 773	137	228,8	323,9
2	1	157,2	141	102	6 000	9 500	1 312	4 328	8 915	3 820	13 001	27 627	326,2	512,3	688,5
2	1	157,2	149	102	9 500	14 000	464	1 524	3 119	1 381	4 791	10 306	120,2	196,1	272,2
2	1	157,2	141	97	8 500	13 000	679	2 399	5 054	1 953	7 044	15 161	291,2	459,4	611,1
2	1	157,2	138	96	8 000	12 000	637	1 911	3 822	1 863	5 765	11 878	177,8	270,3	359,4
2	1	157,2	138	91	10 000	16 000	446	1 338	2 675	1 291	3 965	8 116	176,4	264,3	346,7
2	-	159,7	64	53	9 500	15 000	219	658	1 317	653	2 046	4 251	91,8	143	194,3
2	-	159,7	60	50	8 500	13 000	357	1 070	2 139	1 026	3 133	6 381	231,4	343,5	446,3
2	-	159,7	60	48	11 000	17 000	244	733	1 466	700	2 126	4 308	229,6	337,9	435,2
2	-	159,7	92	48	12 000	19 000	244	733	1 466	700	2 126	4 308	229,6	337,9	435,2
2,5	2,5	170,5	215	151	5 600	8 500	1 306	4 034	7 993	4 018	13 354	28 189	147	243,7	343,9
2,5	2,5	170,5	205	144	5 000	7 500	2 065	6 617	13 506	6 015	19 876	41 831	353,1	548,7	734,5
2,5	2,5	170,5	215	144	7 000	11 000	716	2 288	4 642	2 132	7 184	15 307	129,2	208,3	287,8
2,5	2,5	170,5	205	138	6 000	9 000	1 098	3 687	7 648	3 160	10 826	22 934	318,1	492,9	634,6

Spindle bearings

With large balls
Steel or ceramic balls
Steel rings
Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71928-C-T-P4S⁵⁾	–	–	1,62	140	190	24	1,5	1,5	15	149	181
B71928-E-T-P4S⁵⁾	–	–	1,61	140	190	24	1,5	1,5	25	149	181
HCB71928-C-T-P4S⁵⁾	–	–	1,42	140	190	24	1,5	1,5	15	149	181
HCB71928-E-T-P4S⁵⁾	–	–	1,42	140	190	24	1,5	1,5	25	149	181
–	B7028-C-T-P4S⁵⁾	–	3,35	140	210	33	2	2	15	152	199
–	B7028-E-T-P4S⁵⁾	–	3,34	140	210	33	2	2	25	152	199
–	–	B7228-C-T-P4S	7,88	140	250	42	3	3	15	163	226,5
–	–	B7228-E-T-P4S	7,86	140	250	42	3	3	25	163	226,5
–	HCB7028-C-T-P4S⁵⁾	–	2,79	140	210	33	2	2	15	152	199
–	HCB7028-E-T-P4S⁵⁾	–	2,78	140	210	33	2	2	25	152	199
–	–	HCB7228-C-T-P4S	6,62	140	250	42	3	3	15	163	226,5
–	–	HCB7228-E-T-P4S	6,6	140	250	42	3	3	25	163	226,5
B71930-C-T-P4S	–	–	2,5	150	210	28	2	1	15	160	199
B71930-E-T-P4S	–	–	2,5	150	210	28	2	1	25	160	199
HCB71930-C-T-P4S	–	–	2,09	150	210	28	2	1	15	160	199
HCB71930-E-T-P4S	–	–	2,08	150	210	28	2	1	25	160	199
–	B7030-C-T-P4S	–	4,04	150	225	35	2,1	2,1	15	163	213
–	B7030-E-T-P4S	–	4,03	150	225	35	2,1	2,1	25	163	213
–	HCB7030-C-T-P4S	–	3,25	150	225	35	2,1	2,1	15	163	213
–	HCB7030-E-T-P4S	–	3,24	150	225	35	2,1	2,1	25	163	213
–	–	B7230-C-T-P4S	10,1	150	270	45	3	3	15	178	241,5
–	–	B7230-E-T-P4S	10,1	150	270	45	3	3	25	178	241,5
–	–	HCB7230-C-T-P4S	8,82	150	270	45	3	3	15	178	241,5
–	–	HCB7230-E-T-P4S	8,79	150	270	45	3	3	25	178	241,5

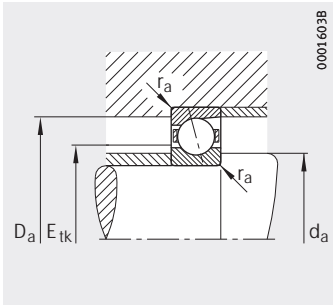
¹⁾ Explanation of short designations, see page 145.

²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

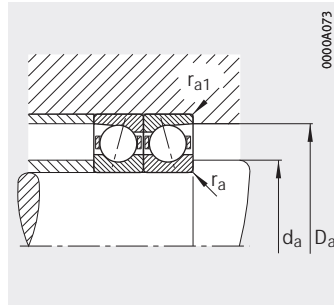
³⁾ Explanation, see page 70.

⁴⁾ Minimal quantity oil lubrication.

⁵⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
Ordering examples: B7028-C-2RSD-T-P4S-UL



Mounting dimensions



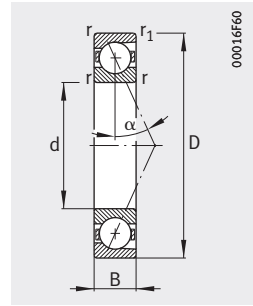
Mounting dimensions



			Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾ F _V			Lift-off force ³⁾ K _{aE}			Axial rigidity ³⁾ c _a		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁴⁾	L	M	H	L	M	H	L	M	H
max.	nom.	nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
0,6	0,6	160,2	94	77	6 700	10 000	504	1 632	3 289	1 539	5 357	11 496	124,1	208,4	295,3
0,6	0,6	160,2	88	72	6 000	9 500	736	2 564	5 373	2 136	7 663	16 542	292	465,7	627,7
0,6	0,6	160,2	94	74	9 500	14 000	259	901	1 876	767	2 806	6 135	107	176,9	246,1
0,6	0,6	160,2	89	70	8 500	13 000	348	1 367	2 967	999	3 997	8 852	253,4	412,9	553,5
2	1	167,2	153	114	6 300	10 000	866	2 724	5 429	2 661	9 007	19 129	142	237	335,23
2	1	167,2	145	108	5 600	9 000	1 336	4 416	9 103	3 888	13 252	28 168	338,7	531,9	714,4
2,5	2,5	185,5	224	164	5 000	7 500	1 353	4 185	8 302	4 158	13 825	29 200	154,9	256,5	361,7
2,5	2,5	185,5	213	157	4 500	6 700	2 141	6 870	14 029	6 233	20 615	43 390	372,7	579	774,7
2	1	167,2	153	109	9 000	14 000	471	1 553	3 179	1 402	4 871	10 483	124,6	203,1	281,8
2	1	167,2	145	103	8 000	12 000	685	2 429	5 123	1 968	7 126	15 352	301,5	475,8	632,8
2,5	2,5	185,5	224	157	6 300	9 500	749	2 397	4 864	2 230	7 516	16 017	136,8	220,4	304,3
2,5	2,5	185,5	213	150	5 300	8 000	1 141	3 839	7 968	3 284	11 267	23 876	336,3	521,1	670,5
1	1	174,3	125	101	6 300	9 500	706	2 249	4 507	2 161	7 402	15 795	140,7	235,3	332,8
1	1	174,3	119	95	5 600	8 500	1 040	3 522	7 317	3 021	10 536	22 549	331,3	523,5	703,6
1	1	174,3	125	96	8 500	13 000	376	1 268	2 617	1 117	3 963	8 587	122,8	201,2	279,3
1	1	174,3	119	91	7 500	12 000	527	1 950	4 164	1 513	5 709	12 445	294,1	470,3	627,4
2,1	1	178,5	187	137	6 000	9 000	1 104	3 443	6 843	3 394	11 397	24 140	156,1	259,9	367,4
2,1	1	178,5	178	130	5 300	8 000	1 691	5 520	11 332	4 923	16 566	35 067	371	580	777,9
2,1	1	178,5	187	131	8 000	13 000	602	1 958	3 992	1 793	6 146	13 171	137,1	222,4	308,1
2,1	1	178,5	178	125	7 500	11 000	889	3 079	6 448	2 556	9 036	19 329	333,1	521,6	692
2,5	2,5	200,5	232	178	4 500	6 700	1 401	4 337	8 611	4 299	14 296	30 211	162,8	269,3	379,5
2,5	2,5	200,5	221	169	4 000	6 000	2 173	6 987	14 280	6 322	20 936	44 075	389,5	604,8	808,4
2,5	2,5	200,5	232	170	6 000	8 500	761	2 440	4 958	2 262	7 633	16 272	142,9	229,9	317
2,5	2,5	200,5	221	162	5 000	7 500	1 167	3 935	8 175	3 355	11 539	24 467	352,4	546,3	702,3

Spindle bearings

With large balls
 Steel or ceramic balls
 Steel rings
 Open or sealed



Dimension table (continued) · Dimensions in mm

Designation ¹⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71932-C-T-P4S⁵⁾	–	–	2,63	160	220	28	2	1	15	170	209
B71932-E-T-P4S⁵⁾	–	–	2,62	160	220	28	2	1	25	170	209
HCB71932-C-T-P4S⁵⁾	–	–	2,21	160	220	28	2	1	15	170	209
HCB71932-E-T-P4S⁵⁾	–	–	2,2	160	220	28	2	1	25	170	209
–	B7032-C-T-P4S	–	5,04	160	240	38	2,1	2,1	15	174	228
–	B7032-E-T-P4S	–	5,01	160	240	38	2,1	2,1	25	174	228
–	–	B7232-C-T-P4S	12,9	160	290	48	3	3	15	191	259
–	–	B7232-E-T-P4S	12,9	160	290	48	3	3	25	191	259
–	HCB7032-C-T-P4S	–	4,2	160	240	38	2,1	2,1	15	174	228
–	HCB7032-E-T-P4S	–	4,18	160	240	38	2,1	2,1	25	174	228
–	–	HCB7232-C-T-P4S	11,4	160	290	48	3	3	15	191	259
–	–	HCB7232-E-T-P4S	11,4	160	290	48	3	3	25	191	259
B71934-C-T-P4S	–	–	2,79	170	230	28	2	1,5	15	180	219
B71934-E-T-P4S	–	–	2,78	170	230	28	2	1,5	25	180	219
HCB71934-C-T-P4S	–	–	2,33	170	230	28	2	1,5	15	180	219
HCB71934-E-T-P4S	–	–	2,32	170	230	28	2	1,5	25	180	219
–	B7034-C-T-P4S	–	6,52	170	260	42	2,1	2,1	15	185	246
–	B7034-E-T-P4S	–	6,49	170	260	42	2,1	2,1	25	185	246
–	–	B7234-C-T-P4S	15,7	170	310	52	4	4	15	205	275
–	–	B7234-E-T-P4S	15,6	170	310	52	4	4	25	205	275
B71936-C-T-P4S	–	–	4,14	180	250	33	2	1	15	192	238
B71936-E-T-P4S	–	–	4,12	180	250	33	2	1	25	192	238
HCB71936-C-T-P4S	–	–	3,45	180	250	33	2	1	15	192	238
HCB71936-E-T-P4S	–	–	3,43	180	250	33	2	1	25	192	238
–	B7036-C-T-P4S	–	8,79	180	280	46	2,1	2,1	15	196	264
–	B7036-E-T-P4S	–	8,76	180	280	46	2,1	2,1	25	196	264
–	–	B7236-C-T-P4S	16,4	180	320	52	4	4	15	213,5	286,5
–	–	B7236-E-T-P4S	16,3	180	320	52	4	4	25	213,5	286,5

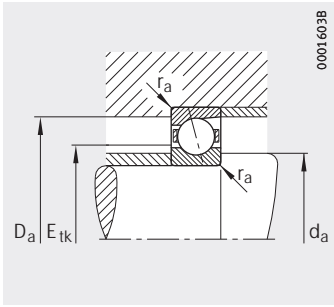
¹⁾ Explanation of short designations, see page 145.

²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

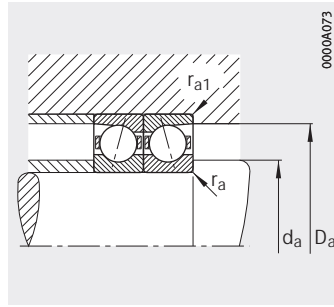
³⁾ Explanation, see page 70.

⁴⁾ Minimal quantity oil lubrication.

⁵⁾ The bearings are also available with gap seals (type HSS, HCS, XCS or suffix 2RSD).
 Ordering example: B71932-C-2RSD-T-P4S-UL.



Mounting dimensions



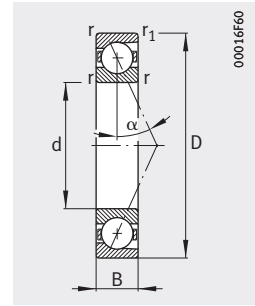
Mounting dimensions



			Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
r_a	r_{a1}	E_{tk}	dyn. C_r	stat. C_{Or}	n_G grease	n_G oil ⁴⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/ μ m	N/ μ m	N/ μ m
1	1	184,3	128	106	6 000	9 000	722	2 304	4 619	2 209	7 572	16 164	145,4	242,9	343,5
1	1	184,3	121	100	5 300	8 000	1 055	3 579	7 439	3 062	10 696	22 899	341,4	539,4	724,8
1	1	184,3	128	101	8 000	12 000	374	1 265	2 614	1 108	3 944	8 551	125,5	205,5	285
1	1	184,3	121	96	7 500	11 000	521	1 940	4 152	1 495	5 676	12 392	300,5	481,2	641,9
2	1	191	192	146	5 600	8 500	1 145	3 574	7 107	3 520	11 821	25 044	163,1	271,4	383,56
2	1	191	182	138	5 000	7 500	1 715	5 606	11 519	4 988	16 807	35 587	384,6	601,1	805,7
2,5	2,5	215,5	249	202	4 300	6 300	1 502	4 659	9 263	4 601	15 309	32 375	178,8	295,3	415,7
2,5	2,5	215,5	236	192	3 800	5 600	2 326	7 493	15 324	6 760	22 418	47 204	428,5	665	888,2
2	1	191	192	140	7 500	12 000	609	1 986	4 053	1 812	6 221	13 337	141,9	230	318,3
2	1	191	182	132	7 000	11 000	898	3 121	6 545	2 581	9 154	19 595	345	540,5	716,9
2,5	2,5	215,5	249	193	5 300	8 000	827	2 657	5 402	2 457	8 298	17 692	158	254	350,1
2,5	2,5	215,5	236	184	4 500	6 700	1 235	4 183	8 703	3 550	12 254	26 003	386,5	599,3	769,6
1	1	194,3	133	115	5 600	8 500	742	2 375	4 770	2 266	7 779	16 624	153,6	256,2	362
1	1	194,3	126	108	5 000	7 500	1 105	3 757	7 816	3 206	11 221	24 031	364,1	575,2	772,6
1	1	194,3	133	110	7 500	12 000	385	1 306	2 703	1 138	4 063	8 815	132,8	217,4	301,2
1	1	194,3	126	104	7 000	11 000	534	2 004	4 295	1 533	5 856	12 804	318,2	510,3	680,6
2	1	203,8	241	189	5 300	8 000	1 448	4 488	8 919	4 439	14 768	31 222	170,7	282	397,19
2	1	203,8	229	180	4 500	7 000	2 250	7 240	14 802	6 541	21 677	45 639	409	634,9	848,3
3	3	228,6	300	255	3 800	5 600	1 864	5 749	11 422	5 698	18 828	39 747	189	310,7	436,3
3	3	228,6	285	241	3 600	5 300	2 860	9 126	18 610	8 307	27 255	57 164	452,4	698,5	930,4
1	1	208,3	171	146	5 300	8 000	960	3 036	6 076	2 933	9 953	21 191	167,9	279,1	393,7
1	1	208,3	162	138	4 500	7 000	1 468	4 890	10 108	4 263	14 618	31 112	401,6	630,3	845
1	1	208,3	171	139	7 000	11 000	519	1 726	3 546	1 540	5 380	11 597	147,6	240	332
1	1	208,3	162	132	6 300	10 000	731	2 635	5 587	2 098	7 710	16 669	354,4	561	745,5
2	1	218,8	248	203	4 800	7 500	1 502	4 659	9 263	4 601	15 309	32 375	178,8	295,3	415,74
2	1	218,8	236	193	4 300	6 700	2 326	7 493	15 324	6 760	22 418	47 204	428,5	665	888,2
3	3	238,6	310	270	3 800	5 600	1 891	5 843	11 625	5 771	19 076	40 296	196,7	322,6	452,6
3	3	238,6	295	260	3 400	5 000	2 957	9 444	19 266	8 585	28 184	59 117	474,9	733	976

Spindle bearings

With large balls
Steel or ceramic balls
Steel rings
Open



Dimension table (continued) · Dimensions in mm

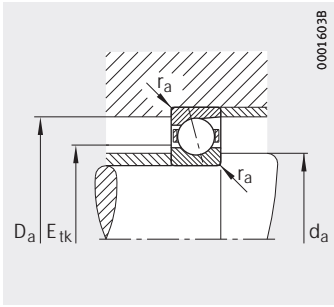
Designation ¹⁾			Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions	
Series 719	Series 70	Series 72		d	D	B	r	r ₁		d _a h12	D _a H12
B71938-C-T-P4S	–	–	4,33	190	260	33	2	1	15	202	247
B71938-E-T-P4S	–	–	4,31	190	260	33	2	1	25	202	247
HCB71938-C-T-P4S	–	–	3,6	190	260	33	2	1	15	202	247
HCB71938-E-T-P4S	–	–	3,58	190	260	33	2	1	25	202	247
–	B7038-C-T-P4S	–	9,2	190	290	46	2,1	2,1	15	206	274
–	B7038-E-T-P4S	–	9,16	190	290	46	2,1	2,1	25	206	274
–	–	B7238-C-T-P4S	20	190	340	55	4	4	15	223,5	306,5
–	–	B7238-E-T-P4S	20	190	340	55	4	4	25	223,5	306,5
B71940-C-T-P4S	–	–	6,05	200	280	38	2,1	1,1	15	214	266
B71940-E-T-P4S	–	–	6,03	200	280	38	2,1	1,1	25	214	266
HCB71940-C-T-P4S	–	–	5,07	200	280	38	2,1	1,1	15	214	266
HCB71940-E-T-P4S	–	–	5,04	200	280	38	2,1	1,1	25	214	266
–	B7040-C-T-P4S	–	11,6	200	310	51	2,1	2,1	15	217	293
–	B7040-E-T-P4S	–	11,6	200	310	51	2,1	2,1	25	217	293
–	–	B7240-C-T-P4S	24,2	200	360	58	4	4	15	238,5	321,5
–	–	B7240-E-T-P4S	24,2	200	360	58	4	4	25	238,5	321,5
B71944-C-T-P4S	–	–	6,6	220	300	38	2,1	1,1	15	234	286
B71944-E-T-P4S	–	–	6,58	220	300	38	2,1	1,1	25	234	286
HCB71944-C-T-P4S	–	–	5,49	220	300	38	2,1	1,1	15	234	286
HCB71944-E-T-P4S	–	–	5,47	220	300	38	2,1	1,1	25	234	286
–	B7044-C-T-P4S	–	15,7	220	340	56	3	3	15	239	321
–	B7044-E-T-P4S	–	15,7	220	340	56	3	3	25	239	321
–	–	B7244-C-T-P4S	33,1	220	400	65	4	4	15	264	356
–	–	B7244-E-T-P4S	33,1	220	400	65	4	4	25	264	356

¹⁾ Explanation of short designations, see page 145.

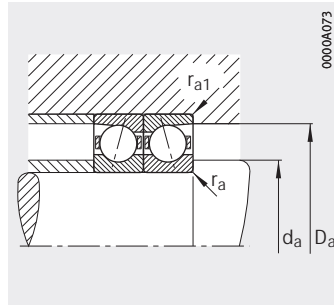
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

⁴⁾ Minimal quantity oil lubrication.



Mounting dimensions



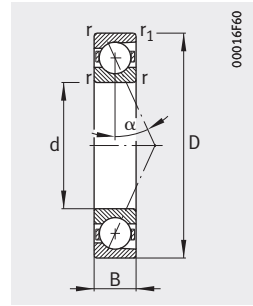
Mounting dimensions



			Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾			Lift-off force ³⁾			Axial rigidity ³⁾		
r _a	r _{a1}	E _{tk}	dyn. C _r	stat. C _{0r}	n _G grease	n _G oil ⁴⁾	L	M	H	L	M	H	L	M	H
max.		nom.	kN	kN	min ⁻¹	min ⁻¹	N	N	N	N	N	N	N/μm	N/μm	N/μm
1	1	218,3	174	152	5 000	7 500	888	2 947	5 992	2 700	9 612	20 790	166,3	280,7	398,1
1	1	218,3	164	144	4 500	6 700	1 250	4 547	9 653	3 619	13 545	29 595	388,3	627	847,4
1	1	218,3	174	146	6 700	10 000	450	1 629	3 436	1 328	5 053	11 178	143	239,3	333,8
1	1	218,3	164	138	6 000	9 500	557	2 383	5 290	1 596	6 951	15 738	330,5	553,6	747
2	1	228,8	255	215	4 500	7 000	1 436	4 599	9 248	4 377	15 038	32 154	180,9	301,6	425,78
2	1	228,8	243	204	4 000	6 300	2 128	7 254	15 104	6 172	21 646	46 379	428,8	677,5	909,7
3	3	253,6	320	290	3 400	5 000	1 846	5 864	11 779	5 614	19 073	40 669	201,1	332,6	467,9
3	3	253,6	305	275	3 200	4 800	2 797	9 366	19 397	8 105	27 894	59 391	481,8	755,2	1 010,2
1	1	232,4	210	179	4 500	7 000	1 127	3 678	7 439	3 433	12 027	25 875	179,5	301,5	427
1	1	232,4	199	170	4 000	6 300	1 635	5 765	12 127	4 737	17 199	37 246	422,5	675,8	911
1	1	232,4	210	171	6 300	10 000	571	2 012	4 211	1 688	6 249	13 711	154,2	255,5	355,4
1	1	232,4	199	162	5 600	9 000	768	3 083	6 732	2 202	9 005	20 060	366	600,6	806,2
2	1	241,5	310	270	4 300	6 700	1 791	5 681	11 402	5 451	18 508	39 448	192,3	318,4	448,15
2	1	241,5	295	260	3 800	6 000	2 711	9 065	18 765	7 860	27 018	57 509	460,2	721,5	965,4
3	3	268,6	330	310	3 200	4 800	1 902	6 047	12 156	5 777	19 638	41 892	209,8	346,8	487,5
3	3	268,6	315	295	3 000	4 500	2 882	9 666	20 030	8 349	28 771	61 275	503,3	788,9	1 055
1	1	252,4	224	203	4 300	6 700	1 185	3 886	7 879	3 600	12 649	27 258	195,9	328,6	464,6
1	1	252,4	212	192	3 800	6 000	1 705	6 060	12 777	4 937	18 042	39 132	461,4	738,5	994,8
1	1	252,4	224	194	6 000	9 000	606	2 147	4 503	1 788	6 651	14 612	169,1	280,3	389,5
1	1	252,4	212	184	5 300	8 000	779	3 184	6 985	2 232	9 284	20 766	396,1	652,9	876,7
2,5	1	266,5	330	310	4 000	6 000	1 902	6 047	12 156	5 777	19 638	41 892	209,8	346,8	487,53
2,5	1	266,5	315	295	3 600	5 300	2 882	9 666	20 030	8 349	28 771	61 275	503,3	788,9	1 055
3	3	296,2	405	400	2 800	4 300	2 387	7 527	15 105	7 238	24 345	51 776	224	367,7	515,3
3	3	296,2	385	380	2 600	4 000	3 642	12 021	24 787	10 546	35 720	75 626	539,7	839,9	1 119,3

Spindle bearings

With large balls
 Steel or ceramic balls
 Steel rings
 Open



Dimension table (continued) · Dimensions in mm

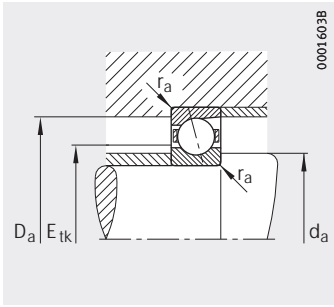
Designation ¹⁾		Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions				
Series 719	Series 70		d	D	B	r	r ₁		d _a h12	D _a H12	r _a max.	r _{a1} max.	E _{tk} nom.
B71948-C-T-P4S	–	7,1	240	320	38	2,1	1,1	15	254	307	1	1	272,4
B71948-E-T-P4S	–	7,08	240	320	38	2,1	1,1	25	254	307	1	1	272,4
–	B7048-C-T-P4S	16,8	240	360	56	3	3	15	260	341	2,5	1	286,5
–	B7048-E-T-P4S	16,7	240	360	56	3	3	25	260	341	2,5	1	286,5
B71952-C-T-P4S	–	12	260	360	46	2,1	1,1	15	278	342	1	1	300,5
B71956-C-T-P4S	–	12,9	280	380	46	2,1	1,1	15	298	362	1	1	320,5
B71960-C-T-P4S	–	20	300	420	56	3	1,1	15	322	398	1	1	348,6

¹⁾ Explanation of short designations, see page 145.

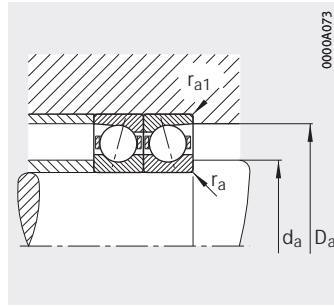
²⁾ The limiting speeds in the dimension tables are based on elastically preloaded single bearings.

³⁾ Explanation, see page 70.

⁴⁾ Minimal quantity oil lubrication.



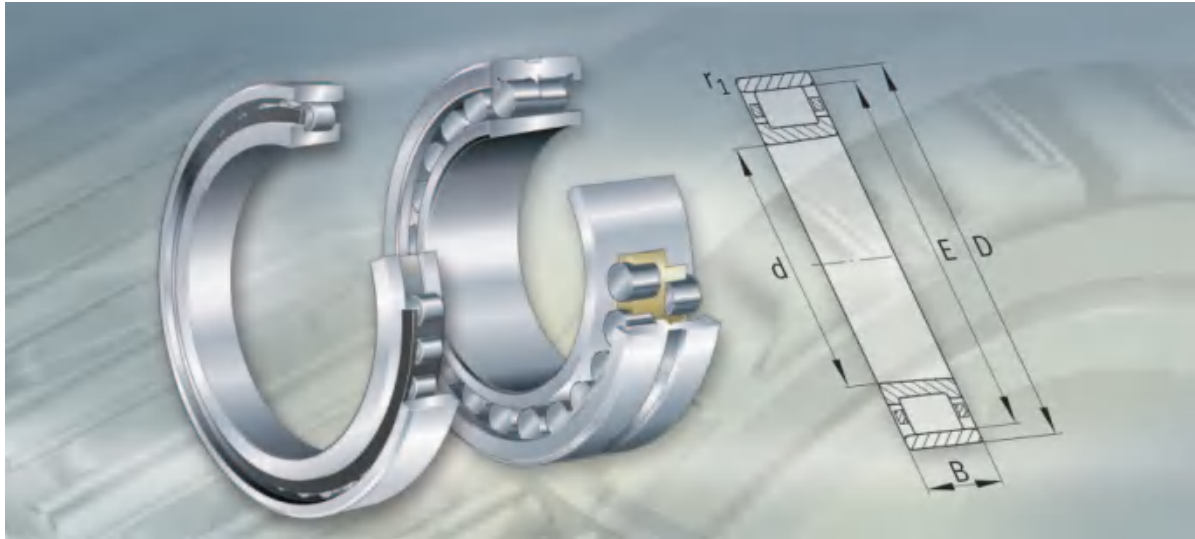
Mounting dimensions



Mounting dimensions



Basic load ratings		Limiting speeds ²⁾		Preload force ³⁾ F_v			Lift-off force ³⁾ K_{aE}			Axial rigidity ³⁾ c_a		
dyn. C_r kN	stat. C_{0r} kN	n_G grease min^{-1}	n_G oil ⁴⁾ min^{-1}	L	M	H	L	M	H	L	M	H
				N	N	N	N	N	N	N/ μm	N/ μm	N/ μm
231	220	4 000	6 000	1 224	4 024	8 171	3 712	13 066	28 181	206,8	346,5	489,6
218	208	3 600	5 300	1 760	6 279	13 255	5 092	18 673	40 536	487,7	781,1	1 051,8
340	330	3 600	5 600	1 957	6 231	12 533	5 940	20 205	43 114	218,5	360,9	507,16
320	310	3 200	5 000	2 914	9 801	20 327	8 437	29 140	62 090	521,3	817,3	1 092,3
295	290	3 600	5 300	1 615	5 221	10 556	4 894	16 900	36 243	221,7	368	517,8
305	320	3 200	5 000	1 696	5 491	11 113	5 134	17 744	38 073	236,4	392	551,3
370	405	3 000	4 500	2 084	6 676	13 480	6 297	21 485	45 930	248,6	409,3	573,5



Super precision cylindrical roller bearings

Single row

Double row

Super precision cylindrical roller bearings

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Product overview Super precision cylindrical roller bearings

**Single row,
tapered bore**

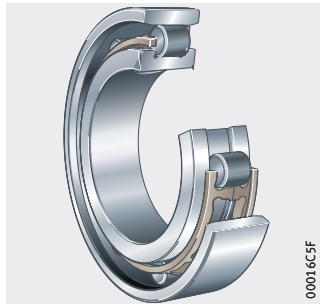
X-life
Standard

N10..-K-TVP-XL, N10..-K-M1



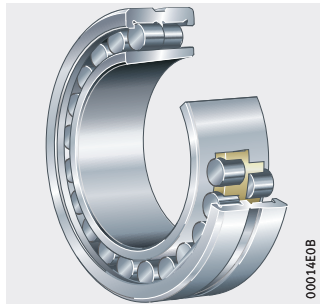
**Hybrid bearings
with half the number of rollers**

HCN10..-K-PVPA1-..-H193



**Double row,
tapered bore**

NN30..-K-TVP-XL, NN30..-K,
NNU49..-K-M



Super precision cylindrical roller bearings

Features FAG super precision cylindrical roller bearings comprise solid outer rings, solid inner rings with a tapered bore (taper 1:12) and cylindrical roller and cage assemblies with cages made from polyamide, brass or PEEK (polyether ether ketone). The outer ring is removable and can thus be mounted separately from the rest of the bearing package. The inner ring is only removable in the case of series NNU49.

The single and double row bearings are used when very high precision under very high radial load is required. Typical areas of application include machine tools and printing machinery. The bearings facilitate bearing arrangements with very high precision, high radial rigidity and very high load carrying capacity. In machine tool building, they provide radial support for the main spindle.

Ideal non-locating bearings

Since variations in length during rotary motion can be compensated between the rollers and the ribless raceway without constraining forces, the cylindrical roller bearings are highly suitable as non-locating bearings. Axial forces are supported by axial bearings, such as double direction axial angular contact ball bearings.

The standard series N10, HCN10 (single row) and NN30, NNU49 (double row) are an established part of the FAG super precision range. Diameter ranges not shown in the catalogue are available by agreement.



X-life cylindrical roller bearings

The super precision cylindrical roller bearings N10 and NN30 in the X-life design have a higher load carrying capacity and thus a significantly increased bearing rating life. A newly developed plastic cage gives lower friction than the previous standard design with brass cage.

The advantages of this bearing design are:

- lower noise level
- running temperatures up to 12 K lower
- less strain on the lubricant
- longer grease operating life
- limiting speeds up to 35% higher
- higher basic load ratings.

Super precision cylindrical roller bearings

The basic dynamic load ratings C are up to 19% higher than those of the previous bearing designs and the basic bearing rating life L_{10} is up to 65% longer than the previous standard.

As a result of the increase in the basic bearing rating life L_{10} , this gives a longer operating life of the bearings under the same operating conditions. If the rating life values are maintained, alternatively, higher loads can be applied to the bearing arrangement.

Single row cylindrical roller bearings

Single row super precision cylindrical roller bearings are available:

- with tapered or cylindrical bore on the inner ring
- as hybrid cylindrical roller bearings with half the number of rollers.

In the series N10, the rollers are guided on the inner ring and held at a spacing from each other by a cage made from polyamide, brass or PEEK, *Figure 1*.



Figure 1
Single row cylindrical roller bearing

Bearings with smaller cross-section

The super precision cylindrical roller bearings NNU49 have a smaller cross-section. As a result, smaller centre distances can be achieved in multi-spindle arrangements. In addition, diameter ranges not described in the dimension tables can be supplied by agreement.

Hybrid cylindrical roller bearings with half the number of rollers

In hybrid cylindrical roller bearings, the rollers are made from a high performance ceramic. This material gives a significant reduction in the friction and wear in the bearing. In addition, there is less strain on the lubricant and temperatures in the bearing are lower. As a result, cylindrical roller bearings of the hybrid design achieve the highest permissible speeds of any cylindrical roller bearings. Furthermore, the low coefficient of thermal expansion of the ceramic rollers reduces the increase in preload at higher temperatures.

When these hybrid bearings are used, spindles and machinery achieve considerably longer life and the systems are significantly more viable. Ceramic rollers also lead to increased rigidity in both static and dynamic terms. This has a positive effect on the quality of the machining results.

Hybrid cylindrical roller bearings with half the number of rollers have the suffix H193, *Figure 2*. Due to the reduction in the number of rollers, the speed can be increased further.

HCN10..-K-H193

Figure 2
Hybrid bearings with half the number of rollers



Super precision cylindrical roller bearings

Double row cylindrical roller bearings

In bearings of series NN30, the rollers are guided on the inner ring. The outer ring is ground cylindrically and is removable, *Figure 3*.

Series NNU49 has a cylindrically ground, separable inner ring. The rollers are guided on the outer ring.

NN30

Figure 3
Double row cylindrical roller bearing



Sealing

Super precision cylindrical roller bearings are supplied in an open design.

Lubrication

Due to the high surface quality of the raceways and rollers, FAG cylindrical roller bearings are particularly suitable for grease lubrication.

Pneumatic oil lubrication

When using pneumatic oil lubrication, they can be lubricated via the end faces. The recommended injection pitch circle diameter (E_{tk}) is given in the dimension tables for the cylindrical roller bearings. In cylindrical roller bearings with a polyamide or brass cage, the recommended injection pitch circle diameter (E_{tk1}) lies between the outside diameter of the cage and the outer ring. Lubrication is possible from both sides.

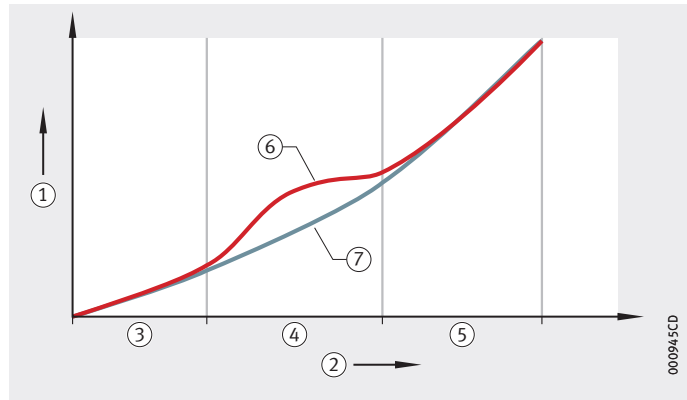
In cylindrical roller bearings with a PEEK cage guided on one side (PVPA1), lubrication can also be carried out on both sides between the rib on the inner ring and the inside diameter of the cage (E_{tk2}). As an alternative, lubrication can be carried out on the open side of the cage between the outside diameter of the cage and the outer ring (E_{tk1}).

Cylindrical roller bearings require only very small quantities of oil for lubrication. This applies in particular where cages are guided on the outer ring since the guidance rib in this case prevents all but a small quantity of oil from leaving the bearing.

Overlubrication of the bearing can therefore occur, at low and moderate speeds in particular, if lubrication is carried out between the cage and inner ring, as a result of which the operating temperature of the bearing may increase. If bearings with a PVPA1 cage guided on one side are lubricated on the open side of the cage, excess oil is then reliably conveyed out of the bearing, giving a highly uniform temperature behaviour of the bearing.

- ① Temperature
- ② Speed
- ③ Low
- ④ Moderate
- ⑤ High
- ⑥ Lubrication between inner ring and cage E_{tk2}
- ⑦ Lubrication on open side of cage E_{tk2}

Figure 4
Speed/temperature behaviour of cylindrical roller bearings with cage guided on outer ring with oil lubrication



Oil lubrication

Double row bearings with the suffix S have a lubrication groove and lubrication holes in the outer ring.



Bearings with a modified internal construction and the suffix D do not have a lubrication hole or lubrication groove as standard.



When selecting a lubricant, the operating temperature of the lubricant must be taken into consideration.

Cages

Single row super precision cylindrical roller bearings have solid cages made from polyamide (TVP) and brass (M1) or PEEK (PVPA1). Double row bearings have solid cages made from polyamide (TVP) or brass (M1).

Super precision cylindrical roller bearings

Bearing designations

The designation structure for single row cylindrical roller bearings is shown in *Figure 5*, the structure for double row bearings is shown in *Figure 6*, page 215.

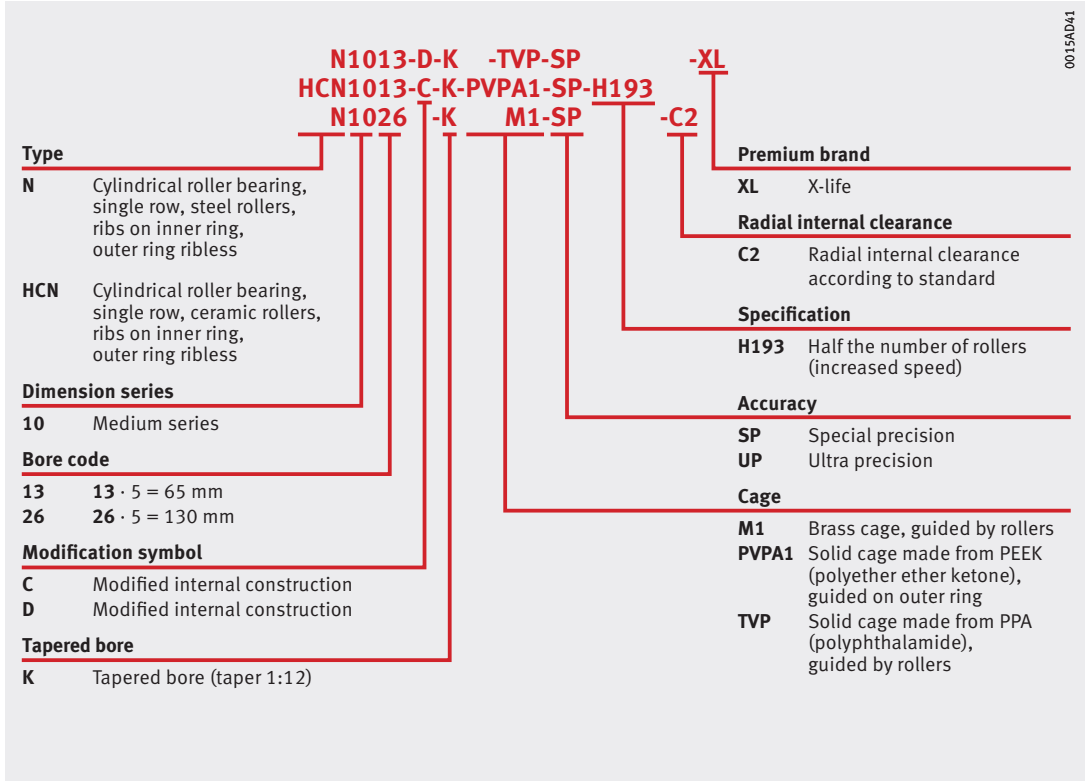


Figure 5
Bearing designations

Super precision cylindrical roller bearings

Marking of bearings

Marking of the bearings on the end faces of the bearing rings is shown in *Figure 7* to *Figure 9*, page 217.

- ① Data matrix code
- ② Trademark
- ③ X-life symbol
- ④ Short designation (bearing designation)
- ⑤ Country of manufacture
- ⑥ Internal code
- ⑦ Internal code

Figure 7
Example of marking for single row bearings with TVP cage



- ① Data matrix code
- ② Trademark
- ③ Short designation (bearing designation)
- ④ Country of manufacture
- ⑤ Internal code
- ⑥ Internal code

Figure 8
Example of marking for single row bearings with brass cage



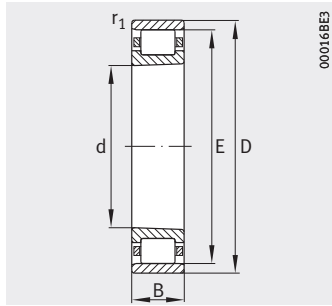
- ① Data matrix code
- ② Trademark
- ③ X-life symbol
- ④ Short designation (bearing designation)
- ⑤ Country of manufacture
- ⑥ Internal code
- ⑦ Internal code

Figure 9
 Example of marking
 for double row bearings
 with TVP cage

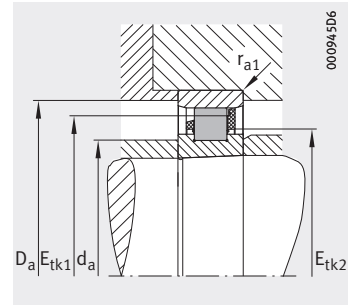


Super precision cylindrical roller bearings

Single row
Steel or ceramic rollers



N10
Steel rollers



HCN10
Ceramic rollers

Dimension table - Dimensions in mm

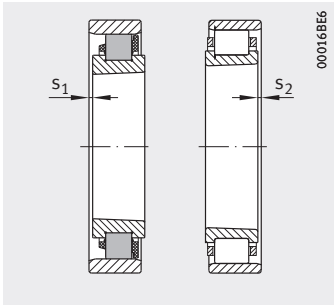
Designation ¹⁾	Mass m ≈ kg	Dimensions					Axial displacement ²⁾	
		d	D	B	r ₁ min.	E	s ₁	s ₂
N1006-D-K-TVP-SP-XL	0,12	30	55	13	0,6	48,5	2,8	2,8
N1006-K-PVPA1-SP	0,12	30	55	13	0,6	48,5	0,85	2,2
HCN1006-K-PVPA1-SP	0,11	30	55	13	0,6	48,5	0,85	2,2
HCN1006-K-PVPA1-SP-H193	0,1	30	55	13	0,6	48,5	0,85	2,2
N1007-D-K-TVP-SP-XL	0,16	35	62	14	0,6	55	2,8	2,8
N1007-C-K-PVPA1-SP	0,16	35	62	14	0,6	55	0,9	2,4
HCN1007-C-K-PVPA1-SP	0,14	35	62	14	0,6	55	0,9	2,4
HCN1007-C-K-PVPA1-SP-H193	0,13	35	62	14	0,6	55	0,9	2,4
N1008-D-K-TVP-SP-XL	0,2	40	68	15	0,6	61	3,1	3,1
N1008-K-PVPA1-SP	0,19	40	68	15	0,6	61	0,95	2,5
HCN1008-K-PVPA1-SP	0,16	40	68	15	0,6	61	0,95	2,5
HCN1008-K-PVPA1-SP-H193	0,15	40	68	15	0,6	61	0,95	2,5
N1009-D-K-TVP-SP-XL	0,24	45	75	16	0,6	67,5	3,1	3,1
N1009-C-K-PVPA1-SP	0,24	45	75	16	0,6	67,5	1,2	2,5
HCN1009-C-K-PVPA1-SP	0,22	45	75	16	0,6	67,5	1,2	2,5
HCN1009-C-K-PVPA1-SP-H193	0,2	45	75	16	0,6	67,5	1,2	2,5
N1010-D-K-TVP-SP-XL	0,27	50	80	16	0,6	72,5	3,1	3,1
N1010-C-K-PVPA1-SP	0,27	50	80	16	0,6	72,5	1,15	2,7
HCN1010-C-K-PVPA1-SP	0,23	50	80	16	0,6	72,5	1,15	2,7
HCN1010-C-K-PVPA1-SP-H193	0,22	50	80	16	0,6	72,5	1,15	2,7
N1011-D-K-TVP-SP-XL	0,4	55	90	18	1	81	3,4	3,4
N1011-K-PVPA1-SP	0,4	55	90	18	1	80,5	1,4	3
HCN1011-K-PVPA1-SP	0,34	55	90	18	1	80,5	1,4	3
HCN1011-K-PVPA1-SP-H193	0,32	55	90	18	1	80,5	1,4	3

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

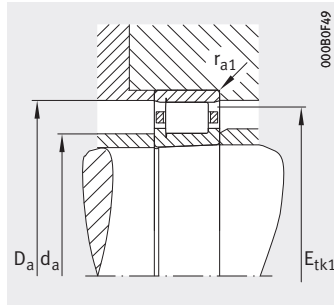
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: N1006-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement distance



Mounting dimensions

Mounting dimensions

Basic load ratings

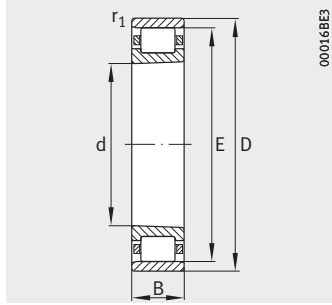
Limiting speeds

d_a h12	D_a H12	E_{tk1} nom.	E_{tk2} nom.	r_{a1} max.	dyn. C_r N	stat. C_{0r} N	n_G grease min^{-1}	n_G oil ⁽³⁾ min^{-1}
38,5	49,5	47,5	–	0,6	17 500	15 600	21 700	25 500
36,5	49,4	47	39,7	0,6	20 200	20 400	33 500	39 500
36,5	49,4	47	39,7	0,6	20 200	19 200	36 500	43 000
36,5	49,4	47	39,7	0,6	12 000	9 600	42 000	49 000
43	56	53,9	–	0,6	23 600	20 900	18 700	22 000
43	56,1	53,4	45,8	0,6	19 900	20 900	30 000	35 000
43	56,1	53,4	45,8	0,6	19 900	19 600	32 500	38 500
43	56,1	53,4	45,8	0,6	11 900	9 800	37 500	44 000
49	62,1	59,8	–	0,6	27 000	26 000	17 100	20 100
47	62,1	59,3	50,8	0,6	27 500	29 000	26 500	31 000
47	62,1	59,3	50,8	0,6	27 500	27 000	29 000	34 000
47	62,1	59,3	50,8	0,6	16 200	13 600	33 000	39 000
53,5	68,6	66,2	–	0,6	34 500	32 500	15 200	17 800
53,5	68,7	65,6	56,9	0,6	29 000	32 500	24 400	28 500
53,5	68,7	65,6	56,9	0,6	29 000	31 000	26 500	31 000
53,5	68,7	65,6	56,9	0,6	17 300	15 400	30 500	35 500
58,5	73,6	71,2	–	0,6	36 500	36 500	14 200	16 800
58,5	73,7	70,6	61,9	0,6	31 000	36 500	22 800	27 000
58,5	73,7	70,6	61,9	0,6	31 000	34 000	24 900	29 500
58,5	73,7	70,6	61,9	0,6	18 400	17 100	28 500	33 500
65	82,2	79,3	–	1	48 000	48 500	12 600	14 800
64,5	81,8	78,5	68,8	1	40 500	48 000	20 200	23 800
64,5	81,8	78,5	68,8	1	40 500	45 500	22 100	26 000
64,5	81,8	78,5	68,8	1	24 100	22 700	25 500	29 500

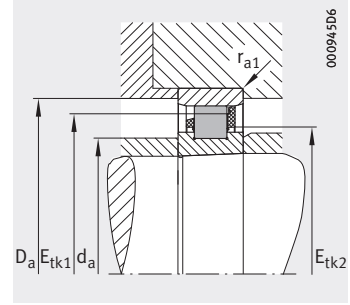


Super precision cylindrical roller bearings

Single row
Steel or ceramic rollers



N10
Steel rollers



HCN10
Ceramic rollers

Dimension table (continued) · Dimensions in mm

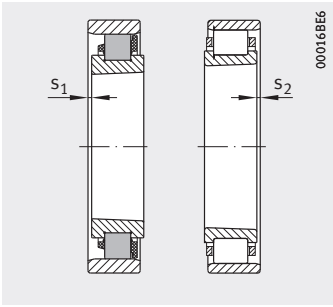
Designation ¹⁾	Mass m ≈ kg	Dimensions					Axial displacement ²⁾	
		d	D	B	r ₁ min.	E	s ₁	s ₂
N1012-D-K-TVP-SP-XL	0,43	60	95	18	1	86,1	3,4	3,4
N1012-K-PVPA1-SP	0,42	60	95	18	1	85,5	1,25	3
HCN1012-K-PVPA1-SP	0,37	60	95	18	1	85,5	1,25	3
HCN1012-K-PVPA1-SP-H193	0,36	60	95	18	1	85,5	1,25	3
N1013-D-K-TVP-SP-XL	0,45	65	100	18	1	91	3,4	3,4
N1013-C-K-PVPA1-SP	0,45	65	100	18	1	91	1,4	2,5
HCN1013-C-K-PVPA1-SP	0,4	65	100	18	1	91	1,4	2,5
HCN1013-C-K-PVPA1-SP-H193	0,38	65	100	18	1	91	1,4	2,5
N1014-D-K-TVP-SP-XL	0,64	70	110	20	1	100	3,8	3,8
N1014-K-PVPA1-SP	0,61	70	110	20	1	100	1,25	3,3
HCN1014-K-PVPA1-SP	0,52	70	110	20	1	100	1,25	3,3
HCN1014-K-PVPA1-SP-H193	0,49	70	110	20	1	100	1,25	3,3
N1015-D-K-TVP-SP-XL	0,67	75	115	20	1	105	3,8	3,8
N1015-K-PVPA1-SP	0,65	75	115	20	1	105	1	3
HCN1015-K-PVPA1-SP	0,56	75	115	20	1	105	1	3
HCN1015-K-PVPA1-SP-H193	0,54	75	115	20	1	105	1	3
N1016-D-K-TVP-SP-XL	0,9	80	125	22	1	113	4,1	4,1
N1016-K-PVPA1-SP	0,88	80	125	22	1	113,5	1,1	3,5
HCN1016-K-PVPA1-SP	0,76	80	125	22	1	113,5	1,1	3,5
HCN1016-K-PVPA1-SP-H193	0,73	80	125	22	1	113,5	1,1	3,5
N1017-D-K-TVP-SP-XL	0,95	85	130	22	1	118	4,1	4,1
N1017-K-PVPA1-SP	1	85	130	22	1	118,5	1,5	2,7
HCN1017-K-PVPA1-SP	0,89	85	130	22	1	118,5	1,5	2,7
HCN1017-K-PVPA1-SP-H193	0,75	85	130	22	1	118,5	1,5	2,7

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

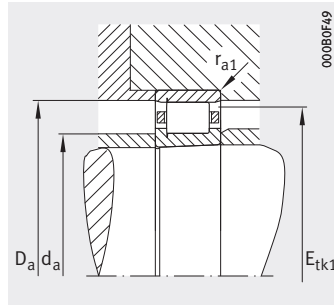
The bearings are also available by agreement with a cylindrical bore (without suffix K),
ordering example: N1012-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement distance



Mounting dimensions

Mounting dimensions

Basic load ratings

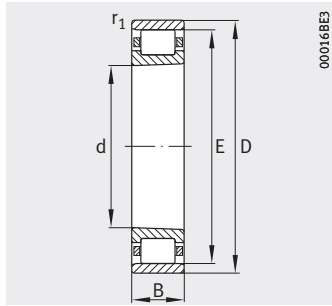
Limiting speeds

d_a h12	D_a H12	E_{tk1} nom.	E_{tk2} nom.	r_{a1} max.	dyn. C_r N	stat. C_{0r} N	n_G grease min^{-1}	n_G oil ⁽³⁾ min^{-1}
70,1	87,3	84,4	–	1	51 000	53 000	11 900	14 000
69,5	86,8	83,5	73,8	1	43 000	53 000	19 200	22 600
69,5	86,8	83,5	73,8	1	43 000	50 000	21 000	24 700
69,5	86,8	83,5	73,8	1	25 500	25 000	24 000	28 000
75	92,2	89,3	–	1	53 000	58 000	11 400	13 400
75	92,3	88,5	78,7	1	45 000	58 000	18 200	21 400
75	92,3	88,5	78,7	1	45 000	54 000	19 900	23 400
75	92,3	88,5	78,7	1	27 000	27 000	22 800	27 000
82	101,3	98,2	–	1	66 000	72 000	10 200	12 000
80	101,3	97,5	85,4	1	63 000	77 000	16 000	18 800
80	101,3	97,5	85,4	1	61 000	70 000	17 500	20 600
80	101,3	97,5	85,4	1	36 500	35 000	20 000	23 500
87	106,3	103,2	–	1	65 000	73 000	9 800	11 500
85	106,3	102,5	90,4	1	66 000	85 000	15 300	18 000
85	106,3	102,5	90,4	1	65 000	77 000	16 800	19 700
85	106,3	102,5	90,4	1	38 500	38 500	19 200	22 500
93	114,4	111,4	–	1	81 000	91 000	9 000	10 600
91,5	115	110,8	97,4	1	77 000	99 000	14 000	16 500
91,5	115	110,8	97,4	1	77 000	93 000	15 300	18 100
91,5	115	110,8	97,4	1	45 500	46 500	17 500	20 600
98	119,4	116,3	–	1	80 000	91 000	8 700	10 200
96,5	120	115,8	102,4	1	76 000	99 000	13 500	15 900
96,5	120	115,8	102,4	1	76 000	93 000	14 800	17 400
96,5	120	115,8	102,4	1	45 500	46 500	16 900	19 900

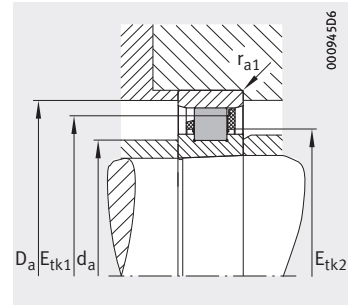


Super precision cylindrical roller bearings

Single row
Steel or ceramic rollers



N10
Steel rollers



HCN10
Ceramic rollers

Dimension table (continued) · Dimensions in mm

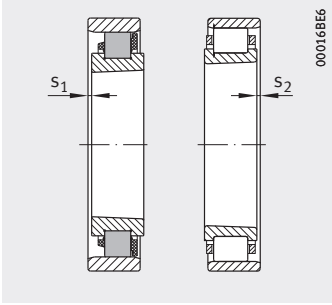
Designation ¹⁾	Mass m ≈ kg	Dimensions					Axial displacement ²⁾	
		d	D	B	r ₁ min.	E	s ₁	s ₂
N1018-D-K-TVP-SP-XL	1,23	90	140	24	1,1	127	4,4	4,4
N1018-K-PVPA1-SP	1,2	90	140	24	1,1	127	1,2	3,7
HCN1018-K-PVPA1-SP	1,06	90	140	24	1,1	127	1,2	3,7
HCN1018-K-PVPA1-SP-H193	0,99	90	140	24	1,1	127	1,2	3,7
N1019-D-K-TVP-SP-XL	1,29	95	145	24	1,1	132	4,4	4,4
N1019-K-PVPA1-SP	1,26	95	145	24	1,1	132	1,2	3,7
HCN1019-K-PVPA1-SP	1,2	95	145	24	1,1	132	1,2	3,7
HCN1019-K-PVPA1-SP-H193	1,04	95	145	24	1,1	132	1,2	3,7
N1020-D-K-TVP-SP-XL	1,34	100	150	24	1,1	137	4,4	4,4
N1020-K-PVPA1-SP	1,29	100	150	24	1,1	137	1,1	3,5
HCN1020-K-PVPA1-SP	1,2	100	150	24	1,1	137	1,1	3,5
HCN1020-K-PVPA1-SP-H193	1,07	100	150	24	1,1	137	1,1	3,5
N1021-D-K-TVP-SP-XL	1,67	105	160	26	1,1	146	4,5	4,5
N1021-K-PVPA1-SP	1,66	105	160	26	1,1	145,5	0,6	3,2
HCN1021-K-PVPA1-SP	1,6	105	160	26	1,1	145,5	0,6	3,2
HCN1021-K-PVPA1-SP-H193	1,55	105	160	26	1,1	145,5	0,6	3,2
N1022-D-K-TVP-SP-XL	2,06	110	170	28	1,1	155	4,8	4,8
N1022-K-PVPA1-SP	2,02	110	170	28	1,1	155	1	4
HCN1022-K-PVPA1-SP-H193	1,85	110	170	28	1,1	155	1	4
N1024-D-K-TVP-SP-XL	2,22	120	180	28	1,1	165	4,8	4,8
N1024-K-PVPA1-SP	2,18	120	180	28	1,1	165	1	4
HCN1024-K-PVPA1-SP	2,05	120	180	28	1,1	165	1	4
HCN1024-K-PVPA1-SP-H193	1,95	120	180	28	1,1	165	1	4

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

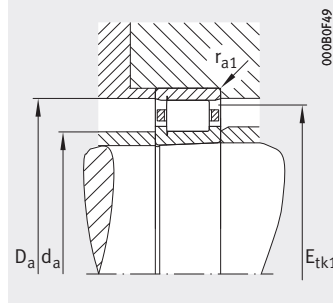
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: N1015-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement distance



Mounting dimensions

Mounting dimensions

Basic load ratings

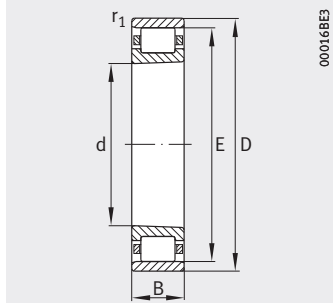
Limiting speeds

d_a h12	D_a H12	E_{tk1} nom.	E_{tk2} nom.	r_{a1} max.	dyn. C_r N	stat. C_{0r} N	n_G grease min^{-1}	n_G oil ⁽³⁾ min^{-1}
105	128,5	124,9	–	1	95 000	108 000	8 000	9 400
103	128,6	124	109,4	1	91 000	119 000	12 500	14 700
103	128,6	124	109,4	1	91 000	112 000	13 700	16 100
103	128,6	124	109,4	1	54 000	56 000	15 600	18 400
110	133,5	129,8	–	1	99 000	117 000	7 700	9 100
108	133,6	129	114,4	1	96 000	130 000	12 100	14 200
108	133,6	129	114,4	1	96 000	122 000	13 200	15 600
108	133,6	129	114,4	1	57 000	61 000	15 100	17 800
115	138,5	134,8	–	1	99 000	118 000	7 500	8 800
113	138,6	134	119,4	1	95 000	130 000	11 700	13 800
113	138,6	134	119,4	1	95 000	123 000	12 800	15 100
113	138,6	134	119,4	1	57 000	61 000	14 600	17 200
120	147,5	143,5	–	1	132 000	154 000	6 800	8 000
119,5	147,2	142,3	126,5	1	112 000	154 000	10 900	12 900
119,5	147,2	142,3	126,5	1	111 000	144 000	11 900	14 100
119,5	147,2	142,3	126,5	1	66 000	72 000	13 700	16 100
127	156,6	152,4	–	1	153 000	180 000	6 400	7 500
125	156,7	151,3	133,1	1	141 000	191 000	10 000	11 800
125	156,7	151,3	133,1	1	84 000	95 000	12 000	14 000
137	166,6	162,4	–	1,1	160 000	196 000	6 000	7 100
135	166,7	161,3	143,1	1,1	148 000	208 000	9 500	11 200
135	166,7	161,3	143,1	1,1	147 000	195 000	10 400	12 200
135	166,7	161,3	143,1	1,1	88 000	97 000	11 900	14 000

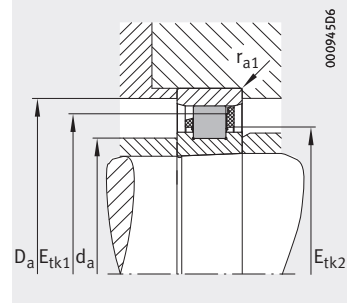


Super precision cylindrical roller bearings

Single row
Steel or ceramic rollers



N10
Steel rollers



HCN10
Ceramic rollers

Dimension table (continued) · Dimensions in mm

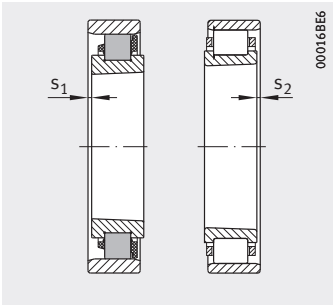
Designation ¹⁾	Mass m ≈ kg	Dimensions					Axial displacement ²⁾	
		d	D	B	r_1 min.	E	s_1	s_2
N1026-K-M1-SP	3,72	130	200	33	1,1	182	4,2	4,2
N1028-K-M1-SP	3,85	140	210	33	1,1	192	4,2	4,2
N1030-K-M1-SP	4,81	150	225	35	1,5	205,5	4,4	4,4
N1032-K-M1-SP	5,76	160	240	38	1,5	220	4,6	4,6
N1034-K-M1-SP	7,77	170	260	42	2,1	237	5	5
N1036-K-M1-SP	10,2	180	280	46	2,1	255	5,6	5,6

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

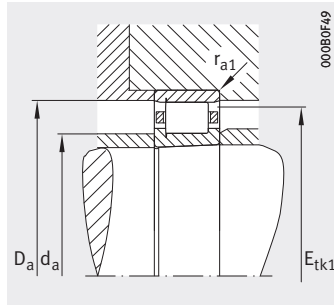
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: N1024-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement distance



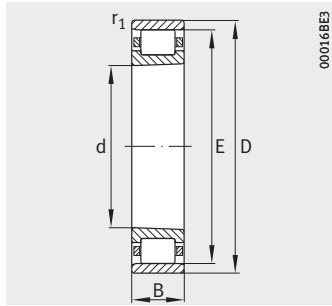
Mounting dimensions

Mounting dimensions					Basic load ratings		Limiting speeds	
d_a h12	D_a H12	E_{tk1} nom.	E_{tk2} nom.	r_{a1} max.	dyn. C_r N	stat. C_{0r} N	n_G grease min^{-1}	n_G oil ⁽³⁾ min^{-1}
148	184,1	177,8	–	1,1	179 000	250 000	4 800	5 600
158	194,1	187,8	–	1,1	183 000	265 000	4 550	5 400
169,5	207,8	201	–	1,5	210 000	310 000	4 250	5 000
180	222,4	215	–	1,5	245 000	355 000	3 900	4 600
193	239,7	231,5	–	2,1	295 000	435 000	3 600	4 250
205	257,8	248,8	–	2,1	360 000	520 000	3 300	3 850

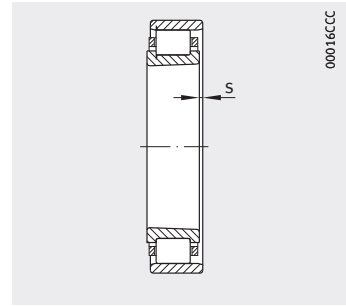


Super precision cylindrical roller bearings

Single row
Steel rollers



N10
Steel rollers



Axial displacement distance

Dimension table - Dimensions in mm

Designation ¹⁾	Mass m ≈ kg	Dimensions					Axial displacement ²⁾ s
		d	D	B	r ₁ min.	E	
N1038-K-M1-SP	10,6	190	290	46	2,1	265	5,6
N1040-K-M1-SP	13,7	200	310	51	2,1	281	6,4

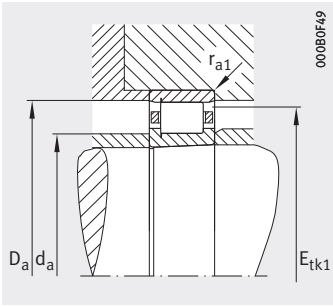
¹⁾ Explanation of short designations, see section Bearing designations, page 214.

The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: N1038-M1-SP.

By agreement, bearings are available with a larger bore diameter.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



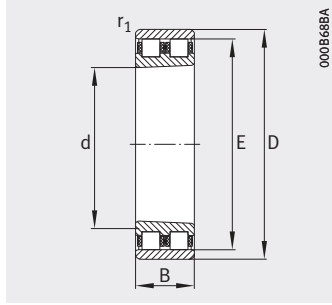
Mounting dimensions

Mounting dimensions				Basic load ratings		Limiting speeds	
d_a h12	D_a H12	E_{tk1} nom.	r_{a1} max.	dyn. C_r N	stat. C_{0r} N	n_G grease min^{-1}	n_G oil ³⁾ min^{-1}
215	267,8	258,8	2,1	370 000	550 000	3 200	3 600
229	284,3	274,5	2,1	395 000	600 000	3 000	3 400

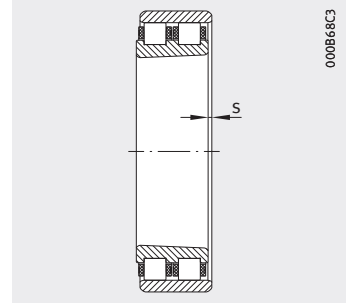


Super precision cylindrical roller bearings

Double row



NN30...-K-TVP



Axial displacement distance

Dimension table - Dimensions in mm

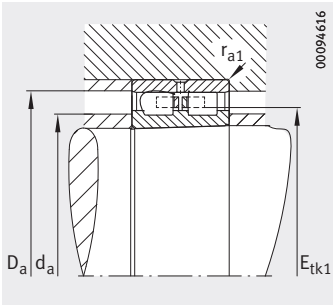
Designation ¹⁾	Mass m ≈ kg	Dimensions							
		d	D	B	r min.	E	F	n _s	d _s
NN3006-D-K-TVP-SP-XL	0,18	30	55	19	1	48,5	-	-	-
NN3007-D-K-TVP-SP-XL	0,24	35	62	20	1	55	-	-	-
NN3008-D-K-TVP-SP-XL	0,28	40	68	21	1	61	-	-	-
NN3009-D-K-TVP-SP-XL	0,36	45	75	23	1	67,5	-	-	-
NN3010-D-K-TVP-SP-XL	0,39	50	80	23	1	72,5	-	-	-
NN3011-D-K-TVP-SP-XL	0,59	55	90	26	1,1	81	-	-	-
NN3012-D-K-TVP-SP-XL	0,63	60	95	26	1,1	86,1	-	-	-
NN3013-D-K-TVP-SP-XL	0,67	65	100	26	1,1	91	-	-	-
NN3014-D-K-TVP-SP-XL	0,98	70	110	30	1,1	100	-	-	-
NN3015-D-K-TVP-SP-XL	1,02	75	115	30	1,1	105	-	-	-
NN3016-D-K-TVP-SP-XL	1,42	80	125	34	1,1	113	-	-	-
NN3017-D-K-TVP-SP-XL	1,48	85	130	34	1,1	118	-	-	-
NN3018-D-K-TVP-SP-XL	1,93	90	140	37	1,5	127	-	-	-
NN3019-D-K-TVP-SP-XL	2,03	95	145	37	1,5	132	-	-	-

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: NN3006-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



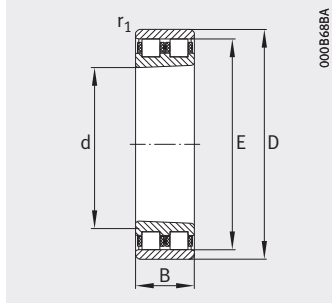
Mounting dimensions

Axial displacement ²⁾ s	Mounting dimensions			Basic load ratings		Limiting speeds	
	d _a h12	D _A H12	r _{a1} max.	dyn. C _r N	stat. C _{0r} N	n _G grease min ⁻¹	n _G oil ³⁾ min ⁻¹
1,7	38,5	50	1	30 000	31 000	20 600	24 200
1,4	43	56,5	1	40 500	41 500	17 800	20 900
1,7	49	62,6	1	46 500	52 000	16 200	19 100
1,7	53,5	69,2	1	59 000	65 000	14 400	16 900
1,7	58,5	74,2	1	63 000	73 000	13 500	15 900
1,9	65	82,9	1	82 000	97 000	11 900	14 100
1,9	70,1	88	1	87 000	106 000	11 300	13 300
1,9	75	92,9	1	91 000	116 000	10 800	12 700
2,3	82	102,3	1	113 000	145 000	9 700	11 400
2,3	87	107,3	1	112 000	146 000	9 300	11 000
2,5	93	115,6	1	139 000	182 000	8 500	10 000
2,5	98	120,6	1	138 000	183 000	8 200	9 700
2,5	105	129,8	1,5	162 000	216 000	7 600	8 900
2,5	110	134,8	1,5	170 000	234 000	7 300	8 600

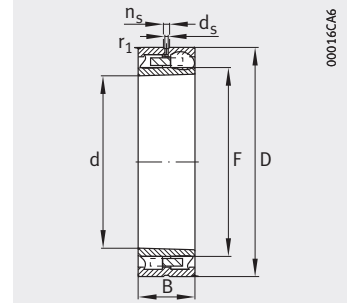


Super precision cylindrical roller bearings

Double row



NN30..-K-TVP



NNU49

Dimension table (continued) · Dimensions in mm

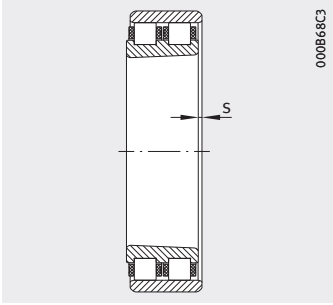
Designation ¹⁾	Mass m ≈ kg	Dimensions							
		d	D	B	r min.	E	F	n_s	d_s
NNU4920-S-K-M-SP	1,88	100	140	40	1,1	–	113	6,5	3,2
NN3020-D-K-TVP-SP-XL	2,09	100	150	37	1,5	137	–	–	–
NNU4921-S-K-M-SP	1,93	105	145	40	1,1	–	118	6,5	3,2
NN3021-D-K-TVP-SP-XL	2,68	105	160	41	2	146	–	–	–
NNU4922-S-K-M-SP	2,01	110	150	40	1,1	–	123	6,5	3,2
NN3022-D-K-TVP-SP-XL	3,41	110	170	45	2	155	–	–	–
NNU4924-S-K-M-SP	2,78	120	165	45	1,1	–	134,5	6,5	3,2
NN3024-D-K-TVP-SP-XL	3,72	120	180	46	2	165	–	–	–
NNU4926-S-K-M-SP	3,81	130	180	50	1,5	–	146	6,5	3,2
NN3026-AS-K-M-SP	5,84	130	200	52	2	182	–	9,5	4,8
NNU4928-S-K-M-SP	4,04	140	190	50	1,5	–	156	6,5	3,2
NN3028-AS-K-M-SP	6,22	140	210	53	2	192	–	9,5	4,8
NNU4930-S-K-M-SP	6,1	150	210	60	2	–	168,5	6,5	3,2
NN3030-AS-K-M-SP	7,59	150	225	56	2,1	206	–	9,5	4,8
NNU4932-S-K-M-SP	6,46	160	220	60	2	–	178,5	6,5	3,2
NN3032-AS-K-M-SP	9,23	160	240	60	2,1	219	–	9,5	4,8
NNU4934-S-K-M-SP	6,9	170	230	60	2	–	188,5	6,5	3,2
NN3034-AS-K-M-SP	12,5	170	260	67	2,1	236	–	9,5	4,8

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

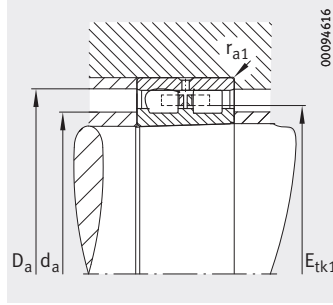
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: NN3020-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement



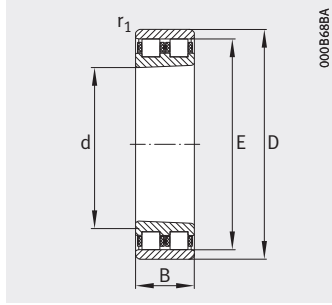
Mounting dimensions

Axial displacement ²⁾ s	Mounting dimensions			Basic load ratings		Limiting speeds	
	d _a h12	D _a H12	r _{a1} max.	dyn. C _r N	stat. C _{0r} N	n _G grease min ⁻¹	n _G oil ³⁾ min ⁻¹
2	112	129	1	128 000	255 000	5 700	6 700
2,5	115	139,8	1,5	169 000	235 000	7 100	8 300
2	117	134	1	130 000	260 000	5 500	6 500
2,6	120	149	2	226 000	310 000	6 500	7 600
2	122	139	1	132 000	270 000	5 400	6 300
2,9	127	158,3	2	260 000	360 000	6 000	7 100
2,3	133,4	154,5	1	175 000	340 000	4 750	5 600
3,1	137	168,4	2	275 000	390 000	5 700	6 700
2,7	144,7	166	1,5	188 000	385 000	4 450	5 300
3,1	150	186	2	295 000	500 000	4 100	4 800
2,7	155,1	176	1,5	190 000	400 000	4 250	5 000
3,4	160	196	2	300 000	520 000	3 900	4 600
2,7	167,2	196,5	2	330 000	650 000	3 550	4 200
3,8	172	210	2,1	335 000	590 000	3 650	4 250
2,7	177,2	206,5	2	335 000	680 000	3 400	4 000
4,3	183	224	2,1	375 000	670 000	3 400	4 000
2,7	187,2	216,5	2	340 000	700 000	3 300	3 850
4,6	196	241	2,1	450 000	800 000	3 100	3 650

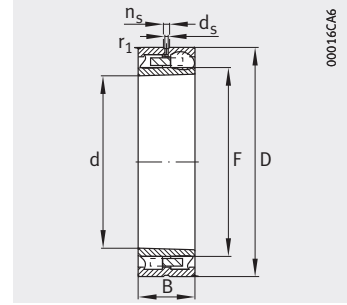


Super precision cylindrical roller bearings

Double row



NN30..-K-M



NNU49

Dimension table (continued) · Dimensions in mm

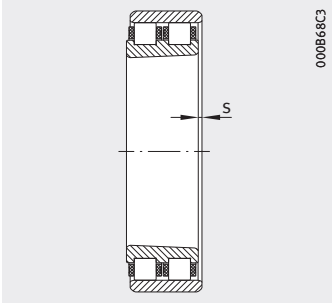
Designation ¹⁾	Mass m ≈ kg	Dimensions							
		d	D	B	r	E	F	ns	ds
NNU4936-S-K-M-SP	9,96	180	250	69	2	–	202	9,5	4,8
NN3036-AS-K-M-SP	16,4	180	280	74	2,1	255	–	12,2	6,3
NNU4938-S-K-M-SP	10,6	190	260	69	2	–	212	9,5	4,8
NN3038-AS-K-M-SP	17,3	190	290	75	2,1	265	–	12,2	6,3
NNU4940-S-K-M-SP	14,7	200	280	80	2,1	–	225	12,2	6,3
NN3040-AS-K-M-SP	22,2	200	310	82	2,1	282	–	12,2	6,3
NNU4944-S-K-M-SP	16,3	220	300	80	2,1	–	245	12,2	6,3
NN3044-AS-K-M-SP	29,1	220	340	90	3	310	–	15	8
NNU4948-S-K-M-SP	17,1	240	320	80	2,1	–	265	12,2	6,3
NN3048-AS-K-M-SP	31,5	240	360	92	3	330	–	15	8
NNU4952-S-K-M-SP	30,4	260	360	100	2,1	–	292	15	8
NN3052-AS-K-M-SP	46,2	260	400	104	4	364	–	15	8
NNU4956-S-K-M-SP	32,5	280	380	100	2,1	–	312	15	8
NN3056-AS-K-M-SP	49,7	280	420	106	4	384	–	15	8
NNU4960-S-K-M-SP	48,6	300	420	118	3	–	339	17,7	9,5
NN3060-AS-K-M-SP	68,5	300	460	118	4	418	–	17,7	9,5
NNU4964-S-K-M-SP	52,5	320	440	118	3	–	359	17,7	9,5
NN3064-AS-K-M-SP	73,8	320	480	121	4	438	–	17,7	9,5

¹⁾ Explanation of short designations, see page 214.

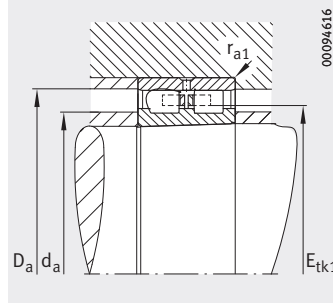
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: NN3020-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



Axial displacement distance



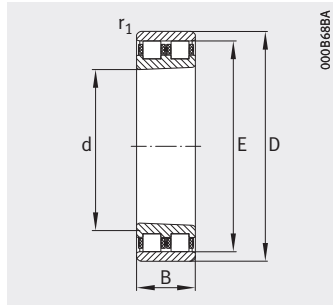
Mounting dimensions

Axial displacement ²⁾ s	Mounting dimensions			Basic load ratings		Limiting speeds	
	d _a h12	D _a H12	r _{a1} max.	dyn. C _r N	stat. C _{0r} N	n _G grease min ⁻¹	n _G oil ³⁾ min ⁻¹
3,2	200,5	232	2	405 000	860 000	3 000	3 550
4,8	209	260	2,1	570 000	1 000 000	2 850	3 300
3,2	210,5	242	2	410 000	880 000	2 900	3 450
4,8	219	271	2,1	580 000	1 040 000	2 750	3 200
4,3	223	259	2,1	490 000	1 040 000	2 700	3 200
5,7	232	288	2,1	660 000	1 190 000	2 550	3 000
4,3	243	279	2,1	510 000	1 140 000	2 550	3 000
5,7	254	317	2,5	810 000	1 450 000	2 290	2 700
4,3	263	299	2,1	530 000	1 210 000	2 400	2 800
6,1	274	337	2,5	840 000	1 580 000	2 170	2 550
5,4	289,4	334	2,1	750 000	1 690 000	2 070	2 430
6,6	300	372	3	1 070 000	2 010 000	1 930	2 280
5,4	309,4	354	2,1	770 000	1 790 000	1 970	2 320
6,9	320	392	3	1 090 000	2 090 000	1 850	2 170
6,3	336	389	2,5	1 040 000	2 380 000	1 740	2 040
7,5	346	427	3	1 270 000	2 400 000	1 670	1 970
6,3	356	409	2,5	1 070 000	2 550 000	1 670	1 960
8	366	447	3	1 330 000	2 600 000	1 610	1 890

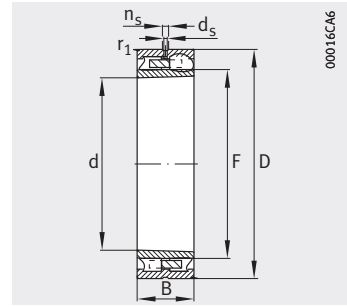


Super precision cylindrical roller bearings

Double row



NN30



NNU49

Dimension table (continued) · Dimensions in mm

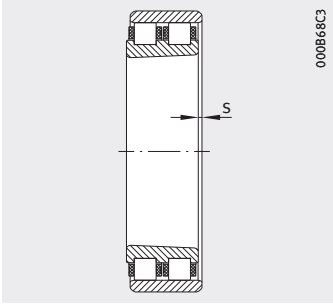
Designation ¹⁾	Mass m ≈ kg	Dimensions							
		d	D	B	r	E	F	ns	ds
NNU4968-S-K-M-SP	55,7	340	460	118	3	–	379	17,7	9,5
NN3068-AS-K-M-SP	99,3	340	520	133	5	473	–	17,7	9,5
NNU4972-S-K-M-SP	57,3	360	480	118	3	–	399	17,7	9,5
NN3072-AS-K-M-SP	104	360	540	134	5	493	–	17,7	9,5
NNU4976-S-K-M-SP	86,9	380	520	140	4	–	426	17,7	9,5
NN3076-AS-K-M-SP	110	380	560	135	5	513	–	17,7	9,5
NNU4980-S-K-M-SP	91	400	540	140	4	–	446	17,7	9,5
NN3080-AS-K-M-SP	143	400	600	148	5	549	–	17,7	9,5
NNU4984-S-K-M-SP	94,4	420	560	140	4	–	466	17,7	9,5
NN3084-AS-K-M-SP	150	420	620	150	5	569	–	17,7	9,5
NNU4988-S-K-M-SP	130	440	600	160	4	–	490	17,7	9,5
NN3088-AS-K-M-SP	172	440	650	157	6	597	–	23,5	12,5
NNU4992-S-K-M-SP	134	460	620	160	4	–	510	17,7	9,5
NN3092-AS-K-M-SP	197	460	680	163	6	624	–	23,5	12,5
NNU4996-S-K-M-SP	158	480	650	170	5	–	534	17,7	9,5
NN3096-AS-K-M-SP	208	480	700	165	6	644	–	23,5	12,5
NNU49/500-S-K-M-SP	163	500	670	170	5	–	554	17,7	9,5
NN30/500-AS-K-M-SP	214	500	720	167	6	664	–	23,5	12,5

¹⁾ Explanation of short designations, see section Bearing designations, page 214.

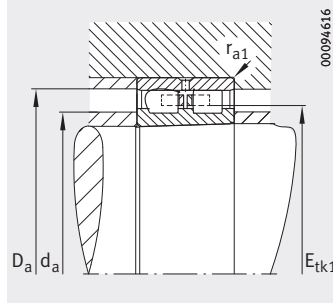
The bearings are also available by agreement with a cylindrical bore (without suffix K), ordering example: NN3006-D-TVP-SP-XL.

²⁾ Axial displacement of outer ring from central position.

³⁾ Minimal quantity oil lubrication.



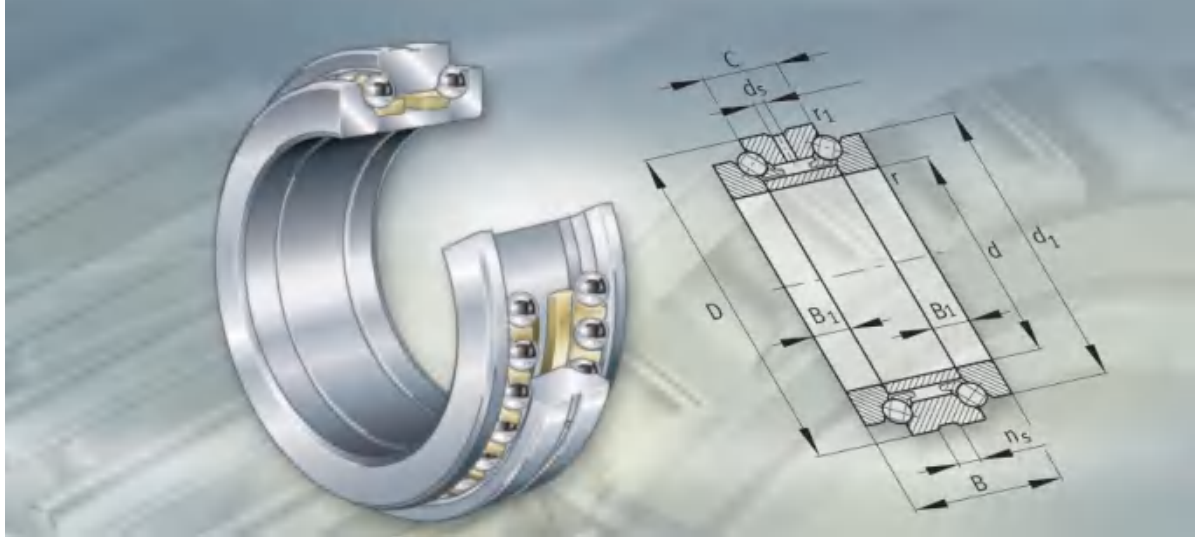
Axial displacement



Mounting dimensions

Axial displacement ²⁾ s	Mounting dimensions			Basic load ratings		Limiting speeds	
	d _a h12	D _a H12	r _{a1} max.	dyn. C _r N	stat. C _{0r} N	n _G grease min ⁻¹	n _G oil ³⁾ min ⁻¹
6,3	376	429	2,5	1 100 000	2 650 000	1 600	1 890
8,8	393	483	4	1 640 000	3 250 000	1 470	1 730
6,3	396	449	2,5	1 130 000	2 800 000	1 540	1 820
8,8	413	503	4	1 670 000	3 350 000	1 420	1 670
7,2	422,6	482	3	1 440 000	3 600 000	1 380	1 620
9,1	433	523	4	1 700 000	3 500 000	1 370	1 620
7,2	442,6	502	3	1 490 000	3 800 000	1 330	1 570
9,5	459	560	4	2 150 000	4 450 000	1 260	1 480
7,2	462,6	522	3	1 530 000	4 000 000	1 290	1 520
10	479	580	4	2 140 000	4 450 000	1 220	1 440
6,8	486,8	558	3	2 040 000	5 200 000	1 150	1 360
10,2	501	609	5	2 430 000	5 100 000	1 160	1 360
6,8	506,8	578	3	2 110 000	5 500 000	1 120	1 320
10,9	524	636	5	2 600 000	5 400 000	1 100	1 300
7,2	530,6	606	4	2 350 000	6 100 000	1 060	1 250
11,2	544	656	5	2 700 000	5 800 000	1 070	1 260
7,2	550,6	626	4	2 330 000	6 100 000	1 030	1 220
11,7	564	677	5	2 700 000	5 800 000	1 050	1 230





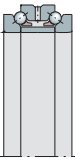
Axial angular contact ball bearings

Axial bearings, double direction 2344

Axial bearings BAX

Axial angular contact ball bearings

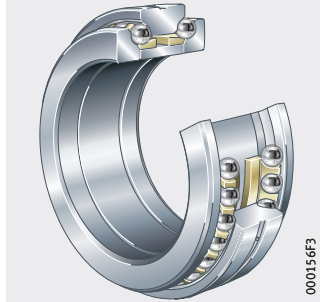
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Product overview Axial angular contact ball bearings

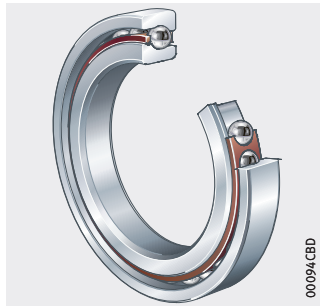
Double direction

2344



Axial bearings BAX

BAX



Axial angular contact ball bearings

Features

Axial angular contact ball bearings 2344

Double direction axial angular contact ball bearings of series 2344 are highly rigid, axially preloaded super precision bearings with restricted tolerances to class SP for the bearing arrangements of precision spindles in machine tools.

These bearings without self-retention comprise solid shaft locating washers, a spacer ring, a housing locating washer and ball and cage assemblies with solid cages. The bearing parts are matched to each other and can be mounted separately, but must not be interchanged with parts from bearings of the same size.

Due to the contact angle of 60° , they can support high axial forces. In bearing arrangements of main spindles, the axial angular contact ball bearing is combined with a double row cylindrical roller bearing with a tapered bore, which supports the radial forces.

Axial bearings BAX

The bearing arrangement of main spindles in machine tools are subjected to high demands. They must have high load carrying capacity and must at the same time also be suitable for high spindle speeds. Increased load carrying capacity normally brings with it a reduction in the maximum speed. Through the use of the new axial bearings BAX, it is now possible to unify both requirements.

The axial bearings:

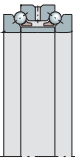
- can support high axial loads
- have the speed capacity of main spindle bearings
- have high rigidity
- can support axial loads only.

The axial bearings BAX conform to the accuracy class P4S and are in principle supplied as ready-to-fit sets in the arrangement DB.

Axial bearings BAX correspond in their dimensions to bearings of size 70. They are thus matched to the diameters of cylindrical roller bearings N10 and NN30.

The outside diameter tolerance is designed to give a loose fit when the seats of the axial angular contact ball bearing and the cylindrical roller bearing are machined together.

Axial bearings BAX are available with a contact angle of 30° and, for even higher rigidities, also with a contact angle of 40° .



Axial angular contact ball bearings

Designs

Axial bearings 2344, double direction

This series has the same nominal outside diameter as the cylindrical roller bearings NN30. The outside diameter tolerance is designed to give a loose fit when the seats of the axial angular contact ball bearing and the cylindrical roller bearing are machined together.

The design 2344 is available by agreement in the accuracy class UP.

Axial bearings BAX

The axial bearings BAX are available in two preload classes, L (light) and M (medium).

Axial bearings BAX are available in two contact angle variants:

- contact angle 30° (suffix F)
- contact angle 40° (suffix H).

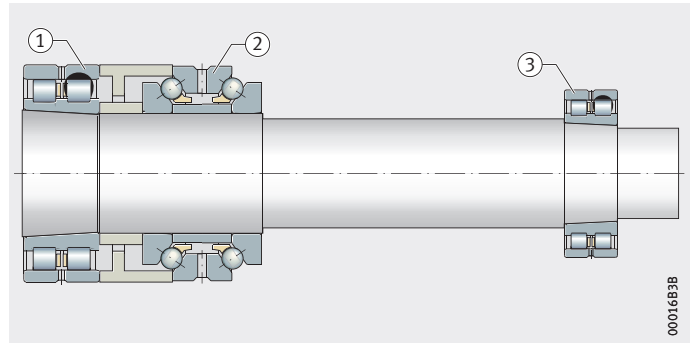
Design of bearing arrangements

Bearing combination and arrangement:

- one double direction axial angular contact bearing and two double row cylindrical roller bearings, *Figure 6*
- two axial bearings and two double row cylindrical roller bearings, *Figure 7*.

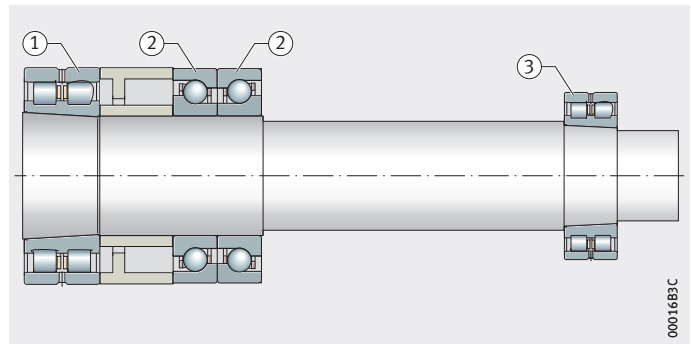
- ① Cylindrical roller bearing NN30
- ② Double direction axial angular contact ball bearing 2344
- ③ Cylindrical roller bearing NN30

Figure 1
Bearing arrangement with axial angular contact ball bearing 2344



- ① Cylindrical roller bearing NN30
- ② Axial bearings BAX
- ③ Cylindrical roller bearing NN30

Figure 2
Bearing arrangement with axial bearings BAX



Sealing Axial angular contact ball bearings of the designs 2344 and BAX are available without seals.

Lubrication The bearings can be lubricated with oil or grease.

Axial bearings 2344 The housing locating washers are designed with a lubrication groove and lubrication holes in the centre. Due to the substantial displacement effect, the bearings require considerably larger quantities of oil than any adjacent cylindrical roller bearings.

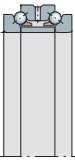


The design must be such that the oil leaving the axial angular contact ball bearings does not enter the adjacent cylindrical roller bearings. When selecting a lubricant, the operating temperature of the lubricant must be taken into consideration.

Cages

Axial bearings 2344 Each row of rolling elements has a ball-guided solid brass cage. The cage is indicated by the suffix M.

Axial bearings BAX The bearings are designed with a cage made from laminated hard fabric (suffix T).



Axial angular contact ball bearings

Bearing designations

The diagram shows the structure of the short designation for axial bearings of the design 2344, *Figure 3*.

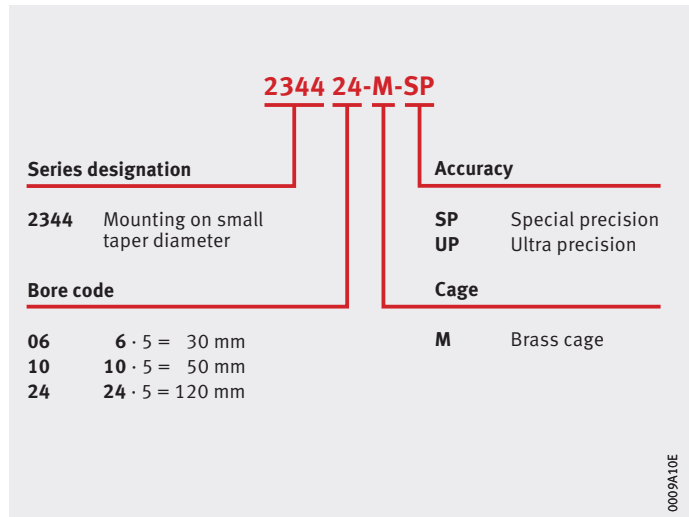


Figure 3
Bearing designation of axial bearings 2344

The structure for axial bearings BAX is shown in *Figure 4*.

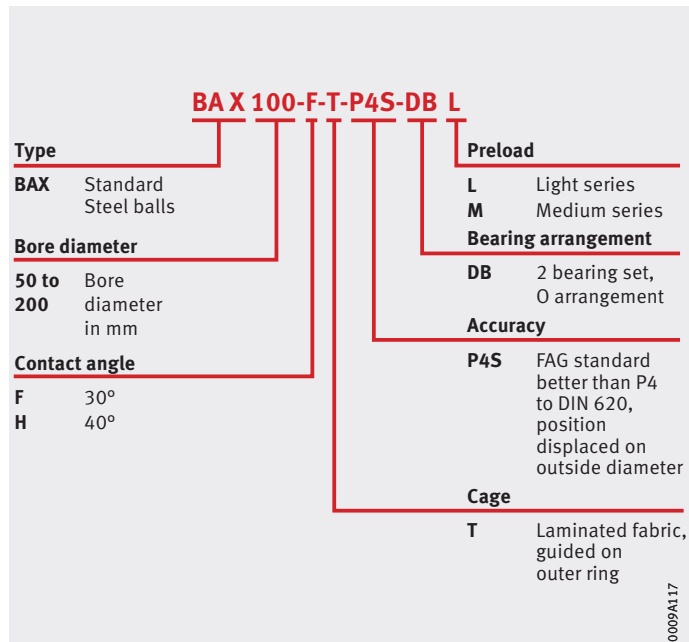


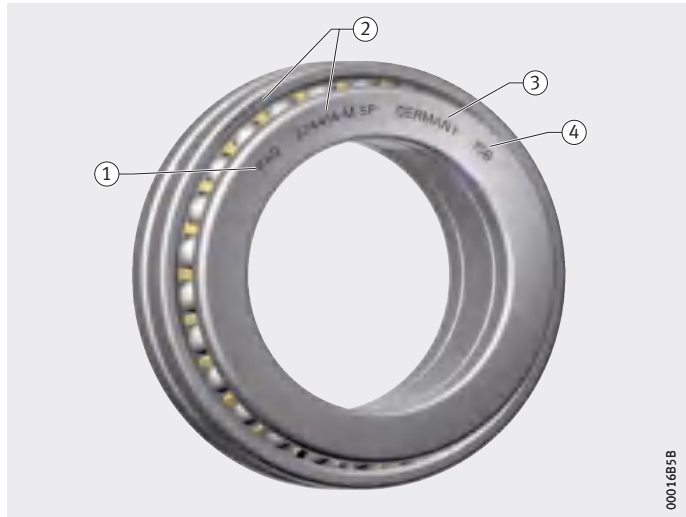
Figure 4
Bearing designation of axial bearings BAX

Marking of bearings

Marking of the bearings on the end faces of the bearing rings is shown in *Figure 5*.

- ① Trademark
- ② Short designation (bearing designation)
- ③ Country of manufacture
- ④ Internal code

Figure 5
Example of marking for axial bearings 2344



The marking on the end face of the axial bearing BAX is shown in *Figure 6*.

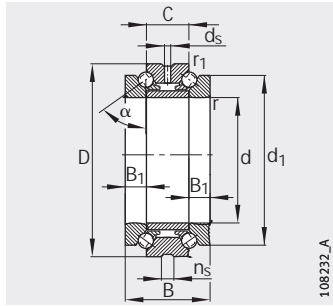
- ① Symbol indicating the load direction of the outer ring
- ② Trademark
- ③ Short designation (bearing designation)
- ④ Symbol for the largest wall thickness of the inner ring
- ⑤ Data matrix code
- ⑥ Actual value code for the bore

Figure 6
Example of marking for axial bearings BAX

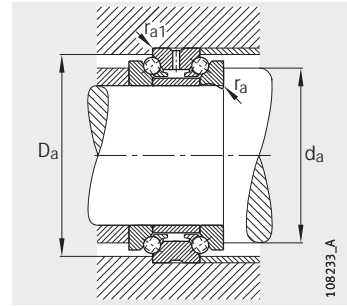


Axial angular contact ball bearings

Double direction



2344
 $\alpha = 60^\circ$



Mounting dimensions

Dimension table - Dimensions in mm

Designation	Mass m ≈ kg	Dimensions									
		d	D	B	C	d ₁	B ₁	r	r ₁	d _s	n _s
234406-M-SP	0,29	30	55	32	16	47	8	1	0,15	3,2	4,8
234407-M-SP	0,38	35	62	34	17	53	8,5	1	0,15	3,2	4,8
234408-M-SP	0,463	40	68	36	18	58,5	9	1	0,15	3,2	4,8
234409-M-SP	0,579	45	75	38	19	65	9,5	1	0,15	3,2	4,8
234410-M-SP	0,629	50	80	38	19	70	9,5	1	0,15	3,2	4,8
234411-M-SP	0,944	55	90	44	22	78	11	1,1	0,3	3,2	6,5
234412-M-SP	1,01	60	95	44	22	83	11	1,1	0,3	3,2	6,5
234413-M-SP	1,08	65	100	44	22	88	11	1,1	0,3	3,2	6,5
234414-M-SP	1,49	70	110	48	24	97	12	1,1	0,3	3,2	6,5
234415-M-SP	1,57	75	115	48	24	102	12	1,1	0,3	3,2	6,5
234416-M-SP	2,16	80	125	54	27	110	13,5	1,1	0,3	3,2	6,5
234417-M-SP	2,25	85	130	54	27	115	13,5	1,1	0,3	4,8	9,5
234418-M-SP	2,92	90	140	60	30	123	15	1,5	0,3	4,8	9,5
234419-M-SP	3,04	95	145	60	30	128	15	1,5	0,3	4,8	9,5
234420-M-SP	3,17	100	150	60	30	133	15	1,5	0,3	4,8	9,5
234421-M-SP	4,07	105	160	66	33	142	16,5	2	0,6	4,8	9,5
234422-M-SP	5,19	110	170	72	36	150	18	2	0,6	4,8	9,5
234424-M-SP	5,56	120	180	72	36	160	18	2	0,6	4,8	9,5
234426-M-SP	8,28	130	200	84	42	177	21	2	0,6	6,3	12,2
234428-M-SP	8,78	140	210	84	42	187	21	2,1	0,6	6,3	12,2
234430-M-SP	10,8	150	225	90	45	200	22,5	2,1	0,6	8	15
234432-M-SP	12,9	160	240	96	48	212	24	2,1	0,6	8	15
234434-M-SP	17,7	170	260	108	54	230	27	2,1	0,6	8	15
234436-M-SP	23,4	180	280	120	60	248	30	2,1	0,6	8	15
234438-M-SP	24,7	190	290	120	60	258	30	2,1	0,6	8	15
234440-M-SP	31,5	200	310	132	66	274	33	2,1	0,6	8	15
234444-M-SP	41,7	220	340	144	72	304	36	3	1,1	9,5	17,7
234448-M-SP	43,8	240	360	144	72	322	36	3	1,1	9,5	17,7
234452-M-SP	64,5	260	400	164	82	354	41	4	1,5	9,5	17,7
234456-M-SP	69	280	420	164	82	374	41	4	1,5	9,5	17,7

1) The lift-off force is the force at which the row of balls released from load by an axial force acting concentrically on the bearing becomes free of load.

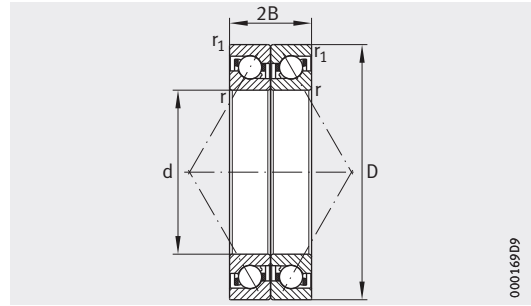
2) The values are valid up to an axial force equal to 2,2% of the basic dynamic load rating C_a.

3) Minimal quantity oil lubrication.

Mounting dimensions				Basic load ratings		Limiting speeds		Preload force F_V N	Lift-off force ¹⁾ K_{aE} N	Axial rigidity ²⁾ c_a N/ μ m
d_a h12	D_a H12	r_a max.	r_{a1} max.	dyn. C_a N	stat. C_{0a} N	n_G grease min^{-1}	n_G oil ³⁾ min^{-1}			
40,5	50,5	1	0,15	15 300	36 000	11 000	16 000	108	308	276
46,5	57	1	0,15	18 900	47 000	9 500	14 000	134	382	316
51,5	63,5	1	0,15	22 900	59 000	8 500	12 000	160	456	354
57,5	70	1	0,15	25 000	67 000	7 500	10 000	180	514	387
62,5	75	1	0,15	26 000	72 000	7 000	9 500	183	522	410
69	84,5	1,1	0,3	36 500	99 000	6 300	8 500	260	743	458
74	89,5	1,1	0,3	36 000	98 000	6 000	8 000	255	728	455
79	94,5	1,1	0,3	38 500	111 000	5 600	7 500	275	785	506
86,5	103,5	1,1	0,3	46 000	134 000	5 300	7 000	325	926	552
91,5	108,5	1,1	0,3	47 500	144 000	5 000	6 700	340	969	589
98,5	117	1,1	0,3	56 000	175 000	4 500	6 000	400	1 140	640
103,5	122	1,1	0,3	57 000	181 000	4 500	6 000	400	1 140	655
110,5	130,5	1,5	0,3	66 000	213 000	4 000	5 300	465	1 326	708
115,5	135,5	1,5	0,3	66 000	219 000	4 000	5 300	465	1 326	724
120,5	140,5	1,5	0,3	67 000	226 000	3 800	5 000	685	1 956	843
128	150	2	0,6	74 000	250 000	3 600	4 800	530	1 511	775
134,5	160	2	0,6	98 000	325 000	3 400	4 500	695	1 983	853
144,5	170	2	0,6	101 000	345 000	3 200	4 300	960	2 736	996
159	188	2	0,6	128 000	440 000	2 800	3 800	900	2 570	978
169	198	2,1	0,6	132 000	470 000	2 600	3 600	930	2 649	1 034
181	211,5	2,1	0,6	142 000	520 000	2 600	3 600	1 320	3 764	1 183
192,5	226	2,1	0,6	168 000	600 000	2 400	3 400	1 180	3 362	1 149
206,5	245	2,1	0,6	207 000	740 000	2 200	3 200	1 847	5 270	1 362
221	263	2,1	0,6	235 000	840 000	2 000	3 000	1 660	4 733	1 315
231	273	2,1	0,6	244 000	900 000	1 900	2 800	2 110	6 021	1 495
245	291,5	2,1	0,6	285 000	1 060 000	1 800	2 600	2 000	5 704	1 449
269	318	3	1	340 000	1 330 000	1 600	2 200	2 400	6 848	1 629
289	338	3	1	350 000	1 420 000	1 500	2 000	2 500	7 134	1 729
317,5	374,5	4	1,5	400 000	1 680 000	1 400	1 900	2 900	8 257	1 814
337,5	394,5	4	1,5	415 000	1 790 000	1 300	1 800	3 000	8 542	1 920



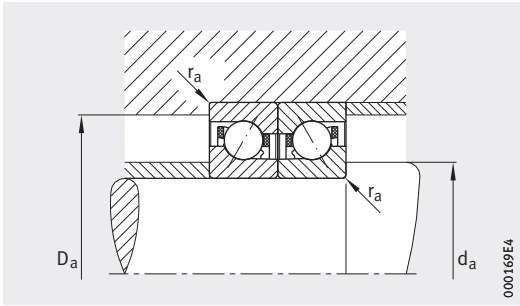
Axial bearings BAX



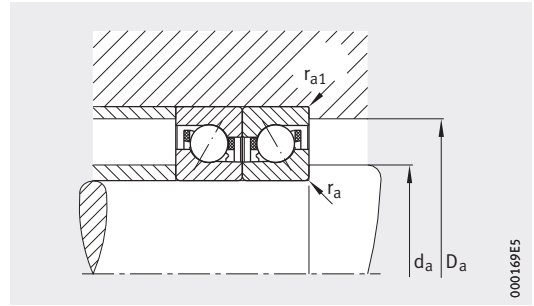
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Dimension table - Dimensions in mm

Designation	Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions			
		d	D	2B	r	r ₁		d _a h12	D _a H12	r _a max.	r _{a1}
BAX50-F-T-P4S-DBL	0,5	50	80	28,5	0,6	0,6	30	57	73	0,6	0,6
BAX50-H-T-P4S-DBL	0,5	50	80	28,5	0,6	0,6	40	57	73	0,6	0,6
BAX55-F-T-P4S-DBL	0,74	55	90	33	0,6	0,6	30	63,5	81,5	0,6	0,6
BAX55-H-T-P4S-DBL	0,74	55	90	33	0,6	0,6	40	63,5	81,5	0,6	0,6
BAX60-F-T-P4S-DBL	0,8	60	95	33	0,6	0,6	30	68,5	86,5	0,6	0,6
BAX60-H-T-P4S-DBL	0,8	60	95	33	0,6	0,6	40	68,5	86,5	0,6	0,6
BAX65-F-T-P4S-DBL	0,84	65	100	33	0,6	0,6	30	73,5	91,5	0,6	0,6
BAX65-H-T-P4S-DBL	0,84	65	100	33	0,6	0,6	40	73,5	91,5	0,6	0,6
BAX70-F-T-P4S-DBL	1,18	70	110	36	0,6	0,6	30	80,5	99,5	0,6	0,6
BAX70-H-T-P4S-DBL	1,18	70	110	36	0,6	0,6	40	80,5	99,5	0,6	0,6
BAX75-F-T-P4S-DBL	1,24	75	115	36	0,6	0,6	30	85,5	104,5	0,6	0,6
BAX75-H-T-P4S-DBL	1,24	75	115	36	0,6	0,6	40	85,5	104,5	0,6	0,6
BAX80-F-T-P4S-DBL	1,68	80	125	40,5	0,6	0,6	30	91	113,5	0,6	0,6
BAX80-H-T-P4S-DBL	1,68	80	125	40,5	0,6	0,6	40	91	113,5	0,6	0,6
BAX85-F-T-P4S-DBL	1,98	85	130	40,5	0,6	0,6	30	96	118,5	0,6	0,6
BAX85-H-T-P4S-DBL	1,98	85	130	40,5	0,6	0,6	40	96	118,5	0,6	0,6
BAX90-F-T-P4S-DBL	2,3	90	140	45	0,6	0,6	30	102	128	0,6	0,6
BAX90-H-T-P4S-DBL	2,3	90	140	45	0,6	0,6	40	102	128	0,6	0,6
BAX95-F-T-P4S-DBL	2,4	95	145	45	0,6	0,6	30	107	133	0,6	0,6
BAX95-H-T-P4S-DBL	2,4	95	145	45	0,6	0,6	40	107	133	0,6	0,6
BAX100-F-T-P4S-DBL	2,58	100	150	45	0,6	0,6	30	112	138	0,6	0,6
BAX100-H-T-P4S-DBL	2,58	100	150	45	0,6	0,6	40	112	138	0,6	0,6



Mounting dimensions

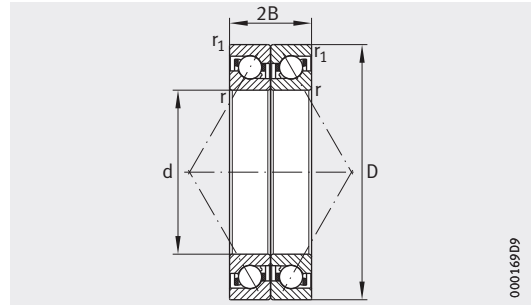


Mounting dimensions

Basic load ratings		Limiting speeds		Preload force F_v			Lift-off force K_{aE}			Axial rigidity c_a		
dyn. C_a kN	stat. C_{0a} kN	n_G grease min^{-1}	n_G oil min^{-1}	L N	M N	H N	L N	M N	H N	L N/ μm	M N/ μm	H N/ μm
20 400	38 000	13 000	18 000	84	416	–	241	1 213	–	123	216	–
25 000	50 000	11 000	15 000	107	595	–	303	1 708	–	200	361	–
24 200	46 000	11 000	16 000	88	436	–	252	1 267	–	129	226	–
30 000	61 000	9 500	14 000	144	741	–	410	2 128	–	229	401	–
24 700	49 000	11 000	15 000	110	517	–	313	1 504	–	143	247	–
30 500	64 000	9 000	13 000	143	747	–	406	2 146	–	235	415	–
26 000	54 000	10 000	14 000	120	554	–	342	1 606	–	148	253	–
31 500	70 000	8 500	12 000	155	792	–	440	2 269	–	242	424	–
30 500	64 000	9 000	13 000	149	661	–	426	1 917	–	164	276	–
37 000	84 000	7 500	11 000	194	944	–	552	2 703	–	269	462	–
31 000	67 000	8 500	12 000	149	668	–	426	1 935	–	168	284	–
37 500	88 000	7 500	10 000	194	955	–	552	2 734	–	277	477	–
40 000	87 000	8 000	11 000	217	903	–	620	2 618	–	195	322	–
49 000	114 000	6 700	9 500	297	1 323	–	846	3 791	–	327	545	–
41 000	91 000	7 500	11 000	220	922	–	629	2 671	–	202	333	–
50 000	119 000	6 300	9 000	297	1 332	–	843	3 816	–	336	561	–
49 500	109 000	7 000	10 000	300	1 181	–	856	3 427	–	221	358	–
61 000	142 000	6 000	8 500	406	1 700	–	1 156	4 871	–	369	602	–
51 000	114 000	6 700	9 500	296	1 188	–	847	3 454	–	235	383	–
62 000	149 000	5 600	8 000	400	1 711	–	1 139	4 910	–	391	643	–
52 000	119 000	6 300	9 000	299	1 206	–	854	3 503	–	242	396	–
63 000	156 000	5 600	8 000	404	1 740	–	1 150	4 991	–	403	665	–



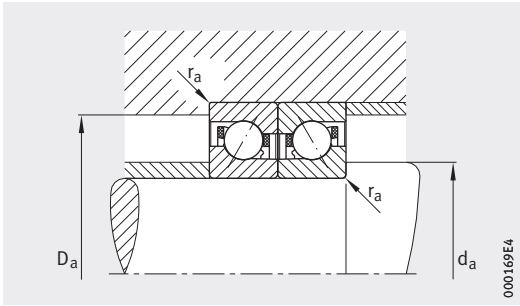
Axial bearings BAX



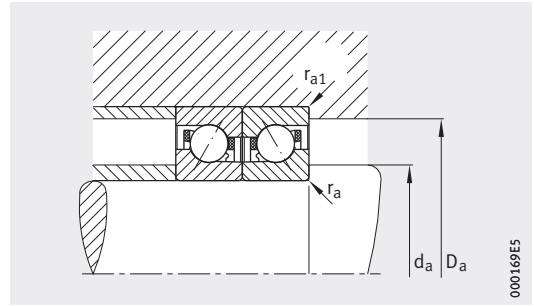
000169D9

Dimension table (continued) · Dimensions in mm

Designation	Mass m ≈ kg	Dimensions					Contact angle α °	Mounting dimensions			
		d	D	2B	r	r ₁		d _a h12	D _a H12	r _a max.	r _{a1}
BAX105-F-T-P4S-DBL	3,2	105	160	49,5	1	1	30	119,5	145,5	1	1
BAX105-H-T-P4S-DBL	3,2	105	160	49,5	1	1	40	119,5	145,5	1	1
BAX110-F-T-P4S-DBL	4,12	110	170	54	1	1	30	125,5	154,5	1	1
BAX110-H-T-P4S-DBL	4,12	110	170	54	1	1	40	125,5	154,5	1	1
BAX120-F-T-P4S-DBL	4,42	120	180	54	1	1	30	135,5	164,5	1	1
BAX120-H-T-P4S-DBL	4,42	120	180	54	1	1	40	135,5	164,5	1	1
BAX130-F-T-P4S-DBL	6,54	130	200	63	1	1	30	147,5	182,5	1	1
BAX130-H-T-P4S-DBL	6,54	130	200	63	1	1	40	147,5	182,5	1	1
BAX140-F-T-P4S-DBL	6,96	140	210	63	1	1	30	157,5	192,5	1	1
BAX140-H-T-P4S-DBL	6,96	140	210	63	1	1	40	157,5	192,5	1	1
BAX150-F-T-P4S-DBL	8,2	150	225	67,5	1,1	1,1	30	169	206	1,1	1,1
BAX150-H-T-P4S-DBL	8,2	150	225	67,5	1,1	1,1	40	169	206	1,1	1,1
BAX160-F-T-P4S-DBL	10,6	160	240	72	1,1	1,1	30	180,5	219,5	1,1	1,1
BAX160-H-T-P4S-DBL	10,6	160	240	72	1,1	1,1	40	180,5	219,5	1,1	1,1
BAX170-F-T-P4S-DBL	13,4	170	260	81	1,1	1,1	30	192,5	237,5	1,1	1,1
BAX170-H-T-P4S-DBL	13,4	170	260	81	1,1	1,1	40	192,5	237,5	1,1	1,1
BAX180-F-T-P4S-DBL	17,8	180	280	90	1,1	1,1	30	204	255,5	1,1	1,1
BAX180-H-T-P4S-DBL	17,8	180	280	90	1,1	1,1	40	204	255,5	1,1	1,1
BAX190-F-T-P4S-DBL	18,6	190	290	90	1,1	1,1	30	214	265,5	1,1	1,1
BAX190-H-T-P4S-DBL	18,6	190	290	90	1,1	1,1	40	214	265,5	1,1	1,1
BAX200-F-T-P4S-DBL	24	200	310	99	1,1	1,1	30	229	280,5	1,1	1,1
BAX200-H-T-P4S-DBL	24	200	310	99	1,1	1,1	40	229	280,5	1,1	1,1



Mounting dimensions



Mounting dimensions

Basic load ratings		Limiting speeds		Preload force F_V			Lift-off force K_{aE}			Axial rigidity c_a		
dyn. C_a kN	stat. C_{0a} kN	n_G grease min^{-1}	n_G oil min^{-1}	L N	M N	H N	L N	M N	H N	L N/ μm	M N/ μm	H N/ μm
53 000	125 000	6 000	8 500	297	1 216	–	851	3 539	–	253	416	–
64 000	163 000	5 300	7 500	396	1 737	–	1 126	4 985	–	418	695	–
64 000	151 000	5 600	8 000	380	1 495	–	1 089	4 351	–	278	451	–
79 000	197 000	4 800	7 000	524	2 178	–	1 492	6 253	–	466	760	–
66 000	164 000	5 300	7 500	392	1 554	–	1 122	4 519	–	296	481	–
81 000	214 000	4 500	6 300	543	2 275	–	1 546	6 530	–	496	811	–
90 000	215 000	4 800	7 000	603	2 235	–	1 728	6 510	–	338	538	–
111 000	280 000	4 000	6 000	850	3 280	–	2 420	9 421	–	570	907	–
94 000	235 000	4 500	6 700	621	2 317	–	1 778	6 743	–	360	573	–
115 000	305 000	3 800	5 600	865	3 372	–	2 463	9 679	–	604	965	–
101 000	260 000	4 300	6 000	674	2 494	–	1 929	7 255	–	375	596	–
124 000	335 000	3 600	5 300	938	3 623	–	2 670	10 397	–	630	1 003	–
112 000	290 000	4 000	5 600	752	2 764	–	2 151	8 038	–	404	641	–
137 000	380 000	3 400	4 800	1 052	4 028	–	2 994	11 558	–	681	1 080	–
142 000	365 000	3 800	5 300	1 016	3 609	–	2 910	10 501	–	448	701	–
174 000	475 000	3 200	4 500	1 447	5 305	–	4 120	15 229	–	758	1 185	–
178 000	455 000	3 400	5 000	1 329	4 610	–	3 809	13 418	–	498	775	–
219 000	590 000	3 000	4 300	1 910	6 798	–	5 437	19 520	–	846	1 310	–
182 000	475 000	3 400	4 800	1 082	4 261	–	3 095	12 375	–	477	773	–
223 000	620 000	2 800	4 000	1 503	6 245	–	4 276	17 913	–	801	1 306	–
184 000	500 000	3 200	4 500	1 089	4 312	–	3 115	12 518	–	490	796	–
226 000	650 000	2 600	3 800	1 501	6 286	–	4 269	18 024	–	822	1 343	–



FAG



Customer solutions

Customer solutions

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Customer solutions

The dimension tables in this catalogue cover spindle bearings corresponding to the standardised design envelope.

The chapter Customer solutions presents solutions with ordering designations that allow these spindle bearing products to be adapted as well as possible to the mounting situation on the spindle. The products do not fall outside the standardised design envelope. They can thus be used without any problems in new designs with existing spindle configurations.

Due to the system of series designations, the bearing type from which the product is derived is retained in the ordering designation. This also takes account of the fundamental series philosophy underlying these special solutions, which stands for speed, flexibility and security of supply.

Furthermore, any type of bearing design is available by agreement as a special solution with a drawing number.

Spindle bearings

Thin dense chromium coating on outside diameter

In order to prevent fretting corrosion on the outer ring, spindle bearings with the ordering designation J24J have a thin dense chromium coating on the outer ring, *Figure 1*. Due to this thin dense chromium coating, the friction coefficient between the housing and outer ring remains consistently low during operation.

Since the thin dense chromium coating is taken into consideration in the manufacture of the outer rings, all tolerances conform to P4S.

The bandwidth of the outside diameter sort is maintained. As a result, coated bearings can be used on existing spindles without modification of the adjacent construction.

Ordering example

HCB7014-E-T-P4S-J24J-UL



Figure 1
Thin dense chromium coating on outside diameter



Customer solutions

Open spindle bearings supplied greased

Open spindle bearings supplied filled with the optimum grease quantity can be ordered using the designations GA21, L298 and L055.

The advantages of these designs are that greasing by the customer is not required and the correct grease in the correct quantity for the application is available at the correct position in the bearing without losing any time during mounting.

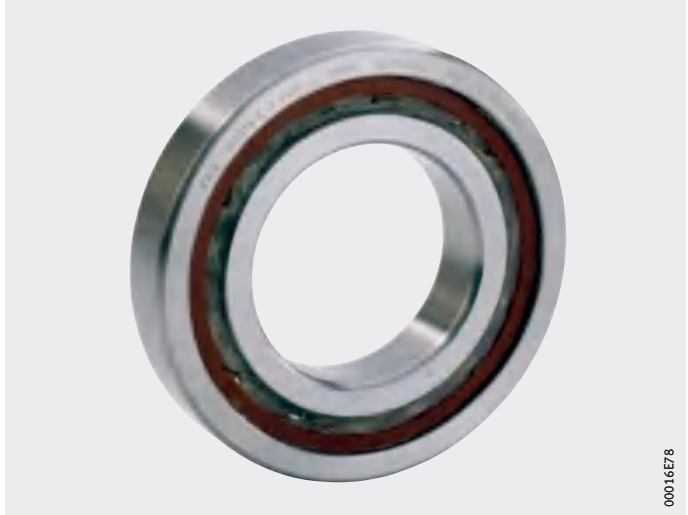


If the grease is not retained in the bearing by adjacent parts, it is recommended that sealed spindle bearings should be used. When selecting bearings, the Application Engineering facilities of Schaeffler Technologies should be contacted for assistance.

Ordering examples **HCB7014-E-T-P4S-UL-GA21**
HCB7014-E-T-P4S-UL-L298

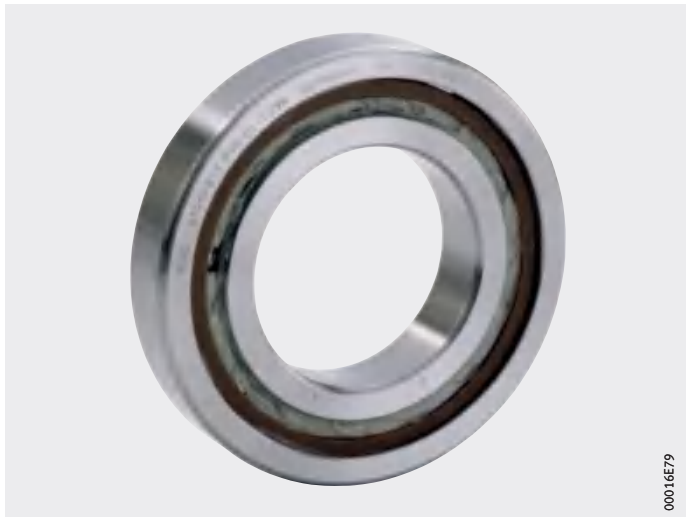
Greased with Arcanol GA21

Figure 2
Open spindle bearing



Greased with Arcanol L298

Figure 3
Open spindle bearing



Customer solutions

Cylindrical roller bearings Cylindrical bore and special radial internal clearance

Cylindrical roller bearings are also available by agreement with a cylindrical bore.

In the case of these bearings, there is no “K” in the short designation, see examples in brackets:

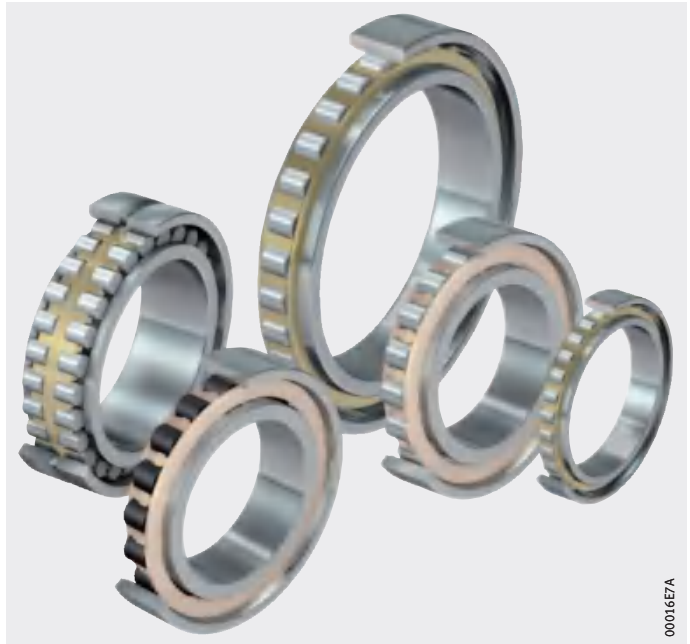
- N10..K-TVP-SP-XL (N10..-TVP-SP-XL)
- N10..K-PVPA1-SP (N10..-PVPA1-SP)
- HCN10..K-PVPA1-SP (HCN10..-PVPA1-SP).

If these bearings are planned for use at high speeds, the Application Engineering facilities should be contacted for assistance in order to achieve the correct design.

The radial internal clearance tables for cylindrical roller bearings with a cylindrical bore contain standardised values. At high speeds, it may be the case that if the interference of the inner ring required to prevent the inner ring from lifting off the shaft is present, the cylindrical roller bearing with a cylindrical bore will run with preload after mounting. In this case, the radial internal clearance of the cylindrical roller bearing must be redefined with the assistance of Application Engineering.

Ordering example

HCN1014-PVPA1-SP-R15-30NA



Cylindrical bore and
special radial internal clearance

Figure 4
Super precision
cylindrical roller bearings

Request for calculation of bearing arrangement



Schaeffler Technologies AG & Co. KG
Product Line Spindle Bearings

Design no.: _____

Customer: _____

Drawing attached: yes no

Contact: _____

Bearing arrangement (diagram, for example << >>):

Application: _____

Drive system: _____

Rigid

Shaft position: vertical

Spring-adjusted

horizontal

Spring force _____

swivelling

Bearing type(s) on working side (front): _____

Bearing type(s) on drive side (rear): _____

Max. speed: _____ min^{-1} Lubrication: _____ Nominal viscosity: _____ $\text{mm}^2 \cdot \text{s}^{-1}$

Forces			Speed	Time proportion	Tool diameter	Boom	Belt tension, drive
F_r	F_a	F_t					
kN	kN	kN	min^{-1}	%	mm	a mm	F_R kN

Special environmental influences, operating conditions:

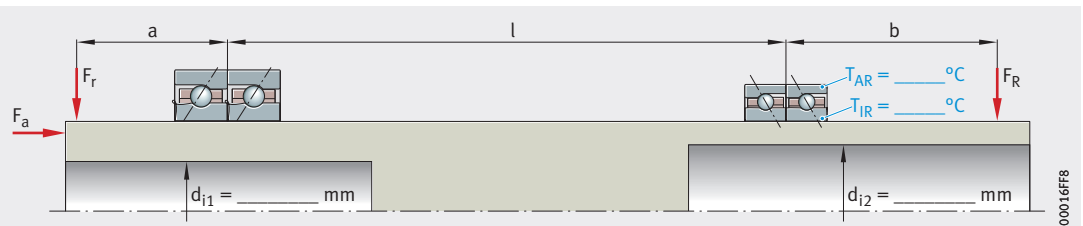
Assumptions:

Bearing operating temperature front/rear: $T =$ _____ / _____ $^{\circ}\text{C}$

ΔT (inner ring/outer ring) front/rear: _____ / _____ K

Interference (shaft/inner ring) front/rear: _____ / _____ μm

Bearing spacing $l =$ _____ mm, drive spacing $b =$ _____ mm, boom $a =$ _____ mm (see table)



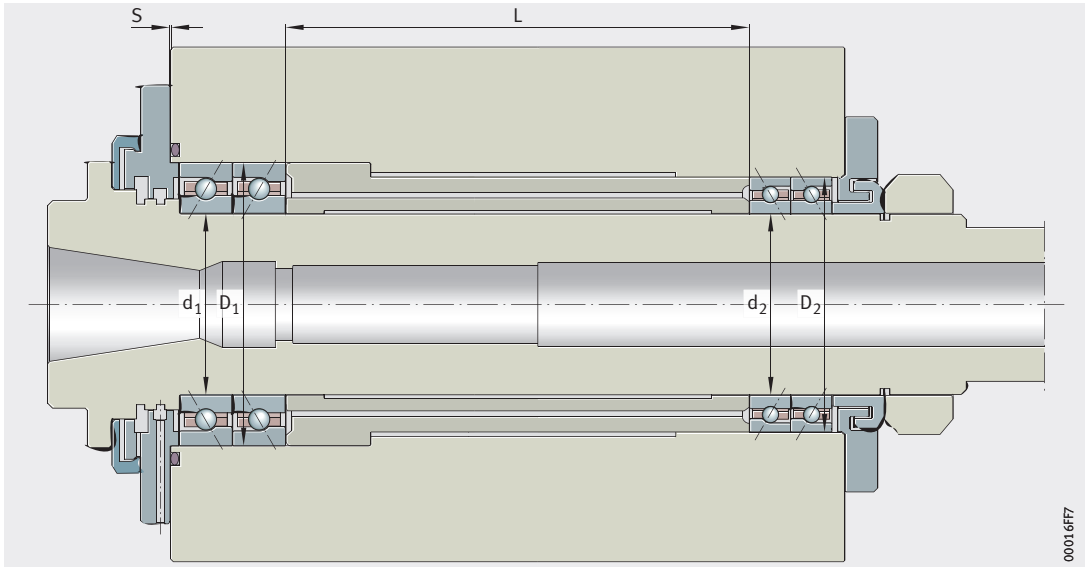
Questions (please attach drawing if possible):

Contact: _____ Date: _____

This form is also available in electronic form at www.fag.de.



Milling spindle (example)



Bearing seat diameter d_1, D_1, d_2, D_2

Spindle $\varnothing 70 \pm 0,004$

front $d_1 = +0,002$ rear $d_2 = 0$

Housing $\varnothing 110 -0,004 / +0,006$

front $d_1 = +0,003$ rear $d_2 = +0,003$

Difference in length L between intermediate sleeves

max. $\pm 0,002$ actual: 0

Gap S before screw tightening

nominal 0,01 to 0,03 actual: 0,02

Balancing of rotational parts

OK

Spindle bearing front

Part designation: **HC7014-E-T-P4S-UL**

Spindle bearing rear

Part designation: **HC7014-E-T-P4S-UL**

Correct designation

OK

Other: _____

Special notes

Grease quantity per bearing $9,2 \text{ cm}^3$ OK

Other: _____

Nut tightening torque, initially three times value

219 Nm

OK, loosen, then

Nut tightening torque, finally one times value

73 Nm

OK

Grease distribution cycle completed OK

Continuous running completed, speed

$10\,000 \text{ min}^{-1}$

OK

Equilibrium temperature

$+44 \text{ }^\circ\text{C}$

Room temperature

$+24 \text{ }^\circ\text{C}$

Note

The difference should (without cooling) not exceed $+30 \text{ K}$.

Radial runout R_{max} 0,002

Actual: 0,001

Axial runout A_{max} 0,002

Actual: 0,001

Machine: Machining centre – customer

Spindle: Drawing, serial number

Location: _____

Date: _____

Fitter: _____

Checklist for mounting of spindle bearings



Spindle name and application: _____

Spindle cross-section drawing
Figure with dimensional data

0009ACEE

Bearing seat diameter d_1, D_1, d_2, D_2

Spindle \varnothing _____ front $d_1 =$ _____ rear $d_2 =$ _____
 Housing \varnothing _____ front $d_1 =$ _____ rear $d_2 =$ _____

Difference in length L between intermediate sleeves max. _____ actual: _____
Gap S before screw tightening nominal _____ to _____ actual: _____

Balancing of rotational parts OK

Spindle bearing front Part designation: _____
Spindle bearing rear Part designation: _____

Correct designation OK Other: _____

Special notes _____

Grease quantity per bearing _____ cm^3 OK Other: _____

Nut tightening torque, initially three times value _____ Nm OK, loosen, then
Nut tightening torque, finally one times value _____ Nm OK

Grease distribution cycle completed OK

Continuous running completed, speed _____ min^{-1} OK

Equilibrium temperature _____ $^{\circ}\text{C}$

Room temperature _____ $^{\circ}\text{C}$

Note _____

Radial runout R_{max} _____ Actual: _____

Axial runout A_{max} _____ Actual: _____

Machine: _____ **Spindle:** _____

Location: _____ **Date:** _____ **Fitter:** _____





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