



## Super precision bearings

Spindle bearings, super precision cylindrical roller bearings,  
axial angular contact ball bearings

Catalogue



# Contents

Preface.....	5
1 Technical principles.....	6
1.1 Components and materials .....	6
1.1.1 Steels for bearing rings and rolling elements.....	6
1.1.2 Materials for rolling elements .....	7
1.1.3 Cage function and materials for cages.....	8
1.1.4 Seal materials .....	10
1.1.5 Coatings.....	10
1.2 Tolerances.....	10
1.2.1 Definitions and measurement principles .....	10
1.2.2 Tolerances of super precision bearings .....	15
1.2.3 Machining tolerances of adjacent parts.....	22
1.3 Speeds.....	34
1.3.1 Spindle bearings .....	34
1.3.2 Super precision cylindrical roller bearings.....	35
1.4 Rigidity.....	36
1.4.1 Axial rigidity .....	36
1.4.2 Lift-off force.....	37
1.4.3 Radial rigidity .....	37
1.5 Load carrying capacity and operating life.....	38
1.5.1 Operating life of super precision bearings .....	38
1.6 Lubrication .....	41
1.6.1 Principles .....	41
1.6.2 Grease lubrication .....	44
1.6.3 Oil lubrication .....	50
1.7 Operating temperature.....	54
1.7.1 Spindle bearings .....	54
1.7.2 Super precision cylindrical roller bearings.....	54
1.7.3 Axial angular contact ball bearings .....	54
1.8 Design and examples of bearing arrangements.....	54
1.8.1 Design and applications .....	54
1.8.2 Preload .....	55
1.8.3 Rigidity.....	55
1.8.4 Bearing contact angle.....	56
1.8.5 Bearing selection according to ball size and material .....	56
1.8.6 Selection of the optimum bearing spacing .....	57
1.8.7 Sealing.....	57
1.8.8 Stages in bearing arrangement design .....	58
1.8.9 Design of main spindles using BEARINX .....	59
1.8.10 Comparison of bearing arrangements.....	61
1.8.11 Examples of bearing arrangements .....	61
1.9 Mounting.....	63
1.9.1 Handling and use .....	63
1.9.2 Mounting .....	63
1.9.3 Bearing Data Service .....	72
1.9.4 Mounting service.....	74
1.9.5 Rental of tools .....	74

1.9.6	Devices for the mounting of super precision bearings.....	75
1.9.7	Training courses.....	79
1.9.8	Other products and services.....	80
1.10	Bearing monitoring.....	80
1.10.1	Factors in bearing monitoring.....	80
1.10.2	Types of monitoring.....	81
2	Spindle bearings.....	83
2.1	Features.....	83
2.1.1	Extensive range of product variants.....	83
2.1.2	Universal bearings.....	84
2.1.3	Universal bearing sets.....	85
2.1.4	Load carrying capacity and contact angle.....	86
2.1.5	Bearing types and product characteristics.....	87
2.1.6	Hybrid bearings.....	88
2.1.7	Bearing rings made from Vacrodur.....	88
2.1.8	Open and sealed spindle bearings.....	89
2.1.9	Direct Lube design.....	90
2.1.10	Cages.....	90
2.1.11	Designation and marking of bearings.....	91
2.2	Product tables.....	93
2.2.1	Explanations.....	93
2.2.2	Spindle bearings.....	94
2.2.3	Spindle bearings, design DLR.....	146
3	Super precision cylindrical roller bearings.....	164
3.1	Features.....	164
3.1.1	Single row super precision cylindrical roller bearings.....	165
3.1.2	Double row super precision cylindrical roller bearings.....	166
3.1.3	Sealing.....	166
3.1.4	Lubrication.....	167
3.1.5	Cages.....	168
3.1.6	Designation and marking of bearings.....	169
3.2	Product tables.....	171
3.2.1	Explanations.....	171
3.2.2	Super precision cylindrical roller bearings N10.....	172
3.2.3	Super precision cylindrical roller bearings NN30.....	174
3.2.4	Super precision cylindrical roller bearings NNU49.....	178
4	Axial angular contact ball bearings.....	180
4.1	Features.....	180
4.1.1	Sealing.....	180
4.1.2	Lubrication.....	181
4.1.3	Cages.....	181
4.1.4	Designation and marking of bearings.....	182
4.2	Product tables.....	183
4.2.1	Explanations.....	183
4.2.2	Axial angular contact ball bearings.....	184

## Preface

Spindle bearing arrangements play a decisive role in the performance of machine tools and have a considerable influence on both the achievable cutting parameters and the quality and stability of the machining process. In addition, virtually no other component in machine tools is operated at its load limit and, on occasion, even overloaded than the spindle bearing arrangement.

Selecting a spindle bearing arrangement that is optimally suited to technical and economic criteria and designed to a high degree of accuracy is, without doubt, a key task in machine tool construction. Indeed, it is not uncommon for the spindle bearing arrangement to be referred to as a supreme discipline.

In order to guide you quickly and easily to your optimum spindle bearing arrangement, whilst also incorporating all parameters as precisely as possible, Schaeffler offers you the following options:

- Technically sound advice from our engineers in Application Engineering, who guide several hundred development projects through to volume production every year.
- Spindle design using our calculation and simulation tool BEARINX-online Spindle Calculation. Registered customers use the same calculation basis as our engineers in Application Engineering, giving them access to decades of experience in spindle bearing arrangement design and allowing factors such as shaft deflection, rolling contact elasticity and bearing ring expansion to be taken into account. BEARINX-online also ensures a simple, rapid and secure exchange of data and calculations between you and Schaeffler.
- Catalogue SP 1 is also available to you in parallel as an entry point and important source of information.

Catalogue SP 1 describes all rolling bearing arrangements available from Schaeffler for use in machine tool spindles. In addition, this catalogue serves as a technical compendium for the selection, design, operation, mounting and monitoring of spindle bearing arrangements, providing a summary of the key technical information for designers in a single publication. A final note on the nomenclature: Our spindle bearing range is essentially composed of the following rolling bearing arrangements:

- spindle bearings (ball bearings)
- super precision cylindrical roller bearings
- axial angular contact ball bearings

# 1 Technical principles

## 1.1 Components and materials

### 1.1.1 Steels for bearing rings and rolling elements

#### 1.1.1.1 Standard rolling bearing steel 100Cr6

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

#### 1.1.1.2 High performance steel Vacrodur

For high performance applications, especially in motor spindles with very high speeds, Schaeffler offers the bearings with rings made from the high performance steel Vacrodur and ceramic rolling elements. The material used for the rings is a high performance steel produced by powder metallurgy with an exceptionally homogeneous and fine structure.

Vacrodur has, in comparison with the normal rolling bearing steel 100Cr6, a significantly higher hardness above 65 HRC combined with simultaneously high toughness. As a result, the permissible contact pressure is higher.

Tests on the material fatigue life have given life values higher by a factor of 13 compared to 100Cr6. The basic dynamic load rating is up to 140 % higher compared to 100Cr6. Due to its high hardness, Vacrodur gives significantly more robust behaviour in collision in comparison with 100Cr6. The static load carrying capacity is increased by 40 %.

In the event of lubricant contamination, the high hardness and toughness of the material leads to a reduction in initial damage caused by overrolling of foreign particles. In the mixed friction range, rating life values of up to 25 times the normal value have even been achieved.

It is also significantly superior to conventional rolling bearing steels where high temperature hardness is concerned.

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

### 1.1.2 Materials for rolling elements

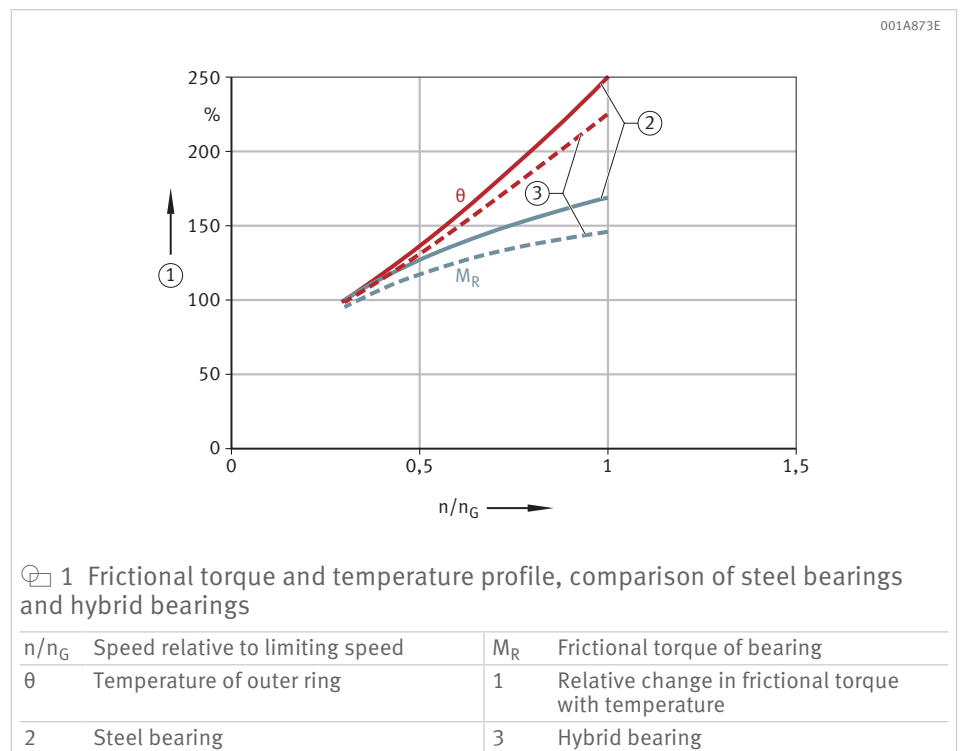
Standard bearings have rolling elements made from 100Cr6.

Hybrid bearings with rings made from standard rolling bearing steel (HCB, HCM, HC) and Vacrodur (VCM) are fitted with ceramic balls made from silicon nitride ( $\text{Si}_3\text{N}_4$ ). In comparison with steel rolling elements, ceramic rolling elements offer many advantages:

- excellent tribological behaviour in the combination of steel and ceramic:
  - significantly reduced strain on the material
  - significantly reduced strain on the lubricant
- lower density:
  - reduced centrifugal forces on the rolling elements
  - improved bearing kinematics as the mass is lower than steel by 60 %
- lower coefficient of thermal expansion of the ceramic rolling elements with positive effect on the change in bearing preload in response to temperature differences in operation
- no magnetism and high current insulation

1 Comparison of silicon nitride  $\text{Si}_3\text{N}_4$  and rolling bearing steel 100Cr6

Material parameters at room temperature		Silicon nitride $\text{Si}_3\text{N}_4$	Rolling bearing steel 100Cr6
Density	$\text{g/cm}^3$	3,2 ... 3,25	7,8 ... 7,85
Coefficient of thermal expansion	$10^{-6} \text{K}^{-1}$	3,2	11,5
Modulus of elasticity	$\text{kN/mm}^2$	315 ... 320	200 ... 210
Hardness	HV 10	1600	700
Flexural strength	$\text{N/mm}^2$	600, 700	2500
Fracture toughness	$\text{MPa} \cdot \sqrt{\text{m}}$	7	20
Thermal conductivity	$\text{W}/(\text{m} \cdot \text{K})$	30 ... 35	40 ... 45
Specific electrical resistance	$\Omega \cdot \text{mm}^2/\text{m}$	approx. 1000	0,1 ... 1



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.

### 1.1.3 Cage function and materials for cages

The cage is an important functional part in a rolling bearing and has the following characteristics:

- The cage keeps the rolling elements separate from each other.
- The cage maintains the spacing between the rolling elements, thus giving more uniform load distribution.
- The cage guides the rolling elements in the unloaded zone of the bearing.
- The cage 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.

#### 1.1.3.1 Angular contact ball bearings with laminated fabric cages

FAG angular contact ball bearings of P4S accuracy class are fitted with phenolic resin/cotton laminated fabric cages. The laminated fabric cages are guided on the outer ring and have good emergency running characteristics (suffix T). The laminated fabric 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, in this respect, is thus superior to many thermoplastics. The maximum operating temperature of laminated fabric cages is +100 °C.

#### 1.1.3.2 Cylindrical roller bearings and double direction axial angular contact ball bearings

Super precision cylindrical roller bearings of series NNU49, N10 and NN30 with a bore diameter outside the range of 30 mm 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 are fitted with ball-guided solid brass cages (suffix M). The maximum operating temperature of brass cages is +150 °C.

### Solid brass cage and polyamide

The new FAG X-life cylindrical roller bearings of series N10 and NN30 and in the bore diameter range 30 to 120 mm are fitted with a window cage made from polyamide. 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. As a result of the lower increase in temperature, speeds up to 25 % 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 %. The light plastic cage (suffix TVP) with better damping characteristics reduces bearing noise so that the bearings run more quietly. The maximum operating temperature of TVP cages is +120 °C.



High Speed cylindrical roller bearings in X-life design, specifically for motor spindles, are available with a cage made from PEEK (PEEK = polyether ether ketone) (suffix PVPA1). Since displacement on the non-locating bearing side of motor spindles only ever occurs in one direction in operation, the cage can be guided unilaterally. Unilateral guidance leads to a more rapid grease distribution cycle with lower maximum temperatures and subsequently to a lower temperature level with smaller scatter. 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.



### 1.1.4 Seal materials

Main spindle bearings that are greased and sealed on both sides have non-contact sealing by means of sealing washers made from nitrile butadiene rubber (NBR). Seals 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. Bearings for pneumatic oil lubrication of the design DLR are each fitted with two O-rings made from FKM.

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).

### 1.1.5 Coatings


Coatings are recommended in certain applications. In order to prevent current passage, to improve anti-corrosion or anti-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 frequently in the case of main spindle bearings in order to prevent fretting corrosion of the outer ring. This coating option is available under the suffix J24). Other coating options are available by agreement.

## 1.2 Tolerances

### 1.2.1 Definitions and measurement principles

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

The symbols for the nominal dimensions of radial bearings indicate the size dimensions and spacings and, with the exception of the font, are listed in accordance with ISO 15241 ▶11|2.

The symbols for the nominal dimensions of axial bearings indicate the size dimensions and spacings and are listed in accordance with DIN EN ISO 1101 and ISO 14405-1 ▶14|3.

2 Symbols for nominal dimensions of radial rolling bearings ISO 492:2014

Symbols for nominal dimensions	GPS symbol and specification modifier	Description for radial bearings	Old term
Tolerance symbol for characteristic	Symbols in accordance with DIN EN ISO 1101 and ISO 14405-1	in accordance with ISO 492:2014 (based on DIN EN ISO 1101, ISO 5459 and ISO 14405-1)	in accordance with ISO 1132-1:2000
<b>Width</b>			
B	–	Nominal inner ring width	Nominal inner ring width
$t_{\Delta Bs}$	(LP)	Symmetrical rings Deviation of a two-point size of inner ring width from its nominal size $\Delta Bs = Bs - B$ $Bs$ = single two-point size of inner ring width	Deviation of a single inner ring width
$t_{\Delta Bs}$	(GNALS) (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	Deviation of a single inner ring width
$t_{\Delta Bs}$	(GNALS) (LP)	Asymmetrical rings, lower limit Deviation of a two-point size of inner ring width from its nominal size	Deviation of a single inner ring width
$t_{VBs}$	(LP) (SR)	Symmetrical rings Range of two-point sizes of inner ring width $VBs = Bs_{max} - Bs_{min}$	Variation of inner ring width
$t_{VBs}$	(GNALS) (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	Variation of inner ring 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 outer ring width	Deviation of a single outer ring width
$t_{\Delta Cs}$	(GNALS) (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	Deviation of a single outer ring width
$t_{\Delta Cs}$	(GNALS) (LP)	Asymmetrical rings, lower limit Deviation of a two-point size of outer ring width from its nominal size	Deviation of a single outer ring width
$t_{VCs}$	(LP) (SR)	Symmetrical rings Range of two-point sizes of outer ring width $VCs = Cs_{max} - Cs_{min}$	Variation of outer ring width
$t_{VCs}$	(GNALS) (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	Variation of outer ring width
<b>Diameter</b>			
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

Symbols for nominal dimensions	GPS symbol and specification modifier	Description for radial bearings	Old term
<b>Tolerance symbol for characteristic</b>	<b>Symbols in accordance with DIN EN ISO 1101 and ISO 14405-1</b>	<b>in accordance with ISO 492:2014 (based on DIN EN ISO 1101, ISO 5459 and ISO 14405-1)</b>	<b>in accordance with ISO 1132-1:2000</b>
$t_{\Delta dmp}$	$\textcircled{LP} \textcircled{SD} \textcircled{ACS}$	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
$t_{\Delta dmp}$	$\textcircled{LP} \textcircled{SD} \textcircled{SCS}$	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	Deviation of mean bore diameter in a single plane
$t_{Vdmp}$	$\textcircled{LP} \textcircled{SD} \textcircled{ACS} \textcircled{SR}$	Range of mid-range sizes (out of two-point sizes) of bore diameter obtained from any cross-section of a cylindrical bore $Vdmp = dmp_{max} - dmp_{min}$	Variation of mean bore diameter
$d_1$	–	Nominal diameter at the theoretical large end of a tapered bore	Variation of mean bore diameter
$t_{\Delta d1mp}$	$\textcircled{LP} \textcircled{SD} \textcircled{SCS}$	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	Variation of mean bore diameter
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
$t_{\Delta Dmp}$	$\textcircled{LP} \textcircled{SD} \textcircled{ACS}$	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
$t_{VDmp}$	$\textcircled{LP} \textcircled{SD} \textcircled{ACS} \textcircled{SR}$	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
<b>Running accuracy</b>			
$t_{Kea}$	$\nearrow$	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
$t_{Kia}$	$\nearrow$	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
$t_{Sd}$	$\nearrow$	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
$t_{Se}$	$\nearrow$	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
$t_{Sia}$	$\nearrow$	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
<b>Tapered bore</b>			
SL	–	Taper slope: The difference between nominal diameters at the theoretical large end and small end of a tapered bore $SL = d_1 - d$ SL = spacing	–

Symbols for nominal dimensions	GPS symbol and specification modifier	Description for radial bearings	Old term
<b>Tolerance symbol for characteristic</b>	<b>Symbols in accordance with DIN EN ISO 1101 and ISO 14405-1</b>	<b>in accordance with ISO 492:2014 (based on DIN EN ISO 1101, ISO 5459 and ISO 14405-1)</b>	<b>in accordance with ISO 1132-1:2000</b>
$t_{\Delta SL}$	–	Deviation of taper slope of a tapered bore from its nominal size (description based on DIN EN ISO 1119) $\Delta SL = \Delta d_{1mp} - \Delta d_{mp}$	–
$\alpha$	–	Frustum angle of tapered inner ring bore	–
<b>Width of assembled bearing</b>			
$T$	–	Nominal assembled bearing width	Assembled bearing width
$t_{\Delta Ts}$	ⓄGN	Deviation of minimum circumscribed size of assembled bearing width from its nominal size	Deviation of the actual bearing width
$T_1$	–	Nominal effective width of inner subunit assembled with a master outer ring	Nominal effective width of inner subunit
$t_{\Delta T1s}$	ⓄGN	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

3 Symbols for nominal dimensions of axial rolling bearings ISO 199:2014

Symbols for nominal dimensions	GPS symbol and specification modifier	Description for axial bearings	Old term
<b>Tolerance symbol for characteristic</b>	<b>Symbols in accordance with DIN EN ISO 1101 and ISO 14405-1</b>	<b>in accordance with ISO 199:2014 (based on DIN EN ISO 1101, ISO 5459 and ISO 14405-1)</b>	<b>in accordance with ISO 1132-1:2000</b>
<b>Diameter</b>			
d	–	Nominal bore diameter of shaft washer, single-direction bearing	Nominal bore diameter of shaft washer
$t_{\Delta dmp}$	$\textcircled{LP} \textcircled{SD} ACS$	Nominal bore diameter of shaft washer, single-direction bearing	Deviation of mean bore diameter in a single plane
$t_{Vdsp}$	$\textcircled{LP} \textcircled{SR} ACS$	Deviation of a mid-range size (out of two-point sizes) of shaft washer bore diameter in any cross-section from its nominal size $dmp = (d_{max} + d_{min})/2$ $\Delta dmp = dmp - d$	Variation of single bore diameter in a single plane
D	–	Nominal outside diameter of housing washer	Nominal outside diameter of bore (housing washer)
$t_{\Delta Dmp}$	$\textcircled{LP} \textcircled{SD} ACS$	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
$t_{VDsp}$	$\textcircled{LP} \textcircled{SR} ACS$	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
<b>Height</b>			
T	–	Nominal assembled bearing height, single-direction bearing	Nominal bearing height
$t_{\Delta Ts}$	$\textcircled{GN}$	Deviation of minimum circumscribed size of assembled bearing height from its nominal size, single-direction bearing	Deviation of the actual bearing height
$T_1$	–	Nominal assembled bearing height, double-direction bearing	–
$t_{\Delta T1s}$	$\textcircled{GN}$	Deviation of minimum circumscribed size of assembled bearing height from its nominal size, double-direction bearing	–
$t_{Se}$	$\textcircled{LP} \textcircled{SR}$	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
$t_{Se}$	$\textcircled{LS} \textcircled{SN} ALS \textcircled{SR} \left\langle \begin{array}{ c } \hline \equiv \\ \hline \end{array} \right\rangle$	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	Variation in thickness between housing washer raceway and back face
$t_{Si}$	$\textcircled{LP} \textcircled{SR}$	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
$t_{Si}$	$\textcircled{LS} \textcircled{SN} ALS \textcircled{SR} \left\langle \begin{array}{ c } \hline \equiv \\ \hline \end{array} \right\rangle$	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	Variation in thickness between shaft washer raceway and back face

## 1.2.2 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 ISO 1132.

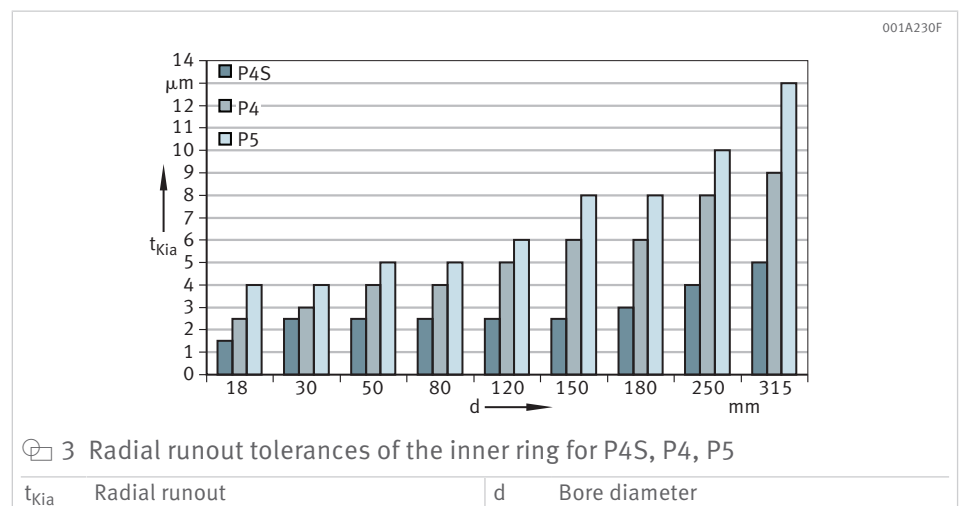
In order to ensure full use of the bearing performance capacity and a high machining accuracy, the dimensional, geometrical and running accuracy of super precision bearings is produced within very narrow tolerance ranges.

In general, super precision spindle bearings (including BAX) are manufactured to the accuracy standard P4S.

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. In this case, the roundness and running tolerances correspond to at least ISO tolerance class 4.

P4S means:

- mean deviations in accordance with ISO tolerance class 4
- all geometrical and running tolerances in accordance with ISO tolerance class 2



### 1.2.2.1 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. The tolerance width is 1/3 of the diameter tolerance. The diameter tolerances stated are thus narrower than P2.

### 1.2.2.2 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 and on the packaging label.

1.2.2.3 Tolerances of the inner and outer ring in spindle bearings

The following values are valid as tolerances for the inner and outer ring in spindle bearings.

4 Tolerances of the inner ring (tolerance class P4S)

Nominal size		Variation (out of roundness)		Variation of mean diameter	Deviation		Variation of width	Width deviation		Radial runout	Axial runout	
d		t <sub>VDsp</sub>		t <sub>VDmp</sub>	t <sub>ADmp</sub> <sup>1)</sup> , t <sub>ADs</sub>		t <sub>VBs</sub>	t <sub>ABs</sub>		t <sub>Kia</sub>	t <sub>Sd</sub>	t <sub>Sia</sub>
mm	mm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm
over	incl.	Series 9	Series 0,2									
-	10	2,5	2	1,5	0	-4	1,5	0	-100	1,5	1,5	1,5
10	18	2,5	2	1,5	0	-4	1,5	0	-100	1,5	1,5	1,5
18	30	2,5	2	1,5	0	-5	1,5	0	-120	2,5	1,5	2,5
30	50	3	2,5	2	0	-6	1,5	0	-120	2,5	1,5	2,5
50	80	3,5	3	2	0	-7	1,5	0	-150	2,5	1,5	2,5
80	120	4	3	2,5	0	-8	2,5	0	-200	2,5	2,5	2,5
120	150	5	4	3	0	-10	2,5	0	-250	2,5	2,5	2,5
150	180	5	4	3	0	-10	4	0	-250	3	4	5
180	250	6	5	4	0	-12	5	0	-300	4	5	5
250	315	8	6	5	0	-15	6	0	-350	5	6	7
315	400	10	8	6	0	-19	7	0	-400	7	7	9
400	500	12	10	8	0	-23	8	0	-450	8	8	11
500	630	13	10	8	0	-26	10	0	-500	9	10	13
630	800	16	13	10	0	-32	12	0	-750	10	12	15

1) For series 719.

5 Tolerances of the outer ring (tolerance class P4S)

Nominal size		Deviation		Variation (out of roundness)		Variation of mean diameter	Variation of width	Radial runout	Axial runout	
D		t <sub>ADs</sub> , t <sub>ADmp</sub> <sup>2)</sup>		t <sub>VDsp</sub> <sup>3)</sup>		t <sub>VDmp</sub>	t <sub>VCs</sub>	t <sub>Kea</sub>	t <sub>SD</sub>	t <sub>Se</sub>
mm	mm	µm	µm	µm	µm	µm	µm	µm	µm	µm
over	incl.			Series 9	Series 0,2					
10	18	0	-4	2,5	2	1,5	1,5	1,5	0,75	1,5
18	30	0	-5	2,5	2	1,5	1,5	2,5	0,75	2,5
30	50	0	-6	3	2,5	2	1,5	2,5	0,75	2,5
50	80	0	-7	3,5	3	2	1,5	3	0,75	4
80	120	0	-8	4	3	2,5	2,5	4	1,25	5
120	150	0	-9	5	4	3	2,5	4	1,25	5
150	180	0	-10	5	4	3	2,5	5	1,25	5
180	250	0	-11	6	5	4	4	7	2	7
250	315	0	-13	7	6	4	5	7	2,5	7
315	400	0	-15	8	6	5	7	8	3,5	8
400	500	0	-18	9	7	6	7	9	4	10
500	630	0	-22	11	9	7	8	11	4,5	12
630	800	0	-26	13	10	8	9	13	5	14
800	1000	0	-33	17	14	11	11	15	6	17

2) For series 719.

3) Valid for open bearings. For sealed bearings and DLR bearings, the values apply before assembly.



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

Nominal size		Deviation	
d		$t_{\Delta ds}, t_{\Delta dmp}$ <sup>4)</sup>	
mm	mm	$\mu\text{m}$	$\mu\text{m}$
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

<sup>4)</sup> For series 719.

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

Nominal size		Deviation	
D		$t_{\Delta DS}, t_{\Delta Dmp}$	
mm	mm	$\mu\text{m}$	$\mu\text{m}$
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

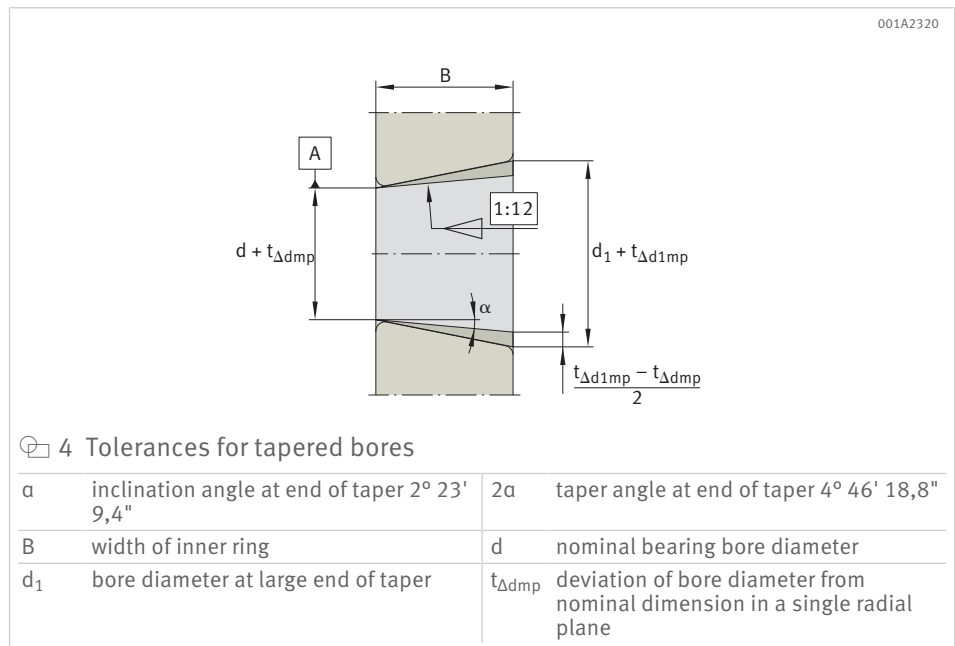
1.2.2.4 Dimensional, geometrical and positional tolerances of super precision cylindrical roller bearings

For the deviation of the tapered bore  $t_{\Delta dmp}$ , the following illustration ▶18|📐4 and table values apply.

For series N10 and HCN10, the values in the table apply ▶18|📊8 ▶19|📊9.

For series NN30 and NNU49, the values in the table apply ▶19|📊10 ▶19|📊11.

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



📊 8 Tolerances of the inner ring for single row bearings (tolerance class SP)

Nominal size		Deviation of cyl. bore		Deviation of tap. bore		Variation (out of roundness)		Variation of mean diameter	Deviation		Variation of width	Width deviation		Radial runout	Axial runout
d		$t_{\Delta d}, t_{\Delta dmp}$		$t_{\Delta dmp}$		$t_{Vdsp}$		$t_{Vdmp}$	$t_{\Delta d1mp}, t_{\Delta dmp}$		$t_{VBs}$	$t_{\Delta Bs}$		$t_{Kia}$	$t_{sd}$
mm	mm	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$
over	incl.					cyl.	tap.								
18	30	0	-6	10	0	3	3	3	4	0	1,5	0	-120	3	3
30	50	0	-8	12	0	4	4	4	4	0	2	0	-120	4	3
50	80	0	-9	15	0	5	5	5	5	0	3	0	-150	4	4
80	120	0	-10	20	0	5	5	5	6	0	3	0	-200	5	4
120	180	0	-13	25	0	7	7	7	8	0	4	0	-250	6	5
180	250	0	-15	30	0	8	8	8	9	0	5	0	-300	8	6
250	315	0	-18	35	0	9	9	9	11	0	6	0	-350	9	7
315	400	0	-23	40	0	12	12	12	12	0	7	0	-400	10	9
400	500	0	-27	45	0	14	14	14	14	0	8	0	-450	12	11
500	630	0	-30	50	0	15	15	15	15	0	10	0	-500	14	13
630	800	0	-40	65	0	20	20	20	18	0	12	0	-750	17	15

9 Tolerances of the outer ring for single row bearings (tolerance class SP)

Nominal size		Deviation		Variation (out of roundness)	Variation of mean diameter	Variation of width	Radial runout	Perpendicularity
D		$t_{\Delta Ds}, t_{\Delta Dmp}$		$t_{VDsp}$	$t_{VDmp}$	$t_{VCs}$	$t_{Kea}$	$t_{SD}$
mm	mm	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$
over	incl.							
30	50	0	-7	4	4	2,5	5	2
50	80	0	-9	5	5	3	5	2
80	120	0	-10	5	5	4	6	2,5
120	150	0	-11	6	6	5	7	2,5
150	180	0	-13	7	7	5	8	2,5
180	250	0	-15	8	8	7	10	3,5
250	315	0	-18	9	9	7	11	4
315	400	0	-20	10	10	8	13	5
400	500	0	-23	12	12	9	15	5,5
500	630	0	-28	14	14	11	17	6,5
630	800	0	-35	18	18	13	20	7,5
800	1000	0	-40	20	20	15	23	8,5

10 Tolerances of the inner ring SP for double row bearings (tolerance class SP)

Nominal size		Deviation of cyl. bore		Deviation of tap. bore		Variation (out of roundness)		Variation of mean diameter	Deviation		Variation of width	Width deviation		Radial runout	Axial runout
d		$t_{\Delta d}, t_{\Delta dmp}$		$t_{\Delta dmp}$		$t_{VDsp}$		$t_{VDmp}$	$t_{\Delta d1mp}, t_{\Delta dmp}$		$t_{VBs}$	$t_{\Delta Bs}$		$t_{Kia}$	$t_{sd}$
mm	mm	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$
over	incl.					cyl.	tap.								
18	30	0	-6	10	0	3	3	3	4	0	2,5	0	-120	3	4
30	50	0	-8	12	0	4	4	4	5	0	3	0	-120	4	4
50	80	0	-9	15	0	5	5	5	5	0	4	0	-150	4	5
80	120	0	-10	20	0	5	5	5	7	0	4	0	-200	5	5
120	180	0	-13	25	0	7	7	7	8	0	5	0	-250	6	6
180	250	0	-15	30	0	8	8	8	9	0	6	0	-300	8	7
250	315	0	-18	35	0	9	9	9	11	0	8	0	-350	8	8
315	400	0	-23	40	0	12	12	12	12	0	10	0	-400	10	10
400	500	0	-27	45	0	14	14	14	14	0	12	0	-450	10	12
500	630	0	-30	50	0	15	15	15	15	0	14	0	-500	12	14
630	800	0	-40	65	0	20	20	20	20	0	17	0	-750	15	17

11 Tolerances of the outer ring SP for double row bearings (tolerance class SP)

Nominal size		Deviation		Variation (out of roundness)	Variation of mean diameter	Variation of width	Radial runout	Perpendicularity
D		$t_{\Delta Ds}, t_{\Delta Dmp}$		$t_{VDsp}$	$t_{VDmp}$	$t_{VCs}$	$t_{Kea}$	$t_{SD}$
mm	mm	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$	$\mu m$
over	incl.							
30	50	0	-7	4	4	2,5	5	4
50	80	0	-9	5	5	3	5	4
80	120	0	-10	5	5	4	6	5
120	150	0	-11	6	6	5	7	5
150	180	0	-13	7	7	5	8	5
180	250	0	-15	8	8	7	10	7
250	315	0	-18	9	9	7	11	8
315	400	0	-20	10	10	8	13	10
400	500	0	-23	12	12	9	15	11
500	630	0	-28	14	14	11	17	13
630	800	0	-35	18	18	13	20	15
800	1000	0	-40	20	20	15	23	17

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

The dimensional, geometrical and running tolerances correspond to tolerance class SP.

12 Tolerances of the shaft locating washer

Nominal size		Deviation		Variation (out of roundness)	Wall thickness variation	Height deviation	
d		t <sub>Δdmp</sub>		t <sub>Vdsp</sub>	t <sub>si</sub>	t <sub>ΔHs</sub>	
mm	mm	μm	μm	μm	μm	μm	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

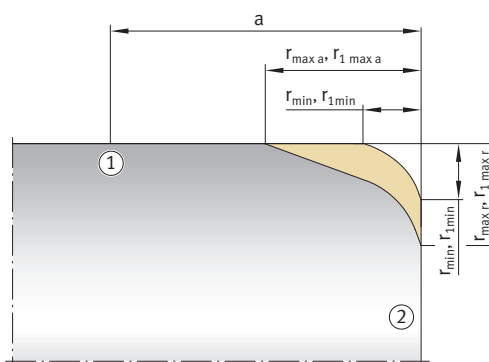
13 Tolerances of the housing locating washer

Nominal size		Variation (out of roundness)	Wall thickness variation	Deviation of outside diameter		Width deviation
D		t <sub>Vdsp</sub>	t <sub>se</sub>	t <sub>ΔDmp</sub>		t <sub>ΔCs</sub>
mm	mm	μm	μm	μm	μm	μm
over	incl.					
30	50	5	3	-20	-36	-120
50	80	6	4	-24	-43	-120
80	120	8	4	-28	-50	-125
120	150	9	5	-33	-58	-125
150	180	9	5	-33	-58	-125
180	250	10	5	-37	-66	-125
250	315	12	7	-41	-73	-150
315	400	13	7	-46	-82	-150
400	500	15	9	-50	-90	-200
500	630	16	11	-55	-99	-200
630	800	18	13	-60	-110	-250

1.2.2.6 Chamfer dimensions

The tables describe the chamfer dimensions for:

- radial bearings with a cylindrical bore
- radial bearings with a tapered bore
- axial bearings



5 Limit chamfer dimensions

a	Measurement spacing: this spacing is used for inspection of the bore or outside diameter tolerances	$r_{\min}$ $r_{1 \min}$	Symbol for smallest chamfer dimension in radial and axial direction
$r_{\max r}$ $r_{1 \max r}$	Largest chamfer dimension in radial direction	$r_{\max a}$ $r_{1 \max a}$	Largest chamfer dimension in axial direction
1	Bore or outside diameter	2	Lateral face

14 Chamfer dimension of radial bearings with cylindrical bore

Bore		Chamfer dimension			Measurement spacing
		–	radial	axial	
d		$r_{\min}$ $r_{1 \min}$	$r_{\max r}$	$r_{\max a}$ $r_{1 \max a}$	a
mm over	mm incl.	mm	mm	mm	mm
–	–	0,1	0,2	0,4	0,9
–	–	0,15	0,3	0,6	1,1
–	–	0,2	0,5	0,8	1,3
–	40	0,3	0,6	1	1,5
40	–	0,3	0,8	1	1,5
–	40	0,6	1	2	2,5
40	–	0,6	1,3	2	2,5
–	50	1	1,5	3	3,6
50	–	1	1,9	3	3,6
–	120	1,1	2	3,5	4,2
120	–	1,1	2,5	4	4,8
–	120	1,5	2,3	4	4,8
120	–	1,5	3	5	6
–	80	2	3	4,5	5,4
80	220	2	3,5	5	6
220	–	2	3,8	6	7,2
–	280	2,1	4	6,5	7,8
280	–	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	–	2,5	5	7	8,4
–	280	3	5	8	9,6
280	–	3	5,5	8	9,6
–	–	4	6,5	9	10,8
–	–	5	8	10	12
–	–	6	10	13	15,6

Spindle bearings M, HCM, VCM or with suffix DLR have a reduced tolerance of the maximum chamfer dimensions.

 15 Chamfer dimensions of radial bearings with tapered bore

Chamfer dimension			Measurement spacing
–	radial	axial	
$r_{\min}$	$r_{\max r}$	$r_{\max a}$	<b>a</b>
$r_{1 \min}$		$r_{1 \max a}$	
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>mm</b>
0,05	0,15	0,25	0,8
0,1	0,3	0,5	1
0,15	0,45	0,75	1,3
0,2	0,6	1	1,5
0,25	0,75	1,25	1,8
0,3	0,9	1,5	2
0,35	1,05	1,75	2,3
0,4	1,2	2	2,5
0,45	1,35	2,25	2,8
0,5	1,5	2,5	3
0,55	1,65	2,75	3,3
0,6	1,8	3	3,5
0,7	2,1	3,5	4,2
0,8	2,4	4	4,8
0,9	2,7	4,5	5,4
1	3	5	6
1,1	3,3	5,5	6,6
1,2	3,6	6	7,2
1,5	4,5	7,5	9
1,8	5,5	9	10,8
2,2	6,5	11	13,2
3	9	15	18

 16 Chamfer dimensions of axial bearings

Chamfer dimension			Measurement spacing
–	radial	axial	
$r_{\min}$	$r_{\max r}$	$r_{\max a}$	<b>a</b>
$r_{1 \min}$		$r_{1 \max a}$	
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>mm</b>
0,1	0,2	0,2	0,7
0,15	0,3	0,3	0,8
0,2	0,5	0,5	1
0,3	0,8	0,8	1,3
0,6	1,5	1,5	2
1	2,2	2,2	2,6
1,1	2,7	2,7	3,2
1,5	3,5	3,5	4,2
2	4	4	4,8
2,1	4,5	4,5	5,4
3	5,5	5,5	6,6
4	6,5	6,5	7,8

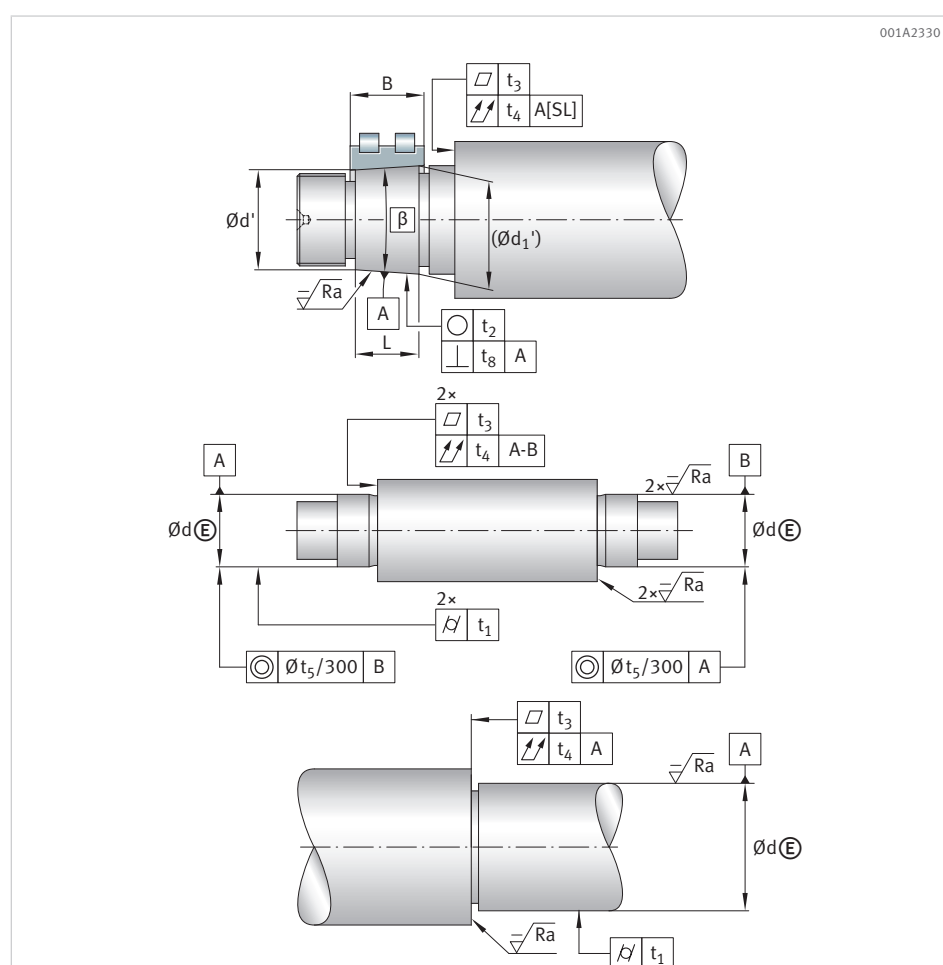
### 1.2.3 Machining tolerances of adjacent parts

The performance capacity of super precision bearings in relation to speed suitability and running accuracy continues to increase. This increased performance capacity can only be used with adjacent parts that match the bearings in terms of precision.

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.

- ! 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). Furthermore, 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 be observed.

### 1.2.3.1 Geometrical and positional tolerances of the shaft



6 Geometrical and positional tolerances of the shaft

$d$	Nominal shaft diameter	$d'$	Small taper diameter ( $d$ + lower deviation)
$d_1'$	Large taper diameter $d_1' = d' + 1/12 \cdot L$	$L$	Taper length $L = 0,95 \cdot B$ (bearing width)
$t_1$	Cylindricity tolerance	$t_2$	Roundness tolerance
$t_3$	Flatness tolerance	$t_4$	Total axial runout tolerance
$t_5$	Coaxiality tolerance	$t_1 \dots t_5$	In accordance with DIN EN ISO 1101
$AT_D$	Taper angle tolerance to DIN 7178	$R_a$	Mean roughness value to DIN EN ISO 21920

- ! In order to make comprehensive use of the performance capability of the bearings, the adjacent construction must be of an appropriate design.

Minimum requirements for the machining tolerances of the spindle bearing surrounding parts shafts are shown in the tables ▶24|▣17 ▶24|▣18 ▶25|▣19 ▶26|▣21.

▣ 17 Machining tolerances of the shaft for spindle bearings

Nominal size		Deviation for d		Cylindricity	Flatness	Total axial runout	Coaxiality	Mean roughness
d				t <sub>1</sub>	t <sub>3</sub>	t <sub>4</sub>	t <sub>5</sub>	Ra
mm	mm	µm	µm	µm	µm	µm	µm	µm
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

▣ 18 Machining tolerances of the cylindrical shaft for cylindrical roller bearings (tolerance class SP)

Nominal size		Deviation for d		Cylindricity	Flatness	Total axial runout	Coaxiality	Mean roughness
d				t <sub>1</sub>	t <sub>3</sub>	t <sub>4</sub>	t <sub>5</sub>	Ra
mm	mm	µm	µm	µm	µm	µm	µm	µm
over	incl.							
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



### 19 Machining tolerances of the tapered shaft for cylindrical roller bearings (tolerance class SP)

Nominal size		Deviation of small taper diameter <sup>1)</sup>		Roundness	Flatness	Total axial runout	Mean roughness
d				t <sub>2</sub>	t <sub>3</sub>	t <sub>4</sub>	Ra
mm	mm	µm	µm	µm	µm	µm	µm
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

<sup>1)</sup> In relation to the nominal shaft diameter d (calculation example).

#### Calculation example

For cylindrical roller bearings, the tolerance of the tapered shaft can be calculated according to the following 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 half taper angle tolerance  $AT_D/2$  applies vertical to the axis and is defined as the half differential diameter.

20 Deviation of taper angle

Nominal size		Taper angle tolerance AT <sub>D</sub> /2	
L <sub>U</sub>	L <sub>O</sub>	AT <sub>DU</sub> /2	AT <sub>DO</sub> /2
mm	mm	µm	µm
over	incl.		
10	16	0,8	1,3
16	25	1	1,6
25	40	1,3	2
40	63	1,6	2,5
63	100	2	3,2
100	160	2,5	4
160	250	3,2	5

For taper lengths with nominal dimensions that are between the values listed, the taper angle tolerance AT<sub>D</sub>/2 is determined by means of interpolation. The recommended taper length L is 95 % of the bearing width.

For a single row cylindrical roller bearing N1014-D-TVP-SP-XL, the bearing width is 20 mm. The recommended taper length L is 19 mm (95 % of the bearing width).

$$f1 \quad AT_D / 2 = \frac{\frac{AT_{DO}}{2} - \frac{AT_{DU}}{2}}{L_O - L_U} \cdot L$$

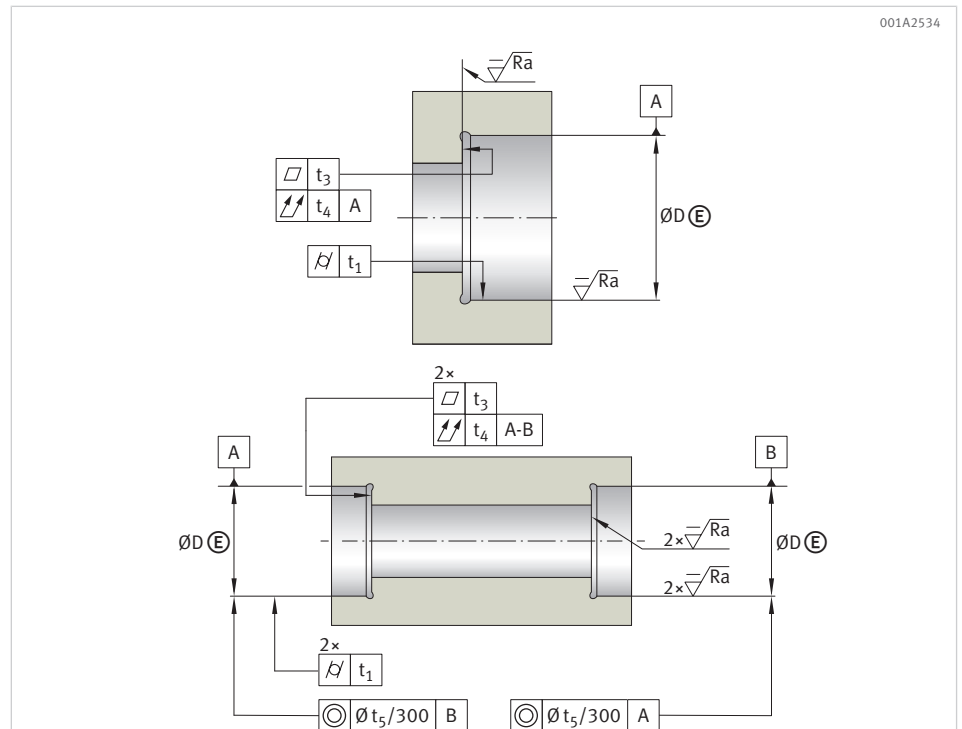
AT                      µm                      Taper angle tolerance  
 L                        mm                      Length

$$f2 \quad AT_D / 2 = \frac{1,6 - 1}{25 - 16} \cdot 19 = 1,3 \mu\text{m}$$

21 Machining tolerances of the shaft for axial angular contact ball bearings (tolerance class SP)

Nominal size		Deviation for d		Cylindricity	Flatness	Total axial runout	Mean roughness
d				t <sub>1</sub>	t <sub>3</sub>	t <sub>4</sub>	Ra
mm	mm	µm	µm	µm	µm	µm	µm
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

## 1.2.3.2 Geometrical and positional tolerances of the housing



7 Geometrical and positional tolerances of the housing

D	Nominal housing bore diameter	$t_1$	Cylindricity tolerance
$t_3$	Flatness tolerance	$t_4$	Total axial runout tolerance
$t_5$	Coaxiality tolerance	$t_1 \dots$ $t_5$	In accordance with DIN EN ISO 1101
Ra	Mean roughness value to DIN EN ISO 21920		

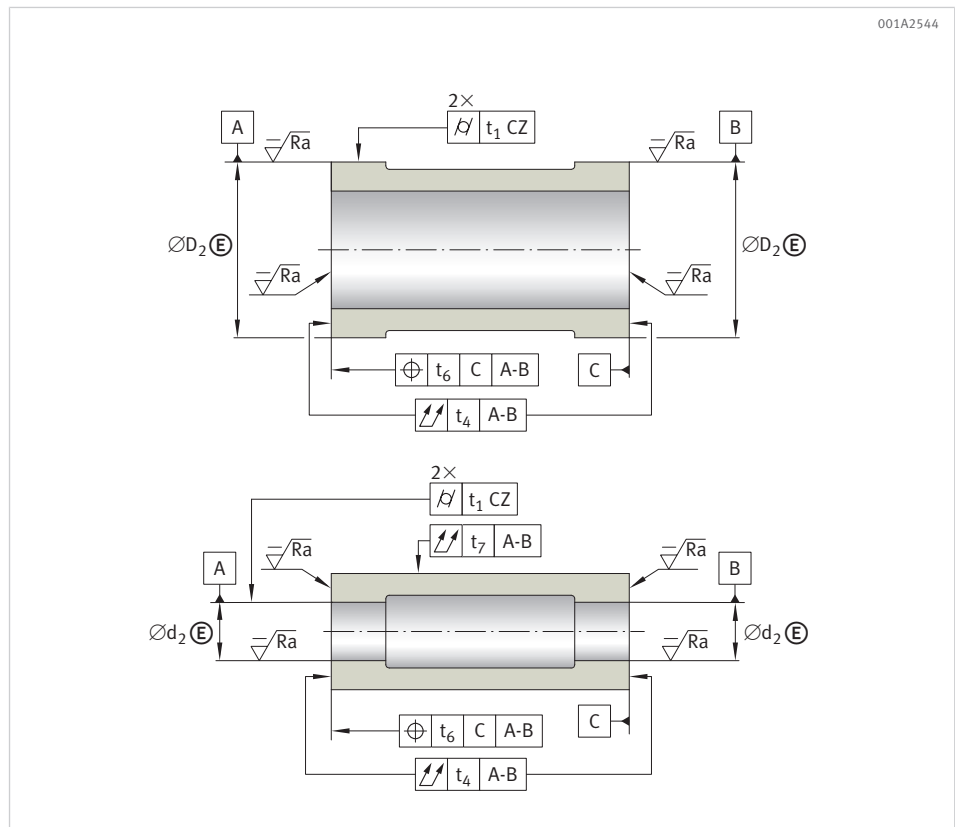
22 Machining tolerances of the housing for spindle bearings

Nominal size		Deviation for D				Cylindricity	Flatness	Total axial runout	Coaxiality	Mean roughness value
D						$t_1$	$t_3$	$t_4$	$t_5$	Ra
mm	mm	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$
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

23 Machining tolerances of the housing for super precision cylindrical roller bearings and axial angular contact ball bearings

Nominal size		Deviation for D		Cylindricity	Flatness	Total axial runout	Coaxiality	Mean roughness
D				t <sub>1</sub>	t <sub>3</sub>	t <sub>4</sub>	t <sub>5</sub>	Ra
mm	mm	µm	µm	µm	µm	µm	µm	µm
over	incl.							
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

1.2.3.3 Geometrical and positional tolerances of spacer sleeves



8 Geometrical tolerances and positional tolerances of spacer sleeves

d <sub>2</sub>	Nominal spacer sleeve bore diameter	D <sub>2</sub>	Nominal spacer sleeve outside diameter
t <sub>1</sub>	Cylindricity tolerance	t <sub>4</sub>	Total runout tolerance
t <sub>6</sub>	Positional tolerance	t <sub>7</sub>	Total runout tolerance
t <sub>1</sub> ... t <sub>7</sub>	In accordance with DIN EN ISO 1101	Ra	Mean roughness value to DIN EN ISO 1302

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.

#### 24 Machining tolerances of the inner spacer sleeve

Nominal size		Deviation for $d_2$		Cylindricity	Total axial runout	Parallelism	Radial runout	Mean roughness <sup>1)</sup>
$d_2$		$\mu\text{m}$	$\mu\text{m}$	$t_1$	$t_4$	$t_6$	$t_7$	Ra
mm	mm	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$
over	incl.							
–	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.

#### 25 Machining tolerances of the outer spacer sleeve

Nominal size		Deviation for $D_2$		Cylindricity	Total axial runout	Parallelism	Mean roughness <sup>2)</sup>
$D_2$		$\mu\text{m}$	$\mu\text{m}$	$t_1$	$t_4$	$t_6$	Ra
mm	mm	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$	$\mu\text{m}$
over	incl.						
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

2) Including end faces.

1.2.3.4 Fit tolerances for spindle bearings

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  $2,1 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$ , and, in the case of oil lubrication, even  $3,3 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$  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.

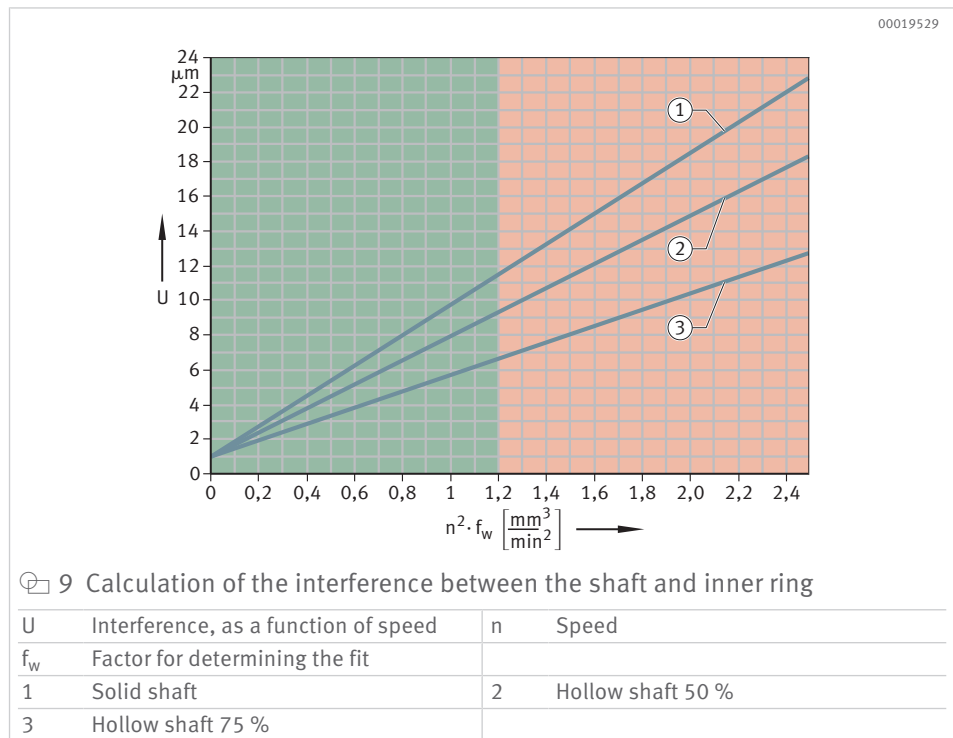
This may have the following consequences:

- 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

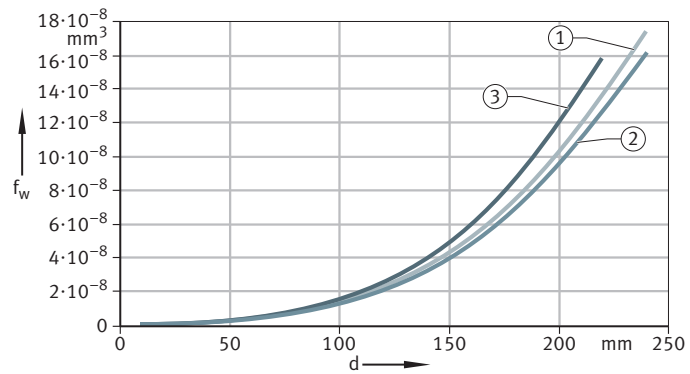
This can be prevented by correspondingly tight fits on the shaft. The necessary interference can be taken from the diagram or calculated using BEARINX. The values calculated in this way will give a fit under which there will still be interference of  $1 \mu\text{m}$  at the highest speed.

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), it is recommended that advice should be obtained from the Application Engineering facilities of the Schaeffler Group.

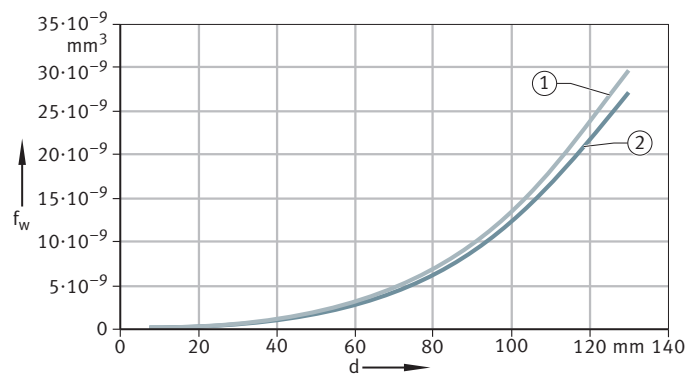


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 10 Factor  $f_w$  for B, HCB

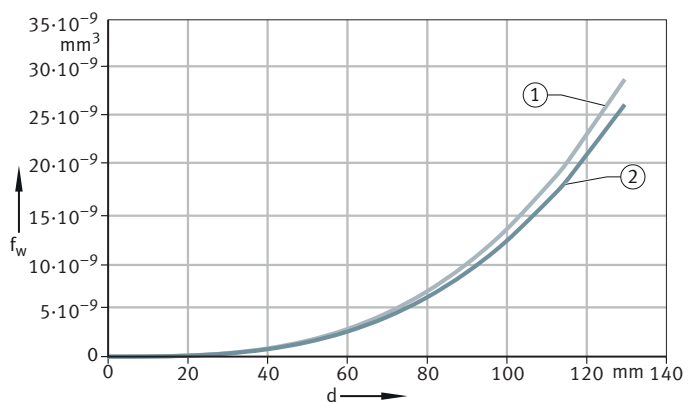
$f_w$	Factor for determining the fit between the inner ring and shaft, as a function of speed	d	Bearing bore
1	B70, HCB70	2	B719, HCB719
3	B72, HCB72		

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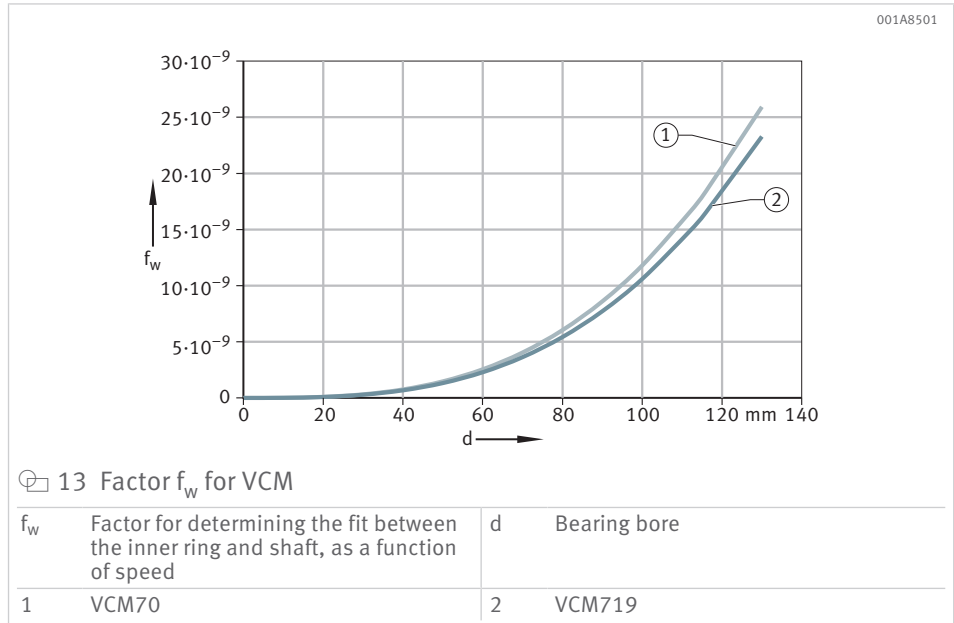

 11 Factor  $f_w$  for HS, HC

$f_w$	Factor for determining the fit between the inner ring and shaft, as a function of speed	d	Bearing bore
1	HS70, HC70	2	HS719, HC719

001A84F1


 12 Factor  $f_w$  for M, HCM

$f_w$	Factor for determining the fit between the inner ring and shaft, as a function of speed	d	Bearing bore
1	M70, HCM70	2	M719, HCM719



**Example:**

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

- Spindle bearing
  - HCS71914-E-T-P4S-UL
- Speed n
  - 16000 min<sup>-1</sup>
- Inner ring actual dimension (the deviation from the actual dimension is indicated on the bearing ring)
  - 70 mm – 3 μm = 69,997 mm
- Bore of hollow shaft
  - 35 mm (approx. 50 % of the diameter)
- Factor for determining the fit, as a function of the speed
  - $f_w = 4,30 \cdot 10^{-9}$
- $n^2 \cdot f_w = 1,1$

With the value 1,1 and the illustrated curve, the necessary interference is calculated as 9 μm.

The actual dimension of the shaft must thus be 70,006 mm, in order that the inner ring is still firmly seated on the shaft at a speed of  $n = 16000 \text{ min}^{-1}$ .

1.2.3.5 Radial internal clearance for super precision cylindrical roller bearings and axial bearings (2344)

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. The radial internal clearance is listed without the measurement load. Bearings of accuracy SP have a radial internal clearance C1. The bearing rings are not interchangeable (NA). The internal clearance groups C2, CN and C3 can be ordered using suffixes for the accuracy SP. The bearing rings are interchangeable.



## 26 Radial internal clearance, tapered bore

Nominal size		Internal clearance group							
d		C1		C2		CN		C3	
mm	mm	µm	µm	µm	µm	µm	µm	µm	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

## 27 Radial internal clearance, cylindrical bore

Nominal size		Internal clearance group							
d		C1		C2		CN		C3	
mm	mm	µm	µm	µm	µm	µm	µm	µm	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

### 1.3 Speeds

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

The decisive factors are:

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

#### 1.3.1 Spindle bearings



The limiting speeds are based on elastically preloaded single bearings and are theoretical guide values. In practice, the actual speeds may deviate up or down from the guide values depending on the operating conditions. However, they give a general indication of the speed suitability under ideal conditions, i.e. under 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.

##### 1.3.1.1 Reduction factors

The speed limits stated are reduced in the case of bearings fitted with rigid preload or high preload, if the design call for a higher rigidity of the spindle, as well as in bearing pairs and bearing groups. The speeds must therefore be multiplied by reduction factors.

Arrangement of bearings	Bearing preload		
	L	M	H
Factor $f_r$			
Large bearing spacing			
	0,85	0,75	0,5
	0,8	0,7	0,5
	0,75	0,65	0,45
Small bearing spacing			
	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

### 1.3.2 Super precision cylindrical roller bearings

The limiting speeds  $n_G$  are valid for grease lubrication or for 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.

#### 28 Achievable speeds for single row cylindrical roller bearings

Clearance or preload $\mu\text{m}$	Maximum achievable speed $\text{min}^{-1}$
-5 ... 0	$< 0,75 \cdot n_G$ grease
0 (clearance-free)	$0,75 \dots 1,0 \cdot n_G$ grease
0... 5	$1,0 \dots 1,1 \cdot n_G$ grease
0... 5	$1,0 \cdot n_G$ oil

#### 29 Achievable speeds for double row cylindrical roller bearings

Clearance or preload		Maximum achievable speed
$\mu\text{m}$	mm	$\text{min}^{-1}$
-5 ... 0	-	$< 0,50 \cdot n_G$ grease
-	$2 \cdot 10^{-5} \cdot d_M$ <sup>1)</sup>	$0,50 \dots 0,75 \cdot n_G$ grease
-	$4 \cdot 10^{-5} \cdot d_M$ <sup>1)</sup>	$0,75 \dots 1,0 \cdot n_G$ grease
-	$1 \cdot 10^{-4} \cdot d_M$ <sup>1)</sup>	$1,0 \cdot n_G$ oil

<sup>1)</sup>  $d_M = (d + D)/2$

These values are guide values for  $\Delta T$  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.

## 1.4 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.

### 1.4.1 Axial rigidity

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



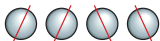
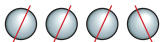

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$$c_a = \frac{F_a}{\delta_a}$$

$c_a$	N/ $\mu$ m	Axial rigidity
$F_a$	N	Axial load
$\delta_a$	$\mu$ m	Axial displacement

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

30 Axial rigidity of spindle bearing sets

Bearing arrangement	Axial rigidity	Lift-off force
	$c_a$ <sup>1)</sup>	$K_{aE}$
	N/ $\mu$ m	N
	$c_a$	$3 \cdot F_V$
	$1,64 \cdot c_a$	$6 \cdot F_V$
	$2 \cdot c_a$	$6 \cdot F_V$
	$2,24 \cdot c_a$	$9 \cdot F_V$
	$2,64 \cdot c_a$	$9 \cdot F_V$

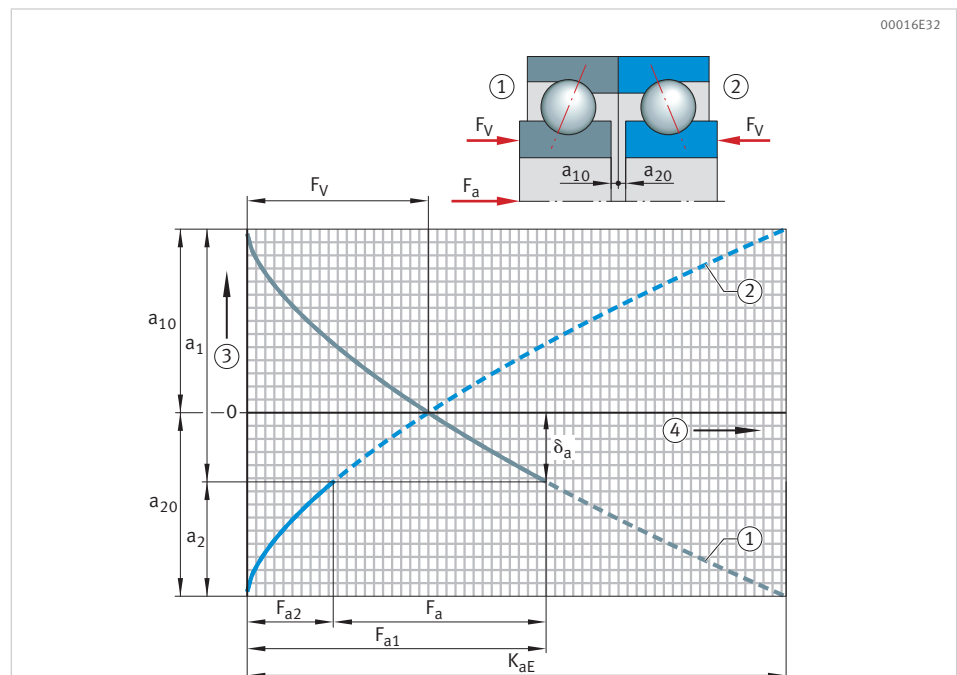
<sup>1)</sup> For values, see product tables.

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 produce tables for the axial rigidity  $c_a$  are valid for bearing pairs in an O or X arrangement.

In sets with more than two bearings, there is an increase in the rigidity values and the lift-off force.

### 1.4.2 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.



14 Preload force, axial load, lift-off force

$F_V$	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	$\delta_a$	Axial displacement
1	Bearing 1	2	Bearing 2
3	Deflection	4	Axial load

### 1.4.3 Radial rigidity

f 4

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



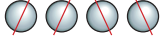
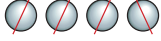

$c_r$	N/ $\mu$ m	Radial rigidity
$F_r$	N	Radial load
$\delta_r$	$\mu$ m	Axial displacement

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  $\alpha = 15^\circ$
- $c_r \approx 5 \cdot c_a$  for  $\alpha = 17^\circ$
- $c_r \approx 2 \cdot c_a$  for  $\alpha = 25^\circ$

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.

31 Radial rigidity of spindle bearing sets

Bearing arrangement	Radial rigidity	
	$c_r$	$N/\mu m$
	$c_r$	
	$1,4 \cdot c_r$	
	$2 \cdot c_r$	
	$1,6 \cdot c_r$	
	$2,7 \cdot c_r$	

## 1.5 Load carrying capacity and operating life

### 1.5.1 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 can 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.

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.

#### 1.5.1.1 Fatigue strength

f 5

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

$S_0^*$	–	Dynamic load safety factor (load ratio for fatigue strength)
$C_0$	N	Basic static load rating
$P_0^*$	N	Equivalent bearing load

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

For spindle bearings, the load ratio  $S_0^*$  at which the essential precondition for fatigue strength is fulfilled is dependent on the series and the material used for the components.

A load ratio for super precision cylindrical roller bearings of  $S_0^* \geq 8$  is an essential precondition for fatigue strength.

## 32 Load ratio

Series	Contact angle $\alpha = 15^\circ$		Contact angle $\alpha = 17^\circ$		Contact angle $\alpha = 25^\circ$	
	$\frac{F_{0a}}{F_{0r}} \leq 1,09$	$\frac{F_{0a}}{F_{0r}} > 1,09$	$\frac{F_{0a}}{F_{0r}} \leq 1,13$	$\frac{F_{0a}}{F_{0r}} > 1,13$	$\frac{F_{0a}}{F_{0r}} \leq 1,3$	$\frac{F_{0a}}{F_{0r}} > 1,3$
B	8	12	–	–	8	10
HCB	8	12	–	–	8	10
HS	8	12	–	–	8	10
HC	8	12	–	–	8	10
M	–	–	10	12	9	10
HCM	–	–	10	12	9	15
VCM	–	–	6	8	5	7

A more precise method is individual calculation of the Hertzian pressures and checking of the bearing kinematics using the BEARINX calculation program.

If the bearing fulfils the other preconditions for an effective separating lubricant film (viscosity ratio  $\kappa \geq 2$ ) and very high cleanliness, calculation of the rating life  $L_{10}$  in accordance with ISO 281 is not necessary.

If the bearing does not fulfil these preconditions, 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 for manual calculation or in accordance with DIN ISO 281, Beiblatt 4, for computer-aided methods.

## 1.5.1.2 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  $S_0$ .

f) 6

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

$S_0$	–	Static load safety factor
$C_0$	N	Basic static load rating
$P_0$	N	Equivalent static bearing load



In order to be able 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, only with short-term and concentrically acting axial load (tool ejection force).  $S_0 \geq 1$
- super precision cylindrical roller bearings:  $S_0 > 3$
- axial angular contact ball bearings:  $S_0 > 2,5$

1.5.1.3 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.

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

33 Spindle bearings with contact angle 15°

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

34 Spindle bearings with contact angle 17°

Load ratio	Equivalent static load
$\frac{F_{0a}}{F_{0r}} \leq 1,13$	$P_0 = F_{0r}$
$\frac{F_{0a}}{F_{0r}} > 1,13$	$P_0 = 0,5 \cdot F_{0r} + 0,44 \cdot F_{0a}$

35 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 Largest axial load present (maximum load)
- $F_{0r}$  N Largest radial load present (maximum load)
- $P_0$  N Equivalent static bearing load


Super precision cylindrical roller bearings can support radial forces only.

f 7  $P_0 = F_{0r}$

Axial angular contact ball bearings can support axial forces only.







f 8  $P_{0a} = F_{0a}$

Where there are several bearings at one bearing position, the external load is distributed over the individual bearings. 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.



36 Distribution of load

Arrangement	Load component on most heavily loaded bearing	
	$F_a$ %	$F_r$ %
	100	60
	100	60
	50	60
	50	60
	33	60
	33	60

## 1.6 Lubrication

### 1.6.1 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.

The following factors are essential preconditions for the formation of a lubricant film that separates the rolling contact partners at their contact points:

- presence of lubricant at all contact points and at all times
- definition of a lubrication method that is appropriate to the required speed
- selection of a lubricant with the correct characteristics

#### 1.6.1.1 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, which are grease lubrication and minimal quantity oil lubrication. 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  $\gg 34$ .

Grease lubrication is predominantly used in practice for super precision bearings.

This is a simple means of providing advantages such as:

- low friction
- lifetime lubrication
- very little design work required
- low system costs

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 ▶49|□17.

1.6.1.2 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 the temperature and running-in behaviour for a spindle running at high speed, are particularly important.

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.

1.6.1.3 Lubricant viscosity

The condition of the lubricant film is determined by the viscosity ratio  $\kappa$ , which is defined as the quotient of the operating viscosity  $\nu$  and the reference viscosity  $\nu_1$ .

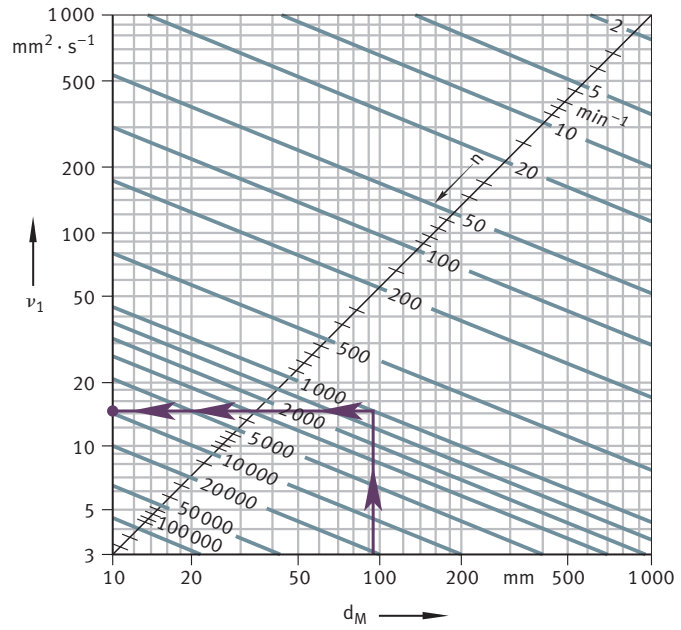
$$\text{f1 9} \quad \kappa = \frac{\nu}{\nu_1}$$

$\kappa$	–	Viscosity ratio
$\nu$	mm <sup>2</sup> /s	Kinematic viscosity of the lubricant at operating temperature
$\nu_1$	mm <sup>2</sup> /s	Reference viscosity of the lubricant at operating temperature

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.

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.

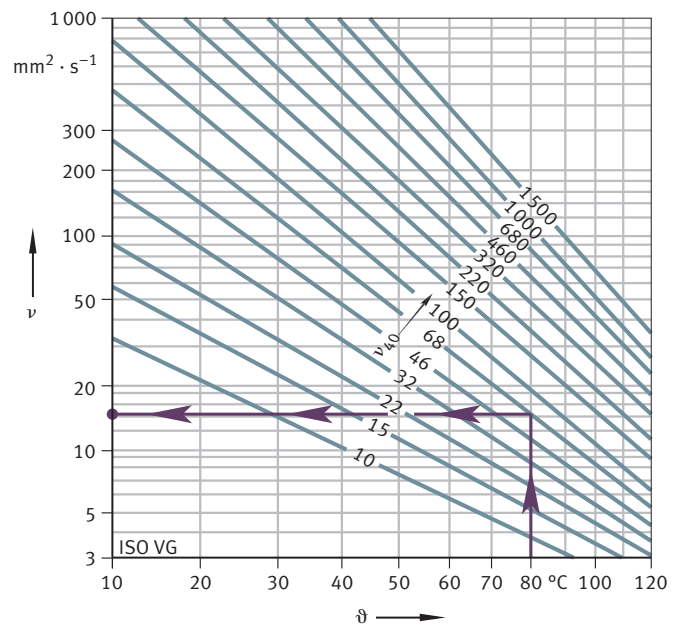
00016C14



15 Reference viscosity  $v_1$

$v_1$	Reference viscosity	$d_M$	Mean bearing diameter
$n$	Speed		

00016C15



16 V/T diagram

$v$	Operating viscosity	$\theta$	Operating temperature
$v_{40}$	Viscosity at +40 $^{\circ}\text{C}$		

### 1.6.2 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  $2100000 \text{ min}^{-1} \cdot \text{mm}$ .

The use of spindle bearings which are already supplied with lifetime lubrication and are already sealed brings further advantages, such as very high cleanliness, since the interior of the bearing is protected. It also gives simplified mounting.

#### 1.6.2.1 Greases with special suitability

Many of the rolling bearings supplied by Schaeffler have a grease filling. In mechanical-dynamic tests, the greases used have proved particularly suitable for the application.

37 Greases for super precision bearings

Lubricating greases		Designation		
		L252	L055	L298
Identifier according to DIN 51 825	–	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	55
	+100 °C	5	12,5	9
NLGI grade	–	2 ... 3	2	3
Maximum operating temperature <sup>1)</sup>	°C	80	80	110
Speed parameter $n \cdot d_M$ <sup>2)</sup>	$\text{min}^{-1} \cdot \text{mm}$	2100000	800000	1300000
Specific mass	$\approx \text{g/cm}^3$	0,94	0,9	0,86
Application as	–	High speed grease	High pressure grease	High temperature grease

<sup>1)</sup> Without minimisation of service life.

<sup>2)</sup> 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 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. Grease L252 is available under the commercial name Arcanol SPEED2,6.

### L055

L055 is a high pressure grease that has proved effective in the end bearings of ball screw drives, in indexing table bearings and, for example, also in tailstock lathe centre bearing arrangements.

### 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.

### GA21

In the case of sealed bearings supplied with standard greasing, the grease grade is not stated on the packaging or on the bearing. For open bearings that are supplied greased with high speed grease, markings on the bearing and on the packaging indicate application-specific grease group GA21. In the case of these bearings, Schaeffler 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.

## 1.6.2.2 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.

38 Recommended grease quantities for spindle bearings

Bore code	Bearing series						
	HS719, HC719	HS70, HC70	B719, HCB719	B70, HCB70	B72, HCB72	M719, HCM719, VCM719	M70, HCM70, VCM70
	Grease quantity						
	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>
6	–	0,12	–	0,04	–	–	–
7	–	0,13	–	0,06	–	–	–
8	–	0,17	–	0,11	–	–	–
9	–	0,21	–	0,1	–	–	–
00	0,17	0,26	0,09	0,17	0,26	–	–
01	0,18	0,28	0,1	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	0,4	0,86	1,44	0,38	0,68
06	0,92	1,72	0,42	1,12	2,1	0,42	0,87
07	1,18	2,2	0,64	1,74	3	0,64	1,22
08	1,62	2,6	1,36	2,35	3,8	0,99	1,48
09	2,1	3,65	1,6	3	4,55	1,11	1,79
10	2,35	4	1,74	3,3	5,45	1,2	1,93
11	3,4	5,95	2,2	4,6	6,5	1,62	2,88
12	3,6	6,4	2,5	4,95	8	1,74	3,06
13	3,9	6,8	2,65	5,3	9,35	1,84	3,47
14	5,8	9,2	4,35	7,1	10,8	3,24	4,65
15	6,1	9,7	4,6	7,5	12,9	3,41	4,88
16	7	12,8	4,9	9,65	12,3	3,59	6,47
17	8,55	13,4	6,8	10,3	18,3	5	6,82
18	9,4	17,7	7,1	13,3	19,1	5,18	8,71
19	9,85	18,4	7,45	13,9	26,1	5,41	9,12
20	12,8	19,2	9,7	14,6	27,2	7,18	9,49
21	13,3	24,6	10,1	15	36,3	7,47	12,35
22	14,7	28,2	10,4	21,9	43,9	7,76	14,35
24	17,9	30,3	14,2	23,6	38,8	10,53	15,41
26	24	43,7	18,1	36,1	41,9	13,06	20,24
28	25,6	46,3	19,3	38,3	58,6	–	–
30	37,8	57,1	28,4	44,7	81,3	–	–
32	39,9	69,7	30	58,2	102,9	–	–
34	–	–	31,7	65,3	120,4	–	–
36	–	–	47,4	94,9	125,7	–	–
38	–	–	50	99,1	155,4	–	–
40	–	–	70,6	118,3	187,8	–	–
44	–	–	68,3	172,6	250,1	–	–
48	–	–	73,7	185,3	–	–	–
52	–	–	118,2	267	–	–	–
56	–	–	126	283,9	–	–	–
60	–	–	204,5	–	–	–	–

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

The spindle bearings B719, B70 and some bearings of series B72 as well as the corresponding hybrid designs are also available greased and sealed, design 2RSD. The spindle bearings M, HCM and VCM are also available greased and sealed, design 2RSD.

☒ 39 Recommended grease quantities for cylindrical roller bearings

Bore code	Bearing series					
	N10-TVP-XL	N10-PVPA1-XL	N10-M1	NN30-TVP-XL	NN30-M	NNU49-M
	Grease quantity					
	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>	cm <sup>3</sup>
06	0,83	–	0,69	0,69	0,76	–
07	1,10	–	0,91	0,69	0,95	–
08	1,45	1,57	1,15	1,01	1,14	–
09	1,87	2,02	1,44	1,31	1,61	–
10	2,02	2,18	1,56	1,41	1,74	–
11	2,95	3,11	2,25	2,20	2,55	–
12	3,16	3,32	2,45	2,37	2,70	–
13	3,36	3,54	2,60	2,53	2,85	–
14	4,32	4,83	3,10	3,55	4,20	2,90
15	4,56	–	3,30	3,65	4,45	3,10
16	5,51	–	4,30	4,61	6,10	3,25
17	5,79	–	4,50	4,76	6,40	4,50
18	7,29	8,96	5,75	5,68	7,85	4,75
19	7,65	–	6,00	6,03	8,20	4,95
20	7,96	9,74	6,20	6,42	8,50	6,25
21	9,99	–	7,75	7,85	10,60	6,50
22	11,67	–	8,50	9,57	13,70	6,75
24	12,52	–	9,05	11,57	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	–	–	36,80	–	63,50	32,70
38	–	–	38,30	–	67,40	34,20
40	–	–	55,80	–	86,70	54,50
44	–	–	67,90	–	110,10	59,00
48	–	–	72,50	–	127,50	63,60
52	–	–	112,50	–	177,30	109,50
56	–	–	119,10	–	196,70	116,60

#### 40 Recommended grease quantities double direction axial angular contact ball bearings

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

#### 1.6.2.3 Grease operating life

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

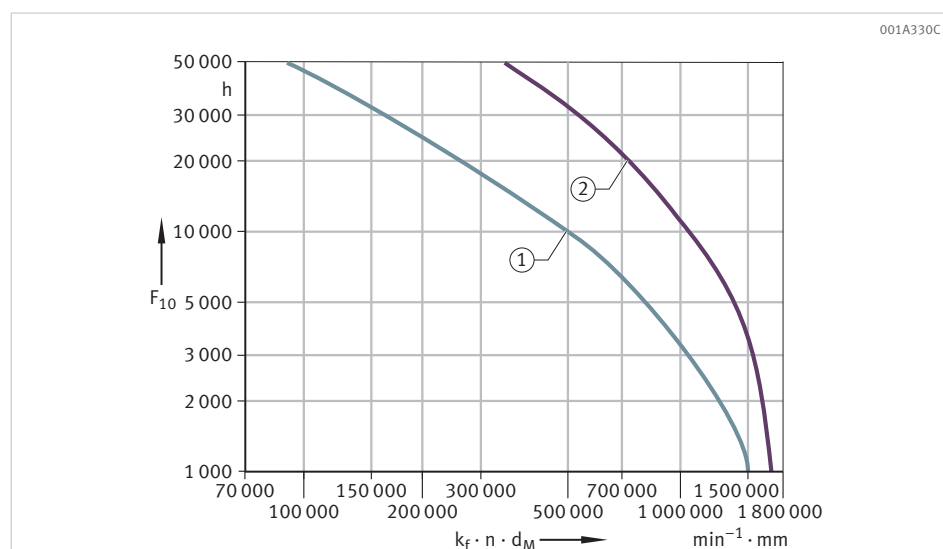
The grease operating life is dependent on the following factors:

- grease quantity
- grease type
- bearing type
- speed
- temperature
- mounting conditions
- operating conditions
- 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  $k_f \cdot n \cdot d_M$ .



17 Grease operating life  $F_{10}$

$F_{10}$	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		

41 Factor  $k_f$ , as a function of bearing type

Bearing type		Factor $k_f$
Spindle bearings with contact angle	15°	0,75
	17°	0,75
	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.

f 10

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

$F_{10 \text{ tot}}$	h	Total grease operating life
$n$	–	Number of load cases
$q_i$	%	Time periods
$F_{10 i}$	h	Grease operating life for individual speeds in speed duty cycle



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

1.6.2.4 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.

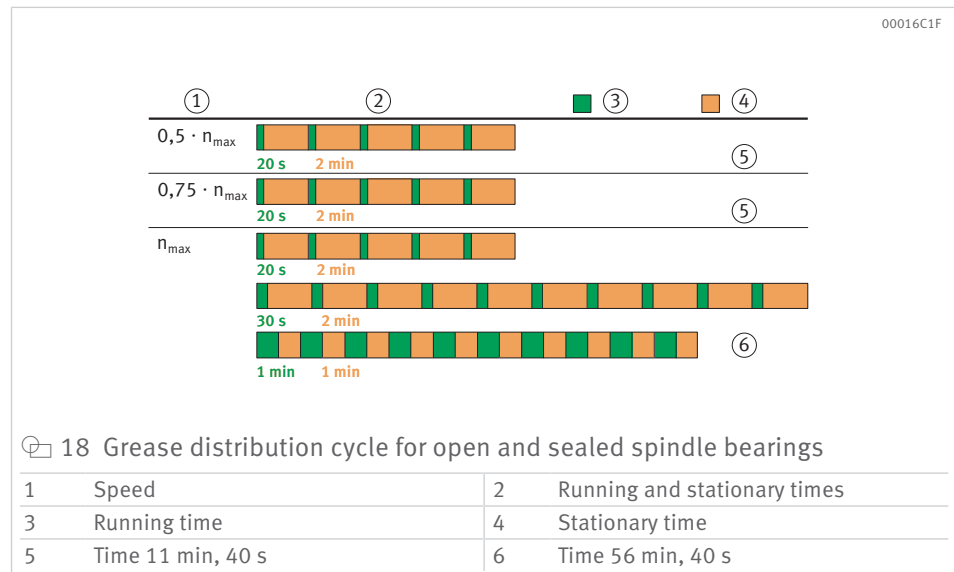
It is recommended that the temperature should be monitored during the grease distribution cycle as well as during the subsequent continuous running. The temperature sensor should be located as close as possible to the outer ring.

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

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

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.



1.6.3 Oil lubrication

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

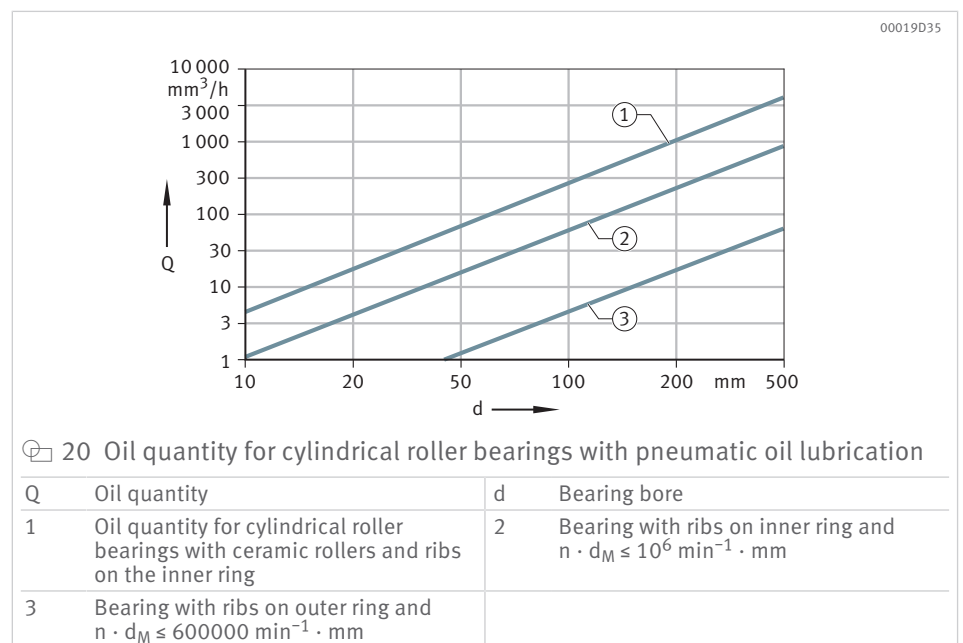
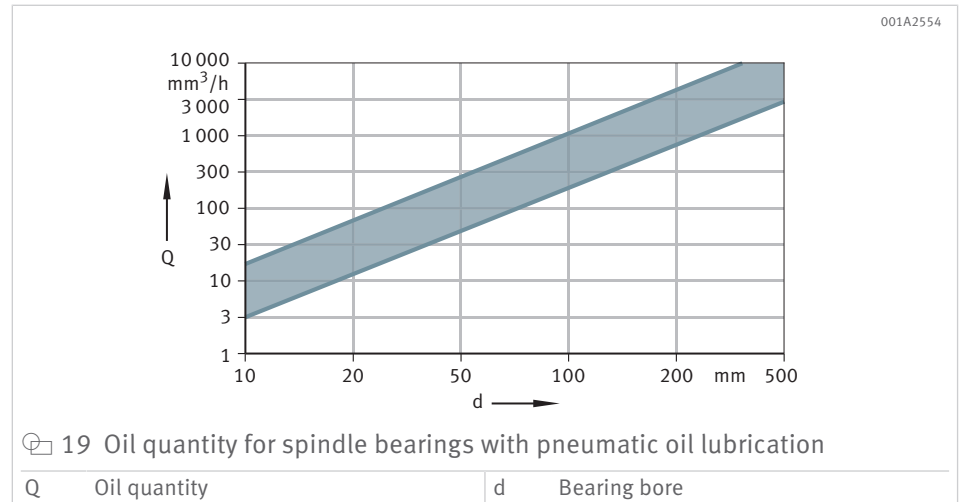
Oils in accordance with the designation ISO VG 68 + EP have proved effective here. This means that the oil has a nominal viscosity of 68 mm<sup>2</sup>/s at +40 °C and Extreme Pressure additives.

1.6.3.1 Minimal quantity oil lubrication

Lubrication of FAG spindle bearings requires very little oil. Quantities of the order of magnitude of approx. 100 mm<sup>3</sup>/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.

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.



Spindle bearings B, HCB, HS, HC, M, HCM and VCM are also available in the Direct Lube design.

#### 42 Air quality

Characteristic	Recommendation
Air cleanliness	Particle size < 5 $\mu\text{m}$
Dryness of air	Dew point < +3 °C
Air pressure in the feed pipe	$\approx 3 \text{ bar}$
Oil concentration	< 1

Nozzle design:

- recommendation for nozzle diameter = 0,5 mm to 1 mm
- 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
- for spindle bearings, feed from the load side of the outer ring to support the pumping action

Injection pitch circle diameter:

- injection pitch circle diameter  $E_{tk}$
- in cylindrical roller bearings with a PVPA1 cage, two injection pitch circle diameters, depending on the injection side

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. 5 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. The diameter of the outlet hole should preferably be  $\geq 5$  mm.
- Connect all outlet holes from all bearings on one spindle in order to equalise pressures.

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

43 Pneumatic oil lubrication devices

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

### 1.6.3.2 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.

#### 44 Recommended oil purity classes with point contact

(D – d)/2		Requisite oil purity class in accordance with ISO 4406	Requisite filter retention rate in accordance with ISO 16889		Maximum size of overrolled particles <sup>1)</sup> µm
mm over	mm incl.		$\beta_3 \geq$		
–	12,5	14/11/8	$\beta_3 \geq$	200	10
12,5	20	15/12/9	$\beta_3 \geq$	200	15
20	35	16/13/10	$\beta_3 \geq$	200	25
35	–	17/14/11	$\beta_3 \geq$	200	40

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

#### 45 Recommended oil purity classes with line contact

(D – d)/2		Requisite oil purity class in accordance with ISO 4406	Requisite filter retention rate in accordance with ISO 16889		Maximum size of overrolled particles µm
mm over	mm incl.		$\beta_3 \geq$		
–	12,5	15/12/9	$\beta_3 \geq$	200	15
12,5	20	16/13/10	$\beta_3 \geq$	200	25
20	35	17/14/11	$\beta_3 \geq$	200	40
35	–	17/14/11	$\beta_3 \geq$	200	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 through the filter in the so-called multi-pass test.



Coarser filters 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.

## 1.7 Operating temperature

### 1.7.1 Spindle bearings

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

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

### 1.7.2 Super precision cylindrical roller bearings

The bearings are suitable for operating temperatures of  $-30\text{ °C}$  to  $+100\text{ °C}$  (or higher depending on the cage design).

### 1.7.3 Axial angular contact ball bearings

Axial angular contact ball bearings are suitable for operating temperatures of  $-30\text{ °C}$  to  $+150\text{ °C}$ .



Note the information on the operating temperatures of greases.

## 1.8 Design and examples of bearing arrangements

### 1.8.1 Design and applications

In practical application, a large number of different spindle bearing arrangements are used. The specific use in turning, milling and grinding or in high frequency motor spindles determines the selection and arrangement of spindle bearing arrangements. 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  $n \cdot d_M = 2,1 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$  and with pneumatic oil lubrication, up to  $n \cdot d_M = 3,3 \cdot 10^6 \text{ min}^{-1} \cdot \text{mm}$ ) at the lowest possible operating temperatures. These requirements call for the use of super precision bearings and correspondingly accurate adjacent parts.

The following guidelines serve 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

## 1.8.2 Preload

Rigidly adjusted bearing arrangements, specifically those with a short spacing between the bearings, react with a high degree of sensitivity to temperature differences between the shaft and housing. This may be because the preload within the bearing set can increase sharply or because 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  $15^\circ$ . 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  $17^\circ$  or  $25^\circ$  are less sensitive.

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

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

In bearing arrangements adjusted by springs or hydraulic means, the stated speeds are achieved due to the lower thermal sensitivity. In bearings with a contact angle of  $15^\circ$  or  $17^\circ$ , the  $\Delta T$  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  $M$ .

### 1.8.2.1 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.

## 1.8.3 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.

### 1.8.3.1 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 contact angle of  $15^\circ$  or  $17^\circ$  have only 45 % or 50 % of the axial rigidity of bearings with a contact angle of  $25^\circ$ , but have greater radial rigidity.

If the spindle bearing and boom is considered as a complete system, the total rigidity of a bearing arrangement with 25° bearings is normally better in terms of radial displacement and tilting due to the wider support spacing than in a bearing arrangement with 15° bearings.

1.8.3.2 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 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.

1.8.4 Bearing contact angle

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

46 Contact angles, advantages and applications

Advantages and applications	Contact angle		
	15°	17°	25°
Advantages	<ul style="list-style-type: none"> <li>radial rigidity</li> <li>radial load carrying capacity</li> <li>higher speed at small <math>\Delta T</math></li> <li>kinematically insensitive to tilting</li> </ul>	<ul style="list-style-type: none"> <li>radial rigidity</li> <li>radial and combined loads</li> <li>higher speeds at moderate <math>\Delta T</math></li> <li>kinematically insensitive to tilting</li> </ul>	<ul style="list-style-type: none"> <li>axial rigidity</li> <li>radial system rigidity</li> <li>axial load carrying capacity</li> <li>combined axial and radial load carrying capacity</li> <li>high permissible <math>\Delta T</math> between inner ring and outer ring</li> </ul>
Applications	<ul style="list-style-type: none"> <li>grinding machines</li> <li>lathes</li> <li>precision machining equipment</li> <li>bearing arrangement on belt side</li> </ul>	<ul style="list-style-type: none"> <li>milling at high output</li> <li>machining centres</li> <li>motor spindles</li> </ul>	<ul style="list-style-type: none"> <li>milling machines</li> <li>drilling machines</li> <li>machining centres</li> <li>motor spindles</li> </ul>

1.8.5 Bearing selection according to ball size and material

Spindle bearings with a B in the designation are filled with large balls. Spindle bearings with an M in the designation are filled with medium-sized balls. Spindle bearings with an H in the designation 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. Bearings with small balls should be selected in preference for high speeds. Due to their optimised internal construction, the M bearings with medium-sized balls offer excellent speed suitability combined with a good load carrying capacity.

1.8.5.1 Ceramic

Bearings with ceramic rolling elements have additional speed advantages and also offer a longer grease life.



### 1.8.5.2 Specifications for bearing selection

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

47 Comparison of bearing designs

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

### 1.8.6 Selection of the optimum bearing spacing

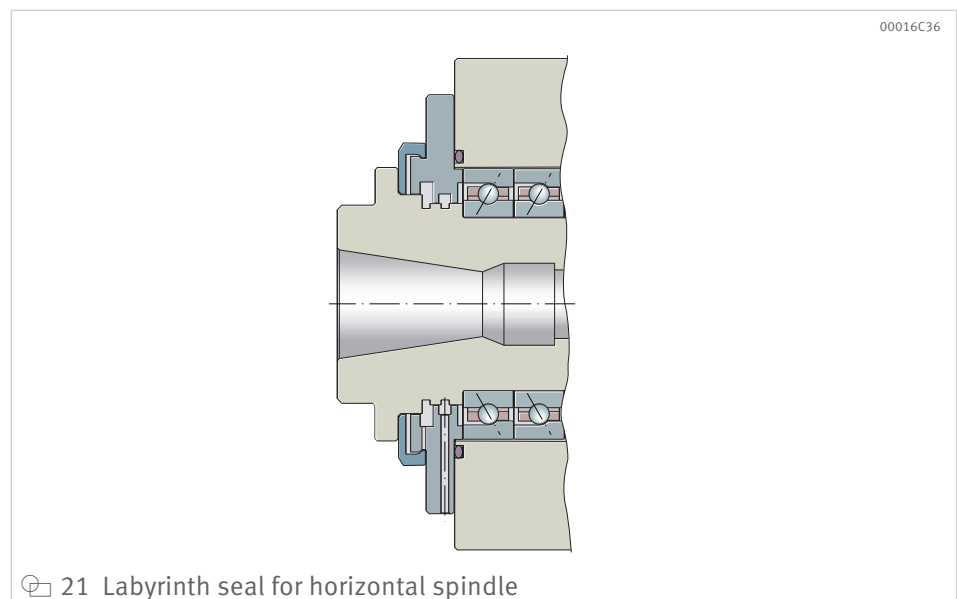
In rigidly preloaded bearing arrangements, it is recommended that a thermally neutral bearing spacing is selected at which the effects of the radial and axial thermal expansion of the shaft in relation to the influence on preload are compensated.

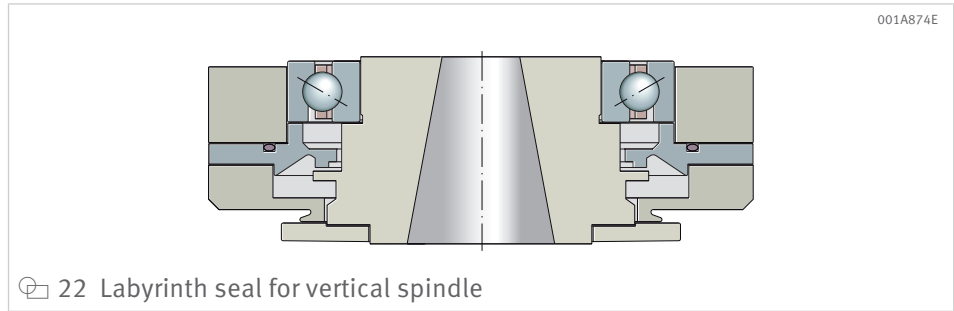
This thermally optimum bearing spacing  $L$  corresponds for spindle bearings with a  $25^\circ$  contact angle to approx. three times the shaft diameter  $d$ . In bearings with a  $15^\circ$  or  $17^\circ$  contact angle,  $L$  is approx.  $5 \cdot d$ , and it often takes too long for the axial thermal expansion to take effect due to the long bearing spacing. Such an approach is not very advisable in practice.

### 1.8.7 Sealing

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

When using grease lubrication, sealed bearings assist the effect of the labyrinth and prevent air flows through the bearing arrangement.





### 1.8.8 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 ▶61|▣49.
3. Determine the lubrication ▶41|1.6.
4. Select the bearing type and bearing size on the basis of speed suitability, design envelope and lubrication.
5. Check the grease operating life ▶49|⊕17.
6. Calculate the load distribution on the bearings.
7. Check the fatigue strength of the bearing arrangement ▶38|1.5.1.1.

#### 1.8.8.1 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 ball 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 provides support with design and calculations by agreement. It is advisable in this case to submit the complete bearing arrangement data using the form for bearing arrangement calculations in the appendix of the catalogue. This form is also available for download at <https://www.schaeffler.de/std/1FC6>.

#### ▣ 48 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:	2000 MPa
		Vacrodur:	2700 MPa
	Line contact with	100Cr6:	1500 MPa

## 1.8.9 Design of main spindles using BEARINX

### 1.8.9.1 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 30 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.

### 1.8.9.2 BEARINX – a leading calculation program

In BEARINX, Schaeffler 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:

- non-linear elastic deflection behaviour of the bearings
- elasticity of shafts and axes
- influence of fit, temperature and speed on the operating clearance or preload of the bearings and on their contact angle
- profiling of rollers and raceways as well as raceway oscillations
- 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

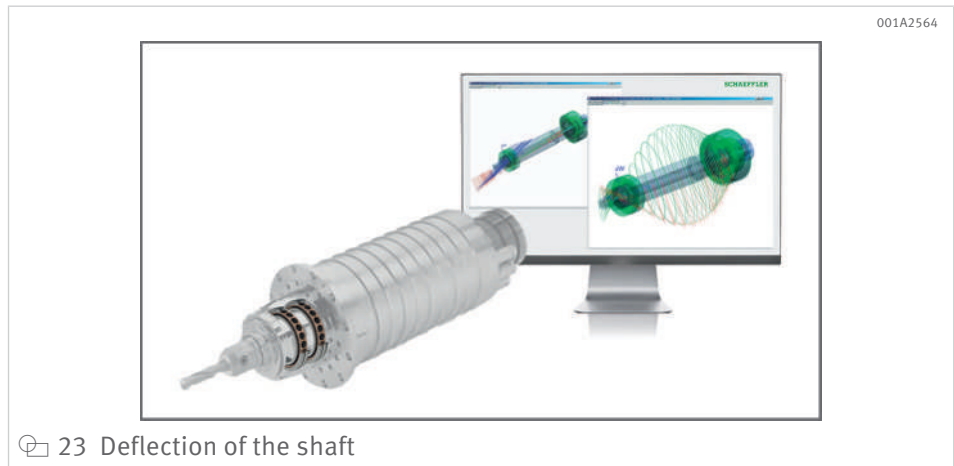
BEARINX thus offers the option of determining the load on spindle bearings that is representative of reality.

### 1.8.9.3 Spindle calculation using BEARINX

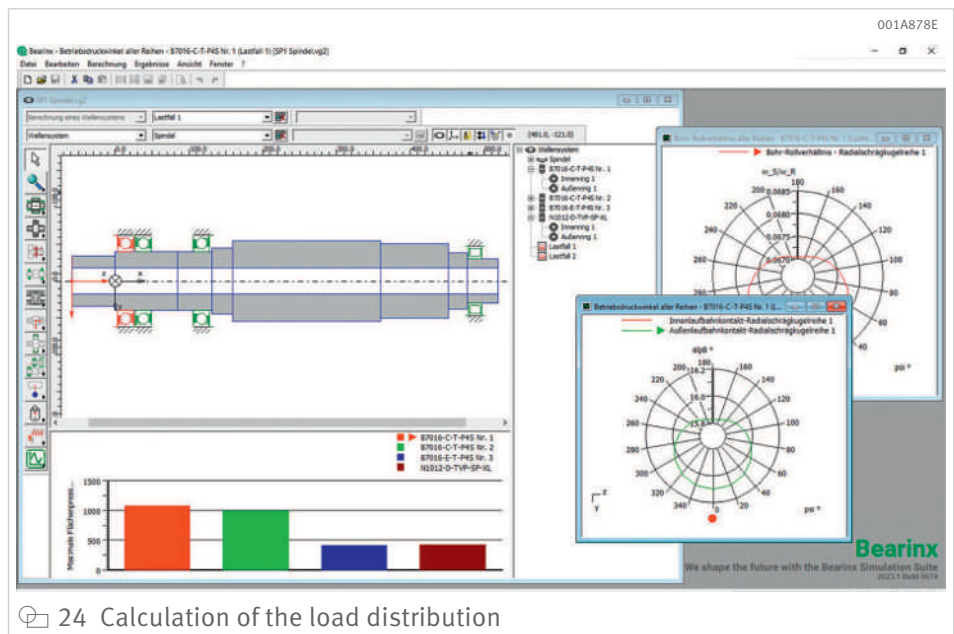
The spindle calculation using BEARINX offers:

- 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, Beiblatt 4
- many other pieces of additional information



23 Deflection of the shaft



24 Calculation of the load distribution

The BEARINX-online spindle calculation program is available to Schaeffler direct customers and Schaeffler sales partners:  
<https://medias.schaeffler.de/de/bearinxonlinespindlcalculation>

The BEARINX-online spindle calculation allows calculations to be carried out for the provisional design of spindle bearing arrangements on a contractually agreed basis and following the completion of a two-day training course.

BEARINX-online uses the same calculation models and algorithms as those found in the full version of BEARINX, since both programs are based on the same source code. Calculation files created in BEARINX-online are compatible with the full version of BEARINX.

### 1.8.10 Comparison of bearing arrangements

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

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

49 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

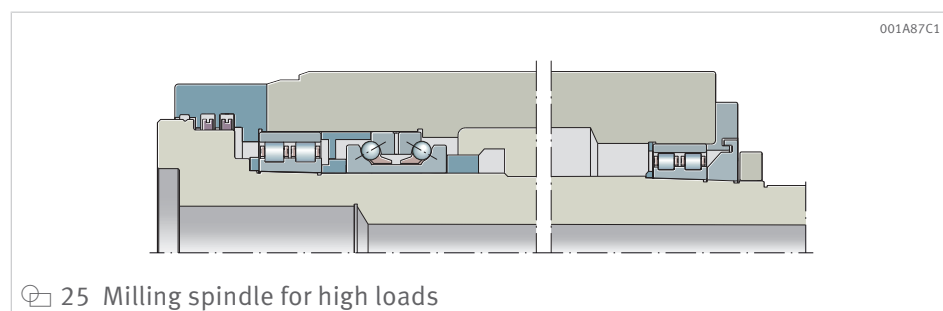
= Single row cylindrical roller bearing

== Double row cylindrical roller bearing

>< Double direction axial angular contact ball bearing

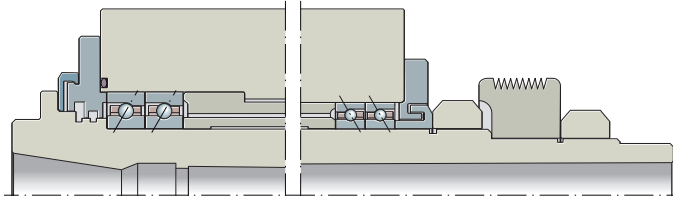
≈ Spring

### 1.8.11 Examples of bearing arrangements



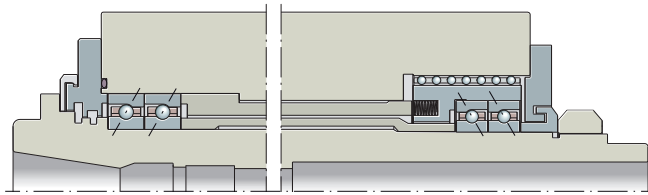
25 Milling spindle for high loads

001A87E1



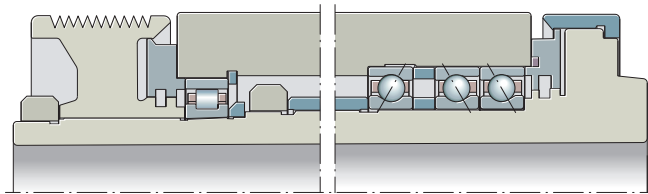
26 Milling spindle for high speeds

001A87F1



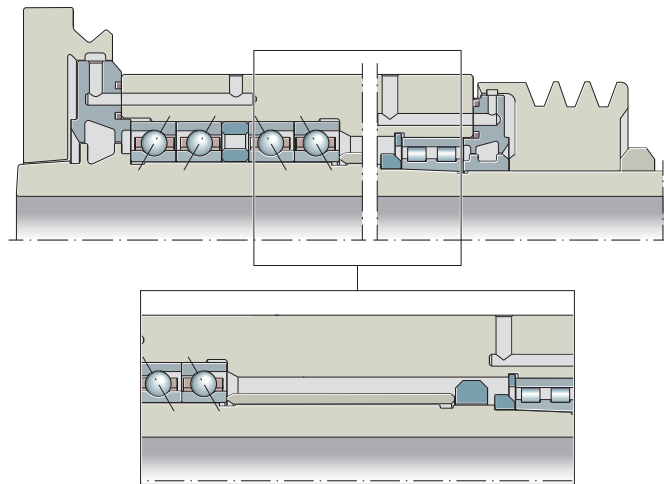
27 Milling spindle for very high speeds

001A87D1



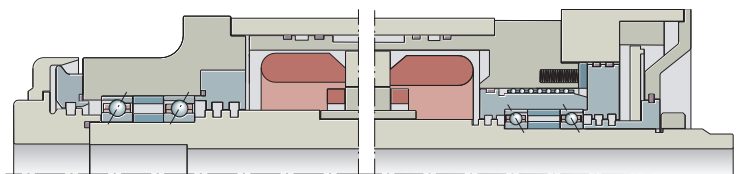
28 Turning spindle

001A8801



29 Grinding spindle

001A8811



30 High frequency motor spindle

## 1.9 Mounting

### 1.9.1 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.

#### 1.9.1.1 Provision of parts

Only approved parts should be used for mounting. Depending on the part, approval comprises dimensional inspection, optical inspection or even prebalancing.

#### 1.9.1.2 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 diameter or housing diameter. Spindle bearings are subdivided by bore diameter tolerance and outside diameter tolerance into groups whose mean deviation is indicated on the packaging and the bearing.

### 1.9.2 Mounting

#### 1.9.2.1 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 anti-corrosion protection from the seating and locating surfaces.
- Rub cylindrical seating surfaces of the bearing rings with a very thin layer of Arcanol MOUNTINGPASTE2.
- 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.

1.9.2.2 Mounting record

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

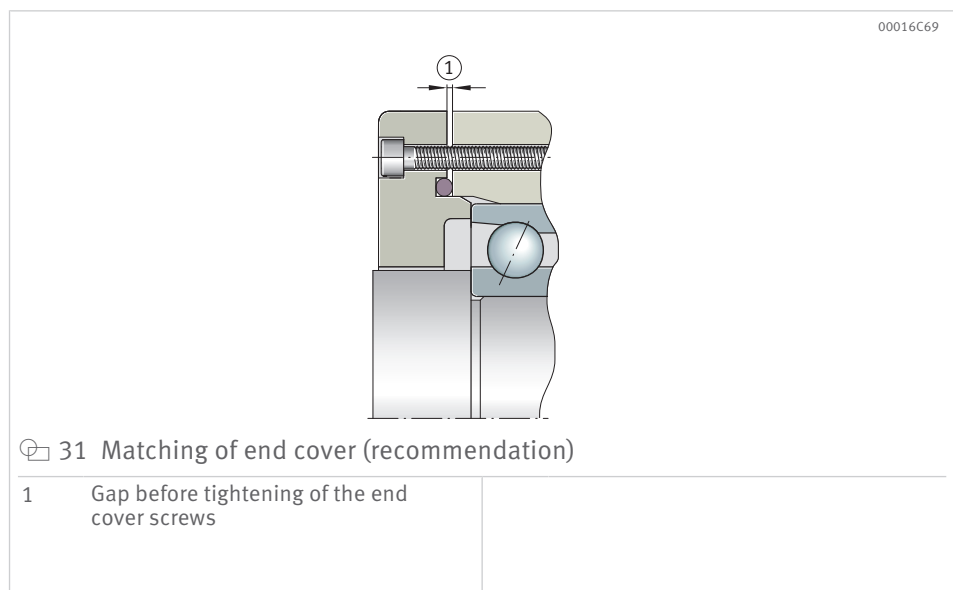
- seat diameter, interference
- differences in intermediate ring dimensions
- equilibrium temperatures
- radial runout and axial runout

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: <https://www.schaeffler.de/std/1FC5>

1.9.2.3 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 end covers used to clamp the bearings. Before clamping, a gap should be present. To simplify and reduce the number of measurement processes, the deviation of the actual width from the nominal width is indicated on the bearing and on the packaging.

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. The deviation of the projection from the nominal projection, as indicated on the bearing and packaging, can be used for this purpose.





#### 1.9.2.4 Greasing

Suitable rolling bearing greases and grease quantities, see ▶44|1.6.2. The introduction 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.

In bearings with grease lubrication, a grease distribution cycle must be carried out on the bearings before the test run on the spindle. The recommendations for the grease distribution cycle are available at: <http://www.schaeffler.de>

#### 1.9.2.5 Axial clamping of inner rings

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.

For spindle bearings B, HS, HC and M 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.

50 Recommended clamping forces and nut tightening torques for spindle bearings

Bore mm	Bore code	Clamping force			Tightening torque			Thread
		kN			Nm			
		719	70	72	719	70	72	
10	00	0,66	1,58	1,36	0,96	2,30	1,99	M10×0,75
12	01	0,71	1,64	1,45	1,19	2,75	2,43	M12×1
15	02	0,79	1,75	1,60	1,60	3,52	3,23	M15×1
17	03	0,86	1,84	1,73	1,93	4,11	3,87	M17×1
20	04	0,99	1,99	1,96	2,54	5,13	5,04	M20×1
25	05	1,24	2,32	2,45	3,87	7,25	7,65	M25×1,5
30	06	1,55	2,73	3,07	5,96	10,0	11,3	M30×1,5
35	07	1,91	3,22	3,83	8,10	13,6	16,2	M35×1,5
40	08	2,34	3,79	4,74	11,2	18,2	22,7	M40×1,5
45	09	2,82	4,45	5,79	15,1	23,8	31,0	M45×1,5
50	10	3,36	5,19	7,00	19,8	30,6	41,3	M50×1,5
55	11	3,96	6,02	8,36	25,6	38,9	54,0	M55×2
60	12	4,62	6,94	9,88	32,4	48,6	69,3	M60×2
65	13	5,34	7,94	11,6	40,4	60,1	87,5	M65×2
70	14	6,12	9,04	13,4	49,7	73,4	109	M70×2
75	15	6,95	10,2	15,4	60,3	88,7	134	M75×2
80	16	7,85	11,5	17,6	72,4	106	163	M80×2
85	17	8,81	12,9	20,0	86,2	126	195	M85×2
90	18	9,82	14,3	22,5	102	148	233	M90×2
95	19	10,9	15,9	25,2	119	173	275	M95×2
100	20	12,0	17,5	28,1	138	201	322	M100×2
105	21	13,2	19,3	31,2	159	231	374	M105×2
110	22	14,5	21,1	34,4	182	265	433	M110×2
120	24	17,2	25,0	41,5	235	342	567	M120×2
130	26	20,1	29,4	49,3	297	434	729	M130×2
140	28	23,3	34,1	57,9	370	541	920	M140×2
150	30	26,7	39,1	67,3	454	666	1144	M150×2
160	32	30,4	44,6	77,4	550	808	1402	M160×3
170	34	34,3	50,5	88,4	659	971	1699	M170×3
180	36	38,4	56,8	100,2	781	1154	2036	M180×3
190	38	42,8	63,4	112,7	918	1360	2417	M190×3
200	40	47,4	70,5	126,2	1070	1589	2845	M200×3
220	44	57,5	85,8	155,5	1423	2125	3853	Tr220×4
240	48	68,4	103	–	1847	2773	–	Tr240×4
260	52	80,4	–	–	2349	–	–	Tr260×4
280	56	93,4	–	–	2935	–	–	Tr280×4
300	60	107	–	–	3612	–	–	Tr300×4

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

☒ 51 Recommended clamping forces for axial angular contact ball bearings

Bore mm	Bore code	Clamping force		Tightening torque		Thread
		kN		Nm		
		from	up to	from	up to	
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

#### 1.9.2.6 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 runout during the clamping operation, the clamping inserts should be ground together with the thread and the axial face.

#### 1.9.2.7 Clearance adjustment of cylindrical roller bearings

Cylindrical roller bearings with a tapered bore are mounted with clearance, clearance-free or with preload. An enveloping circle gauge can assist with setting the clearance to an accuracy of ±1 µm.

## 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 FAG 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.



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

00017048



33 Transferring the raceway diameter to the enveloping circle gauge

- Then position the gauge on the inner ring and roller and cage assembly pre-mounted on the tapered shaft.

00016C6C



34 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°. 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.



0001704A

35 Measuring the spacing from the shaft shoulder

### 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 (drive-up factor F, see table) larger than the radial expansion induced in this way. Surface burnishing and the elastic expansion of the inner ring and the contraction of the shaft are contributory factors here.

$$f 11 \quad A = F \cdot \Delta G$$

A	mm	Drive-up distance
F	–	Drive-up factor
$\Delta G$	$\mu\text{m}$	Change in radial clearance

### 52 Hollow shaft ratio and drive-up factor

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

$d_B$	$\mu\text{m}$	Bore of hollow shaft
$d'$	$\mu\text{m}$	Tapered seat diameter, measured at the centre of the taper

### Calculation of the drive-up distance A

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

- 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  $\mu\text{m}$ , 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. The dial gauge should be positioned as close as possible to the bearing for this purpose.

In order to avoid scraping marks in the mounting of cylindrical roller bearings, the following must be observed:

- Do not tilt the inner ring relative to the outer ring.
- Rotate the spindle back in forth while it is being slid into place .

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

- Determine the axial spacing between the inner ring and the locating shoulder, for example by means of gauge blocks at 4 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:

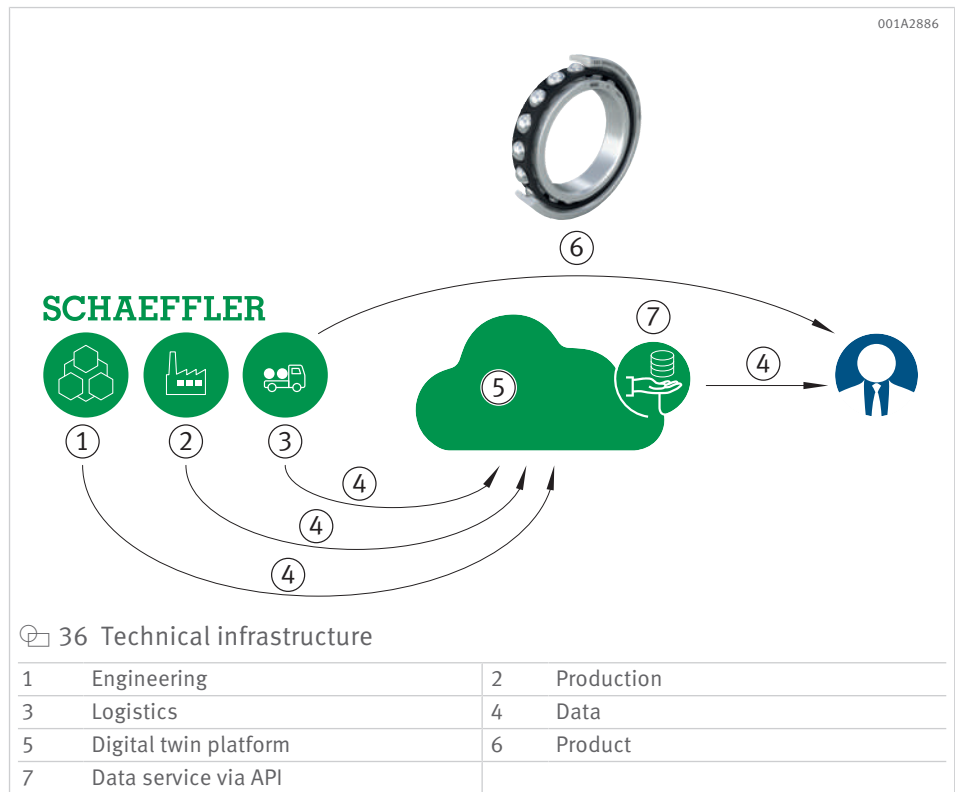
- drive-up distance  $A = \text{drive-up factor } F \cdot \text{change in radial clearance } \Delta G$
- hollow shaft ratio  $d_B/d' = 0,55$   $\mu\text{m}$
- drive-up factor F, see table = 17  $\mu\text{m}$
- change in radial clearance  $\Delta G = 20$   $\mu\text{m}$
- drive-up distance  $A = 17 \cdot 20 \mu\text{m} = 340 \mu\text{m} = 0,34 \text{ mm}$

### 1.9.3 Bearing Data Service

#### 1.9.3.1 Digitalisation

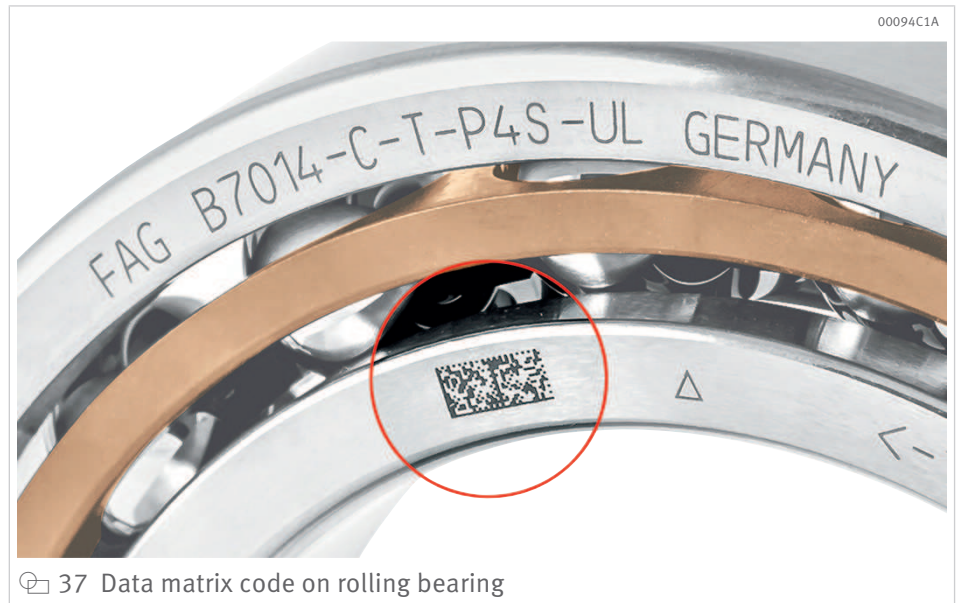
Digitalisation in the industrial sector is advancing at a rapid rate. The implementation strategies involved are as diverse as our customers and their applications, extending from logistics, assembly, logging and maintenance through to the history of component and systems.

In order to satisfy the respective strategies, Schaeffler provides a powerful and highly scalable technical infrastructure, which allows digital or machine-readable data on rolling bearing products to be processed from various source systems. This technical infrastructure consists of the Schaeffler Data Platform and a standardised interface (Digital Twin Data Service).



A data matrix code (DMC) to GS1 standard is used.





The customer receive access to the rolling bearing product data via the individual serial number contained in the DMC. The rolling bearing product data is highly individual data and actual measurement data from the production processes.

The following individual product data can be made available:

- serial number (SSN)
- bearing designation
- production date
- production plant
- actual value codes (bore diameter, outside diameter)
- actual width deviation
- actual deviation from nominal projection
- actual contact angle

#### 1.9.3.2 Generation of added value for customers

The benefit for the customer lies in the automation and acceleration of classic business processes in the value-added chain, as demonstrated by the following examples, which have already been implemented by end customers:

- The automated delivery of measurement values from spindle bearing production to the mounting software of spindle manufacturers and maintenance personnel, for use in the matching process between spindle and bearing. The work involved in manual data transmission is thus eliminated and a one-to-one relationship is created between spindle bearings and spindle on the basis of the data matrix code.
- The use of digitally delivered measurement data on individual bearings, in order to enable prime and highly precise matching of spindle bearing sets and spindles in the customer's inventory management system as early as the provision process.

#### 1.9.4 Mounting service

The Schaeffler Mounting Service offers mounting and dismounting services for rolling bearings that are applicable across industrial sectors. The service has detailed knowledge and extensive experience in all industrial sectors.

The experts in the Mounting 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 services include:

- mounting and dismounting of rolling bearings, plain 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

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

#### 1.9.5 Rental of tools

Customers who require special mounting 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 Mounting Service function is commissioned to carry out the particular activity, rental costs are not generally incurred.

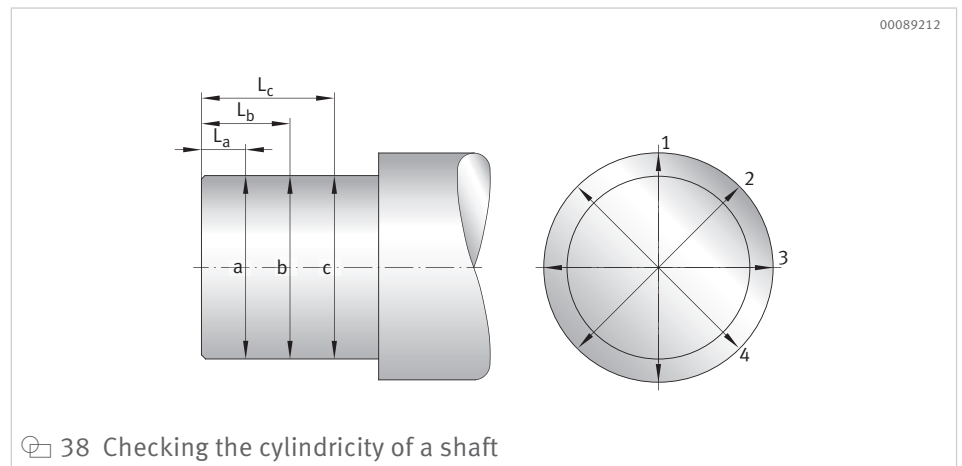
## 1.9.6 Devices for the mounting of super precision bearings

### 1.9.6.1 Devices for measuring the bearing seat

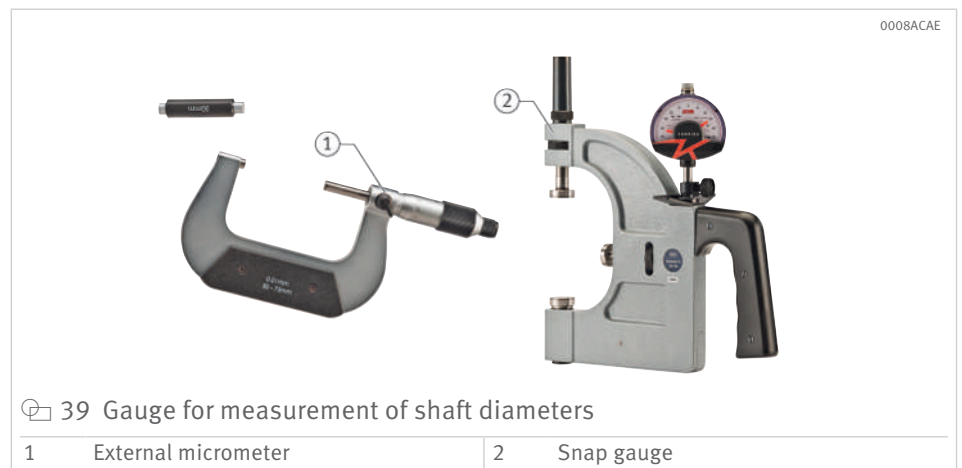
A significant work operation for successful mounting of bearings is the prior measurement of the components used. Various measuring devices are used here. In all measurements, it must be ensured that the measuring device is at approximately the same temperature as the parts to be measured.

#### Cylindrical seating surfaces

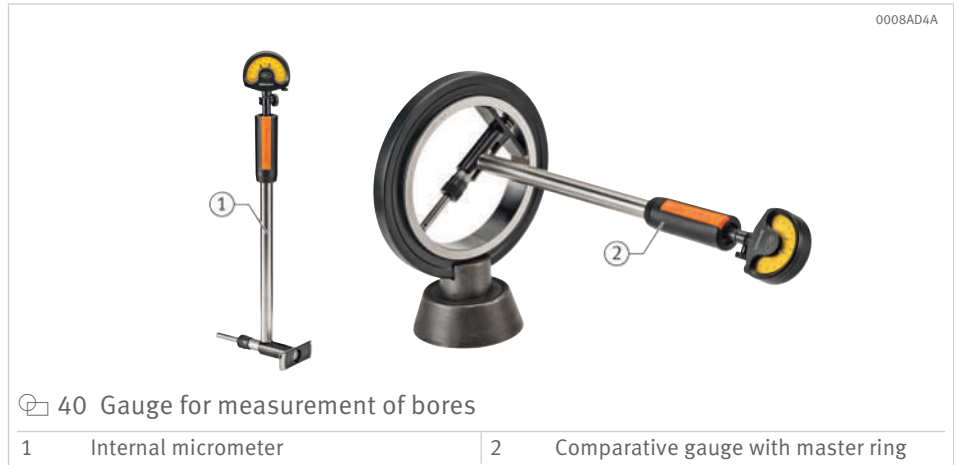
The dimensional accuracy of cylindrical seating surfaces and their roundness should be checked with the aid of micrometers at various measurement points.



Secure positioning and correct measurement of cylindrical seating surfaces is ensured by the snap gauge. The master disc is marked with the diameter to which the gauge must be set.

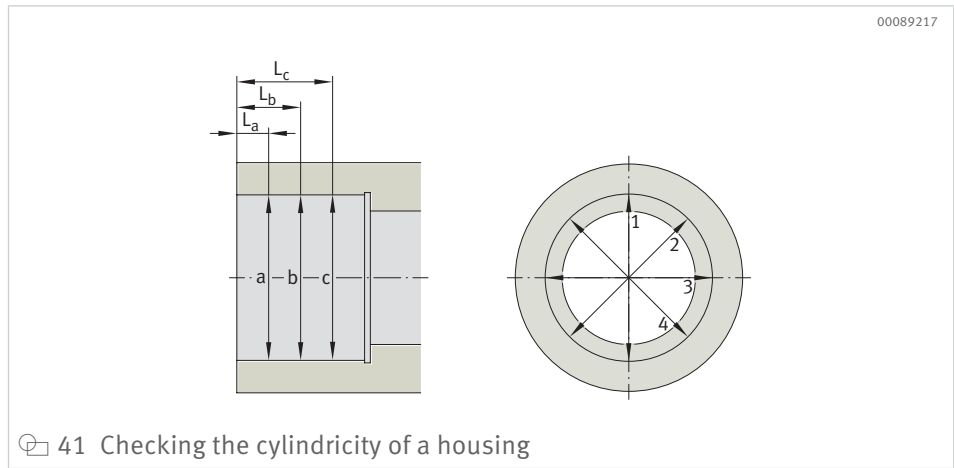


The measurement of bores is carried out using either conventional internal micrometers or so-called comparator gauges. The master ring shown is used for calibration of the measurement tool.



40 Gauge for measurement of bores

- |   |                     |   |                                    |
|---|---------------------|---|------------------------------------|
| 1 | Internal micrometer | 2 | Comparative gauge with master ring |
|---|---------------------|---|------------------------------------|



41 Checking the cylindricity of a housing

### Tapered seating surfaces

In order to ensure that the inner ring has a tight fit on the shaft, the taper of the shaft must match precisely the taper of the inner ring bore.

The taper of rolling bearing rings is standardised. For most bearing series, it is 1:12. Depending on the requirements and the bearing width, bearings with a taper 1:30 are possible.

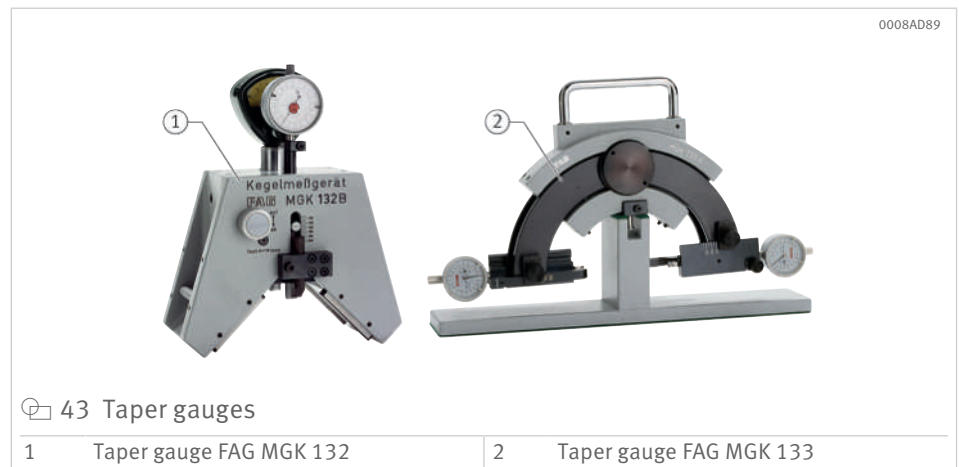
The simplest item of measuring equipment for small, tapered bearing seats is the taper ring gauge. By application of inking material, it can be determined whether the shaft and ring gauge match, while corrections are made until the ring gauge is in contact over its whole width.

**!** The inner rings of bearings should not be used as ring gauges.



42 Inking with a taper ring gauge

For the precise checking of tapered shaft seating surfaces, Schaeffler has developed the taper gauges FAG MGK 133 and FAG MGK 132. The taper and diameter of the bearing seat are measured precisely using a comparator taper or segment. Both devices are easy to use, since it is not necessary to remove the workpiece from the machining equipment for measurement.



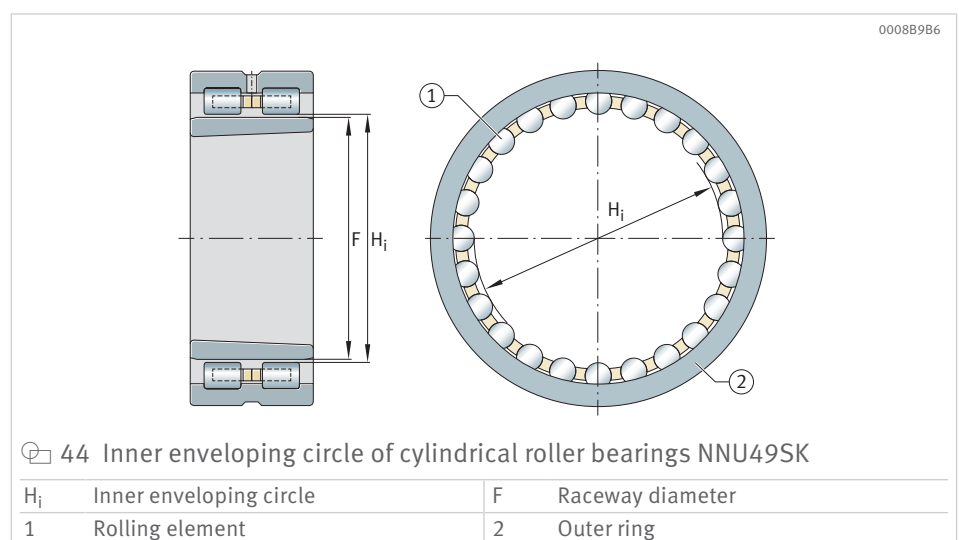
The taper gauge FAG MGK 133 is used to measure tapers shorter than 80 mm. Depending on the device size, the outside diameter of the taper can measure 27 mm ... 205 mm.

The taper gauge FAG MGK 132 is suitable for taper lengths of 80 mm and above and taper diameters of 90 mm ... 820 mm.

### Enveloping circle

The radial internal clearance of a mounted cylindrical roller bearing is determined by the difference between the roller enveloping circle diameter and the raceway diameter of the ribless ring.

In the case of cylindrical roller bearings with a separable inner ring NNU49SK, the radial internal clearance or preload is determined by the difference between the diameter of the inner enveloping circle  $H_i$  and the raceway  $F$ . The internal enveloping circle is defined as the circle inscribed internally by all rollers when they are in contact with the outer ring raceway.

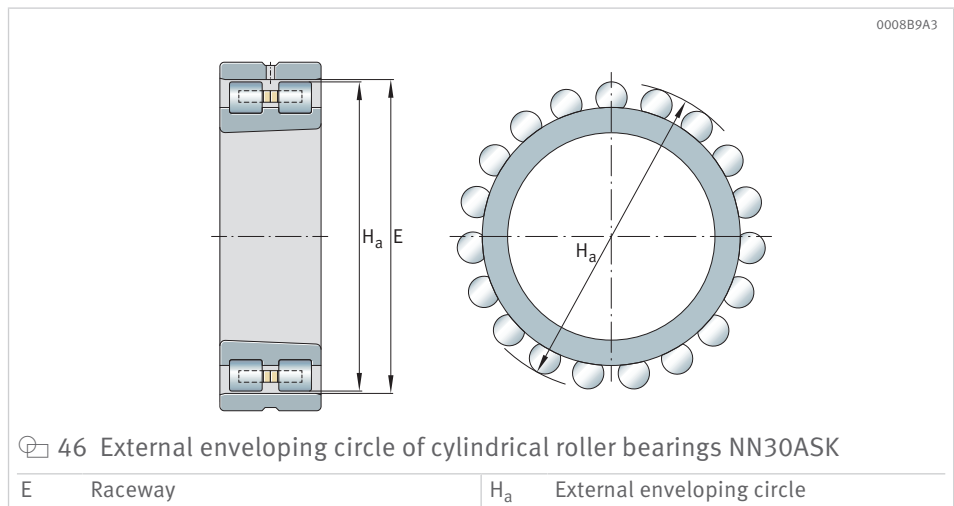


The internal enveloping circle is measured using the enveloping circle gauge MGI 21. In conjunction with a snap gauge, the radial internal clearance of the mounted bearing can be determined. The dimension for the enveloping circle diameter is transferred to the snap gauge. The enveloping circle gauge MGI 21 is used for cylindrical roller bearings with a separable inner ring, e.g. NNU49SK.



45 Enveloping circle gauge FAG MGI 21

In the case of cylindrical roller bearings with a separable outer ring NN30ASK, the radial internal clearance or preload is determined by the difference between the diameter of the raceway  $E$  and the external enveloping circle  $H_a$ . The external enveloping circle is defined as the circle inscribed externally by all rollers when they are in contact with the inner ring raceway.



46 External enveloping circle of cylindrical roller bearings NN30ASK

$E$	Raceway	$H_a$	External enveloping circle
-----	---------	-------	----------------------------

The external enveloping circle is measured using the MGA 31. In conjunction with a bore gauge, the radial internal clearance of the mounted bearing can be determined.

The dimension for the raceway diameter is transferred using the bore gauge to the enveloping circle gauge. The enveloping circle gauge MGA 31 is used for cylindrical roller bearings with a separable inner ring, e.g. FAG NN30ASK.



The two opposing steel segments of the enveloping circle gauge are the measuring surfaces. One segment is rigidly attached to the device while the other is capable of radial motion. This motion is transferred to the precision indicator.

For measurement, the bearing outer ring must be mounted in the housing. Once the diameter of the outer ring raceway has been determined using the bore gauge, the dimension is transferred to the enveloping circle gauge.

The inner ring, which is held together with the roller and cage assembly by the cage, is first slid onto the tapered shaft seat with form fit. The enveloping circle gauge is then positioned on the roller and cage assembly and the inner ring is pressed into place until the precision indicator shows the required dimension.

Plus values indicate preload, while minus values indicate radial internal clearance. The value zero gives a clearance-free bearing.

#### 1.9.6.2 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 for these 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.

#### 1.9.7 Training courses

For the maintenance of main spindles for machine tools, Schaeffler regularly offers a one-day training course on mounting, especially for supervisors and fitters at machine tool operators and manufacturers. Actual implementation is dependent on the number of participants and availability.

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.

#### 1.9.7.1 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

#### 1.9.7.2 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.

### 1.9.8 Other products and services

#### 1.9.8.1 Further information

For enquires, orders, repairs and recalibrations, please contact Schaeffler Sondermaschinenbau: [sondermaschinenbau@schaeffler.com](mailto:sondermaschinenbau@schaeffler.com)

## 1.10 Bearing monitoring

### 1.10.1 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. This 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 auf +40 °C may well be an early indication of bearing damage.



## 1.10.2 Types of monitoring

### 1.10.2.1 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.

### 1.10.2.2 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.

### 1.10.2.3 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 for these purposes. 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.

### 1.10.2.4 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.

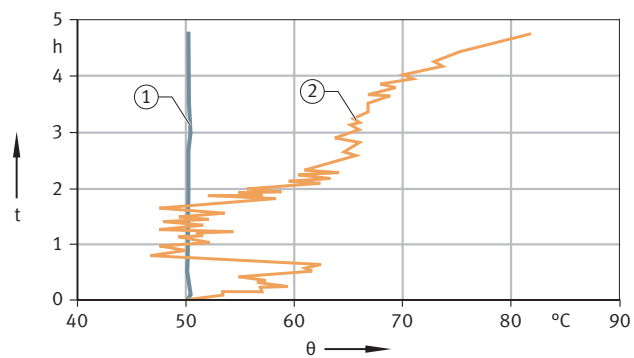
Where changes in preload or malfunction of non-locating bearings occur, there are relatively stable specimens of typical temperature curves.

The temperature is generally measured on the stationary ring. This 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.



48 Bearing/temperature behaviour

t	Time	θ	Temperature
1	Normal	2	End of grease operating life

## 2 Spindle bearings

### 2.1 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. 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.

#### 2.1.1 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 product 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.

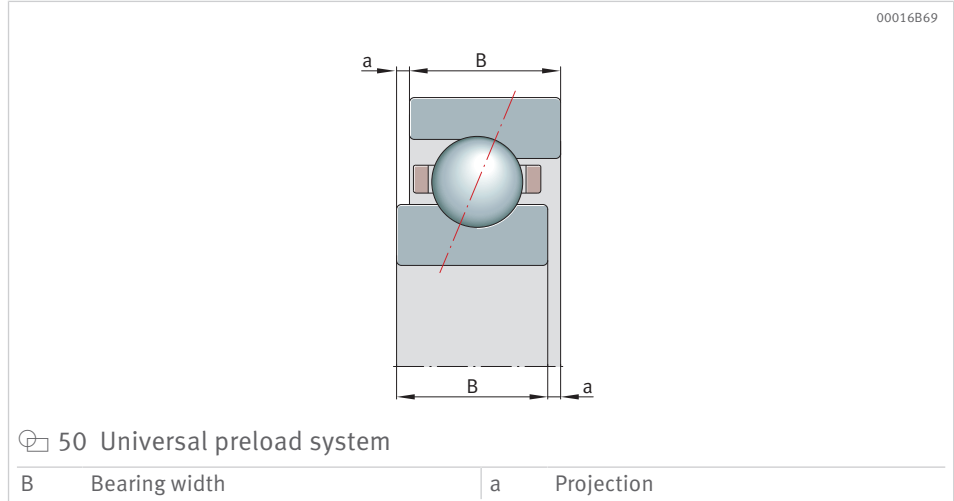
In new designs, this can allow the machine manufacturer to achieve a unique position in the market. In existing designs too, refitting with FAG spindle bearings can still give further increases in the performance and profitability of machines.



### 2.1.2 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.



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.

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 between the housing bore 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. This provides logistical advantages for the customer, especially in spare parts procurement and stockholding of bearings.

### 2.1.3 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.

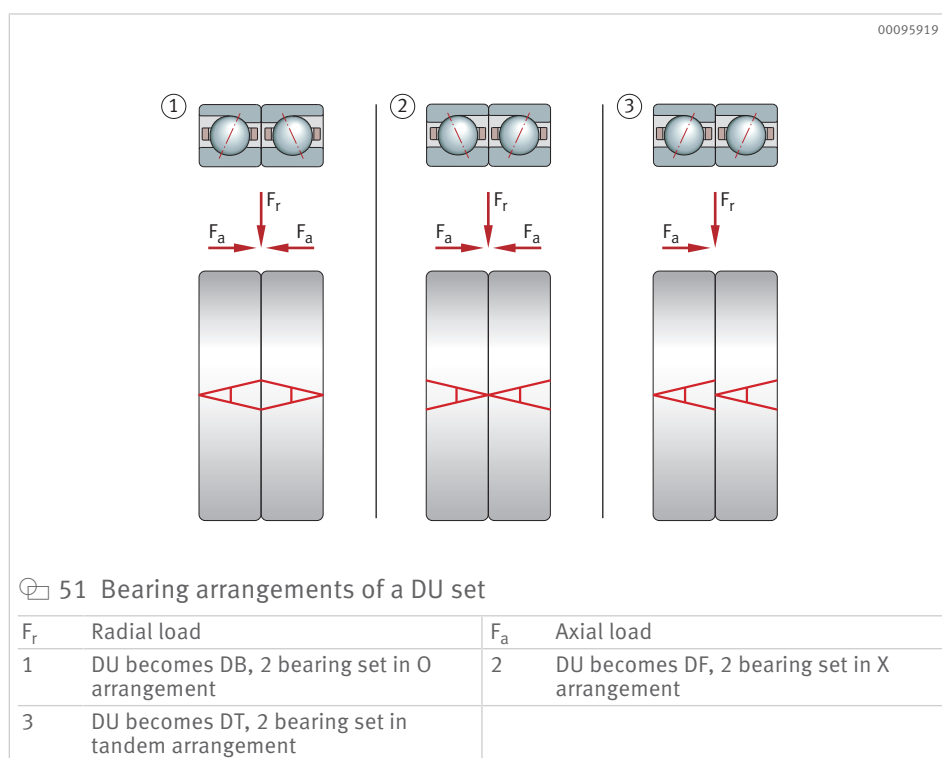
The sets are of identical technical quality to single bearings with the same deviation in the inner ring bore and the outside diameter.

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.

Universal bearing sets can be mounted in any arrangement required.



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. Universal bearing sets, however, offer significant logistical advantages over the ready-to-fit sets, especially in the procurement and stockholding of spare parts.

### 2.1.4 Load carrying capacity and contact angle

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

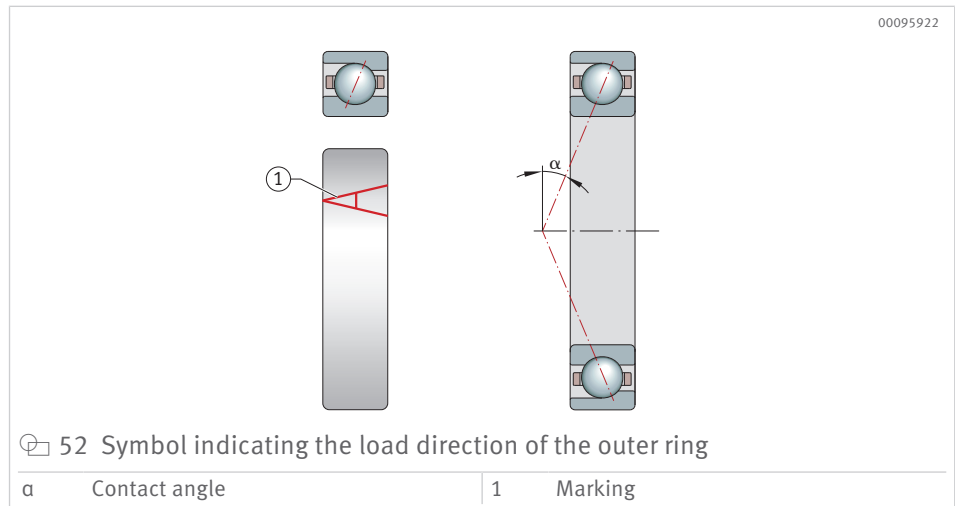
If bearings are used in an O or X arrangement, they can support axial forces in both directions as well as moments. Bearings in a tandem arrangement can only support axial loads in one direction.

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:

- $\alpha = 15$  (suffix C)
- $\alpha = 17$  (suffix C, M series)
- $\alpha = 25$  (suffix E)

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



### 2.1.5 Bearing types and product characteristics

Universal spindle bearings are available in B, M and H bearing designs.

B spindle bearings:

- classical spindle bearing
- with large balls
- contact angle 15° and 25°
- very high load carrying capacity and high rigidity
- for moderate speed level

M spindle bearing in X-life design:

- with medium balls
- contact angle 17° and 25°
- suitable for high to very high speeds due to bearing internal design with optimised friction
- kinematic insensitivity to tilting
- high load carrying capacity
- particularly suitable for high speed milling spindles and motor spindles.

H spindle bearings (high speed design):

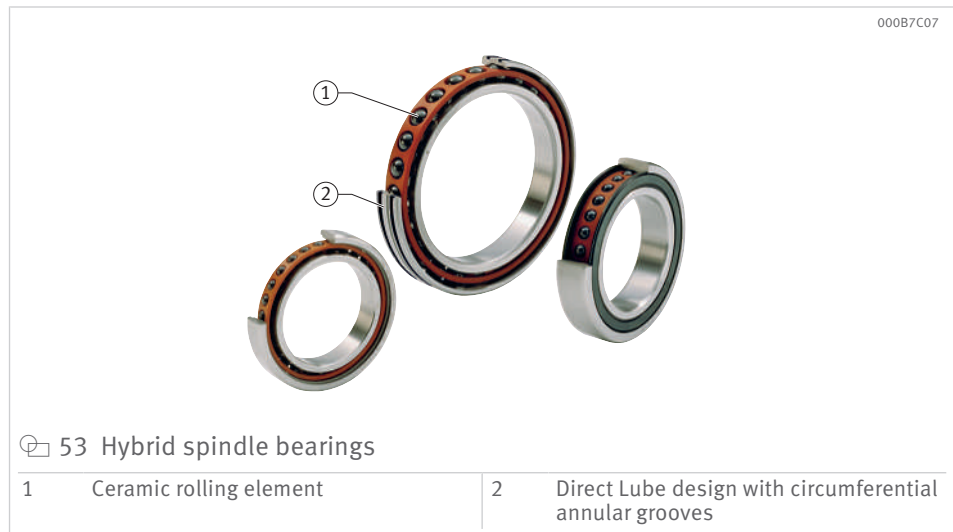
- with small balls
- contact angle 15° and 25°
- suitable for very high speeds due to internal design with optimised friction and very low centrifugal forces on the rolling elements
- high rigidity at high speeds
- particularly suitable for very high speed spindles and grinding spindles

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

M spindle bearings in X-life design are also available with rings made from the high performance steel Vacrodur in conjunction with ceramic balls.

### 2.1.6 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  $\text{Si}_3\text{N}_4$ ).



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.

### 2.1.7 Bearing rings made from Vacrodur

Bearings with rings made from Vacrodur are suitable for very high speeds and have very high load carrying capacity. These bearings are always designed as hybrid bearings. Vacrodur is a high performance steel with an exceptionally homogeneous and fine structure.

Vacrodur has, in comparison with the normal rolling bearing steel 100Cr6, a significantly higher hardness above 65 HRC combined with simultaneously high toughness. As a result, the permissible contact pressure is higher.

In the event of lubricant contamination, the high hardness and toughness of the material leads to a reduction in initial damage caused by overrolling of foreign particles. In the mixed friction range, rating life values of up to 25 times the normal value have even been achieved.

It is also significantly superior to conventional rolling bearing steels where high temperature hardness is concerned.

The longer life achieved with Vacrodur compared to conventional rolling bearing steel makes a considerable contribution to reducing system costs.



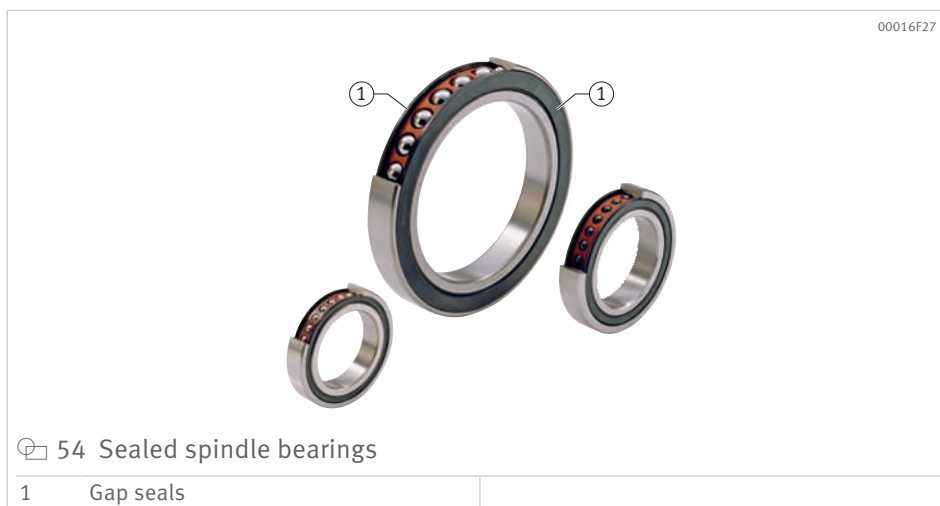
### 2.1.8 Open and sealed spindle bearings

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

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

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

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



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.

### 2.1.9 Direct Lube design

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. 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.

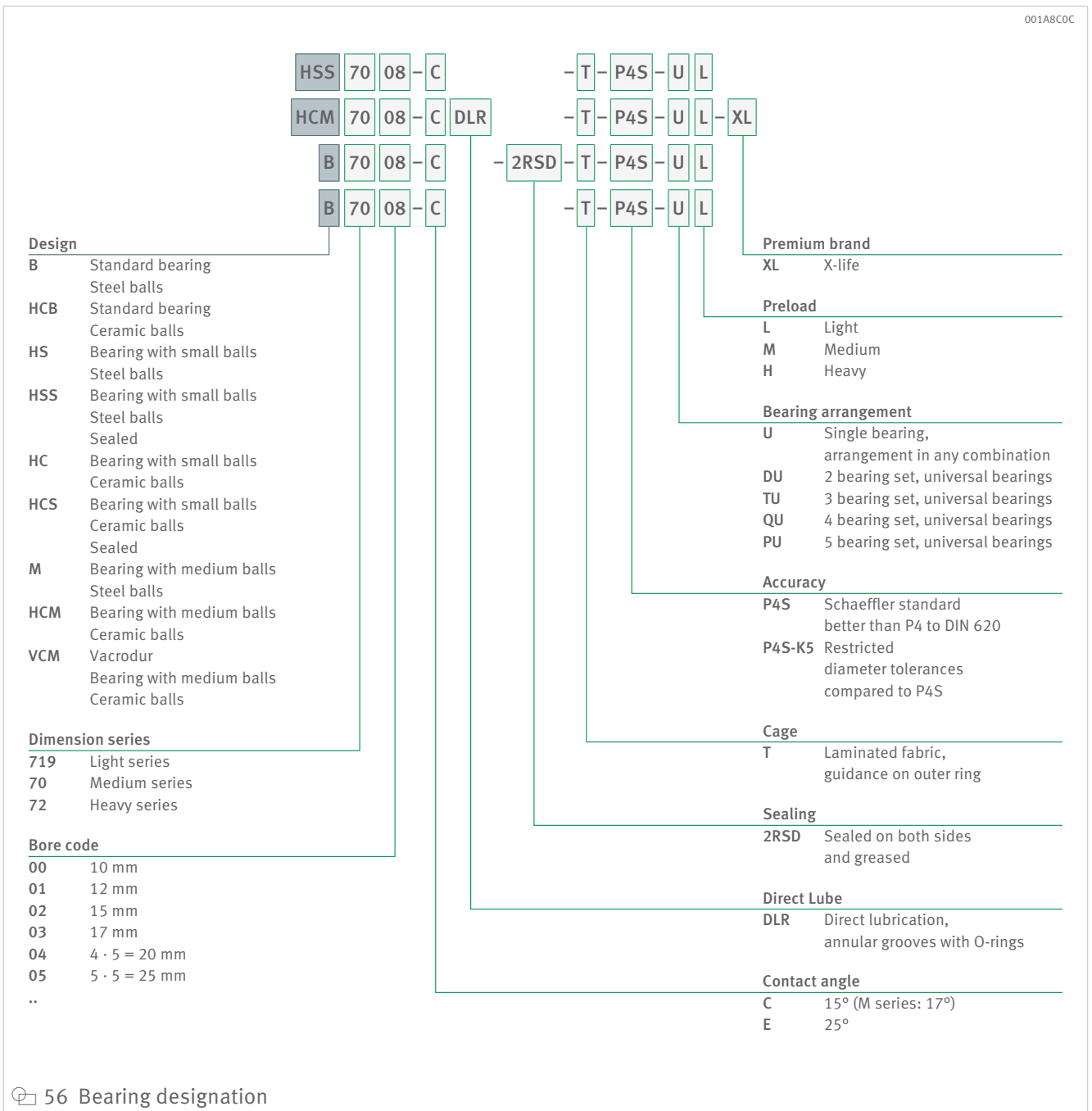


### 2.1.10 Cages

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

-  Check the chemical resistance of the seal material 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.

## 2.1.11 Designation and marking of bearings



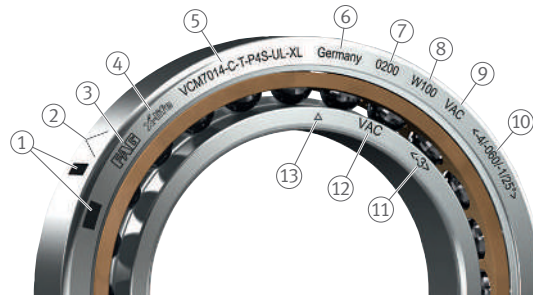
56 Bearing designation

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

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

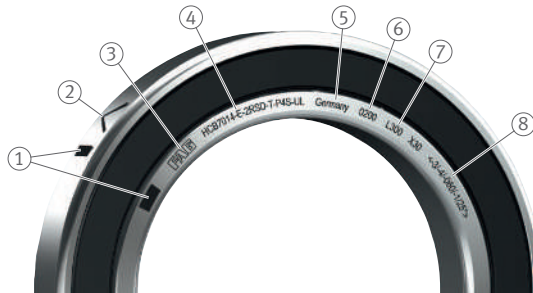
- tolerances and actual value codes (bore, outside diameter, width, projection, contact angle)
- mounting position indicated by the marking on the cylindrical surface of the outer ring (symbol indicating the load direction of the outer ring)

These indications are, depending on the size of the bearing, subject to tolerances. The marking is located on the end faces of the bearing rings.



57 Example of marking for bearing with Vacrodur rings

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



58 Example of marking for sealed 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	Actual 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 angle

## 2.2 Product tables

### 2.2.1 Explanations

B	mm	Width
B <sub>1</sub>	mm	Shaft washer height
B <sub>N</sub>	mm	Ring groove spacing
C	mm	Outer ring width
C <sub>0a</sub>	N	Basic static load rating, axial
C <sub>0r</sub>	N	Basic static load rating, radial
c <sub>a</sub>	N/μm	Axial rigidity
C <sub>a</sub>	N	Basic dynamic load rating, axial
c <sub>a</sub> H	N/μm	Axial rigidity, high
c <sub>a</sub> L	N/μm	Axial rigidity, slight
c <sub>a</sub> M	N/μm	Axial rigidity, moderate
C <sub>r</sub>	N	Basic dynamic load rating, radial
d	mm	Bore diameter
D	mm	Outside diameter
d <sub>1</sub>	mm	Rib diameter on shaft washer
d <sub>a</sub>	mm	Abutment diameter, shaft shoulder
D <sub>a</sub>	mm	Abutment diameter, outer ring
D <sub>a</sub>	mm	Housing shoulder diameter
d <sub>s</sub>	mm	Lubrication hole diameter
E	mm	Raceway diameter of outer ring
E <sub>tk</sub>	mm	Injection pitch circle diameter
E <sub>tk1</sub>	mm	Injection pitch circle diameter 1
E <sub>tk2</sub>	mm	Injection pitch circle diameter 2
F	mm	Inner ring raceway diameter
F <sub>V</sub>	N	Preload force
F <sub>V</sub> H	N	Preload force, high
F <sub>V</sub> L	N	Preload force, slight
F <sub>V</sub> M	N	Preload force, moderate
K <sub>aE</sub>	N	Lift-off force
K <sub>aE</sub> H	N	Lift-off force, high
K <sub>aE</sub> L	N	Lift-off force, slight
K <sub>aE</sub> M	N	Lift-off force, moderate
m	kg	Mass
n <sub>G</sub>	min <sup>-1</sup>	Limiting speed
n <sub>G</sub> grease	min <sup>-1</sup>	Limiting speed for grease lubrication
n <sub>G</sub> oil	min <sup>-1</sup>	Limiting speed for oil lubrication
n <sub>s</sub>	mm	Lubrication groove width
r <sub>1 min</sub>	mm	Min. chamfer dimension
r <sub>min</sub>	mm	Min. chamfer dimension
s	mm	Displacement distance, axial
s <sub>1</sub>	mm	Displacement distance, axial
s <sub>2</sub>	mm	Displacement distance, axial
S <sub>B</sub>	mm	Lubrication groove width
S <sub>N</sub>	mm	Lubrication hole spacing
α	°	Contact angle

### 2.2.2 Spindle bearings

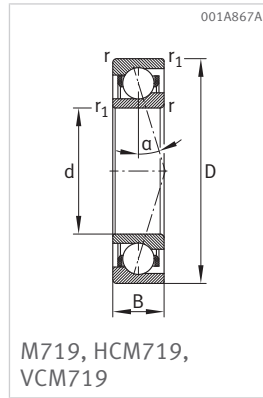
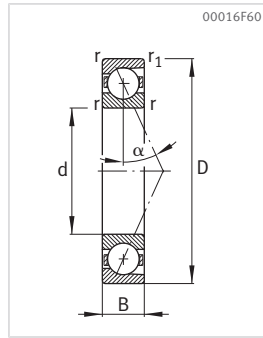
With large, medium or small balls

Steel balls or ceramic balls

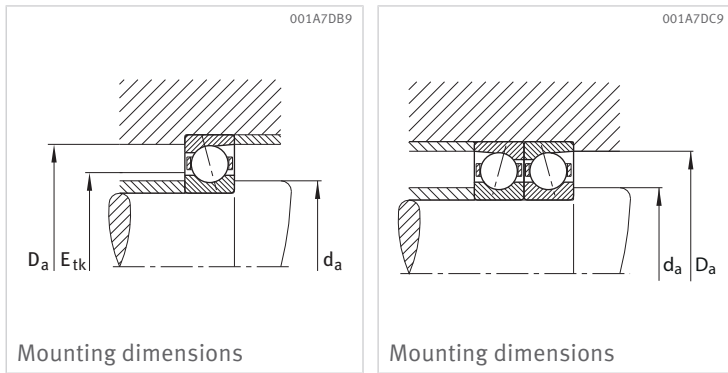
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
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	•	0,01	10	22	6	0,3	0,3	15	13	19,5
HS71900-E-T-P4S	•	0,01	10	22	6	0,3	0,3	25	13	19,5
HC71900-E-T-P4S	•	0,01	10	22	6	0,3	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	•	0,021	10	26	8	0,3	0,3	15	14	22
HS7000-E-T-P4S	•	0,021	10	26	8	0,3	0,3	25	14	22
HC7000-E-T-P4S	•	0,021	10	26	8	0,3	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
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	0,3	15	15	21,5
HS71901-E-T-P4S	•	0,011	12	24	6	0,3	0,3	25	15	21,5
HC71901-E-T-P4S	•	0,011	12	24	6	0,3	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	0,3	15	16,5	24,5
HS7001-E-T-P4S	•	0,024	12	28	8	0,3	0,3	25	16,5	24,5
HC7001-E-T-P4S	•	0,023	12	28	8	0,3	0,3	25	16,5	24,5
B7201-C-T-P4S	•	0,037	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



$E_{tk}$	$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
15	3000	1070	75000	120000	10	41	87	31	141	320	11	21,1	31,2
15	2900	1020	70000	110000	17	74	163	50	226	521	27,1	47,7	67
15	3000	1020	110000	160000	6	25	54	17	79	185	9,8	18,2	26,5
15	2900	980	95000	150000	5	35	85	16	104	260	20,4	39,9	56,5
15	1790	650	100000	160000	7	20	39	20	63	132	8,8	14,1	19,6
15	1700	620	95000	140000	11	32	64	31	96	196	21,7	32,7	43
15	1700	600	120000	180000	7	22	45	21	65	133	21,6	32	41,7
16,8	4100	1470	67000	100000	18	65	136	54	220	490	12,7	23	33,5
16,8	3950	1410	60000	95000	21	99	223	61	298	698	27,6	49,2	69,1
16,8	4150	1400	95000	140000	7	33	74	21	104	248	9,9	18,5	26,9
16,8	3950	1350	85000	130000	12	57	130	33	167	392	25,1	44,6	61,6
16,9	2470	940	90000	140000	9	28	55	28	89	185	10,9	17,4	24,1
16,9	2350	890	85000	130000	15	45	90	43	133	273	26,8	40,3	53
16,9	2360	860	110000	160000	10	31	62	30	91	185	26,6	39,5	51,4
19,2	6900	2950	56000	85000	25	91	185	79	311	684	16,4	29,8	43,5
19,2	6600	2800	50000	75000	32	141	314	94	429	995	35,8	63,2	88,8
19,2	7000	2800	67000	100000	11	47	103	32	150	352	12,9	23,9	34,9
19,2	6600	2700	60000	90000	18	82	185	52	243	564	32,8	57,2	78,9
17,2	3400	1310	67000	100000	11	46	97	34	155	355	12,6	24,1	35,7
17,2	3250	1250	60000	95000	18	80	179	53	245	567	30,8	54,4	76,5
17,2	3400	1250	95000	140000	6	27	60	18	87	205	11,2	20,8	30,3
17,2	3250	1190	85000	130000	5	38	92	16	111	281	22,7	45,5	64,5
17	1850	720	90000	140000	7	21	41	21	66	137	9,4	15	20,8
17	1760	690	85000	130000	11	33	67	32	99	203	23,1	34,7	45,6
17	1760	660	110000	160000	8	23	46	22	68	138	22,9	34,1	44,3
18,8	4650	1830	60000	90000	19	73	152	59	242	543	14,6	26,5	38,7
18,8	4450	1750	53000	85000	23	109	248	66	328	775	31,8	57,2	80,3
18,8	4700	1750	85000	130000	8	36	82	22	114	274	11,3	21,4	31,1
18,8	4450	1670	75000	120000	12	63	145	35	184	436	29	51,9	71,7
18,9	2450	960	80000	130000	9	27	54	27	87	181	10,8	17,3	23,9
18,9	2320	910	75000	110000	15	44	88	43	131	268	26,7	40	52,6
18,9	2330	870	95000	140000	10	30	61	29	89	181	26,4	39,2	50,9
21,1	9100	3900	50000	75000	35	123	248	109	420	916	19,3	34,6	50,3
21,1	8800	3750	45000	67000	47	193	423	137	588	1342	42,8	73,9	103
21,1	9100	3700	63000	95000	16	65	142	47	210	483	15,6	28,2	40,9
21,1	8800	3600	56000	85000	26	112	248	76	332	757	39,2	66,8	91,6

### 2.2.2 Spindle bearings

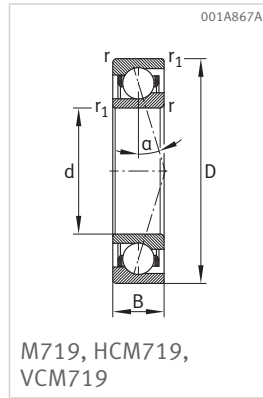
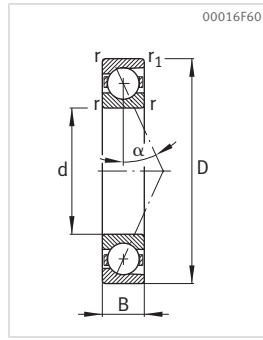
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

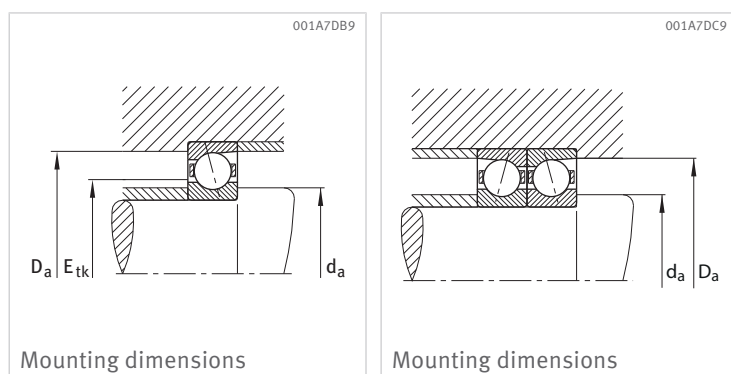
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
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	0,3	15	18	25,5
HS71902-E-T-P4S	•	0,017	15	28	7	0,3	0,3	25	18	25,5
HC71902-E-T-P4S	•	0,016	15	28	7	0,3	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	0,3	15	19	29
HS7002-E-T-P4S	•	0,033	15	32	9	0,3	0,3	25	19	29
HC7002-E-T-P4S	•	0,031	15	32	9	0,3	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
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	0,3	15	20	27,5
HS71903-E-T-P4S	•	0,019	17	30	7	0,3	0,3	25	20	27,5
HC71903-E-T-P4S	•	0,018	17	30	7	0,3	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	•	0,039	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	•	0,033	17	35	10	0,3	0,3	25	21	32
HS7003-C-T-P4S	•	0,04	17	35	10	0,3	0,3	15	21	32
HS7003-E-T-P4S	•	0,04	17	35	10	0,3	0,3	25	21	32
HC7003-E-T-P4S	•	0,038	17	35	10	0,3	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





$E_{tk}$	$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
20,9	5100	2030	56000	85000	19	73	153	59	249	559	16,4	30,5	44,9
20,9	4850	1940	50000	75000	22	111	255	64	336	805	35	64,7	91,9
20,9	5100	1940	75000	120000	7	37	84	21	117	285	12,5	24,4	35,9
20,9	4850	1860	70000	110000	12	64	150	34	190	457	31,9	58,7	82
20,4	2550	1040	75000	110000	9	28	56	28	90	188	11,4	18,2	25,2
20,4	2410	990	67000	100000	15	46	91	44	136	278	28,3	42,4	55,6
20,4	2410	950	85000	130000	11	32	63	30	92	188	28	41,5	53,9
22,3	6100	2410	53000	80000	27	99	204	84	332	733	16,6	29,7	43
22,3	5900	2310	45000	70000	36	154	341	104	464	1066	37,2	64,6	89,8
22,3	6200	2310	70000	110000	12	52	114	35	164	381	13,4	24,3	35,1
22,3	5900	2210	63000	100000	20	88	199	57	260	600	34,1	58,6	80,2
22,4	3450	1480	70000	110000	13	38	75	38	120	251	13,7	21,8	30,2
22,4	3250	1410	63000	95000	20	61	122	59	182	372	34	50,9	66,8
22,4	3250	1350	80000	120000	14	42	85	41	124	252	33,7	49,9	64,8
23,4	11600	5000	45000	67000	46	158	319	144	543	1177	22,1	39,3	57
23,4	11100	4850	40000	60000	64	252	546	187	768	1732	49,7	84,4	117
23,4	11600	4800	56000	85000	22	86	183	65	275	626	18,1	32,3	46,5
23,4	11100	4650	48000	70000	24	126	291	70	371	884	39,7	72	100
22,3	5300	2230	50000	80000	20	78	162	62	263	592	17,5	32,6	47,9
22,3	5100	2120	45000	70000	22	115	265	65	346	833	36,9	68,5	97,3
22,3	5300	2130	70000	110000	8	39	89	22	123	300	13,3	26	38,3
22,3	5100	2030	63000	100000	12	65	154	34	193	466	33,4	61,9	86,4
22,4	2600	1130	70000	110000	10	29	58	29	93	194	12	19,2	26,5
22,4	2480	1070	63000	95000	16	47	93	45	138	283	29,6	44,4	58,3
22,4	2480	1030	80000	120000	11	33	66	31	96	195	29,6	43,9	56,9
24,5	8600	3500	45000	70000	40	142	291	124	474	1042	21,1	37,1	53,6
24,5	8200	3350	43000	63000	54	220	483	156	663	1504	47,6	81	112
24,5	8600	3350	63000	100000	18	75	164	54	237	546	17,3	30,7	43,9
24,5	8200	3250	56000	90000	30	126	279	85	370	840	43,5	73,4	99,7
24,8	3550	1600	63000	95000	13	38	76	38	121	253	14,3	22,7	31,3
24,8	3350	1520	56000	85000	21	63	126	61	187	382	35,7	53,4	70
24,8	3350	1460	75000	110000	14	43	86	41	126	256	35,3	52,2	67,7
26,7	13000	5800	38000	56000	53	179	360	165	614	1327	23,6	41,8	60,6
26,7	12400	5600	36000	53000	74	286	616	216	871	1954	53,3	89,9	125
26,7	13000	5600	50000	75000	25	97	208	75	313	708	19,5	34,4	49,5
26,7	12500	5400	43000	63000	29	145	332	84	428	1011	43,2	77,2	107

### 2.2.2 Spindle bearings

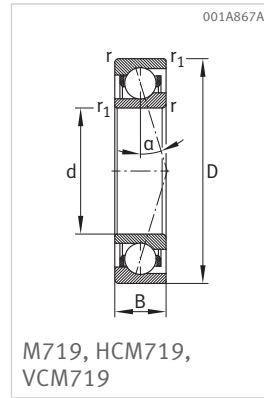
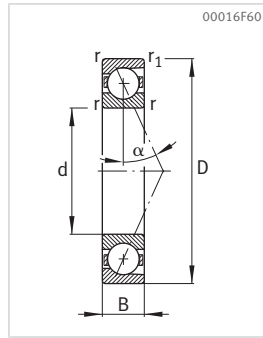
With large, medium or small balls

Steel balls or ceramic balls

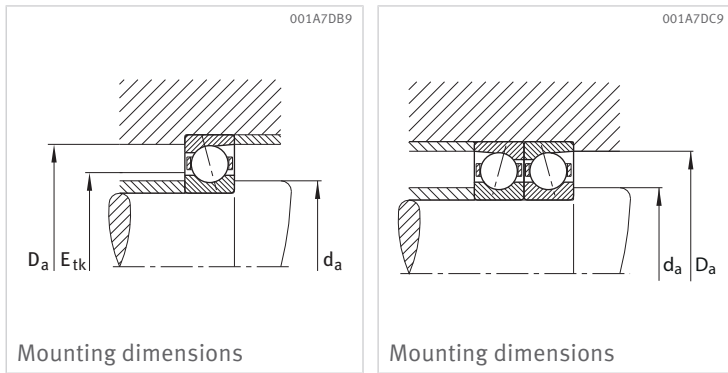
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	►91 ◻56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71904-C-T-P4S	•	0,037	20	37	9	0,3	0,3	15	24	33,5
B71904-E-T-P4S	•	0,037	20	37	9	0,3	0,3	25	24	33,5
HCB71904-C-T-P4S	•	0,033	20	37	9	0,3	0,3	15	24	33,5
HCB71904-E-T-P4S	•	0,033	20	37	9	0,3	0,3	25	24	33,5
HS71904-C-T-P4S	•	0,04	20	37	9	0,3	0,3	15	24	33,5
HS71904-E-T-P4S	•	0,04	20	37	9	0,3	0,3	25	24	33,5
HC71904-E-T-P4S	•	0,039	20	37	9	0,3	0,3	25	24	33,5
B7004-C-T-P4S	•	0,067	20	42	12	0,6	0,6	15	25	37
B7004-E-T-P4S	•	0,067	20	42	12	0,6	0,6	25	25	37
HCB7004-C-T-P4S	•	0,061	20	42	12	0,6	0,6	15	25	37
HCB7004-E-T-P4S	•	0,061	20	42	12	0,6	0,6	25	25	37
HS7004-C-T-P4S	•	0,077	20	42	12	0,6	0,6	15	25	37
HS7004-E-T-P4S	•	0,077	20	42	12	0,6	0,6	25	25	37
HC7004-E-T-P4S	•	0,073	20	42	12	0,6	0,6	25	25	37
B7204-C-T-P4S	•	0,103	20	47	14	1	1	15	26,5	40,5
B7204-E-T-P4S	•	0,103	20	47	14	1	1	25	26,5	40,5
HCB7204-C-T-P4S	•	0,092	20	47	14	1	1	15	26,5	40,5
HCB7204-E-T-P4S	•	0,091	20	47	14	1	1	25	26,5	40,5



$E_{tk}$	$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
27,1	7400	3200	43000	63000	31	113	233	95	384	851	21,6	39,3	57,4
27,1	7000	3050	38000	60000	37	170	384	108	516	1208	46,7	83,3	117
27,1	7400	3100	60000	90000	12	57	128	37	182	431	16,8	31,5	46
27,1	7000	2950	53000	80000	20	98	223	58	289	678	42,5	75,3	104
27,2	3600	1730	56000	90000	13	39	78	39	124	259	15	23,7	32,7
27,2	3400	1630	53000	80000	22	65	129	62	191	392	37,4	55,9	73,2
27,2	3400	1560	67000	100000	15	44	88	42	128	261	36,9	54,6	70,7
29,3	10300	4250	38000	60000	51	175	356	157	586	1276	22,6	39,4	56,8
29,3	9800	4050	34000	53000	71	275	595	205	829	1857	51,6	86,3	119
29,3	10300	4050	53000	80000	24	94	202	72	297	673	18,7	32,7	46,6
29,3	9800	3900	48000	75000	28	140	321	80	410	966	42	74,7	103
29,7	5700	2700	53000	80000	21	62	125	63	198	413	19,8	31,5	43,5
29,7	5400	2600	48000	75000	34	101	202	97	299	611	49,1	73,6	96,4
29,7	5400	2470	60000	95000	23	70	140	67	204	415	48,8	72,3	93,7
31,7	17200	8000	32000	48000	75	248	496	234	851	1828	28,1	49,3	71,1
31,7	16500	7700	30000	45000	107	398	848	313	1212	2686	63,7	106	146
31,7	17300	7600	40000	60000	36	135	284	109	432	967	23,3	40,5	57,9
31,7	16500	7300	36000	53000	46	205	460	131	606	1400	53	91,6	126

### 2.2.2 Spindle bearings

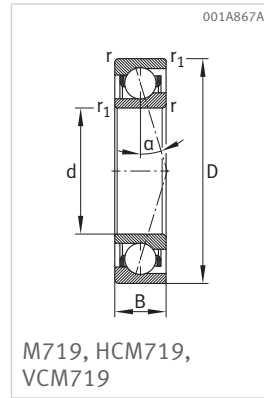
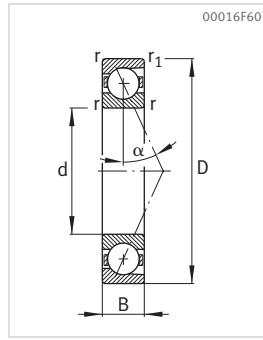
With large, medium or small balls

Steel balls or ceramic balls

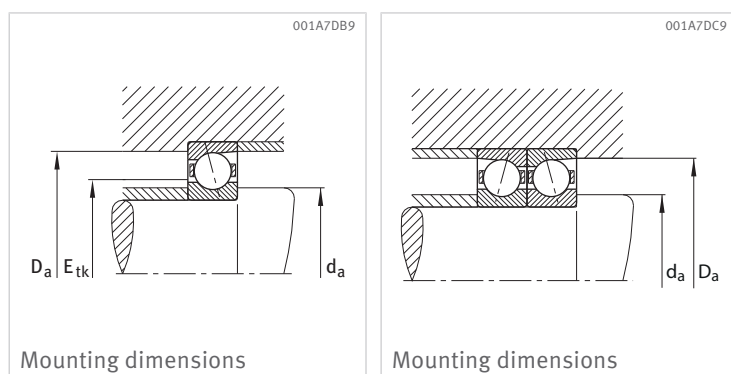
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71905-C-T-P4S	•	0,043	25	42	9	0,3	0,3	15	29	38,5
B71905-E-T-P4S	•	0,043	25	42	9	0,3	0,3	25	29	38,5
HCB71905-C-T-P4S	•	0,039	25	42	9	0,3	0,3	15	29	38,5
HCB71905-E-T-P4S	•	0,039	25	42	9	0,3	0,3	25	29	38,5
HS71905-C-T-P4S	•	0,046	25	42	9	0,3	0,3	15	29	38,5
HS71905-E-T-P4S	•	0,046	25	42	9	0,3	0,3	25	29	38,5
HC71905-E-T-P4S	•	0,045	25	42	9	0,3	0,3	25	29	38,5
M71905-C-T-P4S-XL	•	0,038	25	42	9	0,3	0,15	17	29	38,5
M71905-E-T-P4S-XL	•	0,038	25	42	9	0,3	0,15	25	29	38,5
HCM71905-C-T-P4S-XL	•	0,034	25	42	9	0,3	0,15	17	29	38,5
HCM71905-E-T-P4S-XL	•	0,034	25	42	9	0,3	0,15	25	29	38,5
VCM71905-C-T-P4S-XL	•	0,034	25	42	9	0,3	0,15	17	29	38,5
VCM71905-E-T-P4S-XL	•	0,034	25	42	9	0,3	0,15	25	29	38,5
B7005-C-T-P4S	•	0,077	25	47	12	0,6	0,6	15	30	42
B7005-E-T-P4S	•	0,077	25	47	12	0,6	0,6	25	30	42
HCB7005-C-T-P4S	•	0,065	25	47	12	0,6	0,6	15	30	42
HCB7005-E-T-P4S	•	0,065	25	47	12	0,6	0,6	25	30	42
HS7005-C-T-P4S	•	0,087	25	47	12	0,6	0,6	15	30	42
HS7005-E-T-P4S	•	0,087	25	47	12	0,6	0,6	25	30	42
HC7005-E-T-P4S	•	0,084	25	47	12	0,6	0,6	25	30	42
M7005-C-T-P4S-XL	•	0,076	25	47	12	0,6	0,3	17	30	42
M7005-E-T-P4S-XL	•	0,076	25	47	12	0,6	0,3	25	30	42
HCM7005-C-T-P4S-XL	•	0,069	25	47	12	0,6	0,3	17	30	42
HCM7005-E-T-P4S-XL	•	0,069	25	47	12	0,6	0,3	25	30	42
VCM7005-C-T-P4S-XL	•	0,069	25	47	12	0,6	0,3	17	30	42
VCM7005-E-T-P4S-XL	•	0,069	25	47	12	0,6	0,3	25	30	42
B7205-C-T-P4S	•	0,127	25	52	15	1	1	15	31,5	45,5
B7205-E-T-P4S	•	0,127	25	52	15	1	1	25	31,5	45,5
HCB7205-C-T-P4S	•	0,114	25	52	15	1	1	15	31,5	45,5
HCB7205-E-T-P4S	•	0,114	25	52	15	1	1	25	31,5	45,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
32	8000	3800	36000	56000	34	127	265	102	418	934	24,9	45,4	66,3
32	7600	3600	32000	50000	41	191	432	115	566	1335	54,1	97,3	137
32	8000	3650	50000	75000	14	65	145	39	199	475	19,4	36,6	53,4
32	7600	3450	45000	67000	22	107	246	60	310	735	48,7	87,4	121
32,2	3900	2060	48000	75000	14	43	85	43	135	282	17	26,8	36,9
32,2	3650	1950	43000	67000	23	69	138	66	204	416	42,2	63,1	82,4
32,2	3650	1870	56000	85000	16	47	95	45	138	281	41,8	61,9	80,1
32	6500	2750	49300	74700	29	78	163	86	235	514	24	35	48
32	6300	2650	46300	68700	42	110	229	121	321	682	48	68	89
32	6600	2650	61200	89600	21	54	114	60	161	348	24	34	45
32	6300	2550	58300	83600	30	77	161	85	224	472	48	67	88
32	15700	3700	62700	98600	18	49	102	54	144	310	23	33	45
32	15100	3550	59800	89600	27	70	145	76	201	422	48	67	87
34,1	13700	5900	34000	50000	73	248	502	226	831	1807	29,6	51,2	73,5
34,1	13100	5600	30000	45000	99	381	820	290	1150	2560	67,2	112	153
34,1	13700	5600	45000	70000	35	132	283	104	419	944	24,6	42,5	60,2
34,1	13100	5400	40000	63000	40	194	443	117	573	1338	55,4	96,9	133
34,5	5800	3000	45000	70000	21	63	127	64	201	419	20,6	32,7	45
34,5	5500	2800	40000	63000	35	104	207	100	306	626	51,2	76,7	100
34,5	5500	2700	53000	80000	23	70	140	67	204	415	50,4	74,7	96,7
34,4	8000	3250	45900	69500	34	91	191	101	275	601	24	35	48
34,4	7700	3150	43100	63900	49	130	270	142	378	802	49	69	91
34,4	8000	3150	57000	83400	24	64	133	70	189	407	24	34	46
34,4	7700	3000	54200	77800	35	91	190	100	264	555	49	69	90
34,4	19200	4400	58400	91700	22	57	119	63	169	362	24	34	46
34,4	18400	4200	55600	83400	31	82	170	90	236	497	49	68	89
36,5	14800	6100	28000	43000	80	265	531	248	906	1949	30,4	53,4	77
36,5	14200	5800	26000	40000	114	425	907	333	1293	2868	69,2	115	159
36,5	14800	5800	36000	53000	40	147	311	117	465	1042	25,3	44,1	63,1
36,5	14200	5600	32000	48000	50	223	500	140	650	1504	57,6	99,8	137

### 2.2.2 Spindle bearings

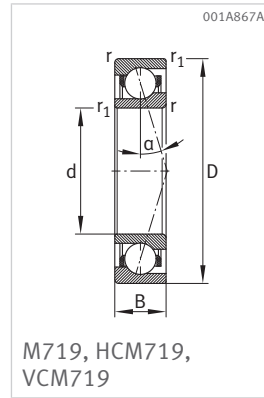
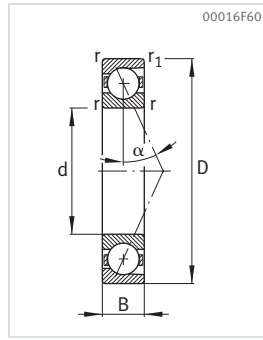
With large, medium or small balls

Steel balls or ceramic balls

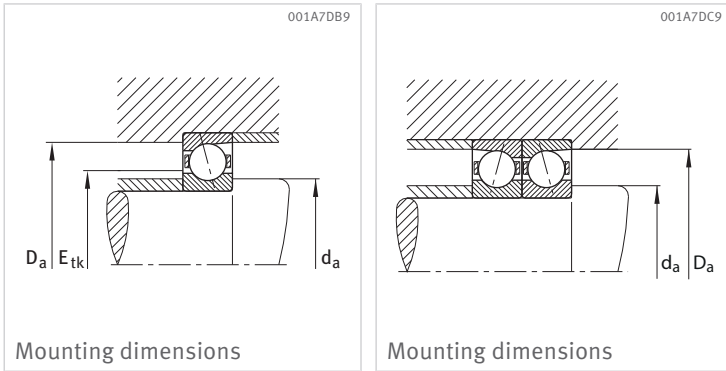
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	►91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71906-C-T-P4S	•	0,05	30	47	9	0,3	0,3	15	34	43,5
B71906-E-T-P4S	•	0,05	30	47	9	0,3	0,3	25	34	43,5
HCB71906-C-T-P4S	•	0,045	30	47	9	0,3	0,3	15	34	43,5
HCB71906-E-T-P4S	•	0,045	30	47	9	0,3	0,3	25	34	43,5
HS71906-C-T-P4S	•	0,05	30	47	9	0,3	0,3	15	34	43,5
HS71906-E-T-P4S	•	0,05	30	47	9	0,3	0,3	25	34	43,5
HC71906-E-T-P4S	•	0,046	30	47	9	0,3	0,3	25	34	43,5
M71906-C-T-P4S-XL	•	0,044	30	47	9	0,3	0,15	17	34	43,5
M71906-E-T-P4S-XL	•	0,044	30	47	9	0,3	0,15	25	34	43,5
HCM71906-C-T-P4S-XL	•	0,039	30	47	9	0,3	0,15	17	34	43,5
HCM71906-E-T-P4S-XL	•	0,039	30	47	9	0,3	0,15	25	34	43,5
VCM71906-C-T-P4S-XL	•	0,039	30	47	9	0,3	0,15	17	34	43,5
VCM71906-E-T-P4S-XL	•	0,039	30	47	9	0,3	0,15	25	34	43,5
B7006-C-T-P4S	•	0,114	30	55	13	1	1	15	36	49
B7006-E-T-P4S	•	0,114	30	55	13	1	1	25	36	49
HCB7006-C-T-P4S	•	0,101	30	55	13	1	1	15	36	49
HCB7006-E-T-P4S	•	0,101	30	55	13	1	1	25	36	49
HS7006-C-T-P4S	•	0,124	30	55	13	1	1	15	36	49
HS7006-E-T-P4S	•	0,124	30	55	13	1	1	25	36	49
HC7006-E-T-P4S	•	0,119	30	55	13	1	1	25	36	49
M7006-C-T-P4S-XL	•	0,12	30	55	13	1	0,6	17	36	49
M7006-E-T-P4S-XL	•	0,12	30	55	13	1	0,6	25	36	49
HCM7006-C-T-P4S-XL	•	0,11	30	55	13	1	0,6	17	36	49
HCM7006-E-T-P4S-XL	•	0,11	30	55	13	1	0,6	25	36	49
VCM7006-C-T-P4S-XL	•	0,11	30	55	13	1	0,6	17	36	49
VCM7006-E-T-P4S-XL	•	0,11	30	55	13	1	0,6	25	36	49
B7206-C-T-P4S	•	0,197	30	62	16	1	1	15	37,5	54,5
B7206-E-T-P4S	•	0,197	30	62	16	1	1	25	37,5	54,5
HCB7206-C-T-P4S	•	0,172	30	62	16	1	1	15	37,5	54,5
HCB7206-E-T-P4S	•	0,172	30	62	16	1	1	25	37,5	54,5



$E_{tk}$	$C_r$	$C_{Or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
37	8500	4350	30000	48000	36	134	281	106	439	985	27	49,3	72,1
37	8100	4150	28000	43000	41	197	448	114	580	1377	58	105	148
37	8500	4200	43000	67000	14	68	155	40	210	504	21,1	40	58,3
37	8100	3950	38000	60000	22	112	258	60	322	768	52,5	95,1	132
37	5900	3100	43000	63000	21	64	129	65	204	425	21,3	33,8	46,5
37	5600	2950	38000	60000	35	104	207	100	306	625	52,9	79,1	103
37	5600	2850	48000	75000	24	72	143	69	209	425	52,5	77,7	101
37	6900	3200	42900	65000	34	89	188	99	270	592	27	39	54
37	6600	3050	40300	59800	48	126	263	138	368	782	54	76	100
37	6900	3050	53300	78000	24	62	131	69	186	400	27	38	51
37	6600	2900	50700	72800	34	89	185	97	257	541	54	76	99
37	16700	4250	54600	85800	21	56	117	62	166	356	26	38	51
37	15900	4100	52000	78000	30	80	166	87	230	484	54	75	98
40,6	14400	6700	28000	43000	74	254	516	228	848	1844	32,4	56,7	81,8
40,6	13700	6400	24000	38000	102	396	854	294	1188	2661	73,5	123	170
40,6	14400	6400	38000	60000	35	137	293	104	431	976	26,9	47	67,1
40,6	13700	6100	34000	53000	42	203	465	117	592	1395	60,1	107	147
40,9	8200	4250	38000	56000	29	88	177	89	280	584	24,4	38,7	53,2
40,9	7800	4050	34000	53000	48	143	286	138	423	865	60,6	90,6	119
40,9	7800	3850	43000	67000	33	98	197	94	287	583	60	88,8	115
40,9	8900	4050	38900	58900	43	113	238	125	342	749	29	43	59
40,9	8500	3900	36500	54200	61	161	335	176	469	995	59	84	110
40,9	8900	3900	48300	70600	30	79	166	87	235	507	29	42	56
40,9	8500	3700	45900	65900	43	113	235	124	327	689	59	83	109
40,9	21400	5400	49500	77700	27	71	148	78	210	450	29	41	55
40,9	20400	5200	47100	70600	39	102	211	111	293	616	59	83	108
43,7	23100	10400	24000	38000	123	404	806	385	1375	2945	39,6	68,8	98,9
43,7	22100	9900	22000	36000	177	641	1355	518	1946	4271	90,4	148	203
43,7	23100	9900	30000	45000	62	222	465	185	711	1576	33,3	57,1	81,1
43,7	22200	9500	26000	40000	80	339	749	231	1001	2273	76,8	130	177

### 2.2.2 Spindle bearings

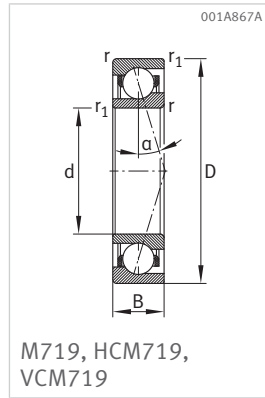
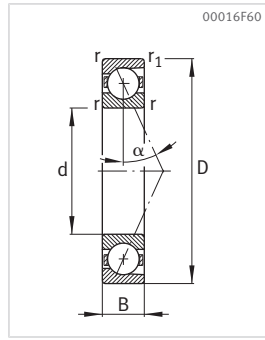
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

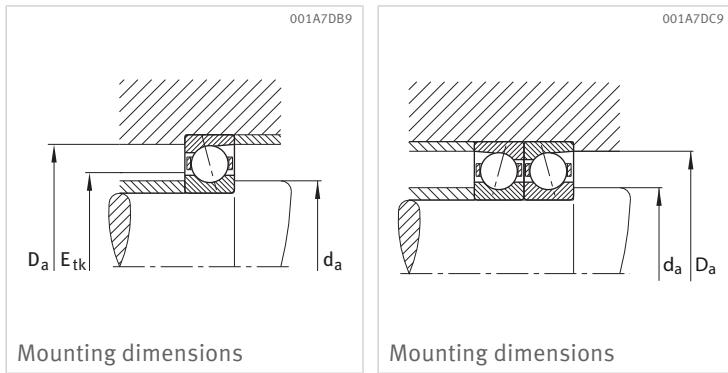
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71907-C-T-P4S	•	0,077	35	55	10	0,6	0,6	15	40	51,5
B71907-E-T-P4S	•	0,077	35	55	10	0,6	0,6	25	40	51,5
HCB71907-C-T-P4S	•	0,067	35	55	10	0,6	0,6	15	40	51,5
HCB71907-E-T-P4S	•	0,067	35	55	10	0,6	0,6	25	40	51,5
HS71907-C-T-P4S	•	0,081	35	55	10	0,6	0,6	15	40	51,5
HS71907-E-T-P4S	•	0,081	35	55	10	0,6	0,6	25	40	51,5
HC71907-E-T-P4S	•	0,076	35	55	10	0,6	0,6	25	40	51,5
M71907-C-T-P4S-XL	•	0,069	35	55	10	0,6	0,3	17	40	51,5
M71907-E-T-P4S-XL	•	0,069	35	55	10	0,6	0,3	25	40	51,5
HCM71907-C-T-P4S-XL	•	0,061	35	55	10	0,6	0,3	17	40	51,5
HCM71907-E-T-P4S-XL	•	0,061	35	55	10	0,6	0,3	25	40	51,5
VCM71907-C-T-P4S-XL	•	0,061	35	55	10	0,6	0,3	17	40	51,5
VCM71907-E-T-P4S-XL	•	0,061	35	55	10	0,6	0,3	25	40	51,5
B7007-C-T-P4S	•	0,154	35	62	14	1	1	15	41	56
B7007-E-T-P4S	•	0,154	35	62	14	1	1	25	41	56
HCB7007-C-T-P4S	•	0,135	35	62	14	1	1	15	41	56
HCB7007-E-T-P4S	•	0,135	35	62	14	1	1	25	41	56
HS7007-C-T-P4S	•	0,169	35	62	14	1	1	15	41	56
HS7007-E-T-P4S	•	0,169	35	62	14	1	1	25	41	56
HC7007-E-T-P4S	•	0,163	35	62	14	1	1	25	41	56
M7007-C-T-P4S-XL	•	0,15	35	62	14	1	0,6	17	41	56
M7007-E-T-P4S-XL	•	0,15	35	62	14	1	0,6	25	41	56
HCM7007-C-T-P4S-XL	•	0,14	35	62	14	1	0,6	17	41	56
HCM7007-E-T-P4S-XL	•	0,14	35	62	14	1	0,6	25	41	56
VCM7007-C-T-P4S-XL	•	0,14	35	62	14	1	0,6	17	41	56
VCM7007-E-T-P4S-XL	•	0,14	35	62	14	1	0,6	25	41	56
B7207-C-T-P4S	•	0,301	35	72	17	1,1	1,1	15	44	63
B7207-E-T-P4S	•	0,3	35	72	17	1,1	1,1	25	44	63
HCB7207-C-T-P4S	•	0,265	35	72	17	1,1	1,1	15	44	63
HCB7207-E-T-P4S	•	0,264	35	72	17	1,1	1,1	25	44	63





$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N	N	N	N	N/μm	N/μm	N/μm
44	12100	6800	26000	40000	50	185	384	155	619	1377	33,5	60,2	87,5
44	11500	6500	24000	36000	60	273	613	174	820	1910	72,9	129	179
44	12100	6500	36000	56000	21	96	213	63	301	709	26,7	49,1	71
44	11500	6200	32000	50000	33	158	359	95	463	1081	66,7	117	161
43,4	6400	3800	36000	56000	23	70	140	70	220	459	24,5	38,6	53
43,4	6100	3600	32000	50000	38	113	226	109	333	680	61	91,1	119
43,4	6100	3450	40000	63000	26	78	155	74	226	459	60,5	89,4	116
43,3	9400	4550	36700	55600	48	127	267	141	384	841	33	48	66
43,3	9000	4350	34500	51200	69	180	376	198	526	1117	66	93	123
43,3	9500	4350	45600	66700	34	89	186	98	264	569	33	47	63
43,3	9000	4200	43400	62300	48	127	264	139	367	773	66	93	121
43,3	22700	6100	46700	73400	30	79	166	88	235	506	32	46	62
43,3	21700	5900	44500	66700	44	114	237	125	329	692	66	92	120
46,3	19300	9600	24000	38000	95	321	649	296	1087	2357	38,3	66,6	95,8
46,3	18400	9200	22000	34000	134	511	1097	394	1551	3446	87,9	146	200
46,3	19400	9200	34000	53000	46	175	372	138	558	1255	32	55,5	78,9
46,3	18500	8800	30000	45000	54	257	585	157	761	1771	72,1	126	173
46,8	8900	5000	34000	50000	31	93	187	94	295	614	27,1	42,8	58,8
46,8	8400	4700	30000	45000	51	152	304	146	448	915	67,7	101	132
46,8	8400	4500	38000	60000	35	105	210	101	307	623	67,3	99,5	129
46,6	11300	5300	34100	51600	56	148	311	164	448	979	34	49	67
46,6	10800	5000	32000	47500	80	210	438	230	613	1302	68	96	126
46,6	11300	5000	42300	61900	39	103	217	114	307	663	33	48	64
46,6	10800	4850	40300	57800	57	148	308	162	428	901	68	95	124
46,6	27000	7100	43300	68100	35	93	194	102	274	589	33	47	63
46,6	26000	6800	41300	61900	51	133	276	145	383	806	68	95	123
51	25500	12600	20000	34000	134	443	887	418	1500	3223	44,8	77,8	112
51	24500	12100	19000	32000	195	710	1504	570	2152	4730	103	169	232
51	25500	12100	26000	40000	67	243	510	200	774	1720	37,7	64,7	91,8
51	24600	11600	22000	36000	84	363	806	242	1069	2438	86,2	146	200

### 2.2.2 Spindle bearings

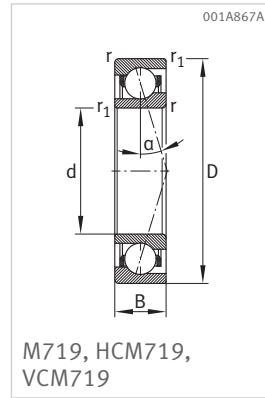
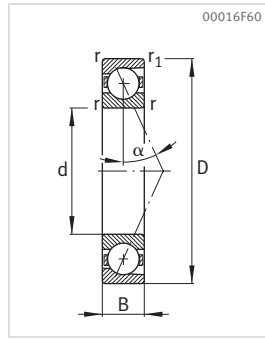
With large, medium or small balls

Steel balls or ceramic balls

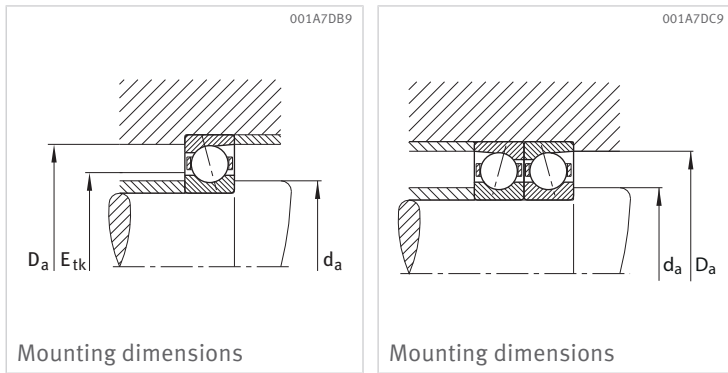
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71908-C-T-P4S	•	0,109	40	62	12	0,6	0,6	15	45	58,5
B71908-E-T-P4S	•	0,109	40	62	12	0,6	0,6	25	45	58,5
HCB71908-C-T-P4S	•	0,092	40	62	12	0,6	0,6	15	45	58,5
HCB71908-E-T-P4S	•	0,092	40	62	12	0,6	0,6	25	45	58,5
HS71908-C-T-P4S	•	0,125	40	62	12	0,6	0,6	15	45	58,5
HS71908-E-T-P4S	•	0,125	40	62	12	0,6	0,6	25	45	58,5
HC71908-E-T-P4S	•	0,119	40	62	12	0,6	0,6	25	45	58,5
M71908-C-T-P4S-XL	•	0,1	40	62	12	0,6	0,3	17	45	58,5
M71908-E-T-P4S-XL	•	0,1	40	62	12	0,6	0,3	25	45	58,5
HCM71908-C-T-P4S-XL	•	0,089	40	62	12	0,6	0,3	17	45	58,5
HCM71908-E-T-P4S-XL	•	0,089	40	62	12	0,6	0,3	25	45	58,5
VCM71908-C-T-P4S-XL	•	0,089	40	62	12	0,6	0,3	17	45	58,5
VCM71908-E-T-P4S-XL	•	0,089	40	62	12	0,6	0,3	25	45	58,5
B7008-C-T-P4S	•	0,189	40	68	15	1	1	15	46	62
B7008-E-T-P4S	•	0,189	40	68	15	1	1	25	46	62
HCB7008-C-T-P4S	•	0,166	40	68	15	1	1	15	46	62
HCB7008-E-T-P4S	•	0,166	40	68	15	1	1	25	46	62
HS7008-C-T-P4S	•	0,211	40	68	15	1	1	15	46	62
HS7008-E-T-P4S	•	0,211	40	68	15	1	1	25	46	62
HC7008-E-T-P4S	•	0,204	40	68	15	1	1	25	46	62
M7008-C-T-P4S-XL	•	0,19	40	68	15	1	0,6	17	46	62
M7008-E-T-P4S-XL	•	0,19	40	68	15	1	0,6	25	46	62
HCM7008-C-T-P4S-XL	•	0,18	40	68	15	1	0,6	17	46	62
HCM7008-E-T-P4S-XL	•	0,18	40	68	15	1	0,6	25	46	62
VCM7008-C-T-P4S-XL	•	0,18	40	68	15	1	0,6	17	46	62
VCM7008-E-T-P4S-XL	•	0,18	40	68	15	1	0,6	25	46	62
B7208-C-T-P4S	•	0,372	40	80	18	1,1	1,1	15	48	72
B7208-E-T-P4S	•	0,371	40	80	18	1,1	1,1	25	48	72
HCB7208-C-T-P4S	•	0,322	40	80	18	1,1	1,1	15	48	72
HCB7208-E-T-P4S	•	0,321	40	80	18	1,1	1,1	25	48	72



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
49,1	18000	9900	24000	36000	84	292	594	259	979	2140	40,7	71,6	103
49,1	17100	9400	20000	32000	111	447	974	324	1348	3043	91,3	155	213
49,1	18100	9400	32000	50000	39	156	337	116	494	1127	33,5	59,2	84,7
49,1	17200	9000	28000	45000	41	220	514	117	645	1548	72,4	132	183
49,3	6800	4300	32000	48000	24	72	145	72	227	473	26,6	41,8	57,2
49,3	6400	4050	28000	43000	39	117	235	113	345	704	66,6	99,2	129
49,3	6400	3900	36000	56000	27	82	164	78	238	484	66,4	98	127
49,1	11600	5600	32400	49100	59	157	331	174	477	1044	36	52	71
49,1	11100	5400	30400	45100	85	224	466	245	653	1386	72	101	134
49,1	11600	5400	40200	58900	42	110	231	121	327	706	35	51	68
49,1	11100	5100	38300	55000	60	157	327	172	456	960	72	101	132
49,1	28000	7500	41200	64800	37	99	207	109	292	628	35	50	67
49,1	26500	7200	39300	58900	54	141	294	155	408	858	72	100	131
51,8	20900	11200	22000	34000	101	344	698	312	1157	2515	43,2	75,6	109
51,8	19900	10600	20000	30000	141	543	1170	410	1640	3663	98,6	165	227
51,8	20900	10700	30000	45000	49	188	402	146	597	1350	36,1	63,1	89,9
51,8	19900	10200	28000	43000	55	271	622	159	797	1875	80	142	195
52,3	9400	5700	30000	45000	34	101	201	100	316	659	30,1	47,4	64,9
52,3	8900	5400	26000	40000	53	160	321	154	472	964	74,7	111	145
52,3	8900	5200	34000	53000	37	110	221	106	321	652	74,2	110	142
52,1	11900	6000	30600	46300	63	167	352	185	507	1110	38	55	76
52,1	11400	5700	28800	42600	91	238	495	261	694	1473	76	107	141
52,1	11900	5700	38000	55600	44	117	245	129	348	751	37	54	72
52,1	11400	5500	36200	51900	64	167	348	183	484	1020	76	107	139
52,1	28500	8000	38900	61200	40	105	220	116	311	668	37	53	71
52,1	27500	7700	37100	55600	57	150	312	164	434	912	76	106	138
57,2	32500	16100	18000	30000	175	566	1128	544	1920	4102	49,2	84,7	122
57,2	31000	15400	17000	28000	257	906	1903	750	2748	5985	114	184	252
57,2	32500	15400	24000	38000	89	312	650	266	996	2193	41,6	70,6	99,8
57,2	31000	14700	20000	34000	121	485	1059	347	1432	3208	97,6	162	220

### 2.2.2 Spindle bearings

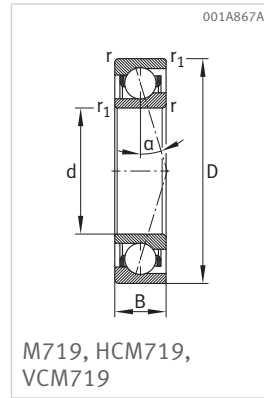
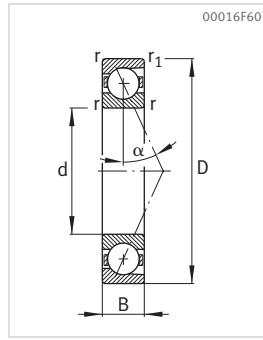
With large, medium or small balls

Steel balls or ceramic balls

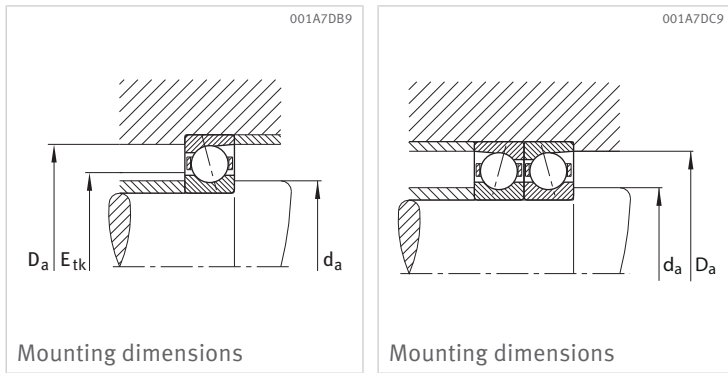
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71909-C-T-P4S	•	0,127	45	68	12	0,6	0,6	15	50	63,5
B71909-E-T-P4S	•	0,127	45	68	12	0,6	0,6	25	50	63,5
HCB71909-C-T-P4S	•	0,108	45	68	12	0,6	0,6	15	50	63,5
HCB71909-E-T-P4S	•	0,108	45	68	12	0,6	0,6	25	50	63,5
HS71909-C-T-P4S	•	0,136	45	68	12	0,6	0,6	15	50	63,5
HS71909-E-T-P4S	•	0,136	45	68	12	0,6	0,6	25	50	63,5
HC71909-E-T-P4S	•	0,129	45	68	12	0,6	0,6	25	50	63,5
M71909-C-T-P4S-XL	•	0,12	45	68	12	0,6	0,3	17	50	63,5
M71909-E-T-P4S-XL	•	0,12	45	68	12	0,6	0,3	25	50	63,5
HCM71909-C-T-P4S-XL	•	0,11	45	68	12	0,6	0,3	17	50	63,5
HCM71909-E-T-P4S-XL	•	0,11	45	68	12	0,6	0,3	25	50	63,5
VCM71909-C-T-P4S-XL	•	0,11	45	68	12	0,6	0,3	17	50	63,5
VCM71909-E-T-P4S-XL	•	0,11	45	68	12	0,6	0,3	25	50	63,5
B7009-C-T-P4S	•	0,232	45	75	16	1	1	15	51	69
B7009-E-T-P4S	•	0,232	45	75	16	1	1	25	51	69
HCB7009-C-T-P4S	•	0,191	45	75	16	1	1	15	51	69
HCB7009-E-T-P4S	•	0,191	45	75	16	1	1	25	51	69
HS7009-C-T-P4S	•	0,262	45	75	16	1	1	15	51	69
HS7009-E-T-P4S	•	0,261	45	75	16	1	1	25	51	69
HC7009-E-T-P4S	•	0,248	45	75	16	1	1	25	51	69
M7009-C-T-P4S-XL	•	0,25	45	75	16	1	0,6	17	51	69
M7009-E-T-P4S-XL	•	0,25	45	75	16	1	0,6	25	51	69
HCM7009-C-T-P4S-XL	•	0,23	45	75	16	1	0,6	17	51	69
HCM7009-E-T-P4S-XL	•	0,23	45	75	16	1	0,6	25	51	69
VCM7009-C-T-P4S-XL	•	0,23	45	75	16	1	0,6	17	51	69
VCM7009-E-T-P4S-XL	•	0,23	45	75	16	1	0,6	25	51	69
B7209-C-T-P4S	•	0,423	45	85	19	1,1	1,1	15	52,5	78
B7209-E-T-P4S	•	0,422	45	85	19	1,1	1,1	25	52,5	78
HCB7209-C-T-P4S	•	0,37	45	85	19	1,1	1,1	15	52,5	78
HCB7209-E-T-P4S	•	0,369	45	85	19	1,1	1,1	25	52,5	78



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
54,5	19100	11200	20000	32000	88	307	628	270	1027	2251	44	77,5	112
54,5	18200	10600	19000	28000	116	470	1028	336	1415	3203	99	168	232
54,5	19200	10700	28000	45000	40	164	355	120	516	1182	36,2	64,1	91,7
54,5	18200	10200	26000	40000	42	233	547	121	682	1643	78,5	144	200
54,7	9600	6000	28000	43000	34	101	201	100	316	657	30,8	48,4	66,2
54,7	9100	5600	26000	40000	55	164	328	158	482	984	77,2	115	150
54,7	9100	5400	32000	50000	38	113	226	108	329	667	76,6	113	146
54,6	12200	6300	29300	44300	67	177	372	196	537	1175	40	58	80
54,6	11700	6000	27500	40800	96	251	524	276	734	1558	80	113	149
54,6	12300	6000	36300	53100	47	124	260	136	368	795	39	57	76
54,6	11700	5800	34600	49600	68	177	368	194	512	1078	80	112	146
54,6	29500	8500	37200	58500	42	111	232	122	329	707	39	56	75
54,6	28000	8100	35400	53100	61	159	330	174	459	964	80	111	145
57,3	28000	14900	19000	30000	144	476	958	445	1606	3461	49,8	86,3	124
57,3	26500	14200	17000	26000	208	763	1622	606	2308	5082	115	189	259
57,3	28000	14300	26000	40000	71	261	549	212	827	1843	41,9	71,9	102
57,3	26500	13600	24000	38000	89	389	869	254	1145	2622	95,8	163	223
58,2	12300	7500	26000	40000	43	130	259	130	409	853	34,3	54,1	74,3
58,2	11600	7100	24000	36000	70	210	421	203	621	1269	85,4	128	167
58,2	11600	6800	30000	48000	48	143	286	137	417	848	84,4	125	161
59	12800	7000	27100	41000	74	196	413	217	595	1303	44	64	88
59	12200	6700	25500	37800	106	278	580	305	812	1726	88	124	164
59	12900	6700	33700	49200	52	137	288	151	408	881	43	62	84
59	12300	6400	32000	46000	75	196	407	214	567	1194	88	123	161
59	31000	9400	34500	54100	47	123	258	135	364	784	43	62	82
59	29500	9000	32800	49200	67	176	365	192	508	1068	88	123	160
62,2	34000	17700	17000	28000	182	592	1182	567	2003	4286	52,2	90	129
62,2	32500	16900	15000	24000	268	948	1994	782	2873	6261	121	196	268
62,2	34500	17000	22000	36000	93	329	685	279	1047	2307	44,4	75,3	106
62,2	32500	16200	18000	30000	123	500	1095	354	1475	3312	103	172	233

### 2.2.2 Spindle bearings

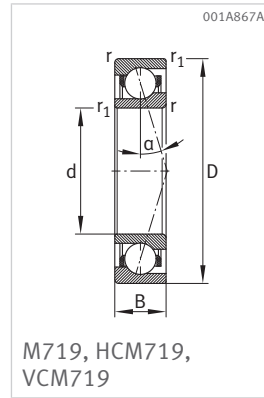
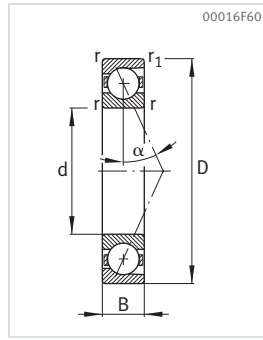
With large, medium or small balls

Steel balls or ceramic balls

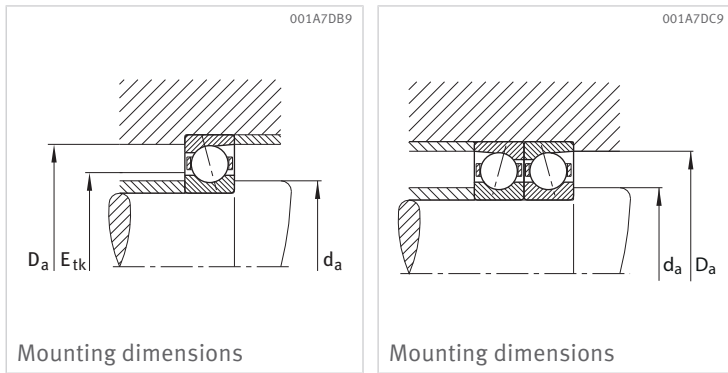
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71910-C-T-P4S	•	0,128	50	72	12	0,6	0,6	15	55	67,5
B71910-E-T-P4S	•	0,128	50	72	12	0,6	0,6	25	55	67,5
HCB71910-C-T-P4S	•	0,109	50	72	12	0,6	0,6	15	55	67,5
HCB71910-E-T-P4S	•	0,109	50	72	12	0,6	0,6	25	55	67,5
HS71910-C-T-P4S	•	0,138	50	72	12	0,6	0,6	15	55	67,5
HS71910-E-T-P4S	•	0,138	50	72	12	0,6	0,6	25	55	67,5
HC71910-E-T-P4S	•	0,131	50	72	12	0,6	0,6	25	55	67,5
M71910-C-T-P4S-XL	•	0,12	50	72	12	0,6	0,3	17	55	67,5
M71910-E-T-P4S-XL	•	0,12	50	72	12	0,6	0,3	25	55	67,5
HCM71910-C-T-P4S-XL	•	0,11	50	72	12	0,6	0,3	17	55	67,5
HCM71910-E-T-P4S-XL	•	0,11	50	72	12	0,6	0,3	25	55	67,5
VCM71910-C-T-P4S-XL	•	0,11	50	72	12	0,6	0,3	17	55	67,5
VCM71910-E-T-P4S-XL	•	0,11	50	72	12	0,6	0,3	25	55	67,5
B7010-C-T-P4S	•	0,25	50	80	16	1	1	15	56	74
B7010-E-T-P4S	•	0,25	50	80	16	1	1	25	56	74
HCB7010-C-T-P4S	•	0,213	50	80	16	1	1	15	56	74
HCB7010-E-T-P4S	•	0,213	50	80	16	1	1	25	56	74
HS7010-C-T-P4S	•	0,283	50	80	16	1	1	15	56	74
HS7010-E-T-P4S	•	0,282	50	80	16	1	1	25	56	74
HC7010-E-T-P4S	•	0,269	50	80	16	1	1	25	56	74
M7010-C-T-P4S-XL	•	0,27	50	80	16	1	0,6	17	56	74
M7010-E-T-P4S-XL	•	0,27	50	80	16	1	0,6	25	56	74
HCM7010-C-T-P4S-XL	•	0,26	50	80	16	1	0,6	17	56	74
HCM7010-E-T-P4S-XL	•	0,26	50	80	16	1	0,6	25	56	74
VCM7010-C-T-P4S-XL	•	0,26	50	80	16	1	0,6	17	56	74
VCM7010-E-T-P4S-XL	•	0,26	50	80	16	1	0,6	25	56	74
B7210-C-T-P4S	•	0,448	50	90	20	1,1	1,1	15	57	83
B7210-E-T-P4S	•	0,446	50	90	20	1,1	1,1	25	57	83
HCB7210-C-T-P4S	•	0,384	50	90	20	1,1	1,1	15	57	83
HCB7210-E-T-P4S	•	0,382	50	90	20	1,1	1,1	25	57	83



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
58,9	19600	11900	19000	30000	89	313	642	274	1044	2293	45,6	80,2	116
58,9	18600	11300	17000	26000	117	479	1049	340	1439	3263	103	174	241
58,9	19600	11400	26000	40000	41	167	362	121	525	1205	37,5	66,4	95
58,9	18600	10800	24000	36000	40	229	542	115	671	1626	79,7	148	205
59,1	9900	6500	26000	40000	35	105	209	104	328	682	32,6	51,2	70
59,1	9400	6100	24000	36000	56	169	338	163	497	1014	81,7	122	159
59,1	9400	5800	30000	48000	39	116	231	110	336	682	80,9	119	154
58,9	12800	7000	27100	41000	74	196	413	217	595	1303	44	64	88
58,9	12200	6700	25500	37800	106	278	580	305	812	1726	88	124	164
58,9	12900	6700	33700	49200	52	137	288	151	408	881	43	62	84
58,9	12300	6400	32000	46000	75	196	407	214	567	1194	88	123	161
58,9	31000	9400	34500	54100	47	123	258	135	364	784	43	62	82
58,9	29500	9000	32800	49200	67	176	365	192	508	1068	88	123	160
62,3	29000	16100	18000	28000	148	493	994	459	1659	3579	52,3	90,5	130
62,3	27500	15300	16000	24000	209	774	1648	610	2336	5151	120	197	270
62,3	29000	15400	24000	38000	73	268	566	217	848	1894	43,9	75,3	107
62,3	27500	14700	22000	34000	90	400	895	259	1175	2697	100	171	234
63	12800	8200	24000	38000	45	135	269	135	424	884	36,4	57,4	78,8
63	12100	7700	22000	34000	72	216	431	208	635	1297	90,6	135	176
63	12100	7400	28000	43000	50	149	298	143	435	883	90	133	172
63	13100	7400	25400	38500	78	206	435	229	627	1373	46	67	92
63	12400	7000	23900	35400	112	293	610	321	855	1816	92	130	171
63	13100	7100	31600	46200	55	144	303	159	430	928	45	65	88
63	12500	6700	30000	43100	79	206	429	225	596	1257	92	129	169
63	31500	9900	32400	50800	49	129	271	143	384	825	45	64	86
63	30000	9400	30800	46200	71	185	385	202	534	1124	92	128	167
66,8	43000	22400	16000	26000	240	771	1534	746	2606	5556	59,9	103	147
66,8	41000	21400	14000	22000	352	1221	2553	1027	3697	8006	138	223	303
66,8	43000	21400	20000	34000	126	434	898	377	1383	3027	51,4	86,5	122
66,8	41500	20400	17000	28000	168	656	1420	484	1933	4292	120	197	265

### 2.2.2 Spindle bearings

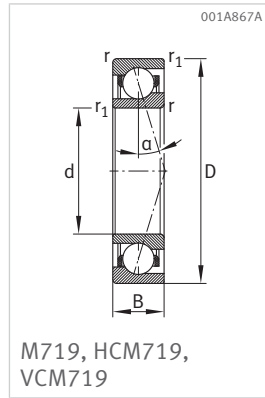
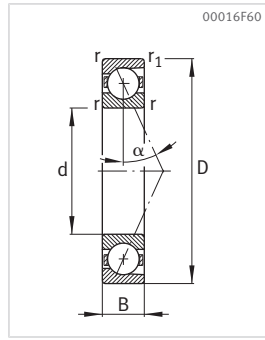
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

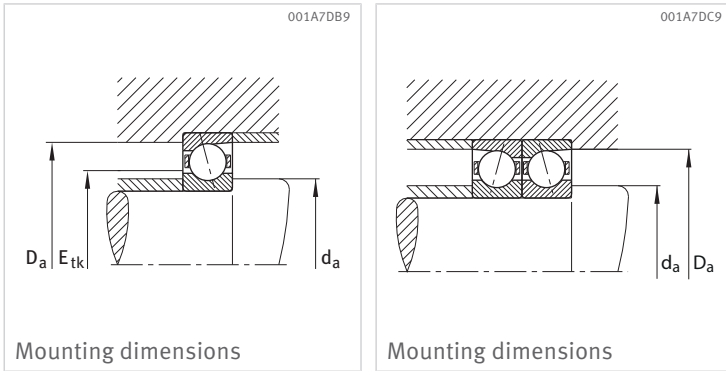
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71911-C-T-P4S	•	0,174	55	80	13	1	1	15	60	75,5
B71911-E-T-P4S	•	0,174	55	80	13	1	1	25	60	75,5
HCB71911-C-T-P4S	•	0,148	55	80	13	1	1	15	60	75,5
HCB71911-E-T-P4S	•	0,148	55	80	13	1	1	25	60	75,5
HS71911-C-T-P4S	•	0,186	55	80	13	1	1	15	60	75,5
HS71911-E-T-P4S	•	0,186	55	80	13	1	1	25	60	75,5
HC71911-E-T-P4S	•	0,172	55	80	13	1	1	25	60	75,5
M71911-C-T-P4S-XL	•	0,16	55	80	13	1	0,6	17	60	75,5
M71911-E-T-P4S-XL	•	0,16	55	80	13	1	0,6	25	60	75,5
HCM71911-C-T-P4S-XL	•	0,13	55	80	13	1	0,6	17	60	75,5
HCM71911-E-T-P4S-XL	•	0,13	55	80	13	1	0,6	25	60	75,5
VCM71911-C-T-P4S-XL	•	0,13	55	80	13	1	0,6	17	60	75,5
VCM71911-E-T-P4S-XL	•	0,13	55	80	13	1	0,6	25	60	75,5
B7011-C-T-P4S	•	0,371	55	90	18	1,1	1,1	15	62	83
B7011-E-T-P4S	•	0,371	55	90	18	1,1	1,1	25	62	83
HCB7011-C-T-P4S	•	0,31	55	90	18	1,1	1,1	15	62	83
HCB7011-E-T-P4S	•	0,311	55	90	18	1,1	1,1	25	62	83
HS7011-C-T-P4S	•	0,405	55	90	18	1,1	1,1	15	62	83
HS7011-E-T-P4S	•	0,404	55	90	18	1,1	1,1	25	62	83
HC7011-E-T-P4S	•	0,386	55	90	18	1,1	1,1	25	62	83
M7011-C-T-P4S-XL	•	0,39	55	90	18	1,1	0,6	17	62	83
M7011-E-T-P4S-XL	•	0,39	55	90	18	1,1	0,6	25	62	83
HCM7011-C-T-P4S-XL	•	0,36	55	90	18	1,1	0,6	17	62	83
HCM7011-E-T-P4S-XL	•	0,36	55	90	18	1,1	0,6	25	62	83
VCM7011-C-T-P4S-XL	•	0,36	55	90	18	1,1	0,6	17	62	83
VCM7011-E-T-P4S-XL	•	0,36	55	90	18	1,1	0,6	25	62	83
B7211-C-T-P4S	•	0,619	55	100	21	1,5	1,5	15	63	92
B7211-E-T-P4S	•	0,617	55	100	21	1,5	1,5	25	63	92
HCB7211-C-T-P4S	•	0,546	55	100	21	1,5	1,5	15	63	92
HCB7211-E-T-P4S	•	0,544	55	100	21	1,5	1,5	25	63	92





$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N	N	N	N	N/μm	N/μm	N/μm
65,1	23500	14400	17000	26000	111	382	780	340	1274	2784	50,8	88,6	128
65,1	22200	13700	15000	24000	149	588	1278	431	1768	3973	115	193	266
65,1	23500	13800	24000	36000	53	208	447	157	654	1487	42,4	74,1	106
65,1	22300	13100	22000	32000	57	296	686	164	867	2058	93	167	230
65,4	13000	8500	24000	36000	45	135	269	135	424	882	37,3	58,6	80,3
65,4	12300	8000	22000	32000	73	219	438	211	645	1317	93,2	139	181
65,4	12300	7700	28000	43000	51	152	304	145	442	897	92,7	137	177
65,1	18500	9900	24500	37100	104	276	583	307	840	1838	50	73	100
65,1	17700	9500	23000	34100	150	393	820	431	1148	2438	100	141	186
65,1	18500	9500	30400	44500	73	194	406	213	576	1243	49	71	95
65,1	17700	9100	28900	41500	106	277	575	303	801	1687	100	140	183
65,1	44500	13300	31200	48900	66	174	363	191	514	1105	49	70	94
65,1	42500	12700	29700	44500	95	249	516	272	718	1509	100	139	182
69,6	38500	22100	16000	24000	205	670	1344	635	2253	4837	61,4	106	151
69,6	37000	21000	14000	22000	296	1059	2234	862	3197	6983	142	230	314
69,6	39000	21200	22000	34000	102	366	765	305	1158	2559	51,9	87,9	124
69,6	37000	20100	20000	30000	136	562	1236	390	1653	3728	121	203	275
70,3	17900	11500	22000	34000	62	187	374	187	588	1225	42,2	66,5	91,1
70,3	16900	10900	20000	30000	101	304	607	292	895	1826	106	157	206
70,3	17000	10400	26000	40000	70	210	421	201	613	1244	105	155	201
70,1	19400	11000	22800	34500	116	306	645	340	931	2038	55	80	110
70,1	18500	10500	21400	31800	166	435	908	477	1271	2700	110	155	205
70,1	19500	10500	28300	41400	81	214	450	236	638	1378	54	78	105
70,1	18600	10000	26900	38700	117	306	637	335	887	1869	110	154	201
70,1	46500	14700	29000	45600	73	192	403	212	570	1225	54	77	103
70,1	44500	14000	27600	41400	105	275	572	301	794	1671	109	153	200
74,3	47000	26500	14000	22000	258	832	1662	800	2800	5985	66,7	114	163
74,3	45000	25000	13000	20000	378	1321	2767	1103	3991	8652	155	249	339
74,3	47000	25000	18000	30000	132	460	956	395	1460	3203	56,9	95,6	135
74,3	45000	24000	15000	24000	180	709	1540	518	2088	4646	134	220	297

### 2.2.2 Spindle bearings

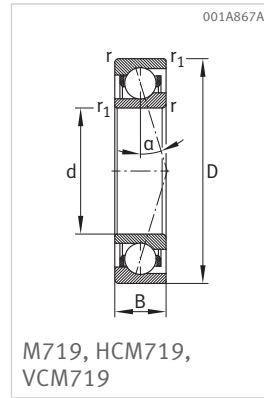
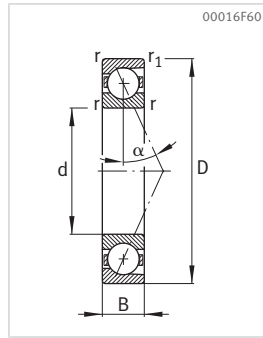
With large, medium or small balls

Steel balls or ceramic balls

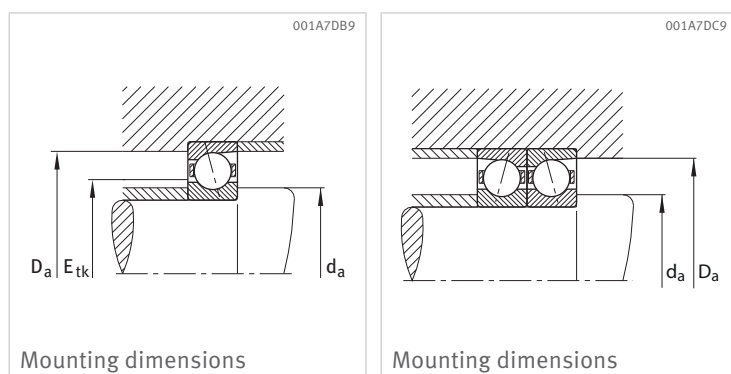
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71912-C-T-P4S	•	0,188	60	85	13	1	1	15	65	80,5
B71912-E-T-P4S	•	0,188	60	85	13	1	1	25	65	80,5
HCB71912-C-T-P4S	•	0,159	60	85	13	1	1	15	65	80,5
HCB71912-E-T-P4S	•	0,159	60	85	13	1	1	25	65	80,5
HS71912-C-T-P4S	•	0,2	60	85	13	1	1	15	65	80,5
HS71912-E-T-P4S	•	0,2	60	85	13	1	1	25	65	80,5
HC71912-E-T-P4S	•	0,185	60	85	13	1	1	25	65	80,5
M71912-C-T-P4S-XL	•	0,17	60	85	13	1	0,6	17	65	80,5
M71912-E-T-P4S-XL	•	0,17	60	85	13	1	0,6	25	65	80,5
HCM71912-C-T-P4S-XL	•	0,14	60	85	13	1	0,6	17	65	80,5
HCM71912-E-T-P4S-XL	•	0,14	60	85	13	1	0,6	25	65	80,5
VCM71912-C-T-P4S-XL	•	0,14	60	85	13	1	0,6	17	65	80,5
VCM71912-E-T-P4S-XL	•	0,14	60	85	13	1	0,6	25	65	80,5
B7012-C-T-P4S	•	0,395	60	95	18	1,1	1,1	15	67	88
B7012-E-T-P4S	•	0,396	60	95	18	1,1	1,1	25	67	88
HCB7012-C-T-P4S	•	0,335	60	95	18	1,1	1,1	15	67	88
HCB7012-E-T-P4S	•	0,335	60	95	18	1,1	1,1	25	67	88
HS7012-C-T-P4S	•	0,433	60	95	18	1,1	1,1	15	67	88
HS7012-E-T-P4S	•	0,433	60	95	18	1,1	1,1	25	67	88
HC7012-E-T-P4S	•	0,413	60	95	18	1,1	1,1	25	67	88
M7012-C-T-P4S-XL	•	0,42	60	95	18	1,1	0,6	17	67	88
M7012-E-T-P4S-XL	•	0,42	60	95	18	1,1	0,6	25	67	88
HCM7012-C-T-P4S-XL	•	0,39	60	95	18	1,1	0,6	17	67	88
HCM7012-E-T-P4S-XL	•	0,39	60	95	18	1,1	0,6	25	67	88
VCM7012-C-T-P4S-XL	•	0,39	60	95	18	1,1	0,6	17	67	88
VCM7012-E-T-P4S-XL	•	0,39	60	95	18	1,1	0,6	25	67	88
B7212-C-T-P4S	•	0,795	60	110	22	1,5	1,5	15	69,5	101,5
B7212-E-T-P4S	•	0,793	60	110	22	1,5	1,5	25	69,5	101,5
HCB7212-C-T-P4S	•	0,687	60	110	22	1,5	1,5	15	69,5	101,5
HCB7212-E-T-P4S	•	0,685	60	110	22	1,5	1,5	25	69,5	101,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
70,1	24700	16000	16000	24000	116	401	822	354	1333	2919	54,5	95,1	137
70,1	23400	15200	14000	22000	155	617	1344	448	1853	4171	124	208	286
70,1	24700	15300	22000	34000	54	214	462	159	671	1530	45,1	79	112
70,1	23400	14500	20000	30000	57	303	707	163	887	2118	98,5	179	246
70,4	13400	9200	22000	34000	47	141	281	140	442	920	39,5	62,1	85
70,4	12600	8700	20000	30000	76	228	455	219	670	1368	98,8	147	192
70,4	12700	8300	26000	40000	52	155	311	148	452	917	97,7	144	186
70	19400	11000	22800	34500	116	306	645	340	931	2038	55	80	110
70	18500	10500	21400	31800	166	435	908	477	1271	2700	110	155	205
70	19500	10500	28300	41400	81	214	450	236	638	1378	54	78	105
70	18600	10000	26900	38700	117	306	637	335	887	1869	110	154	201
70	46500	14700	29000	45600	73	192	403	212	570	1225	54	77	103
70	44500	14000	27600	41400	105	275	572	301	794	1671	109	153	200
74,5	40000	23800	15000	22000	209	687	1381	647	2304	4952	64	110	157
74,5	38000	22600	13000	20000	297	1069	2259	864	3221	7045	147	239	326
74,5	40000	22700	20000	32000	106	379	794	315	1198	2651	54,4	92,2	130
74,5	38000	21600	19000	28000	136	569	1256	391	1673	3782	126	211	286
75,3	18600	12500	20000	32000	65	194	388	194	609	1269	44,8	70,5	96,4
75,3	17600	11800	18000	28000	105	316	631	304	929	1896	112	167	218
75,3	17600	11300	24000	36000	73	219	438	209	638	1294	112	165	213
75,1	19800	11600	21300	32300	122	323	680	358	981	2150	57	84	115
75,1	18800	11000	20000	29700	175	458	956	503	1339	2845	115	162	214
75,1	19800	11100	26500	38800	86	226	474	249	673	1453	57	81	110
75,1	18900	10600	25200	36200	123	323	671	353	934	1968	115	161	211
75,1	47500	15500	27100	42600	77	203	424	223	601	1292	56	81	108
75,1	45500	14800	25900	38800	111	290	602	317	837	1760	115	160	209
81,9	56000	31000	13000	20000	312	996	1982	968	3352	7140	70,9	121	172
81,9	53000	29500	12000	19000	463	1586	3304	1351	4794	10334	165	264	358
81,9	56000	29500	16000	26000	163	557	1149	488	1767	3852	60,9	102	143
81,9	53000	28500	14000	22000	226	859	1847	651	2531	5576	144	234	315

### 2.2.2 Spindle bearings

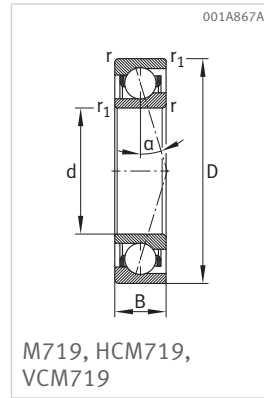
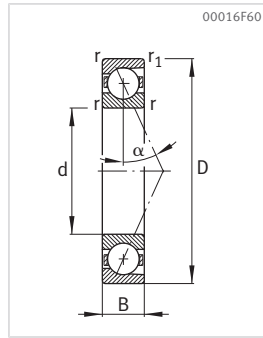
With large, medium or small balls

Steel balls or ceramic balls

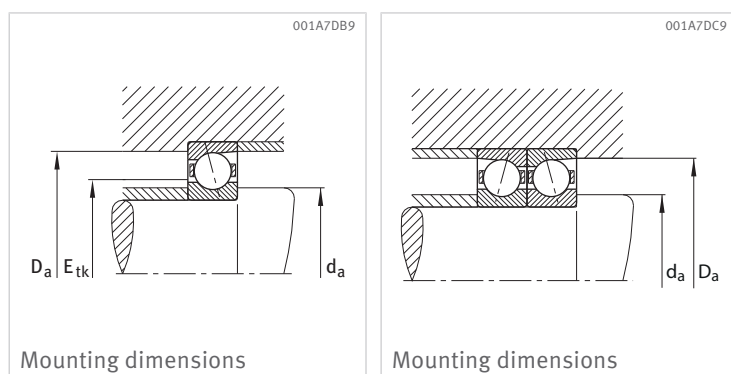
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71913-C-T-P4S	•	0,2	65	90	13	1	1	15	70	85,5
B71913-E-T-P4S	•	0,2	65	90	13	1	1	25	70	85,5
HCB71913-C-T-P4S	•	0,17	65	90	13	1	1	15	70	85,5
HCB71913-E-T-P4S	•	0,17	65	90	13	1	1	25	70	85,5
HS71913-C-T-P4S	•	0,214	65	90	13	1	1	15	70	85,5
HS71913-E-T-P4S	•	0,214	65	90	13	1	1	25	70	85,5
HC71913-E-T-P4S	•	0,198	65	90	13	1	1	25	70	85,5
M71913-C-T-P4S-XL	•	0,18	65	90	13	1	0,6	17	70	85,5
M71913-E-T-P4S-XL	•	0,18	65	90	13	1	0,6	25	70	85,5
HCM71913-C-T-P4S-XL	•	0,15	65	90	13	1	0,6	17	70	85,5
HCM71913-E-T-P4S-XL	•	0,15	65	90	13	1	0,6	25	70	85,5
VCM71913-C-T-P4S-XL	•	0,15	65	90	13	1	0,6	17	70	85,5
VCM71913-E-T-P4S-XL	•	0,15	65	90	13	1	0,6	25	70	85,5
B7013-C-T-P4S	•	0,42	65	100	18	1,1	1,1	15	72	93
B7013-E-T-P4S	•	0,42	65	100	18	1,1	1,1	25	72	93
HCB7013-C-T-P4S	•	0,356	65	100	18	1,1	1,1	15	72	93
HCB7013-E-T-P4S	•	0,356	65	100	18	1,1	1,1	25	72	93
HS7013-C-T-P4S	•	0,461	65	100	18	1,1	1,1	15	72	93
HS7013-E-T-P4S	•	0,461	65	100	18	1,1	1,1	25	72	93
HC7013-E-T-P4S	•	0,44	65	100	18	1,1	1,1	25	72	93
M7013-C-T-P4S-XL	•	0,44	65	100	18	1,1	0,6	17	72	93
M7013-E-T-P4S-XL	•	0,44	65	100	18	1,1	0,6	25	72	93
HCM7013-C-T-P4S-XL	•	0,41	65	100	18	1,1	0,6	17	72	93
HCM7013-E-T-P4S-XL	•	0,41	65	100	18	1,1	0,6	25	72	93
VCM7013-C-T-P4S-XL	•	0,41	65	100	18	1,1	0,6	17	72	93
VCM7013-E-T-P4S-XL	•	0,41	65	100	18	1,1	0,6	25	72	93
B7213-C-T-P4S	•	1	65	120	23	1,5	1,5	15	75,5	109,5
B7213-E-T-P4S	•	0,998	65	120	23	1,5	1,5	25	75,5	109,5
HCB7213-C-T-P4S	•	0,866	65	120	23	1,5	1,5	15	75,5	109,5
HCB7213-E-T-P4S	•	0,863	65	120	23	1,5	1,5	25	75,5	109,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
75,1	25000	16900	15000	22000	117	409	839	360	1356	2973	56,2	98,1	141
75,1	23700	16000	13000	20000	152	613	1339	440	1837	4145	126	213	293
75,1	25000	16100	20000	32000	55	219	473	161	684	1562	46,6	81,7	116
75,1	23800	15300	19000	28000	58	309	723	165	904	2165	102	185	255
75,3	13800	9900	20000	32000	48	144	287	143	450	937	41,5	65	88,8
75,3	13000	9300	18000	28000	77	231	462	222	680	1386	104	154	201
75,3	13000	8900	24000	36000	53	160	321	153	466	946	103	152	196
75	19800	11600	21300	32300	122	323	680	358	981	2150	57	84	115
75	18800	11000	20000	29700	175	458	956	503	1339	2845	115	162	214
75	19800	11100	26500	38800	86	226	474	249	673	1453	57	81	110
75	18900	10600	25200	36200	123	323	671	353	934	1968	115	161	211
75	47500	15500	27100	42600	77	203	424	223	601	1292	56	81	108
75	45500	14800	25900	38800	111	290	602	317	837	1760	115	160	209
79,5	41500	25500	14000	22000	214	704	1417	660	2354	5068	66,7	114	164
79,5	39000	24100	13000	19000	308	1111	2350	896	3347	7323	154	251	342
79,5	41500	24300	19000	30000	107	385	808	318	1213	2688	56,4	95,6	135
79,5	39500	23100	17000	26000	137	577	1276	392	1694	3836	131	219	297
80,2	19300	13400	19000	30000	67	201	402	200	630	1312	47,4	74,4	102
80,2	18200	12700	17000	26000	109	328	656	315	964	1967	119	177	231
80,2	18200	12200	22000	34000	74	223	445	213	647	1313	118	173	224
80	20100	12100	20000	30400	128	339	715	377	1032	2260	60	88	120
80	19100	11600	18800	27900	183	481	1004	528	1406	2988	120	170	224
80	20100	11600	24900	36400	90	237	498	262	707	1528	59	85	115
80	19200	11100	23700	34000	129	339	705	371	981	2067	120	169	220
80	48000	16300	25500	40000	81	213	446	234	631	1358	59	84	113
80	46000	15500	24300	36400	116	304	632	333	879	1849	120	168	218
88,6	68000	38500	12000	19000	386	1224	2431	1198	4118	8752	78,9	134	191
88,6	65000	36500	11000	18000	585	1977	4100	1709	5978	12828	185	295	399
88,6	68000	36500	15000	24000	205	690	1419	614	2192	4757	68,2	113	159
88,6	65000	35000	13000	20000	290	1071	2286	834	3157	6901	162	261	350

### 2.2.2 Spindle bearings

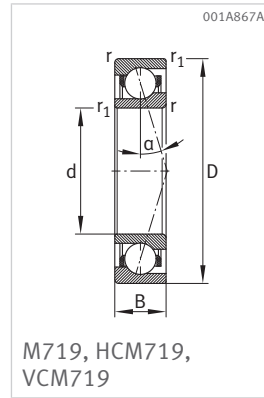
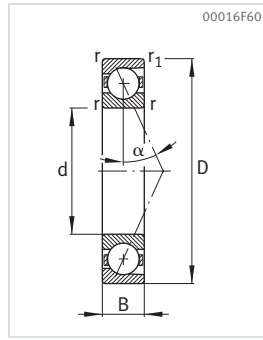
With large, medium or small balls

Steel balls or ceramic balls

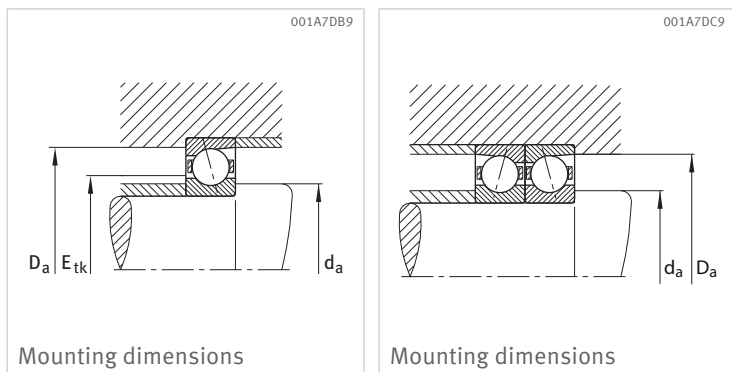
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71914-C-T-P4S	•	0,33	70	100	16	1	1	15	76	94,5
B71914-E-T-P4S	•	0,33	70	100	16	1	1	25	76	94,5
HCB71914-C-T-P4S	•	0,28	70	100	16	1	1	15	76	94,5
HCB71914-E-T-P4S	•	0,28	70	100	16	1	1	25	76	94,5
HS71914-C-T-P4S	•	0,354	70	100	16	1	1	15	76	94,5
HS71914-E-T-P4S	•	0,353	70	100	16	1	1	25	76	94,5
HC71914-E-T-P4S	•	0,334	70	100	16	1	1	25	76	94,5
M71914-C-T-P4S-XL	•	0,3	70	100	16	1	0,6	17	76	94,5
M71914-E-T-P4S-XL	•	0,3	70	100	16	1	0,6	25	76	94,5
HCM71914-C-T-P4S-XL	•	0,25	70	100	16	1	0,6	17	76	94,5
HCM71914-E-T-P4S-XL	•	0,25	70	100	16	1	0,6	25	76	94,5
VCM71914-C-T-P4S-XL	•	0,25	70	100	16	1	0,6	17	76	94,5
VCM71914-E-T-P4S-XL	•	0,25	70	100	16	1	0,6	25	76	94,5
B7014-C-T-P4S	•	0,59	70	110	20	1,1	1,1	15	77	102
B7014-E-T-P4S	•	0,59	70	110	20	1,1	1,1	25	77	102
HCB7014-C-T-P4S	•	0,495	70	110	20	1,1	1,1	15	77	102
HCB7014-E-T-P4S	•	0,495	70	110	20	1,1	1,1	25	77	102
HS7014-C-T-P4S	•	0,644	70	110	20	1,1	1,1	15	77	102
HS7014-E-T-P4S	•	0,643	70	110	20	1,1	1,1	25	77	102
HC7014-E-T-P4S	•	0,611	70	110	20	1,1	1,1	25	77	102
M7014-C-T-P4S-XL	•	0,61	70	110	20	1,1	0,6	17	77	102
M7014-E-T-P4S-XL	•	0,61	70	110	20	1,1	0,6	25	77	102
HCM7014-C-T-P4S-XL	•	0,56	70	110	20	1,1	0,6	17	77	102
HCM7014-E-T-P4S-XL	•	0,56	70	110	20	1,1	0,6	25	77	102
VCM7014-C-T-P4S-XL	•	0,56	70	110	20	1,1	0,6	17	77	102
VCM7014-E-T-P4S-XL	•	0,56	70	110	20	1,1	0,6	25	77	102
B7214-C-T-P4S		1,1	70	125	24	1,5	1,5	15	80	115
B7214-E-T-P4S		1,09	70	125	24	1,5	1,5	25	80	115
HCB7214-C-T-P4S		0,954	70	125	24	1,5	1,5	15	80	115
HCB7214-E-T-P4S		0,951	70	125	24	1,5	1,5	25	80	115



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$min^{-1}$	$min^{-1}$	N	N	N	N	N	N	N/ $\mu m$	N/ $\mu m$	N/ $\mu m$
82,2	34500	23000	14000	20000	170	576	1171	523	1912	4155	66	114	163
82,2	32500	21800	12000	19000	233	886	1902	677	2658	5898	151	249	341
82,2	34500	22000	19000	28000	83	312	665	245	980	2200	55,5	95,3	135
82,2	32500	20800	17000	26000	98	459	1040	281	1343	3118	126	218	298
82,6	17800	12900	19000	28000	61	184	368	183	576	1198	47	73,7	101
82,6	16800	12200	17000	26000	99	298	597	287	877	1789	118	176	229
82,6	16800	11700	22000	34000	69	207	414	198	602	1221	117	173	223
82,1	27000	15700	19500	29500	165	437	921	485	1327	2905	65	96	131
82,1	26000	15000	18300	27100	237	621	1295	681	1813	3851	131	186	245
82,1	27000	15000	24200	35300	116	306	641	337	910	1965	65	93	125
82,1	26000	14300	23000	33000	167	437	909	478	1265	2665	132	184	241
82,1	65000	21000	24800	38900	104	274	574	302	812	1747	64	92	123
82,1	62000	20100	23600	35300	150	393	816	429	1133	2383	131	183	239
86,7	50000	30500	13000	20000	276	894	1790	853	2995	6414	73,5	125	179
86,7	48000	29000	11000	18000	395	1388	2915	1149	4183	9083	169	273	371
86,7	50000	29500	18000	28000	139	487	1014	414	1538	3380	62,3	105	147
86,7	48000	28000	16000	24000	188	749	1633	540	2203	4915	147	242	326
87,5	25000	17200	18000	28000	87	261	523	261	820	1706	52,2	81,9	112
87,5	23600	16300	16000	24000	141	423	845	406	1243	2536	131	194	253
87,5	23700	15600	20000	32000	98	293	587	280	853	1731	130	192	248
87,2	27500	16500	18400	27800	173	460	969	510	1397	3060	68	100	137
87,2	26500	15700	17300	25600	249	653	1362	716	1908	4053	137	194	256
87,2	27500	15800	22800	33400	122	322	675	355	958	2069	68	97	131
87,2	26500	15100	21700	31200	176	460	956	503	1331	2804	138	193	252
87,2	66000	22100	23400	36700	110	289	605	318	855	1839	67	96	129
87,2	63000	21100	22300	33400	158	413	858	451	1192	2508	137	192	250
93,6	71000	41500	11000	18000	399	1269	2524	1238	4260	9062	83,1	141	201
93,6	67000	39500	10000	17000	595	2017	4189	1736	6090	13077	194	309	418
93,6	71000	39500	14000	22000	211	711	1464	630	2253	4894	71,6	119	166
93,6	67000	38000	12000	19000	297	1103	2359	854	3249	7111	171	275	368

### 2.2.2 Spindle bearings

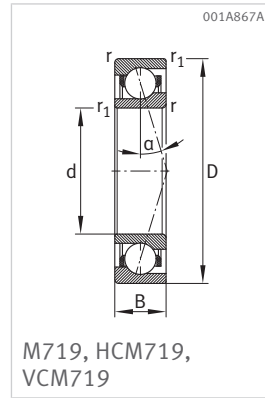
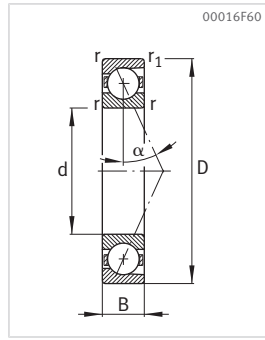
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

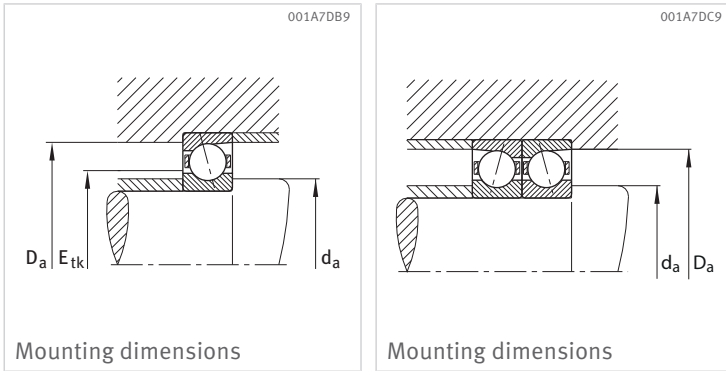
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71915-C-T-P4S	•	0,347	75	105	16	1	1	15	81	99,5
B71915-E-T-P4S	•	0,347	75	105	16	1	1	25	81	99,5
HCB71915-C-T-P4S	•	0,285	75	105	16	1	1	15	81	99,5
HCB71915-E-T-P4S	•	0,285	75	105	16	1	1	25	81	99,5
HS71915-C-T-P4S	•	0,374	75	105	16	1	1	15	81	99,5
HS71915-E-T-P4S	•	0,373	75	105	16	1	1	25	81	99,5
HC71915-E-T-P4S	•	0,353	75	105	16	1	1	25	81	99,5
M71915-C-T-P4S-XL	•	0,32	75	105	16	1	0,6	17	81	99,5
M71915-E-T-P4S-XL	•	0,32	75	105	16	1	0,6	25	81	99,5
HCM71915-C-T-P4S-XL	•	0,27	75	105	16	1	0,6	17	81	99,5
HCM71915-E-T-P4S-XL	•	0,27	75	105	16	1	0,6	25	81	99,5
VCM71915-C-T-P4S-XL	•	0,27	75	105	16	1	0,6	17	81	99,5
VCM71915-E-T-P4S-XL	•	0,27	75	105	16	1	0,6	25	81	99,5
B7015-C-T-P4S	•	0,62	75	115	20	1,1	1,1	15	82	107
B7015-E-T-P4S	•	0,62	75	115	20	1,1	1,1	25	82	107
HCB7015-C-T-P4S	•	0,52	75	115	20	1,1	1,1	15	82	107
HCB7015-E-T-P4S	•	0,52	75	115	20	1,1	1,1	25	82	107
HS7015-C-T-P4S	•	0,679	75	115	20	1,1	1,1	15	82	107
HS7015-E-T-P4S	•	0,678	75	115	20	1,1	1,1	25	82	107
HC7015-E-T-P4S	•	0,644	75	115	20	1,1	1,1	25	82	107
M7015-C-T-P4S-XL	•	0,64	75	115	20	1,1	0,6	17	82	107
M7015-E-T-P4S-XL	•	0,64	75	115	20	1,1	0,6	25	82	107
HCM7015-C-T-P4S-XL	•	0,59	75	115	20	1,1	0,6	17	82	107
HCM7015-E-T-P4S-XL	•	0,59	75	115	20	1,1	0,6	25	82	107
VCM7015-C-T-P4S-XL	•	0,59	75	115	20	1,1	0,6	17	82	107
VCM7015-E-T-P4S-XL	•	0,59	75	115	20	1,1	0,6	25	82	107
B7215-C-T-P4S	•	1,2	75	130	25	1,5	1,5	15	85	120
B7215-E-T-P4S	•	1,2	75	130	25	1,5	1,5	25	85	120
HCB7215-C-T-P4S	•	1,05	75	130	25	1,5	1,5	15	85	120
HCB7215-E-T-P4S	•	1,04	75	130	25	1,5	1,5	25	85	120





$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N	N	N	N	N/μm	N/μm	N/μm
87,2	35000	24200	13000	20000	172	584	1189	527	1933	4206	68	117	168
87,2	33000	22900	11000	18000	235	897	1928	682	2688	5970	156	257	351
87,2	35000	23100	18000	28000	83	317	676	247	991	2229	57,1	98,2	139
87,2	33000	21900	16000	24000	95	454	1034	273	1328	3094	128	223	305
87,5	18300	13800	18000	28000	64	191	382	190	597	1242	49,5	77,5	106
87,5	17200	13000	16000	24000	101	304	607	292	891	1817	123	183	239
87,5	17300	12500	20000	32000	70	210	421	201	611	1240	123	181	233
87,1	27500	16500	18400	27800	173	460	969	510	1397	3060	68	100	137
87,1	26500	15700	17300	25600	249	653	1362	716	1908	4053	137	194	256
87,1	27500	15800	22800	33400	122	322	675	355	958	2069	68	97	131
87,1	26500	15100	21700	31200	176	460	956	503	1331	2804	138	193	252
87,1	66000	22100	23400	36700	110	289	605	318	855	1839	67	96	129
87,1	63000	21100	22300	33400	158	413	858	451	1192	2508	137	192	250
91,7	52000	32500	12000	19000	280	911	1827	865	3043	6525	76,3	130	186
91,7	49500	31000	11000	17000	405	1430	3005	1180	4305	9353	177	285	387
91,7	52000	31500	17000	26000	145	508	1059	431	1603	3524	65,4	110	154
91,7	49500	29500	15000	24000	192	769	1679	551	2260	5050	153	253	341
92,4	25500	17900	17000	26000	89	266	533	265	835	1737	53,7	84,3	115
92,4	23900	17000	15000	24000	144	431	863	415	1268	2587	135	200	261
92,4	24000	16200	19000	30000	99	298	597	285	868	1761	134	197	255
92,1	28000	17300	17400	26400	182	483	1017	536	1467	3214	71	105	143
92,1	26500	16500	16400	24300	261	685	1429	752	2002	4254	143	203	268
92,1	28000	16600	21600	31600	128	338	709	373	1006	2173	71	102	137
92,1	27000	15800	20600	29500	184	483	1003	528	1396	2943	144	202	263
92,1	67000	23200	22200	34800	115	303	635	334	898	1932	70	101	135
92,1	64000	22100	21100	31600	166	433	900	474	1251	2632	143	200	261
98,5	73000	44500	11000	18000	413	1314	2617	1278	4401	9371	87,2	148	210
98,5	70000	42500	9500	16000	615	2091	4345	1794	6306	13546	204	325	439
98,5	73000	42500	14000	22000	219	740	1524	653	2341	5087	75,4	125	175
98,5	70000	40500	12000	19000	308	1149	2459	887	3383	7409	180	290	388

### 2.2.2 Spindle bearings

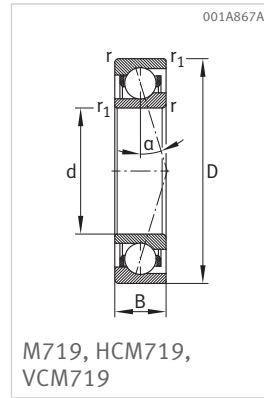
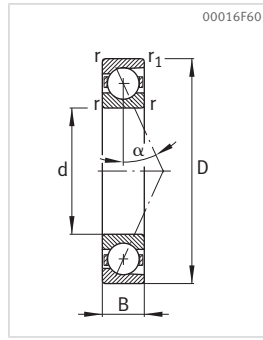
With large, medium or small balls

Steel balls or ceramic balls

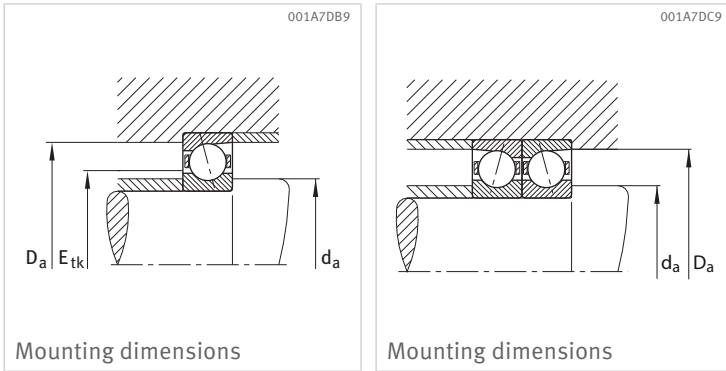
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	►91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71916-C-T-P4S	•	0,366	80	110	16	1	1	15	86	104
B71916-E-T-P4S	•	0,366	80	110	16	1	1	25	86	104
HCB71916-C-T-P4S	•	0,309	80	110	16	1	1	15	86	104
HCB71916-E-T-P4S	•	0,31	80	110	16	1	1	25	86	104
HS71916-C-T-P4S	•	0,379	80	110	16	1	1	15	86	104
HS71916-E-T-P4S	•	0,379	80	110	16	1	1	25	86	104
HC71916-E-T-P4S	•	0,355	80	110	16	1	1	25	86	104
M71916-C-T-P4S-XL	•	0,33	80	110	16	1	0,6	17	86	104
M71916-E-T-P4S-XL	•	0,33	80	110	16	1	0,6	25	86	104
HCM71916-C-T-P4S-XL	•	0,28	80	110	16	1	0,6	17	86	104
HCM71916-E-T-P4S-XL	•	0,28	80	110	16	1	0,6	25	86	104
VCM71916-C-T-P4S-XL	•	0,28	80	110	16	1	0,6	17	86	104
VCM71916-E-T-P4S-XL	•	0,28	80	110	16	1	0,6	25	86	104
B7016-C-T-P4S	•	0,84	80	125	22	1,1	1,1	15	88	117
B7016-E-T-P4S	•	0,84	80	125	22	1,1	1,1	25	88	117
HCB7016-C-T-P4S	•	0,7	80	125	22	1,1	1,1	15	88	117
HCB7016-E-T-P4S	•	0,7	80	125	22	1,1	1,1	25	88	117
HS7016-C-T-P4S	•	0,927	80	125	22	1,1	1,1	15	88	117
HS7016-E-T-P4S	•	0,925	80	125	22	1,1	1,1	25	88	117
HC7016-E-T-P4S	•	0,87	80	125	22	1,1	1,1	25	88	117
M7016-C-T-P4S-XL	•	0,87	80	125	22	1,1	0,6	17	88	117
M7016-E-T-P4S-XL	•	0,87	80	125	22	1,1	0,6	25	88	117
HCM7016-C-T-P4S-XL	•	0,81	80	125	22	1,1	0,6	17	88	117
HCM7016-E-T-P4S-XL	•	0,81	80	125	22	1,1	0,6	25	88	117
VCM7016-C-T-P4S-XL	•	0,81	80	125	22	1,1	0,6	17	88	117
VCM7016-E-T-P4S-XL	•	0,81	80	125	22	1,1	0,6	25	88	117
B7216-C-T-P4S		1,43	80	140	26	2	2	15	91	129
B7216-E-T-P4S		1,42	80	140	26	2	2	25	91	129
HCB7216-C-T-P4S		1,18	80	140	26	2	2	15	91	129
HCB7216-E-T-P4S		1,18	80	140	26	2	2	25	91	129



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$min^{-1}$	$min^{-1}$	N	N	N	N	N	N	N/ $\mu m$	N/ $\mu m$	N/ $\mu m$
92,2	35500	25500	12000	19000	174	591	1206	532	1954	4257	69,9	121	173
92,2	33500	24000	11000	17000	237	908	1955	686	2718	6043	160	265	362
92,2	36000	24300	17000	26000	84	321	686	249	1004	2259	58,8	101	143
92,2	34000	23000	15000	24000	95	459	1049	273	1344	3137	132	230	315
92,5	20300	15500	17000	26000	71	213	426	212	666	1385	52,3	81,9	112
92,5	19200	14600	15000	24000	113	338	676	325	992	2023	130	194	252
92,5	19200	14000	19000	30000	79	236	473	226	686	1392	130	192	248
92,1	28000	17300	17400	26400	182	483	1017	536	1467	3214	71	105	143
92,1	26500	16500	16400	24300	261	685	1429	752	2002	4254	143	203	268
92,1	28000	16600	21600	31600	128	338	709	373	1006	2173	71	102	137
92,1	27000	15800	20600	29500	184	483	1003	528	1396	2943	144	202	263
92,1	67000	23200	22200	34800	115	303	635	334	898	1932	70	101	135
92,1	64000	22100	21100	31600	166	433	900	474	1251	2632	143	200	261
98,8	64000	41000	11000	17000	354	1138	2277	1091	3797	8119	85,7	145	207
98,8	61000	39000	10000	15000	525	1816	3796	1528	5469	11813	201	321	435
98,8	65000	39000	15000	24000	186	640	1327	554	2020	4415	74	123	173
98,8	61000	37500	14000	22000	252	977	2113	726	2872	6354	175	284	383
99,7	30500	21800	15000	24000	106	317	633	315	991	2063	58,7	92	126
99,7	28500	20600	14000	22000	173	518	1035	497	1521	3103	148	220	286
99,7	28500	19700	18000	28000	117	352	704	336	1023	2075	146	215	278
99,6	34000	22800	16100	24400	241	640	1353	715	1977	4374	83	122	170
99,6	32500	21700	15200	22500	345	907	1895	996	2668	5705	164	234	311
99,6	34000	21800	20000	29300	169	447	941	495	1348	2936	81	118	161
99,6	32500	20800	19100	27400	243	638	1328	698	1855	3929	164	231	304
99,6	82000	30500	20500	31900	152	401	842	443	1200	2604	81	117	158
99,6	78000	29000	19600	29300	218	572	1191	627	1661	3509	163	230	301
105,3	94000	55000	10000	17000	549	1721	3412	1701	5781	12250	94,1	159	226
105,3	89000	52000	9000	15000	833	2764	5699	2433	8347	17799	221	349	472
105,3	94000	52000	12000	19000	293	968	1979	876	3068	6618	81,5	134	187
105,3	89000	50000	11000	18000	428	1527	3225	1232	4498	9728	196	312	416

### 2.2.2 Spindle bearings

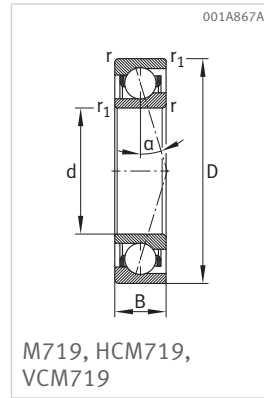
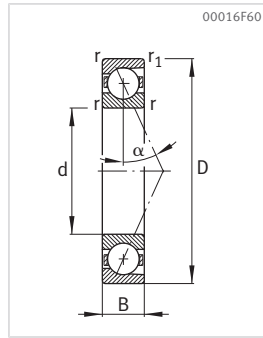
With large, medium or small balls

Steel balls or ceramic balls

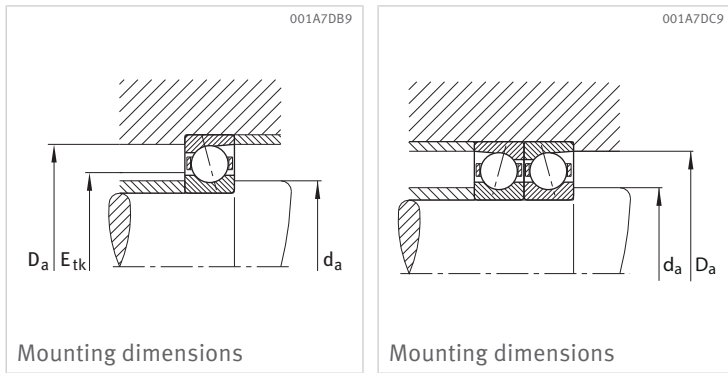
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71917-C-T-P4S	•	0,53	85	120	18	1,1	1,1	15	92	114
B71917-E-T-P4S	•	0,53	85	120	18	1,1	1,1	25	92	114
HCB71917-C-T-P4S	•	0,44	85	120	18	1,1	1,1	15	92	114
HCB71917-E-T-P4S	•	0,44	85	120	18	1,1	1,1	25	92	114
HS71917-C-T-P4S	•	0,572	85	120	18	1,1	1,1	15	92	114
HS71917-E-T-P4S	•	0,571	85	120	18	1,1	1,1	25	92	114
HC71917-E-T-P4S	•	0,545	85	120	18	1,1	1,1	25	92	114
M71917-C-T-P4S-XL	•	0,49	85	120	18	1,1	0,6	17	92	114
M71917-E-T-P4S-XL	•	0,49	85	120	18	1,1	0,6	25	92	114
HCM71917-C-T-P4S-XL	•	0,43	85	120	18	1,1	0,6	17	92	114
HCM71917-E-T-P4S-XL	•	0,43	85	120	18	1,1	0,6	25	92	114
VCM71917-C-T-P4S-XL	•	0,43	85	120	18	1,1	0,6	17	92	114
VCM71917-E-T-P4S-XL	•	0,43	85	120	18	1,1	0,6	25	92	114
B7017-C-T-P4S	•	0,88	85	130	22	1,1	1,1	15	93	122
B7017-E-T-P4S	•	0,88	85	130	22	1,1	1,1	25	93	122
HCB7017-C-T-P4S	•	0,74	85	130	22	1,1	1,1	15	93	122
HCB7017-E-T-P4S	•	0,74	85	130	22	1,1	1,1	25	93	122
HS7017-C-T-P4S	•	0,97	85	130	22	1,1	1,1	15	93	122
HS7017-E-T-P4S	•	0,969	85	130	22	1,1	1,1	25	93	122
HC7017-E-T-P4S	•	0,913	85	130	22	1,1	1,1	25	93	122
M7017-C-T-P4S-XL	•	0,92	85	130	22	1,1	0,6	17	93	122
M7017-E-T-P4S-XL	•	0,92	85	130	22	1,1	0,6	25	93	122
HCM7017-C-T-P4S-XL	•	0,85	85	130	22	1,1	0,6	17	93	122
HCM7017-E-T-P4S-XL	•	0,85	85	130	22	1,1	0,6	25	93	122
VCM7017-C-T-P4S-XL	•	0,85	85	130	22	1,1	0,6	17	93	122
VCM7017-E-T-P4S-XL	•	0,85	85	130	22	1,1	0,6	25	93	122
B7217-C-T-P4S		1,82	85	150	28	2	2	15	98	138
B7217-E-T-P4S		1,81	85	150	28	2	2	25	98	138
HCB7217-C-T-P4S		1,55	85	150	28	2	2	15	98	138
HCB7217-E-T-P4S		1,55	85	150	28	2	2	25	98	138



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
99,3	47000	33500	11000	17000	237	788	1597	726	2609	5644	79,7	136	195
99,3	44500	31500	10000	15000	333	1226	2609	968	3675	8074	184	301	409
99,3	47000	32000	15000	24000	117	428	906	346	1341	2985	67,4	114	161
99,3	44500	30000	14000	22000	143	627	1403	409	1837	4197	154	262	356
99,9	21200	17000	15000	24000	74	221	442	220	689	1433	55,9	87,4	119
99,9	20000	16000	14000	22000	117	352	704	338	1032	2102	140	208	270
99,9	20000	15300	18000	28000	82	247	493	236	716	1452	140	206	265
99,5	31500	19300	16100	24400	203	537	1131	596	1630	3569	74	108	148
99,5	30000	18400	15200	22500	291	764	1592	838	2230	4737	149	210	277
99,5	31500	18500	20000	29300	142	376	788	414	1118	2414	73	105	142
99,5	30000	17600	19100	27400	205	538	1118	588	1556	3278	149	209	273
99,5	75000	26000	20500	32200	128	337	706	371	998	2146	73	104	139
99,5	72000	24700	19600	29300	185	483	1003	528	1394	2932	148	208	270
103,8	66000	43500	11000	16000	367	1183	2368	1132	3942	8434	89,7	152	217
103,8	63000	41500	9500	15000	540	1874	3919	1573	5639	12184	209	336	454
103,8	67000	41500	15000	22000	189	653	1356	562	2058	4501	76,9	128	179
103,8	63000	39500	13000	20000	256	997	2159	736	2927	6484	181	296	398
104,7	30500	22700	15000	22000	107	322	643	320	1006	2093	60,3	94,4	129
104,7	29000	21400	13000	20000	173	518	1035	497	1520	3099	151	224	292
104,7	29000	20500	17000	26000	120	359	718	343	1042	2115	150	221	286
104,5	35500	24800	15400	23300	262	698	1476	780	2157	4772	90	133	185
104,5	33500	23700	14500	21400	376	988	2066	1086	2909	6220	178	254	337
104,5	35500	23800	19100	28000	184	488	1026	540	1470	3203	88	128	175
104,5	34000	22700	18200	26100	265	695	1448	761	2022	4283	178	251	330
104,5	85000	33500	19600	29100	165	437	918	483	1309	2841	88	127	171
104,5	81000	32000	18700	28000	238	624	1298	683	1811	3826	177	249	327
113,2	97000	59000	9000	15000	568	1786	3544	1759	5983	12688	99,1	167	238
113,2	93000	57000	8000	13000	864	2869	5921	2520	8657	18466	233	369	497
113,2	98000	57000	11000	18000	306	1012	2071	915	3205	6915	86,2	142	198
113,2	93000	54000	10000	17000	438	1572	3325	1262	4626	10015	206	328	438

### 2.2.2 Spindle bearings

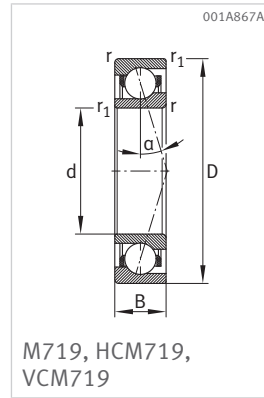
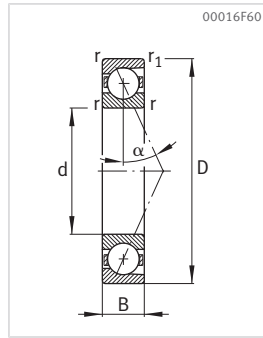
With large, medium or small balls

Steel balls or ceramic balls

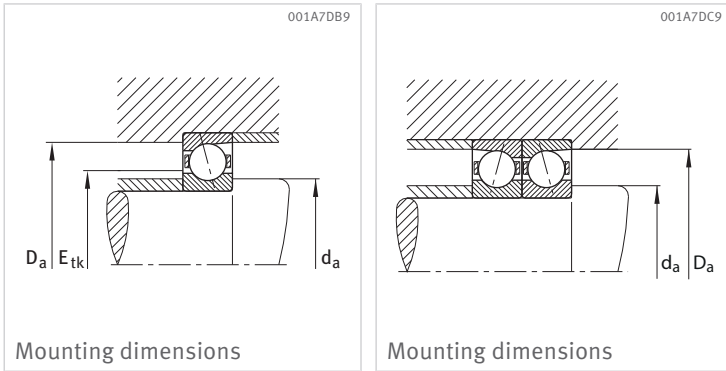
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71918-C-T-P4S	•	0,55	90	125	18	1,1	1,1	15	97	119
B71918-E-T-P4S	•	0,55	90	125	18	1,1	1,1	25	97	119
HCB71918-C-T-P4S	•	0,461	90	125	18	1,1	1,1	15	97	119
HCB71918-E-T-P4S	•	0,462	90	125	18	1,1	1,1	25	97	119
HS71918-C-T-P4S	•	0,58	90	125	18	1,1	1,1	15	97	119
HS71918-E-T-P4S	•	0,579	90	125	18	1,1	1,1	25	97	119
HC71918-E-T-P4S	•	0,564	90	125	18	1,1	1,1	25	97	119
M71918-C-T-P4S-XL	•	0,52	90	125	18	1,1	0,6	17	97	119
M71918-E-T-P4S-XL	•	0,52	90	125	18	1,1	0,6	25	97	119
HCM71918-C-T-P4S-XL	•	0,45	90	125	18	1,1	0,6	17	97	119
HCM71918-E-T-P4S-XL	•	0,45	90	125	18	1,1	0,6	25	97	119
VCM71918-C-T-P4S-XL	•	0,45	90	125	18	1,1	0,6	17	97	119
VCM71918-E-T-P4S-XL	•	0,45	90	125	18	1,1	0,6	25	97	119
B7018-C-T-P4S	•	1,14	90	140	24	1,5	1,5	15	100	131
B7018-E-T-P4S	•	1,14	90	140	24	1,5	1,5	25	100	131
HCB7018-C-T-P4S	•	0,95	90	140	24	1,5	1,5	15	100	131
HCB7018-E-T-P4S	•	0,95	90	140	24	1,5	1,5	25	100	131
HS7018-C-T-P4S	•	1,27	90	140	24	1,5	1,5	15	100	131
HS7018-E-T-P4S	•	1,27	90	140	24	1,5	1,5	25	100	131
HC7018-E-T-P4S	•	1,19	90	140	24	1,5	1,5	25	100	131
M7018-C-T-P4S-XL	•	1,2	90	140	24	1,5	1	17	100	131
M7018-E-T-P4S-XL	•	1,2	90	140	24	1,5	1	25	100	131
HCM7018-C-T-P4S-XL	•	1,1	90	140	24	1,5	1	17	100	131
HCM7018-E-T-P4S-XL	•	1,1	90	140	24	1,5	1	25	100	131
VCM7018-C-T-P4S-XL	•	1,1	90	140	24	1,5	1	17	100	131
VCM7018-E-T-P4S-XL	•	1,1	90	140	24	1,5	1	25	100	131
B7218-C-T-P4S		2,2	90	160	30	2	2	15	104	147
B7218-E-T-P4S		2,19	90	160	30	2	2	25	104	147
HCB7218-C-T-P4S		1,8	90	160	30	2	2	15	104	147
HCB7218-E-T-P4S		1,79	90	160	30	2	2	25	104	147



$E_{tk}$	$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
104,3	48000	35000	11000	16000	238	796	1615	729	2628	5691	81,8	140	200
104,3	45000	33000	9500	15000	334	1236	2634	970	3701	8140	189	309	420
104,3	48000	33500	15000	22000	118	434	919	349	1357	3023	69,4	118	165
104,3	45500	31500	13000	20000	147	648	1450	421	1897	4337	160	272	369
104,8	23200	18700	15000	22000	79	237	474	235	739	1536	57,2	89,4	122
104,8	21900	17700	13000	20000	129	386	773	371	1133	2309	144	214	279
104,8	22000	16900	17000	26000	90	269	538	257	781	1584	144	212	273
104,4	33000	21000	15400	23300	221	585	1233	650	1778	3894	80	117	161
104,4	31000	20100	14500	21400	317	832	1736	913	2431	5164	161	228	301
104,4	33000	20100	19100	28000	155	410	859	452	1220	2633	80	114	154
104,4	31500	19200	18200	26100	224	586	1219	641	1696	3574	162	227	296
104,4	79000	28000	19600	30600	139	367	769	405	1089	2341	79	113	151
104,4	75000	27000	18700	28000	201	526	1093	575	1520	3196	161	225	294
110,9	78000	51000	10000	15000	437	1395	2785	1347	4651	9920	95,2	161	229
110,9	74000	48500	9000	14000	646	2205	4590	1880	6636	14269	223	355	479
110,9	78000	49000	14000	22000	230	781	1613	685	2464	5361	82,3	136	191
110,9	74000	46500	12000	19000	319	1201	2577	916	3528	7745	195	316	423
111,9	36000	26500	14000	22000	126	377	754	375	1178	2451	65,4	102	140
111,9	34000	25000	12000	19000	204	612	1225	588	1799	3667	164	244	318
111,9	34000	24000	16000	24000	141	423	845	404	1228	2490	163	241	310
111,7	39500	27500	14400	21800	291	775	1639	866	2395	5299	93	137	191
111,7	37500	26000	13500	20000	418	1098	2295	1207	3232	6910	184	262	349
111,7	39500	26500	17900	26100	205	542	1140	599	1632	3557	91	133	181
111,7	37500	25000	17000	24400	295	772	1608	846	2247	4759	184	260	341
111,7	95000	37000	18300	27600	184	485	1020	536	1454	3155	91	131	177
111,7	90000	35000	17400	26100	265	693	1443	759	2012	4250	183	258	338
120	125000	75000	8500	14000	732	2280	4513	2267	7640	16156	109	183	260
120	119000	72000	7500	12000	1127	3689	7575	3291	11132	23627	257	404	545
120	125000	72000	11000	18000	400	1303	2655	1197	4129	8866	95,2	156	217
120	119000	69000	9000	15000	586	2042	4283	1688	6013	12905	230	361	481

### 2.2.2 Spindle bearings

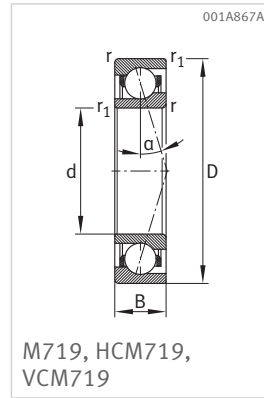
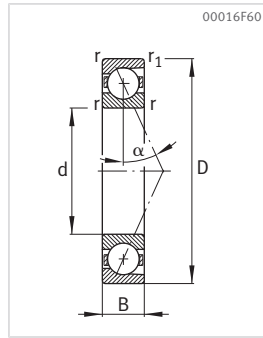
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

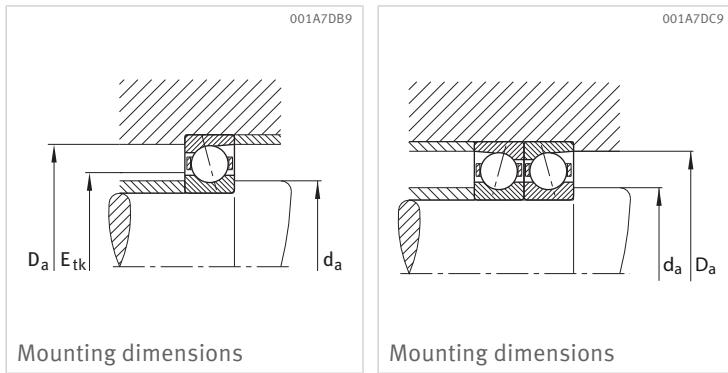
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71919-C-T-P4S	•	0,58	95	130	18	1,1	1,1	15	102	124
B71919-E-T-P4S	•	0,58	95	130	18	1,1	1,1	25	102	124
HCB71919-C-T-P4S	•	0,482	95	130	18	1,1	1,1	15	102	124
HCB71919-E-T-P4S	•	0,483	95	130	18	1,1	1,1	25	102	124
HS71919-C-T-P4S	•	0,606	95	130	18	1,1	1,1	15	102	124
HS71919-E-T-P4S	•	0,605	95	130	18	1,1	1,1	25	102	124
HC71919-E-T-P4S	•	0,59	95	130	18	1,1	1,1	25	102	124
M71919-C-T-P4S-XL	•	0,54	95	130	18	1,1	0,6	17	102	124
M71919-E-T-P4S-XL	•	0,54	95	130	18	1,1	0,6	25	102	124
HCM71919-C-T-P4S-XL	•	0,47	95	130	18	1,1	0,6	17	102	124
HCM71919-E-T-P4S-XL	•	0,47	95	130	18	1,1	0,6	25	102	124
VCM71919-C-T-P4S-XL	•	0,47	95	130	18	1,1	0,6	17	102	124
VCM71919-E-T-P4S-XL	•	0,47	95	130	18	1,1	0,6	25	102	124
B7019-C-T-P4S	•	1,19	95	145	24	1,5	1,5	15	105	136
B7019-E-T-P4S	•	1,19	95	145	24	1,5	1,5	25	105	136
HCB7019-C-T-P4S	•	1	95	145	24	1,5	1,5	15	105	136
HCB7019-E-T-P4S	•	1	95	145	24	1,5	1,5	25	105	136
HS7019-C-T-P4S	•	1,32	95	145	24	1,5	1,5	15	105	136
HS7019-E-T-P4S	•	1,32	95	145	24	1,5	1,5	25	105	136
HC7019-E-T-P4S	•	1,24	95	145	24	1,5	1,5	25	105	136
M7019-C-T-P4S-XL	•	1,3	95	145	24	1,5	1	17	105	136
M7019-E-T-P4S-XL	•	1,3	95	145	24	1,5	1	25	105	136
HCM7019-C-T-P4S-XL	•	1,2	95	145	24	1,5	1	17	105	136
HCM7019-E-T-P4S-XL	•	1,2	95	145	24	1,5	1	25	105	136
VCM7019-C-T-P4S-XL	•	1,2	95	145	24	1,5	1	17	105	136
VCM7019-E-T-P4S-XL	•	1,2	95	145	24	1,5	1	25	105	136
B7219-C-T-P4S		2,73	95	170	32	2,1	2,1	15	110,5	154
B7219-E-T-P4S		2,72	95	170	32	2,1	2,1	25	110,5	154
HCB7219-C-T-P4S		2,3	95	170	32	2,1	2,1	15	110,5	154
HCB7219-E-T-P4S		2,29	95	170	32	2,1	2,1	25	110,5	154





$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
109,2	48500	36500	10000	16000	243	813	1651	743	2679	5806	84,4	144	206
109,2	46000	34500	9000	14000	341	1262	2693	988	3777	8313	196	319	434
109,2	49000	35000	14000	22000	119	440	932	352	1373	3061	71,3	121	170
109,2	46000	33000	13000	19000	148	656	1470	423	1918	4393	164	280	380
109,7	23900	19900	14000	22000	82	246	492	244	766	1593	60	93,7	127
109,7	22500	18700	13000	19000	131	393	787	377	1153	2347	150	223	290
109,7	22500	17900	16000	24000	92	276	552	263	801	1623	150	221	285
109,3	33500	22000	14700	22300	231	611	1288	679	1858	4069	84	122	168
109,3	31500	21000	13800	20500	331	869	1812	953	2539	5393	168	237	313
109,3	33500	21000	18300	26700	162	428	898	472	1275	2752	83	119	160
109,3	32000	20100	17400	24900	234	612	1272	670	1771	3732	168	236	308
109,3	80000	29500	18700	28100	146	384	804	423	1137	2446	82	118	158
109,3	76000	28000	17800	26700	210	550	1142	601	1587	3338	167	234	305
115,8	81000	54000	9500	15000	444	1421	2842	1367	4726	10091	98,8	167	237
115,8	77000	52000	8500	13000	671	2295	4780	1955	6904	14849	233	372	502
115,8	81000	52000	13000	20000	233	794	1643	693	2499	5442	85,3	141	197
115,8	77000	49500	12000	18000	322	1220	2622	924	3581	7871	203	328	439
116,8	36500	27500	13000	20000	127	382	764	380	1192	2480	67	105	143
116,8	34000	26000	12000	18000	204	612	1225	588	1797	3663	168	249	324
116,8	34500	25000	15000	24000	141	423	845	404	1227	2488	167	246	317
116,7	42000	31000	13800	20900	328	874	1846	975	2699	5972	104	154	215
116,7	40000	29500	13000	19200	470	1236	2584	1359	3640	7782	207	295	392
116,7	42000	29500	17100	25000	231	610	1284	675	1839	4007	102	149	203
116,7	40000	28500	16300	23400	332	869	1811	952	2530	5359	207	292	383
116,7	101000	41500	17500	25400	207	547	1149	604	1638	3555	102	147	199
116,7	97000	39500	16700	25000	298	780	1624	854	2265	4786	206	289	379
126,9	130000	81000	8000	13000	760	2373	4703	2353	7935	16792	115	193	273
126,9	124000	78000	7000	11000	1184	3876	7964	3454	11693	24820	273	429	577
126,9	130000	78000	10000	17000	413	1348	2748	1234	4261	9153	100	164	228
126,9	124000	74000	8500	14000	605	2113	4437	1741	6219	13355	242	381	507

### 2.2.2 Spindle bearings

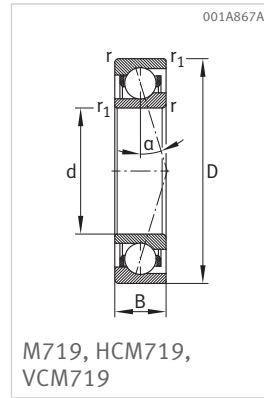
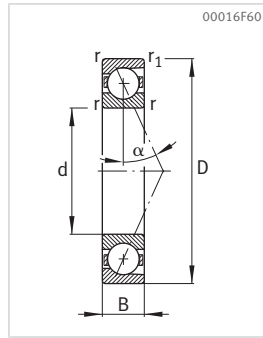
With large, medium or small balls

Steel balls or ceramic balls

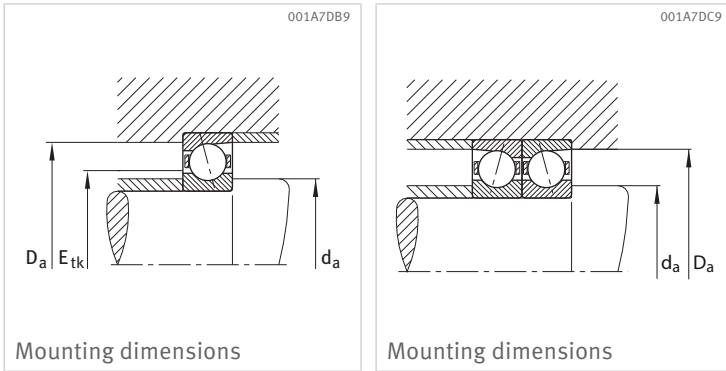
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71920-C-T-P4S	•	0,78	100	140	20	1,1	1,1	15	107	133
B71920-E-T-P4S	•	0,78	100	140	20	1,1	1,1	25	107	133
HCB71920-C-T-P4S	•	0,65	100	140	20	1,1	1,1	15	107	133
HCB71920-E-T-P4S	•	0,65	100	140	20	1,1	1,1	25	107	133
HS71920-C-T-P4S	•	0,86	100	140	20	1,1	1,1	15	107	133
HS71920-E-T-P4S	•	0,86	100	140	20	1,1	1,1	25	107	133
HC71920-E-T-P4S	•	0,81	100	140	20	1,1	1,1	25	107	133
M71920-C-T-P4S-XL	•	0,76	100	140	20	1,1	0,6	17	107	133
M71920-E-T-P4S-XL	•	0,76	100	140	20	1,1	0,6	25	107	133
HCM71920-C-T-P4S-XL	•	0,67	100	140	20	1,1	0,6	17	107	133
HCM71920-E-T-P4S-XL	•	0,67	100	140	20	1,1	0,6	25	107	133
VCM71920-C-T-P4S-XL	•	0,67	100	140	20	1,1	0,6	17	107	133
VCM71920-E-T-P4S-XL	•	0,67	100	140	20	1,1	0,6	25	107	133
B7020-C-T-P4S	•	1,24	100	150	24	1,5	1,5	15	110	141
B7020-E-T-P4S	•	1,24	100	150	24	1,5	1,5	25	110	141
HCB7020-C-T-P4S	•	1,03	100	150	24	1,5	1,5	15	110	141
HCB7020-E-T-P4S	•	1,03	100	150	24	1,5	1,5	25	110	141
HS7020-C-T-P4S	•	1,38	100	150	24	1,5	1,5	15	110	141
HS7020-E-T-P4S	•	1,38	100	150	24	1,5	1,5	25	110	141
HC7020-E-T-P4S	•	1,29	100	150	24	1,5	1,5	25	110	141
M7020-C-T-P4S-XL	•	1,3	100	150	24	1,5	1	17	110	141
M7020-E-T-P4S-XL	•	1,3	100	150	24	1,5	1	25	110	141
HCM7020-C-T-P4S-XL	•	1,2	100	150	24	1,5	1	17	110	141
HCM7020-E-T-P4S-XL	•	1,2	100	150	24	1,5	1	25	110	141
VCM7020-C-T-P4S-XL	•	1,2	100	150	24	1,5	1	17	110	141
VCM7020-E-T-P4S-XL	•	1,2	100	150	24	1,5	1	25	110	141
B7220-C-T-P4S		3,35	100	180	34	2,1	2,1	15	114,5	165,5
B7220-E-T-P4S		3,34	100	180	34	2,1	2,1	25	114,5	165,5
HCB7220-C-T-P4S		2,89	100	180	34	2,1	2,1	15	114,5	165,5
HCB7220-E-T-P4S		2,88	100	180	34	2,1	2,1	25	114,5	165,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
117,5	60000	45000	9500	14000	316	1040	2101	968	3432	7399	94,1	160	228
117,5	57000	42500	8500	13000	450	1616	3417	1305	4839	10556	219	353	479
117,5	60000	43000	13000	20000	160	572	1201	473	1789	3950	80,4	135	189
117,5	57000	40500	12000	18000	204	850	1876	584	2489	5611	187	311	421
116,9	28500	23500	13000	20000	97	291	583	289	906	1883	64,6	101	137
116,9	27000	22100	12000	18000	158	474	949	455	1390	2832	163	242	314
116,9	27000	21200	15000	24000	109	328	656	313	951	1927	162	239	307
116,6	38500	25500	13800	20900	269	714	1506	793	2172	4759	90	132	181
116,6	36500	24500	13000	19200	387	1016	2118	1114	2967	6305	181	256	338
116,6	38500	24600	17100	25000	190	500	1049	551	1489	3217	89	129	173
116,6	36500	23500	16300	23400	273	715	1487	782	2070	4362	182	255	333
116,6	92000	34500	17500	26600	170	448	939	494	1329	2860	89	127	170
116,6	88000	33000	16700	25000	245	642	1334	702	1855	3901	181	253	330
120,8	83000	57000	9000	14000	464	1484	2970	1427	4935	10539	104	175	248
120,8	79000	55000	8000	13000	681	2336	4869	1982	7018	15103	242	385	521
120,8	83000	55000	13000	19000	241	823	1703	717	2587	5636	89,1	148	206
120,8	79000	52000	11000	17000	333	1266	2723	957	3715	8170	212	343	459
121,8	36500	28500	13000	19000	127	382	764	379	1190	2476	68,3	107	145
121,8	34500	27000	11000	17000	207	621	1242	596	1822	3713	172	256	333
121,8	34500	26000	15000	22000	144	431	863	412	1252	2539	171	253	326
121,7	43000	32000	13200	20000	342	909	1922	1016	2810	6220	108	160	223
121,7	40500	31000	12400	18400	489	1287	2690	1414	3788	8101	215	306	406
121,7	43000	31000	16400	23500	240	635	1336	703	1915	4174	106	154	210
121,7	41000	29500	15600	22400	345	905	1885	991	2633	5578	215	302	397
121,7	103000	43000	16800	23500	215	569	1196	629	1706	3702	105	152	206
121,7	98000	41000	16000	23500	310	812	1691	889	2358	4982	213	300	393
134,4	135000	88000	7500	12000	789	2466	4892	2439	8230	17428	121	203	287
134,4	129000	84000	6700	10000	1208	3964	8152	3521	11940	25355	285	449	604
134,4	135000	84000	9500	16000	428	1400	2856	1279	4420	9498	106	172	240
134,4	129000	80000	8000	13000	627	2198	4619	1806	6466	13894	255	402	535

### 2.2.2 Spindle bearings

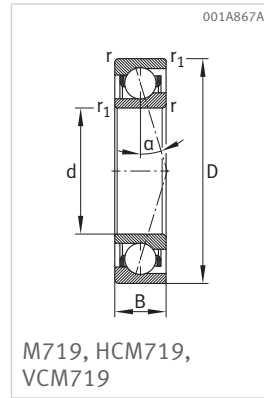
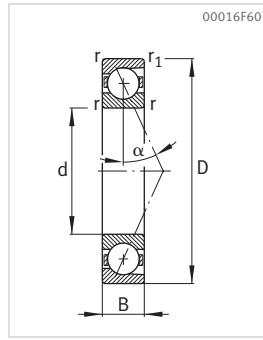
With large, medium or small balls

Steel balls or ceramic balls

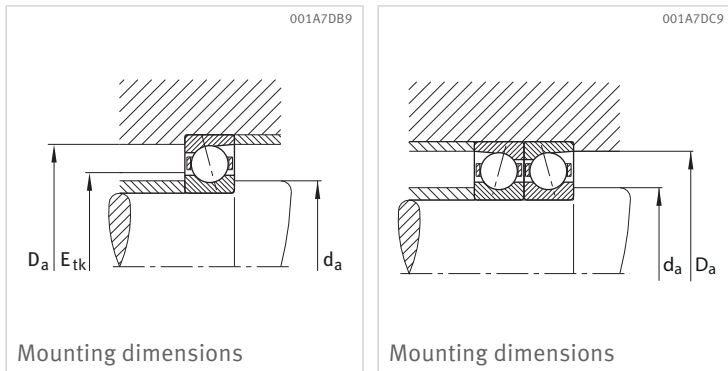
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71921-C-T-P4S	•	0,81	105	145	20	1,1	1,1	15	112	138
B71921-E-T-P4S	•	0,81	105	145	20	1,1	1,1	25	112	138
HCB71921-C-T-P4S	•	0,69	105	145	20	1,1	1,1	15	112	138
HCB71921-E-T-P4S	•	0,69	105	145	20	1,1	1,1	25	112	138
HS71921-C-T-P4S	•	0,89	105	145	20	1,1	1,1	15	112	138
HS71921-E-T-P4S	•	0,89	105	145	20	1,1	1,1	25	112	138
HC71921-E-T-P4S	•	0,83	105	145	20	1,1	1,1	25	112	138
M71921-C-T-P4S-XL	•	0,79	105	145	20	1,1	0,6	17	112	138
M71921-E-T-P4S-XL	•	0,79	105	145	20	1,1	0,6	25	112	138
HCM71921-C-T-P4S-XL	•	0,69	105	145	20	1,1	0,6	17	112	138
HCM71921-E-T-P4S-XL	•	0,69	105	145	20	1,1	0,6	25	112	138
VCM71921-C-T-P4S-XL	•	0,69	105	145	20	1,1	0,6	17	112	138
VCM71921-E-T-P4S-XL	•	0,69	105	145	20	1,1	0,6	25	112	138
B7021-C-T-P4S	•	1,6	105	160	26	2	2	15	116	150
B7021-E-T-P4S	•	1,6	105	160	26	2	2	25	116	150
HCB7021-C-T-P4S	•	1,39	105	160	26	2	2	15	116	150
HCB7021-E-T-P4S	•	1,39	105	160	26	2	2	25	116	150
HS7021-C-T-P4S	•	1,7	105	160	26	2	2	15	116	150
HS7021-E-T-P4S	•	1,7	105	160	26	2	2	25	116	150
HC7021-E-T-P4S	•	1,59	105	160	26	2	2	25	116	150
M7021-C-T-P4S-XL	•	1,6	105	160	26	2	1	17	116	150
M7021-E-T-P4S-XL	•	1,6	105	160	26	2	1	25	116	150
HCM7021-C-T-P4S-XL	•	1,5	105	160	26	2	1	17	116	150
HCM7021-E-T-P4S-XL	•	1,5	105	160	26	2	1	25	116	150
VCM7021-C-T-P4S-XL	•	1,5	105	160	26	2	1	17	116	150
VCM7021-E-T-P4S-XL	•	1,5	105	160	26	2	1	25	116	150
B7221-C-T-P4S		3,89	105	190	36	2,1	2,1	15	120,5	174,5
B7221-E-T-P4S		3,88	105	190	36	2,1	2,1	25	120,5	174,5
HCB7221-C-T-P4S		3,26	105	190	36	2,1	2,1	15	120,5	174,5
HCB7221-E-T-P4S		3,25	105	190	36	2,1	2,1	25	120,5	174,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
121,4	60000	45000	9000	14000	316	1040	2101	968	3432	7399	94,1	160	228
121,4	57000	42500	8000	13000	450	1616	3417	1305	4839	10556	219	353	479
121,4	60000	43000	13000	19000	157	564	1185	466	1763	3895	80	134	188
121,4	57000	41000	11000	17000	204	850	1876	584	2489	5611	187	311	421
121,9	29000	24800	13000	19000	101	302	603	299	937	1946	67,6	105	143
121,9	27500	23400	11000	17000	161	483	966	463	1414	2880	170	252	327
121,9	27500	22400	15000	22000	113	338	676	323	980	1987	170	250	321
121,6	39000	27000	13200	20000	281	745	1569	827	2265	4962	94	137	188
121,6	37000	25500	12400	18400	403	1058	2207	1161	3092	6571	188	266	351
121,6	39000	25500	16400	24000	198	521	1093	575	1553	3354	93	134	180
121,6	37000	24400	15600	22400	285	745	1549	815	2157	4546	189	265	346
121,6	94000	36000	16800	24700	177	467	979	515	1385	2981	92	132	177
121,6	89000	34000	16000	24000	256	669	1390	732	1933	4065	188	263	343
128,3	85000	61000	8500	13000	471	1511	3027	1447	5010	10710	107	181	257
128,3	80000	58000	7500	12000	691	2377	4959	2010	7133	15359	251	399	539
128,3	85000	58000	12000	18000	244	836	1732	725	2623	5718	92,1	153	213
128,3	81000	55000	11000	16000	336	1285	2768	966	3768	8297	219	355	476
129	47500	36500	12000	18000	164	492	985	489	1536	3194	75	117	160
129	45000	34500	11000	16000	267	802	1604	770	2354	4797	189	281	365
129	45000	33000	14000	22000	184	552	1104	527	1602	3250	188	277	357
129	53000	39500	12500	18900	419	1114	2356	1244	3445	7626	115	171	238
129	51000	38000	11700	17400	599	1574	3292	1731	4636	9916	229	326	433
129	53000	38000	15500	22700	294	778	1638	861	2347	5116	113	165	225
129	51000	36000	14800	21200	422	1107	2306	1213	3222	6827	229	323	424
129	128000	53000	15900	23400	264	697	1465	770	2090	4537	112	163	220
129	122000	51000	15100	22700	379	994	2069	1088	2885	6097	228	320	420
141,2	164000	104000	7000	11000	989	3069	6072	3060	10252	21655	131	219	311
141,2	156000	99000	6300	9500	1545	5006	10249	4508	15092	31918	312	488	656
141,2	164000	99000	9000	15000	536	1733	3524	1603	5476	11721	114	186	258
141,2	157000	95000	7500	12000	800	2742	5723	2303	8067	17220	278	434	577

### 2.2.2 Spindle bearings

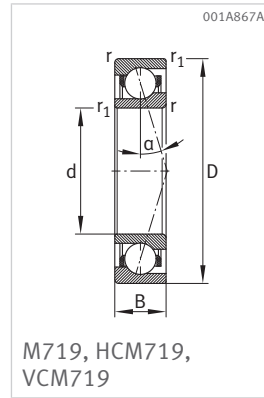
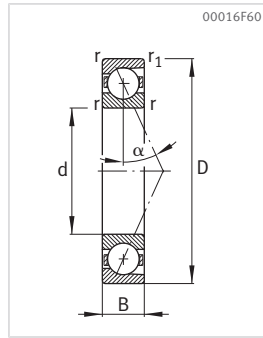
With large, medium or small balls

Steel balls or ceramic balls

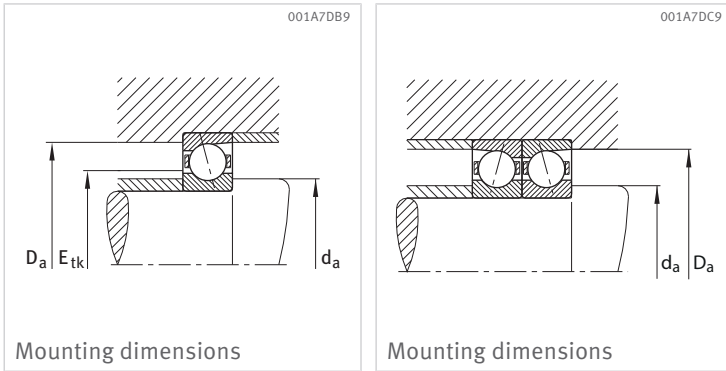
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71922-C-T-P4S	•	0,85	110	150	20	1,1	1,1	15	117	143
B71922-E-T-P4S	•	0,85	110	150	20	1,1	1,1	25	117	143
HCB71922-C-T-P4S	•	0,71	110	150	20	1,1	1,1	15	117	143
HCB71922-E-T-P4S	•	0,71	110	150	20	1,1	1,1	25	117	143
HS71922-C-T-P4S	•	0,91	110	150	20	1,1	1,1	15	117	143
HS71922-E-T-P4S	•	0,91	110	150	20	1,1	1,1	25	117	143
HC71922-E-T-P4S	•	0,84	110	150	20	1,1	1,1	25	117	143
M71922-C-T-P4S-XL	•	0,82	110	150	20	1,1	0,6	17	117	143
M71922-E-T-P4S-XL	•	0,82	110	150	20	1,1	0,6	25	117	143
HCM71922-C-T-P4S-XL	•	0,72	110	150	20	1,1	0,6	17	117	143
HCM71922-E-T-P4S-XL	•	0,72	110	150	20	1,1	0,6	25	117	143
VCM71922-C-T-P4S-XL	•	0,72	110	150	20	1,1	0,6	17	117	143
VCM71922-E-T-P4S-XL	•	0,72	110	150	20	1,1	0,6	25	117	143
B7022-C-T-P4S	•	1,95	110	170	28	2	2	15	121	159
B7022-E-T-P4S	•	1,95	110	170	28	2	2	25	121	159
HCB7022-C-T-P4S	•	1,62	110	170	28	2	2	15	121	159
HCB7022-E-T-P4S	•	1,62	110	170	28	2	2	25	121	159
HS7022-C-T-P4S	•	2,17	110	170	28	2	2	15	121	159
HS7022-E-T-P4S	•	2,17	110	170	28	2	2	25	121	159
HC7022-E-T-P4S	•	2,05	110	170	28	2	2	25	121	159
M7022-C-T-P4S-XL	•	2,1	110	170	28	2	1	17	121	159
M7022-E-T-P4S-XL	•	2,1	110	170	28	2	1	25	121	159
HCM7022-C-T-P4S-XL	•	1,9	110	170	28	2	1	17	121	159
HCM7022-E-T-P4S-XL	•	1,9	110	170	28	2	1	25	121	159
VCM7022-C-T-P4S-XL	•	2,09	110	170	28	2	1	17	121	159
VCM7022-E-T-P4S-XL	•	2,09	110	170	28	2	1	25	121	159
B7222-C-T-P4S		4,6	110	200	38	2,1	2,1	15	126,5	183,5
B7222-E-T-P4S		4,59	110	200	38	2,1	2,1	25	126,5	183,5
HCB7222-C-T-P4S		3,97	110	200	38	2,1	2,1	15	126,5	183,5
HCB7222-E-T-P4S		3,96	110	200	38	2,1	2,1	25	126,5	183,5



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
126,4	61000	47000	8500	13000	314	1038	2102	961	3415	7373	96,1	163	232
126,4	58000	44500	8000	12000	455	1642	3475	1321	4913	10722	225	364	493
126,4	61000	45000	12000	19000	158	570	1199	468	1777	3931	82,1	138	193
126,4	58000	42500	11000	17000	208	871	1923	596	2547	5747	193	322	435
126,9	34000	28500	12000	19000	116	347	693	344	1077	2238	70,6	110	149
126,9	32000	27000	11000	17000	187	561	1121	538	1642	3344	178	264	343
126,9	32000	26000	14000	22000	131	393	787	375	1141	2312	178	262	337
126,5	39500	28000	12700	19300	292	775	1633	861	2357	5165	97	142	195
126,5	37500	26500	12000	17700	419	1101	2296	1208	3217	6837	195	276	365
126,5	39500	26500	15800	23000	206	542	1138	598	1616	3491	96	139	187
126,5	38000	25500	15000	21600	296	775	1612	848	2244	4730	196	275	359
126,5	95000	37500	16200	23000	185	486	1019	536	1442	3103	96	137	184
126,5	91000	35500	15400	23000	266	696	1446	761	2010	4230	195	273	356
135,1	112000	77000	8000	12000	643	2033	4052	1981	6757	14370	119	200	283
135,1	106000	73000	7500	12000	968	3242	6709	2820	9745	20814	280	443	596
135,1	112000	74000	12000	18000	337	1126	2314	1004	3540	7655	103	169	234
135,1	106000	70000	11000	16000	490	1779	3778	1409	5224	11341	248	395	527
136,5	48000	38000	12000	18000	168	503	1005	499	1566	3257	77,2	121	164
136,5	45500	35500	11000	16000	267	802	1604	770	2352	4792	193	287	373
136,5	45500	34000	13000	20000	187	561	1121	535	1627	3299	193	284	366
136,4	54000	41500	11800	17900	437	1164	2461	1300	3600	7970	120	178	248
136,4	51000	39500	11100	16500	625	1644	3437	1807	4841	10356	238	339	451
136,4	54000	39500	14700	21500	307	813	1711	900	2452	5346	118	171	234
136,4	51000	37500	14000	20000	441	1156	2408	1266	3365	7129	238	335	441
136,4	129000	55000	15000	21500	276	728	1530	805	2184	4742	117	169	229
136,4	123000	53000	14300	21500	396	1038	2160	1136	3012	6367	237	333	436
148,7	164000	105000	6700	10000	989	3069	6072	3060	10252	21655	131	219	311
148,7	156000	100000	6000	9000	1512	4905	10048	4410	14777	31257	309	484	650
148,7	164000	101000	8500	14000	536	1733	3524	1603	5476	11721	114	186	258
148,7	156000	96000	7000	10000	800	2742	5723	2303	8067	17220	278	434	577

### 2.2.2 Spindle bearings

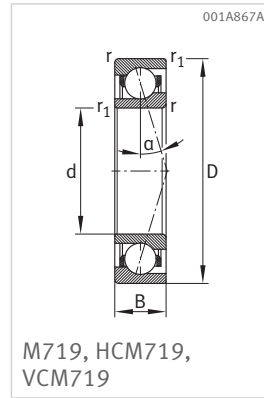
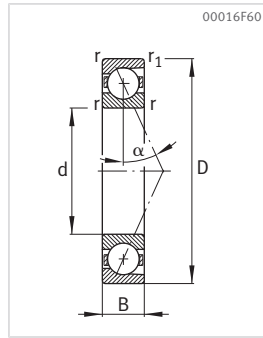
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

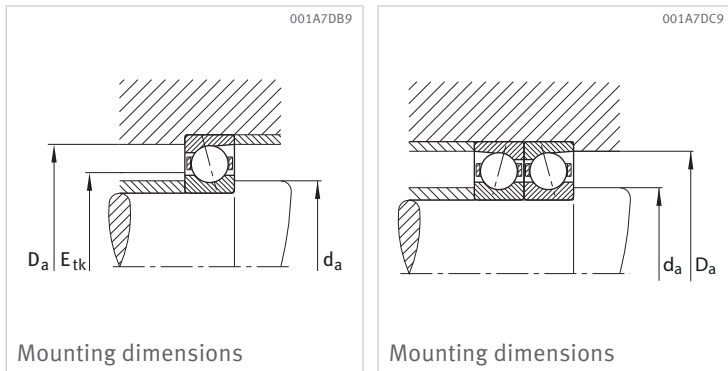
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71924-C-T-P4S	•	1,16	120	165	22	1,1	1,1	15	128	157
B71924-E-T-P4S	•	1,16	120	165	22	1,1	1,1	25	128	157
HCB71924-C-T-P4S	•	0,97	120	165	22	1,1	1,1	15	128	157
HCB71924-E-T-P4S	•	0,97	120	165	22	1,1	1,1	25	128	157
HS71924-C-T-P4S	•	1,29	120	165	22	1,1	1,1	15	128	157
HS71924-E-T-P4S	•	1,29	120	165	22	1,1	1,1	25	128	157
HC71924-E-T-P4S	•	1,21	120	165	22	1,1	1,1	25	128	157
M71924-C-T-P4S-XL	•	1,1	120	165	22	1,1	0,6	17	128	157
M71924-E-T-P4S-XL	•	1,1	120	165	22	1,1	0,6	25	128	157
HCM71924-C-T-P4S-XL	•	0,97	120	165	22	1,1	0,6	17	128	157
HCM71924-E-T-P4S-XL	•	0,97	120	165	22	1,1	0,6	25	128	157
VCM71924-C-T-P4S-XL	•	1,11	120	165	22	1,1	0,6	17	128	157
VCM71924-E-T-P4S-XL	•	1,11	120	165	22	1,1	0,6	25	128	157
B7024-C-T-P4S	•	2,08	120	180	28	2	2	15	131	169
B7024-E-T-P4S	•	2,07	120	180	28	2	2	25	131	169
HCB7024-C-T-P4S	•	1,74	120	180	28	2	2	15	131	169
HCB7024-E-T-P4S	•	1,73	120	180	28	2	2	25	131	169
HS7024-C-T-P4S	•	2,33	120	180	28	2	2	15	131	169
HS7024-E-T-P4S	•	2,32	120	180	28	2	2	25	131	169
HC7024-E-T-P4S	•	2,2	120	180	28	2	2	25	131	169
M7024-C-T-P4S-XL	•	2,2	120	180	28	2	1	17	131	169
M7024-E-T-P4S-XL	•	2,2	120	180	28	2	1	25	131	169
HCM7024-C-T-P4S-XL	•	2,1	120	180	28	2	1	17	131	169
HCM7024-E-T-P4S-XL	•	2,1	120	180	28	2	1	25	131	169
VCM7024-C-T-P4S-XL	•	2,23	120	180	28	2	1	17	131	169
VCM7024-E-T-P4S-XL	•	2,23	120	180	28	2	1	25	131	169
B7224-C-T-P4S		5,3	120	215	40	2,1	2,1	15	140	195
B7224-E-T-P4S		5,28	120	215	40	2,1	2,1	25	140	195
HCB7224-C-T-P4S		4,2	120	215	40	2,1	2,1	15	140	195
HCB7224-E-T-P4S		4,18	120	215	40	2,1	2,1	25	140	195





$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
138,5	76000	59000	8000	12000	405	1321	2665	1239	4349	9350	109	184	261
138,5	72000	56000	7000	11000	587	2073	4361	1705	6203	13450	255	409	553
138,5	76000	57000	11000	17000	208	732	1530	616	2286	5019	93,7	156	218
138,5	72000	54000	10000	15000	274	1101	2407	785	3223	7191	220	362	487
139,2	35500	32000	11000	17000	122	367	734	363	1137	2362	76,8	119	162
139,2	33500	30000	10000	15000	196	587	1173	562	1716	3492	193	286	371
139,2	33500	29000	13000	20000	136	407	814	388	1179	2389	192	283	364
138,8	49500	35000	11600	17600	366	970	2045	1077	2950	6464	107	157	215
138,8	47000	33000	10900	16200	525	1379	2875	1512	4028	8558	215	304	401
138,8	49500	33500	14400	21100	257	679	1425	749	2023	4370	106	152	205
138,8	47000	32000	13700	19700	371	971	2018	1062	2809	5922	215	302	395
138,8	119000	46500	14800	21700	231	609	1276	671	1805	3884	105	151	202
138,8	113000	44500	14100	21100	333	872	1811	953	2517	5296	214	300	391
145,1	115000	82000	7500	12000	653	2069	4129	2008	6858	14599	123	206	293
145,1	109000	78000	6700	10000	983	3298	6830	2860	9902	21158	290	459	618
145,1	115000	78000	10000	16000	350	1170	2406	1042	3677	7953	107	176	245
145,1	109000	75000	9500	14000	496	1810	3849	1427	5313	11543	257	410	547
146,4	49500	40500	10000	16000	171	513	1025	508	1594	3313	80,8	126	171
146,4	46500	38500	9500	14000	276	828	1656	795	2426	4942	203	302	392
146,4	46500	36500	12000	19000	193	578	1156	552	1676	3398	203	299	385
146,4	56000	44500	11000	16700	473	1258	2659	1405	3891	8618	129	191	266
146,4	53000	42500	10400	15400	675	1775	3712	1952	5229	11187	256	364	484
146,4	56000	42500	13700	18800	332	878	1848	972	2650	5780	127	184	251
146,4	53000	40500	13000	18700	476	1248	2601	1368	3634	7700	255	360	474
146,4	134000	60000	14000	18800	298	787	1654	870	2361	5126	126	182	246
146,4	127000	57000	13400	18800	428	1120	2332	1227	3253	6877	254	358	469
159,7	205000	138000	6000	9000	1259	3882	7683	3878	12884	27179	139	231	326
159,7	196000	132000	5300	8000	1989	6365	12984	5797	19139	40275	333	518	694
159,7	205000	132000	7500	12000	688	2196	4452	2051	6906	14713	122	197	272
159,7	196000	126000	6700	9500	1055	3535	7327	3037	10386	21994	300	465	615

### 2.2.2 Spindle bearings

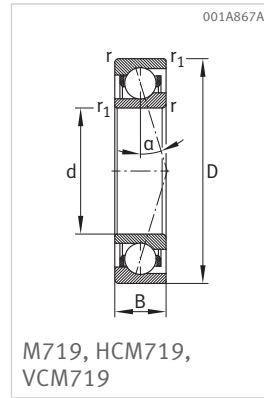
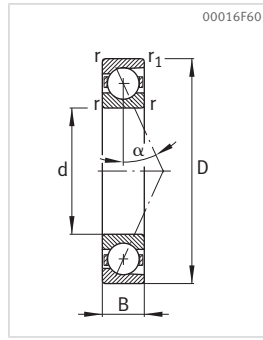
With large, medium or small balls

Steel balls or ceramic balls

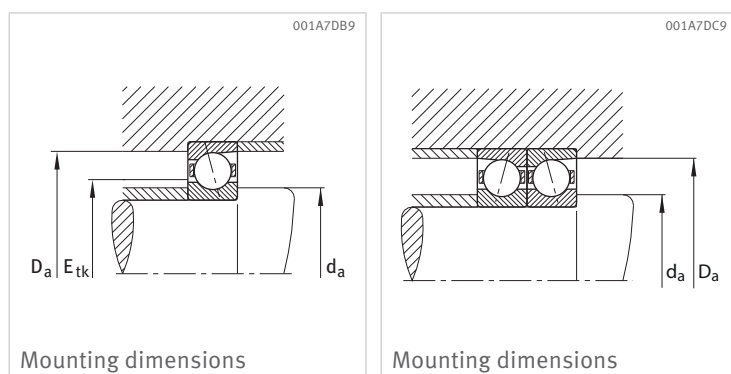
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 ⊕56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71926-C-T-P4S	•	1,52	130	180	24	1,5	1,5	15	139	171
B71926-E-T-P4S	•	1,52	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	•	1,34	130	180	24	1,5	1,5	25	139	171
HS71926-C-T-P4S	•	1,71	130	180	24	1,5	1,5	15	139	171
HS71926-E-T-P4S	•	1,71	130	180	24	1,5	1,5	25	139	171
HC71926-E-T-P4S	•	1,61	130	180	24	1,5	1,5	25	139	171
M71926-C-T-P4S-XL	•	1,5	130	180	24	1,5	1	17	139	171
M71926-E-T-P4S-XL	•	1,5	130	180	24	1,5	1	25	139	171
HCM71926-C-T-P4S-XL	•	1,4	130	180	24	1,5	1	17	139	171
HCM71926-E-T-P4S-XL	•	1,4	130	180	24	1,5	1	25	139	171
VCM71926-C-T-P4S-XL	•	1,53	130	180	24	1,5	1	17	139	171
VCM71926-E-T-P4S-XL	•	1,53	130	180	24	1,5	1	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
HS7026-C-T-P4S	•	3,52	130	200	33	2	2	15	142	189
HS7026-E-T-P4S	•	3,51	130	200	33	2	2	25	142	189
HC7026-E-T-P4S	•	3,36	130	200	33	2	2	25	142	189
M7026-C-T-P4S-XL	•	3,6	130	200	33	2	1	17	142	189
M7026-E-T-P4S-XL	•	3,6	130	200	33	2	1	25	142	189
HCM7026-C-T-P4S-XL	•	3,4	130	200	33	2	1	17	142	189
HCM7026-E-T-P4S-XL	•	3,4	130	200	33	2	1	25	142	189
VCM7026-C-T-P4S-XL	•	3,56	130	200	33	2	1	17	142	189
VCM7026-E-T-P4S-XL	•	3,56	130	200	33	2	1	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



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
150,7	90000	71000	7000	11000	486	1571	3160	1488	5171	11084	117	197	279
150,7	85000	67000	6700	10000	711	2466	5161	2064	7379	15916	275	438	590
150,7	90000	68000	10000	15000	253	875	1819	750	2732	5967	101	167	233
150,7	86000	64000	9000	14000	346	1342	2904	993	3929	8680	240	391	524
151,4	40500	36500	10000	16000	139	417	834	413	1291	2682	81,1	126	171
151,4	38500	34500	9000	14000	224	673	1346	645	1968	4004	205	303	393
151,4	38500	33000	12000	18000	155	466	932	444	1349	2732	204	300	385
151,3	51000	37500	10700	16200	396	1050	2213	1166	3194	7000	115	169	231
151,3	48500	36000	10000	14900	568	1491	3109	1635	4356	9258	231	327	431
151,3	51000	36000	13300	18900	279	735	1542	811	2190	4731	114	164	221
151,3	48500	34500	12600	18100	401	1050	2183	1148	3038	6405	231	325	424
151,3	122000	50000	13600	18900	250	659	1380	726	1954	4205	113	162	217
151,3	117000	48000	13000	18900	360	943	1959	1031	2723	5728	230	323	421
159,3	149000	107000	6700	10000	850	2669	5314	2616	8846	18773	137	229	324
159,3	141000	102000	6000	9500	1312	4328	8915	3820	13001	27627	326	512	689
159,3	149000	102000	9500	14000	464	1524	3119	1381	4791	10306	120	196	272
159,3	141000	97000	8500	13000	679	2399	5054	1953	7044	15161	291	459	611
161,2	64000	53000	9500	15000	219	658	1317	653	2046	4251	91,8	143	194
161,2	60000	50000	8500	13000	357	1070	2139	1026	3133	6381	231	344	446
161,2	60000	48000	11000	17000	244	733	1466	700	2126	4308	230	338	435
161,3	58000	49500	10000	15200	525	1398	2957	1563	4329	9590	142	211	294
161,3	55000	47500	9400	14000	750	1972	4124	2168	5811	12435	282	402	535
161,3	58000	47500	12500	16200	369	976	2055	1081	2948	6431	140	204	278
161,3	55000	45500	11900	16200	529	1387	2889	1519	4038	8558	282	398	523
161,3	139000	67000	12800	16200	331	875	1839	967	2626	5703	139	201	272
161,3	132000	63000	12200	16200	475	1245	2592	1363	3615	7643	281	395	518
172	215000	151000	5600	8500	1306	4034	7993	4018	13354	28189	147	244	344
172	205000	144000	5000	7500	2065	6617	13506	6015	19876	41831	353	549	735
172	215000	144000	7000	11000	716	2288	4642	2132	7184	15307	129	208	288
172	205000	138000	6000	9000	1098	3687	7648	3160	10826	22934	318	493	652

### 2.2.2 Spindle bearings

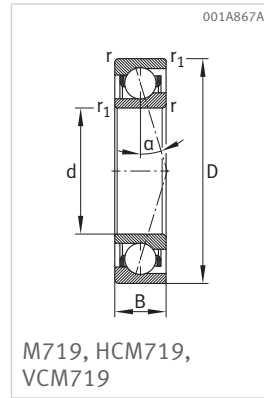
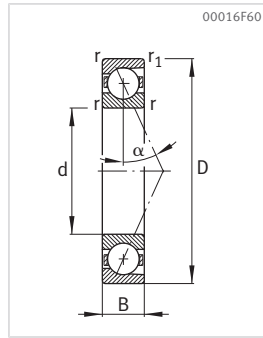
With large, medium or small balls

Steel balls or ceramic balls

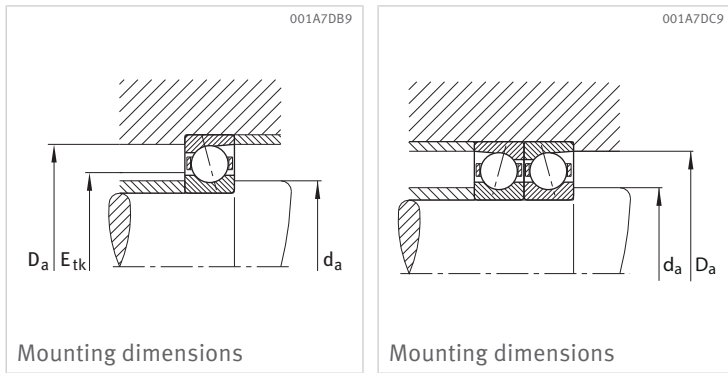
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	►91 ◻56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71928-C-T-P4S	•	1,62	140	190	24	1,5	1,5	15	149	181
B71928-E-T-P4S	•	1,62	140	190	24	1,5	1,5	25	149	181
HCB71928-C-T-P4S	•	1,42	140	190	24	1,5	1,5	15	149	181
HCB71928-E-T-P4S	•	1,42	140	190	24	1,5	1,5	25	149	181
B7028-C-T-P4S	•	3,35	140	210	33	2	2	15	152	199
B7028-E-T-P4S	•	3,34	140	210	33	2	2	25	152	199
HCB7028-C-T-P4S	•	2,79	140	210	33	2	2	15	152	199
HCB7028-E-T-P4S	•	2,78	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
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-E-T-P4S		2,49	150	210	28	2	1	25	160	199
B71930-C-T-P4S		2,49	150	210	28	2	1	15	160	199
HCB71930-C-T-P4S		2,09	150	210	28	2	1	15	160	199
HCB71930-E-T-P4S		2,09	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
B71932-C-T-P4S		2,63	160	220	28	2	1	15	170	209
B71932-E-T-P4S		2,62	160	220	28	2	1	25	170	209
HCB71932-C-T-P4S		2,21	160	220	28	2	1	15	170	209
HCB71932-E-T-P4S		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
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
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
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



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N	N	N	N	N/μm	N/μm	N/μm
160,6	94000	77000	6700	10000	504	1632	3289	1539	5357	11496	124	208	295
160,6	89000	73000	6000	9500	736	2564	5373	2136	7663	16542	292	466	628
160,6	94000	74000	9500	14000	259	901	1876	767	2806	6135	107	177	246
160,6	89000	70000	8500	13000	348	1367	2967	999	3997	8852	253	413	554
169,2	153000	114000	6300	10000	866	2724	5429	2661	9007	19129	142	237	335
169,2	145000	108000	5600	9000	1336	4416	9103	3888	13252	28168	339	532	714
169,2	153000	109000	9000	14000	471	1553	3179	1402	4871	10483	125	203	282
169,2	145000	103000	8000	12000	685	2429	5123	1968	7126	15352	302	476	633
187	224000	164000	5000	7500	1353	4185	8302	4158	13825	29200	155	257	362
187	213000	157000	4500	6700	2141	6870	14029	6233	20615	43390	373	579	775
187	224000	157000	6300	9500	749	2397	4864	2230	7516	16017	137	220	304
187	214000	150000	5300	8000	1141	3839	7968	3284	11267	23876	336	521	689
174,9	119000	95000	5600	8500	1040	3522	7317	3021	10536	22549	331	524	704
174,9	125000	101000	6300	9500	706	2249	4507	2161	7402	15795	141	235	333
174,9	126000	96000	8500	13000	376	1268	2617	1117	3963	8587	123	201	279
174,9	119000	91000	7500	12000	527	1950	4164	1513	5709	12445	294	470	627
181	187000	137000	6000	9000	1104	3443	6843	3394	11397	24140	156	260	367
181	178000	130000	5300	8000	1691	5520	11332	4923	16566	35067	371	580	778
181	188000	131000	8000	13000	602	1958	3992	1793	6146	13171	137	222	308
181	178000	125000	7500	11000	889	3079	6448	2556	9036	19329	333	522	692
201,9	232000	178000	4500	6700	1401	4337	8611	4299	14296	30211	163	269	380
201,9	221000	169000	4000	6000	2173	6987	14280	6322	20936	44075	390	605	808
201,9	232000	170000	6000	8500	761	2440	4958	2262	7633	16272	143	230	317
201,9	221000	162000	5000	7500	1167	3935	8175	3355	11539	24467	352	546	722
184,7	128000	106000	6000	9000	722	2304	4619	2209	7572	16164	145	243	344
184,7	121000	100000	5300	8000	1055	3579	7439	3062	10696	22899	341	539	725
184,7	128000	101000	8000	12000	374	1265	2614	1108	3944	8551	126	206	285
184,7	121000	96000	7500	11000	521	1940	4152	1495	5676	12392	301	481	642
193,4	192000	146000	5600	8500	1145	3574	7107	3520	11821	25044	163	271	384
193,4	182000	138000	5000	7500	1715	5606	11519	4988	16807	35587	385	601	806
193,4	193000	140000	7500	12000	609	1986	4053	1812	6221	13337	142	230	318
193,4	183000	132000	7000	11000	898	3121	6545	2581	9154	19595	345	541	717
216,9	249000	202000	4300	6300	1502	4659	9263	4601	15309	32375	179	295	416
216,9	236000	192000	3800	5600	2326	7493	15324	6760	22418	47204	429	665	888
216,9	249000	193000	5300	8000	827	2657	5402	2457	8298	17692	158	254	350
216,9	237000	184000	4500	6700	1235	4183	8703	3550	12254	26003	387	599	792

### 2.2.2 Spindle bearings

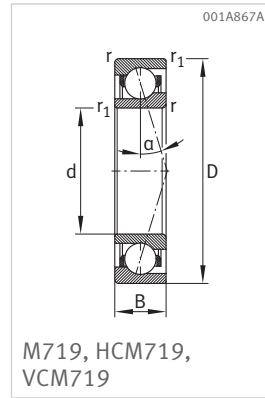
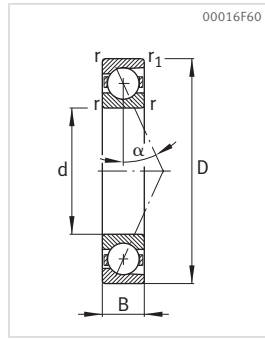
With large, medium or small balls

Steel balls or ceramic balls

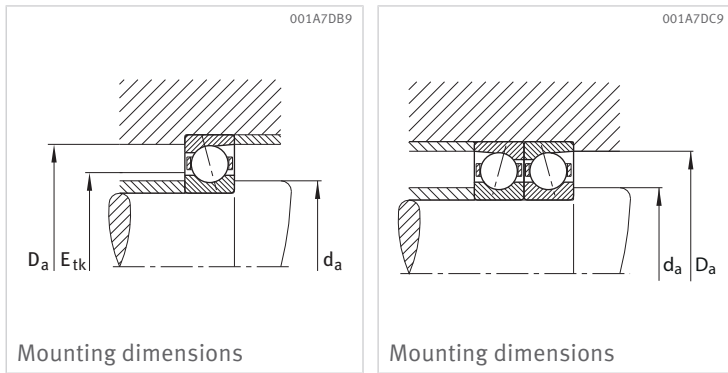
Steel rings or Vacrodur rings

open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	►91 ◻56	kg	mm	mm	mm	mm	mm	°	mm	mm
B71934-C-T-P4S	•	2,79	170	230	28	2	1	15	180	219
B71934-E-T-P4S	•	2,78	170	230	28	2	1	25	180	219
HCB71934-C-T-P4S	•	2,33	170	230	28	2	1	15	180	219
HCB71934-E-T-P4S	•	2,32	170	230	28	2	1	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
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



$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
194,7	133000	115000	5600	8500	742	2375	4770	2266	7779	16624	154	256	362
194,7	126000	108000	5000	7500	1105	3757	7816	3206	11221	24031	364	575	773
194,7	133000	110000	7500	12000	385	1306	2703	1138	4063	8815	133	217	301
194,7	126000	104000	7000	11000	534	2004	4295	1533	5856	12804	318	510	681
206,9	241000	189000	5300	8000	1448	4488	8919	4439	14768	31222	171	282	397
206,9	229000	180000	4500	7000	2250	7240	14802	6541	21677	45639	409	635	848
230,4	300000	255000	3800	5600	1864	5749	11422	5698	18828	39747	189	311	436
230,4	285000	241000	3600	5300	2860	9126	18610	8307	27255	57164	452	699	930
209	171000	146000	5300	8000	960	3036	6076	2933	9953	21191	168	279	394
209	162000	138000	4500	7000	1468	4890	10108	4263	14618	31112	402	630	845
209	171000	139000	7000	11000	519	1726	3546	1540	5380	11597	148	240	332
209	162000	132000	6300	10000	731	2635	5587	2098	7710	16669	354	561	746
221,9	248000	203000	4800	7500	1502	4659	9263	4601	15309	32375	179	295	416
221,9	236000	193000	4300	6700	2326	7493	15324	6760	22418	47204	429	665	888
240,4	310000	270000	3800	5600	1891	5843	11625	5771	19076	40296	197	323	453
240,4	295000	260000	3400	5000	2957	9444	19266	8585	28184	59117	475	733	976
218,9	174000	152000	5000	7500	888	2947	5992	2700	9612	20790	166	281	398
218,9	164000	144000	4500	6700	1250	4547	9653	3619	13545	29595	388	627	847
218,9	174000	146000	6700	10000	450	1629	3436	1328	5053	11178	143	239	334
218,9	165000	138000	6000	9500	557	2383	5290	1596	6951	15738	331	554	747
231,8	255000	215000	4500	7000	1436	4599	9248	4377	15038	32154	181	302	426
231,8	243000	204000	4000	6300	2128	7254	15104	6172	21646	46379	429	678	910
255,3	320000	290000	3400	5000	1846	5864	11779	5614	19073	40669	201	333	468
255,3	305000	275000	3200	4800	2797	9366	19397	8105	27894	59391	482	755	1010
233,1	210000	179000	4500	7000	1127	3678	7439	3433	12027	25875	180	302	427
233,1	199000	170000	4000	6300	1635	5765	12127	4737	17199	37246	423	676	911
233,1	211000	171000	6300	10000	571	2012	4211	1688	6249	13711	154	256	355
233,1	199000	162000	5600	9000	768	3083	6732	2202	9005	20060	366	601	806
245,4	310000	270000	4300	6700	1791	5681	11402	5451	18508	39448	192	318	448
245,4	295000	260000	3800	6000	2711	9065	18765	7860	27018	57509	460	722	965
270,1	330000	310000	3200	4800	1902	6047	12156	5777	19638	41892	210	347	488
270,1	315000	295000	3000	4500	2882	9666	20030	8349	28771	61275	503	789	1055

### 2.2.2 Spindle bearings

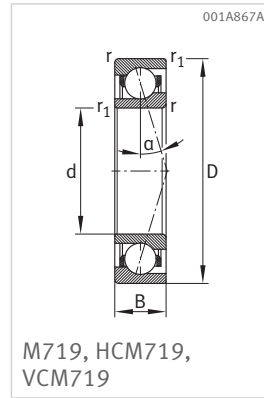
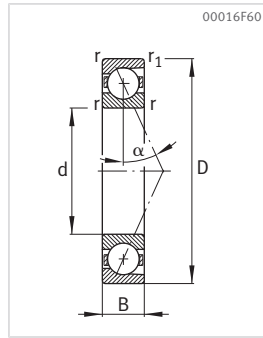
With large, medium or small balls

Steel balls or ceramic balls

Steel rings or Vacrodur rings

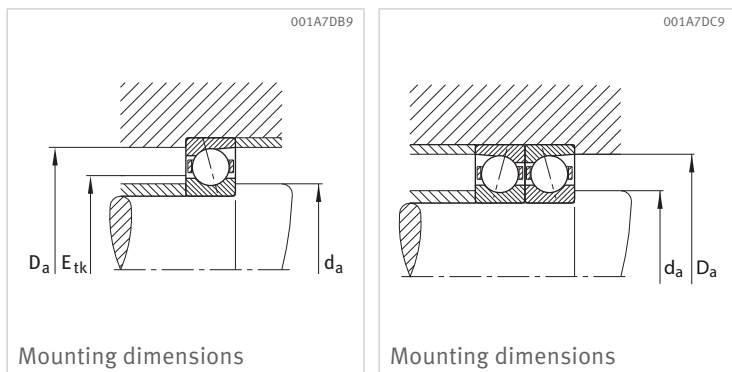
open

sealed



Short designation	Sealed variants (•)	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	▶91 □56	kg	mm	mm	mm	mm	mm	°	mm	mm
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
B71948-C-T-P4S		7,1	240	320	38	2,1	1,1	15	254	307
B71948-E-T-P4S		7,08	240	320	38	2,1	1,1	25	254	307
B7048-C-T-P4S		16,8	240	360	56	3	3	15	260	341
B7048-E-T-P4S		16,7	240	360	56	3	3	25	260	341
B71952-C-T-P4S		12	260	360	46	2,1	1,1	15	278	342
B71956-C-T-P4S		12,9	280	380	46	2,1	1,1	15	298	362
B71960-C-T-P4S		20	300	420	56	3	1,1	15	322	398





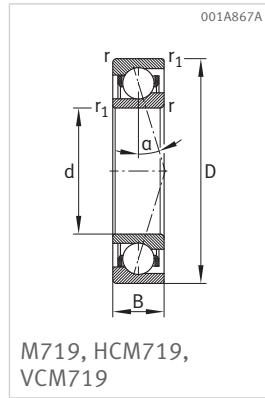
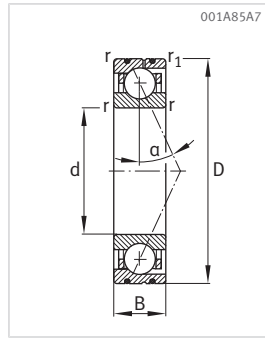
$E_{tk}$	$C_r$	$C_{or}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE L}$	$K_{aE M}$	$K_{aE H}$	$c_a L$	$c_a M$	$c_a H$
Nom.	N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
253,1	224000	203000	4300	6700	1185	3886	7879	3600	12649	27258	196	329	465
253,1	212000	192000	3800	6000	1705	6060	12777	4937	18042	39132	461	739	995
253,1	224000	194000	6000	9000	606	2147	4503	1788	6651	14612	169	280	390
253,1	212000	184000	5300	8000	779	3184	6985	2232	9284	20766	396	653	877
270,1	330000	310000	4000	6000	1902	6047	12156	5777	19638	41892	210	347	488
270,1	315000	295000	3600	5300	2882	9666	20030	8349	28771	61275	503	789	1055
298,2	405000	400000	2800	4300	2387	7527	15105	7238	24345	51776	224	368	515
298,2	385000	380000	2600	4000	3642	12021	24787	10546	35720	75626	540	840	1119
272,9	231000	220000	4000	6000	1224	4024	8171	3712	13066	28181	207	347	490
272,9	218000	208000	3600	5300	1760	6279	13255	5092	18673	40536	488	781	1052
290	340000	330000	3600	5600	1957	6231	12533	5940	20205	43114	219	361	507
290	320000	310000	3200	5000	2914	9801	20327	8437	29140	62090	521	817	1092
301,4	295000	290000	3600	5300	1615	5221	10556	4894	16900	36243	222	368	518
321,2	305000	320000	3200	5000	1696	5491	11113	5134	17744	38073	236	392	551
349,7	370000	405000	3000	4500	2084	6676	13480	6297	21485	45930	249	409	574

### 2.2.3 Spindle bearings, design DLR

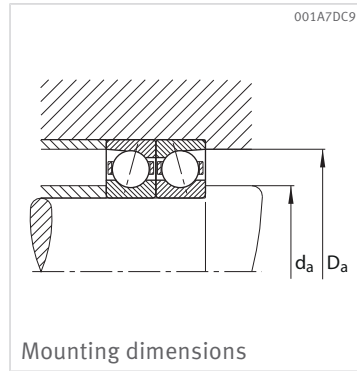
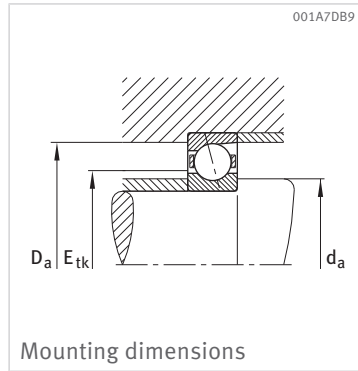
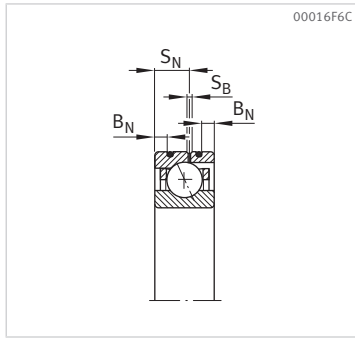
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB7004-CDLR-T-P4S	0,06	20	42	12	0,6	0,6	2,2	6,6	1,4	15	25	37
HCB7004-EDLR-T-P4S	0,06	20	42	12	0,6	0,6	2,2	6,6	1,4	25	25	37
HC7004-EDLR-T-P4S	0,072	20	42	12	0,6	0,6	2,2	6,6	1,4	25	25	37
HCM71905-CDLR-T-P4S-XL	0,034	25	42	9	0,3	0,15	1,4	5,35	1	17	29	38,5
HCM71905-EDLR-T-P4S-XL	0,034	25	42	9	0,3	0,15	1,4	5,35	1	25	29	38,5
VCM71905-CDLR-T-P4S-XL	0,034	25	42	9	0,3	0,15	1,4	5,35	1	17	29	38,5
VCM71905-EDLR-T-P4S-XL	0,034	25	42	9	0,3	0,15	1,4	5,35	1	25	29	38,5
HCB7005-CDLR-T-P4S	0,064	25	47	12	0,6	0,6	2,2	6,6	1,4	15	30	42
HCB7005-EDLR-T-P4S	0,064	25	47	12	0,6	0,6	2,2	6,6	1,4	25	30	42
HC7005-EDLR-T-P4S	0,083	25	47	12	0,6	0,6	2,2	6,6	1,4	25	30	42
HCM7005-CDLR-T-P4S-XL	0,069	25	47	12	0,6	0,3	1,6	6,95	1	17	30	42
HCM7005-EDLR-T-P4S-XL	0,069	25	47	12	0,6	0,3	1,6	6,95	1	25	30	42
VCM7005-CDLR-T-P4S-XL	0,069	25	47	12	0,6	0,3	1,6	6,95	1	17	30	42
VCM7005-EDLR-T-P4S-XL	0,069	25	47	12	0,6	0,3	1,6	6,95	1	25	30	42
HCB71906-CDLR-T-P4S	0,043	30	47	9	0,3	0,3	1,1	5,3	1,4	15	34	43,5
HCB71906-EDLR-T-P4S	0,043	30	47	9	0,3	0,3	1,1	5,3	1,4	25	34	43,5
HC71906-EDLR-T-P4S	0,044	30	47	9	0,3	0,3	1,1	5,3	1,4	25	34	43,5
HCM71906-CDLR-T-P4S-XL	0,039	30	47	9	0,3	0,15	1,4	5,35	1	17	34	43,5
HCM71906-EDLR-T-P4S-XL	0,039	30	47	9	0,3	0,15	1,4	5,35	1	25	34	43,5
VCM71906-CDLR-T-P4S-XL	0,039	30	47	9	0,3	0,15	1,4	5,35	1	17	34	43,5
VCM71906-EDLR-T-P4S-XL	0,039	30	47	9	0,3	0,15	1,4	5,35	1	25	34	43,5
HCB7006-CDLR-T-P4S	0,1	30	55	13	1	1	2,8	7,2	1,4	15	36	49
HCB7006-EDLR-T-P4S	0,1	30	55	13	1	1	2,8	7,2	1,4	25	36	49
HC7006-EDLR-T-P4S	0,118	30	55	13	1	1	2,8	7,2	1,4	25	36	49
HCM7006-CDLR-T-P4S-XL	0,11	30	55	13	1	0,6	2,4	7,4	1	17	36	49
HCM7006-EDLR-T-P4S-XL	0,11	30	55	13	1	0,6	2,4	7,4	1	25	36	49
VCM7006-CDLR-T-P4S-XL	0,11	30	55	13	1	0,6	2,4	7,4	1	17	36	49
VCM7006-EDLR-T-P4S-XL	0,11	30	55	13	1	0,6	2,4	7,4	1	25	36	49



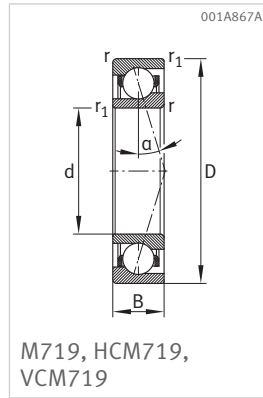
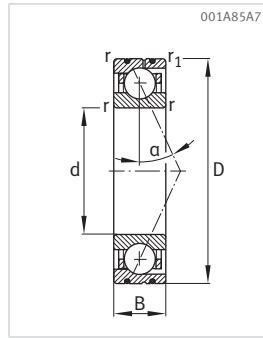
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
10300	4050	53000	80000	24	94	202	72	297	673	18,7	32,7	46,6
9800	3900	48000	75000	28	140	321	80	410	966	42	74,7	103
5400	2470	60000	95000	23	70	140	67	204	415	48,8	72,3	93,7
6600	2650	61200	89600	21	54	114	60	161	348	24	34	45
6300	2550	58300	83600	30	77	161	85	224	472	48	67	88
15700	3700	62700	98600	18	49	102	54	144	310	23	33	45
15100	3550	59800	89600	27	70	145	76	201	422	48	67	87
13700	5600	45000	70000	35	132	283	104	419	944	24,6	42,5	60,2
13100	5400	40000	63000	40	194	443	117	573	1338	55,4	96,9	133
5500	2700	53000	80000	23	70	140	67	204	415	50,4	74,7	96,7
8000	3150	57000	83400	24	64	133	70	189	407	24	34	46
7700	3000	54200	77800	35	91	190	100	264	555	49	69	90
19200	4400	58400	91700	22	57	119	63	169	362	24	34	46
18400	4200	55600	83400	31	82	170	90	236	497	49	68	89
8500	4200	43000	67000	14	68	155	40	210	504	21,1	40	58,3
8100	3950	38000	60000	22	112	258	60	322	768	52,5	95,1	132
5600	2850	48000	75000	24	72	143	69	209	425	52,5	77,7	101
6900	3050	53300	78000	24	62	131	69	186	400	27	38	51
6600	2900	50700	72800	34	89	185	97	257	541	54	76	99
16700	4250	54600	85800	21	56	117	62	166	356	26	38	51
15900	4100	52000	78000	30	80	166	87	230	484	54	75	98
14400	6400	38000	60000	35	137	293	104	431	976	26,9	47	67,1
13700	6100	34000	53000	42	203	465	117	592	1395	60,1	107	147
7800	3850	43000	67000	33	98	197	94	287	583	60	88,8	115
8900	3900	48300	70600	30	79	166	87	235	507	29	42	56
8500	3700	45900	65900	43	113	235	124	327	689	59	83	109
21400	5400	49500	77700	27	71	148	78	210	450	29	41	55
20400	5200	47100	70600	39	102	211	111	293	616	59	83	108

### 2.2.3 Spindle bearings, design DLR

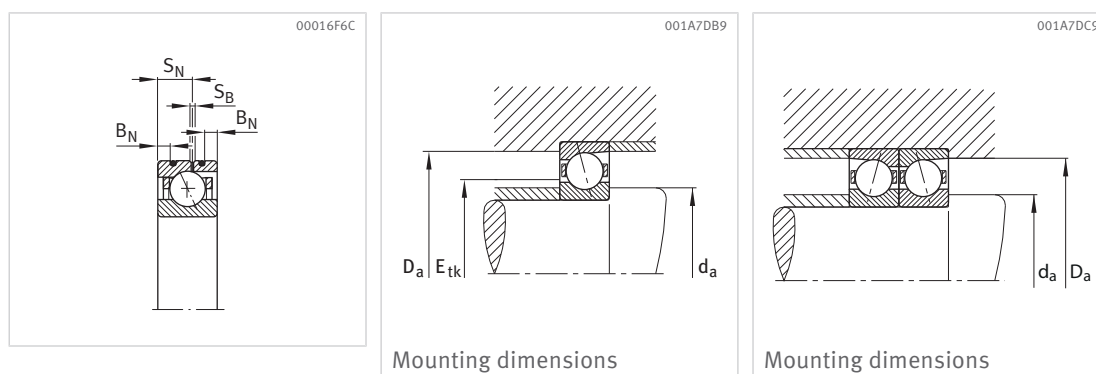
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71907-CDLR-T-P4S	0,065	35	55	10	0,6	0,6	1,6	5,8	1,4	15	40	51,5
HCB71907-EDLR-T-P4S	0,065	35	55	10	0,6	0,6	1,6	5,8	1,4	25	40	51,5
HC71907-EDLR-T-P4S	0,074	35	55	10	0,6	0,6	1,6	5,8	1,4	25	40	51,5
HCM71907-CDLR-T-P4S-XL	0,061	35	55	10	0,6	0,3	2	5,9	1,4	17	40	51,5
HCM71907-EDLR-T-P4S-XL	0,061	35	55	10	0,6	0,3	2	5,9	1,4	25	40	51,5
VCM71907-CDLR-T-P4S-XL	0,061	35	55	10	0,6	0,3	2	5,9	1,4	17	40	51,5
VCM71907-EDLR-T-P4S-XL	0,061	35	55	10	0,6	0,3	2	5,9	1,4	25	40	51,5
HCB7007-CDLR-T-P4S	0,134	35	62	14	1	1	2,8	8	1,4	15	41	56
HCB7007-EDLR-T-P4S	0,134	35	62	14	1	1	2,8	8	1,4	25	41	56
HC7007-EDLR-T-P4S	0,162	35	62	14	1	1	2,8	8	1,4	25	41	56
HCM7007-CDLR-T-P4S-XL	0,14	35	62	14	1	0,6	2,4	8,05	1,4	17	41	56
HCM7007-EDLR-T-P4S-XL	0,14	35	62	14	1	0,6	2,4	8,05	1,4	25	41	56
VCM7007-CDLR-T-P4S-XL	0,14	35	62	14	1	0,6	2,4	8,05	1,4	17	41	56
VCM7007-EDLR-T-P4S-XL	0,14	35	62	14	1	0,6	2,4	8,05	1,4	25	41	56
HCB71908-CDLR-T-P4S	0,086	40	62	12	0,6	0,6	2,2	6,6	1,4	15	45	58,5
HCB71908-EDLR-T-P4S	0,086	40	62	12	0,6	0,6	2,2	6,6	1,4	25	45	58,5
HC71908-EDLR-T-P4S	0,119	40	62	12	0,6	0,6	2,2	6,6	1,4	25	45	58,5
HCM71908-CDLR-T-P4S-XL	0,089	40	62	12	0,6	0,3	2,2	6,9	1,4	17	45	58,5
HCM71908-EDLR-T-P4S-XL	0,089	40	62	12	0,6	0,3	2,2	6,9	1,4	25	45	58,5
VCM71908-CDLR-T-P4S-XL	0,089	40	62	12	0,6	0,3	2,2	6,9	1,4	17	45	58,5
VCM71908-EDLR-T-P4S-XL	0,089	40	62	12	0,6	0,3	2,2	6,9	1,4	25	45	58,5
HCB7008-CDLR-T-P4S	0,164	40	68	15	1	1	2,8	8,5	1,4	15	46	62
HCB7008-EDLR-T-P4S	0,164	40	68	15	1	1	2,8	8,5	1,4	25	46	62
HC7008-EDLR-T-P4S	0,202	40	68	15	1	1	2,8	8,5	1,4	25	46	62
HCM7008-CDLR-T-P4S-XL	0,18	40	68	15	1	0,6	2,6	8,55	1,4	17	46	62
HCM7008-EDLR-T-P4S-XL	0,18	40	68	15	1	0,6	2,6	8,55	1,4	25	46	62
VCM7008-CDLR-T-P4S-XL	0,18	40	68	15	1	0,6	2,6	8,55	1,4	17	46	62
VCM7008-EDLR-T-P4S-XL	0,18	40	68	15	1	0,6	2,6	8,55	1,4	25	46	62



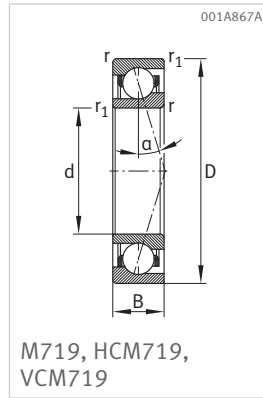
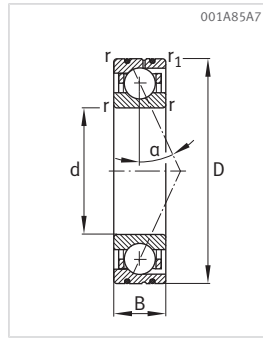
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
12100	6500	36000	56000	21	96	213	63	301	709	26,7	49,1	71
11500	6200	32000	50000	33	158	359	95	463	1081	66,7	117	161
6100	3450	40000	63000	26	78	155	74	226	459	60,5	89,4	116
9500	4350	45600	66700	34	89	186	98	264	569	33	47	63
9000	4200	43400	62300	48	127	264	139	367	773	66	93	121
22700	6100	46700	73400	30	79	166	88	235	506	32	46	62
21700	5900	44500	66700	44	114	237	125	329	692	66	92	120
19400	9200	34000	53000	46	175	372	138	558	1255	32	55,5	78,9
18500	8800	30000	45000	54	257	585	157	761	1771	72,1	126	173
8400	4500	38000	60000	35	105	210	101	307	623	67,3	99,5	129
11300	5000	42300	61900	39	103	217	114	307	663	33	48	64
10800	4850	40300	57800	57	148	308	162	428	901	68	95	124
27000	7100	43300	68100	35	93	194	102	274	589	33	47	63
26000	6800	41300	61900	51	133	276	145	383	806	68	95	123
18100	9400	32000	50000	39	156	337	116	494	1127	33,5	59,2	84,7
17200	9000	28000	45000	41	220	514	117	645	1548	72,4	132	183
6400	3900	36000	56000	27	82	164	78	238	484	66,4	98	127
11600	5400	40200	58900	42	110	231	121	327	706	35	51	68
11100	5100	38300	55000	60	157	327	172	456	960	72	101	132
28000	7500	41200	64800	37	99	207	109	292	628	35	50	67
26500	7200	39300	58900	54	141	294	155	408	858	72	100	131
20900	10700	30000	45000	49	188	402	146	597	1350	36,1	63,1	89,9
19900	10200	28000	43000	55	271	622	159	797	1875	80	142	195
8900	5200	34000	53000	37	110	221	106	321	652	74,2	110	142
11900	5700	38000	55600	44	117	245	129	348	751	37	54	72
11400	5500	36200	51900	64	167	348	183	484	1020	76	107	139
28500	8000	38900	61200	40	105	220	116	311	668	37	53	71
27500	7700	37100	55600	57	150	312	164	434	912	76	106	138

### 2.2.3 Spindle bearings, design DLR

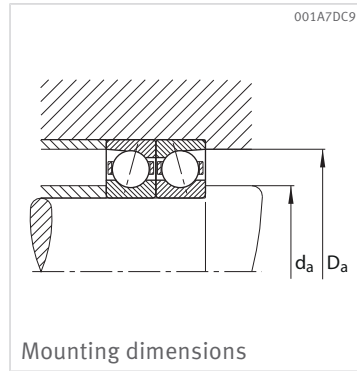
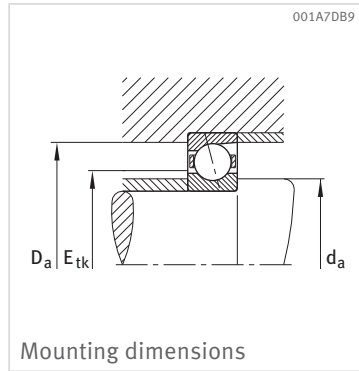
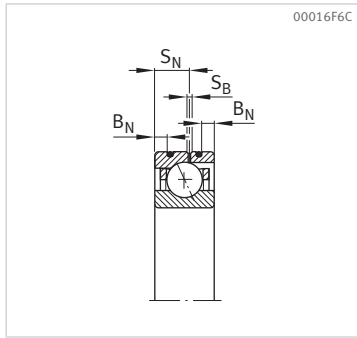
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71909-CDLR-T-P4S	0,107	45	68	12	0,6	0,6	2,2	6,6	1,4	15	50	63,5
HCB71909-EDLR-T-P4S	0,107	45	68	12	0,6	0,6	2,2	6,6	1,4	25	50	63,5
HC71909-EDLR-T-P4S	0,129	45	68	12	0,6	0,6	2,2	6,6	1,4	25	50	63,5
HCM71909-CDLR-T-P4S-XL	0,11	45	68	12	0,6	0,3	2,2	6,9	1,4	17	50	63,5
HCM71909-EDLR-T-P4S-XL	0,11	45	68	12	0,6	0,3	2,2	6,9	1,4	25	50	63,5
VCM71909-CDLR-T-P4S-XL	0,11	45	68	12	0,6	0,3	2,2	6,9	1,4	17	50	63,5
VCM71909-EDLR-T-P4S-XL	0,11	45	68	12	0,6	0,3	2,2	6,9	1,4	25	50	63,5
HCB7009-CDLR-T-P4S	0,191	45	75	16	1	1	3,4	9,3	1,4	15	51	69
HCB7009-EDLR-T-P4S	0,191	45	75	16	1	1	3,4	9,3	1,4	25	51	69
HC7009-EDLR-T-P4S	0,248	45	75	16	1	1	3,4	9,3	1,4	25	51	69
HCM7009-CDLR-T-P4S-XL	0,23	45	75	16	1	0,6	2,6	9,3	1,4	17	51	69
HCM7009-EDLR-T-P4S-XL	0,23	45	75	16	1	0,6	2,6	9,3	1,4	25	51	69
VCM7009-CDLR-T-P4S-XL	0,23	45	75	16	1	0,6	2,6	9,3	1,4	17	51	69
VCM7009-EDLR-T-P4S-XL	0,23	45	75	16	1	0,6	2,6	9,3	1,4	25	51	69
HCB71910-CDLR-T-P4S	0,102	50	72	12	0,6	0,6	2,2	6,6	1,4	15	55	67,5
HCB71910-EDLR-T-P4S	0,102	50	72	12	0,6	0,6	2,2	6,6	1,4	25	55	67,5
HC71910-EDLR-T-P4S	0,13	50	72	12	0,6	0,6	2,2	6,6	1,4	25	55	67,5
HCM71910-CDLR-T-P4S-XL	0,11	50	72	12	0,6	0,3	2,2	7	1,4	17	55	67,5
HCM71910-EDLR-T-P4S-XL	0,11	50	72	12	0,6	0,3	2,2	7	1,4	25	55	67,5
VCM71910-CDLR-T-P4S-XL	0,11	50	72	12	0,6	0,3	2,2	7	1,4	17	55	67,5
VCM71910-EDLR-T-P4S-XL	0,11	50	72	12	0,6	0,3	2,2	7	1,4	25	55	67,5
HCB7010-CDLR-T-P4S	0,205	50	80	16	1	1	3,4	9,3	1,4	15	56	74
HCB7010-EDLR-T-P4S	0,206	50	80	16	1	1	3,4	9,3	1,4	25	56	74
HC7010-EDLR-T-P4S	0,262	50	80	16	1	1	3,4	9,3	1,4	25	56	74
HCM7010-CDLR-T-P4S-XL	0,26	50	80	16	1	0,6	2,6	9,3	1,4	17	56	74
HCM7010-EDLR-T-P4S-XL	0,26	50	80	16	1	0,6	2,6	9,3	1,4	25	56	74
VCM7010-CDLR-T-P4S-XL	0,26	50	80	16	1	0,6	2,6	9,3	1,4	17	56	74
VCM7010-EDLR-T-P4S-XL	0,26	50	80	16	1	0,6	2,6	9,3	1,4	25	56	74



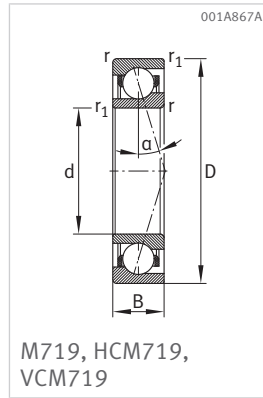
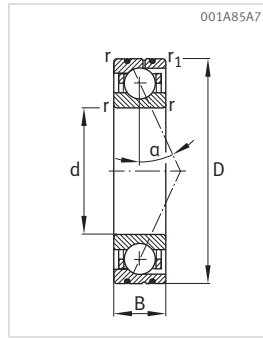
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N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$	$\text{N}/\mu\text{m}$
19200	10700	28000	45000	40	164	355	120	516	1182	36,2	64,1	91,7
18200	10200	26000	40000	42	233	547	121	682	1643	78,5	144	200
9100	5400	32000	50000	38	113	226	108	329	667	76,6	113	146
12300	6000	36300	53100	47	124	260	136	368	795	39	57	76
11700	5800	34600	49600	68	177	368	194	512	1078	80	112	146
29500	8500	37200	58500	42	111	232	122	329	707	39	56	75
28000	8100	35400	53100	61	159	330	174	459	964	80	111	145
28000	14300	26000	40000	71	261	549	212	827	1843	41,9	71,9	102
26500	13600	24000	38000	89	389	869	254	1145	2622	95,8	163	223
11600	6800	30000	48000	48	143	286	137	417	848	84,4	125	161
12900	6700	33700	49200	52	137	288	151	408	881	43	62	84
12300	6400	32000	46000	75	196	407	214	567	1194	88	123	161
31000	9400	34500	54100	47	123	258	135	364	784	43	62	82
29500	9000	32800	49200	67	176	365	192	508	1068	88	123	160
19600	11400	26000	40000	41	167	362	121	525	1205	37,5	66,4	95
18600	10800	24000	36000	40	229	542	115	671	1626	79,7	148	205
9400	5800	30000	48000	39	116	231	110	336	682	80,9	119	154
12900	6700	33700	49200	52	137	288	151	408	881	43	62	84
12300	6400	32000	46000	75	196	407	214	567	1194	88	123	161
31000	9400	34500	54100	47	123	258	135	364	784	43	62	82
29500	9000	32800	49200	67	176	365	192	508	1068	88	123	160
29000	15400	24000	38000	73	268	566	217	848	1894	43,9	75,3	107
27500	14700	22000	34000	90	400	895	259	1175	2697	100	171	234
12100	7400	28000	43000	50	149	298	143	435	883	90	133	172
13100	7100	31600	46200	55	144	303	159	430	928	45	65	88
12500	6700	30000	43100	79	206	429	225	596	1257	92	129	169
31500	9900	32400	50800	49	129	271	143	384	825	45	64	86
30000	9400	30800	46200	71	185	385	202	534	1124	92	128	167

### 2.2.3 Spindle bearings, design DLR

With large, medium or small balls

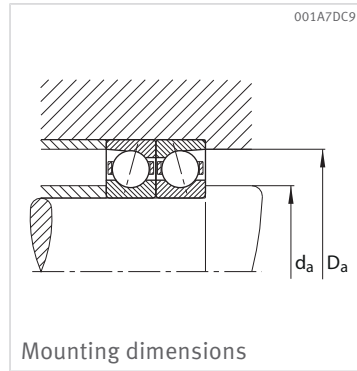
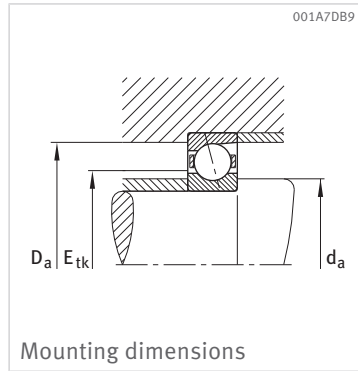
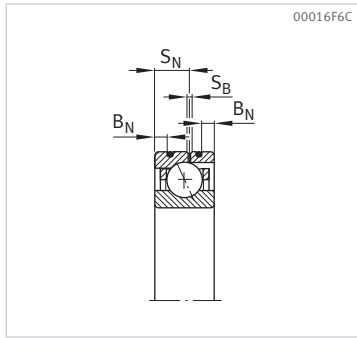
Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71911-CDLR-T-P4S	0,14	55	80	13	1	1	2,8	7,2	1,4	15	60	75,5
HCB71911-EDLR-T-P4S	0,14	55	80	13	1	1	2,8	7,2	1,4	25	60	75,5
HC71911-EDLR-T-P4S	0,166	55	80	13	1	1	2,8	7,2	1,4	25	60	75,5
HCM71911-CDLR-T-P4S-XL	0,13	55	80	13	1	0,6	2,8	7,6	1,4	17	60	75,5
HCM71911-EDLR-T-P4S-XL	0,13	55	80	13	1	0,6	2,8	7,6	1,4	25	60	75,5
VCM71911-CDLR-T-P4S-XL	0,13	55	80	13	1	0,6	2,8	7,6	1,4	17	60	75,5
VCM71911-EDLR-T-P4S-XL	0,13	55	80	13	1	0,6	2,8	7,6	1,4	25	60	75,5
HCB7011-CDLR-T-P4S	0,302	55	90	18	1,1	1,1	4,3	9,7	1,4	15	62	83
HCB7011-EDLR-T-P4S	0,302	55	90	18	1,1	1,1	4,3	9,7	1,4	25	62	83
HC7011-EDLR-T-P4S	0,378	55	90	18	1,1	1,1	4,3	9,7	1,4	25	62	83
HCM7011-CDLR-T-P4S-XL	0,36	55	90	18	1,1	0,6	2,8	10,15	1,4	17	62	83
HCM7011-EDLR-T-P4S-XL	0,36	55	90	18	1,1	0,6	2,8	10,15	1,4	25	62	83
VCM7011-CDLR-T-P4S-XL	0,36	55	90	18	1,1	0,6	2,8	10,15	1,4	17	62	83
VCM7011-EDLR-T-P4S-XL	0,36	55	90	18	1,1	0,6	2,8	10,15	1,4	25	62	83
HCB71912-CDLR-T-P4S	0,151	60	85	13	1	1	2,8	7,2	1,4	15	65	80,5
HCB71912-EDLR-T-P4S	0,151	60	85	13	1	1	2,8	7,2	1,4	25	65	80,5
HC71912-EDLR-T-P4S	0,18	60	85	13	1	1	2,8	7,2	1,4	25	65	80,5
HCM71912-CDLR-T-P4S-XL	0,14	60	85	13	1	0,6	2,8	7,6	1,4	17	65	80,5
HCM71912-EDLR-T-P4S-XL	0,14	60	85	13	1	0,6	2,8	7,6	1,4	25	65	80,5
VCM71912-CDLR-T-P4S-XL	0,14	60	85	13	1	0,6	2,8	7,6	1,4	17	65	80,5
VCM71912-EDLR-T-P4S-XL	0,14	60	85	13	1	0,6	2,8	7,6	1,4	25	65	80,5
HCB7012-CDLR-T-P4S	0,326	60	95	18	1,1	1,1	4,3	9,7	1,4	15	67	88
HCB7012-EDLR-T-P4S	0,326	60	95	18	1,1	1,1	4,3	9,7	1,4	25	67	88
HC7012-EDLR-T-P4S	0,404	60	95	18	1,1	1,1	4,3	9,7	1,4	25	67	88
HCM7012-CDLR-T-P4S-XL	0,39	60	95	18	1,1	0,6	2,8	10,15	1,4	17	67	88
HCM7012-EDLR-T-P4S-XL	0,39	60	95	18	1,1	0,6	2,8	10,15	1,4	25	67	88
VCM7012-CDLR-T-P4S-XL	0,39	60	95	18	1,1	0,6	2,8	10,15	1,4	17	67	88
VCM7012-EDLR-T-P4S-XL	0,39	60	95	18	1,1	0,6	2,8	10,15	1,4	25	67	88





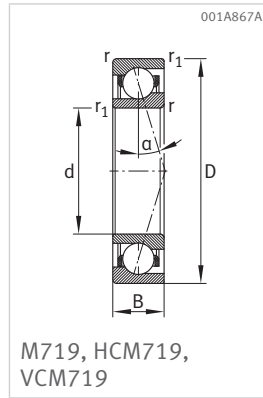
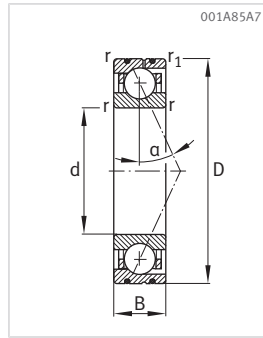
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
23500	13800	24000	36000	53	208	447	157	654	1487	42,4	74,1	106
22300	13100	22000	32000	57	296	686	164	867	2058	93	167	230
12300	7700	28000	43000	51	152	304	145	442	897	92,7	137	177
18500	9500	30400	44500	73	194	406	213	576	1243	49	71	95
17700	9100	28900	41500	106	277	575	303	801	1687	100	140	183
44500	13300	31200	48900	66	174	363	191	514	1105	49	70	94
42500	12700	29700	44500	95	249	516	272	718	1509	100	139	182
39000	21200	22000	34000	102	366	765	305	1158	2559	51,9	87,9	124
37000	20100	20000	30000	136	562	1236	390	1653	3728	121	203	275
17000	10400	26000	40000	70	210	421	201	613	1244	105	155	201
19500	10500	28300	41400	81	214	450	236	638	1378	54	78	105
18600	10000	26900	38700	117	306	637	335	887	1869	110	154	201
46500	14700	29000	45600	73	192	403	212	570	1225	54	77	103
44500	14000	27600	41400	105	275	572	301	794	1671	109	153	200
24700	15300	22000	34000	54	214	462	159	671	1530	45,1	79	112
23400	14500	20000	30000	57	303	707	163	887	2118	98,5	179	246
12700	8300	26000	40000	52	155	311	148	452	917	97,7	144	186
19500	10500	28300	41400	81	214	450	236	638	1378	54	78	105
18600	10000	26900	38700	117	306	637	335	887	1869	110	154	201
46500	14700	29000	45600	73	192	403	212	570	1225	54	77	103
44500	14000	27600	41400	105	275	572	301	794	1671	109	153	200
40000	22700	20000	32000	106	379	794	315	1198	2651	54,4	92,2	130
38000	21600	19000	28000	136	569	1256	391	1673	3782	126	211	286
17600	11300	24000	36000	73	219	438	209	638	1294	112	165	213
19800	11100	26500	38800	86	226	474	249	673	1453	57	81	110
18900	10600	25200	36200	123	323	671	353	934	1968	115	161	211
47500	15500	27100	42600	77	203	424	223	601	1292	56	81	108
45500	14800	25900	38800	111	290	602	317	837	1760	115	160	209

### 2.2.3 Spindle bearings, design DLR

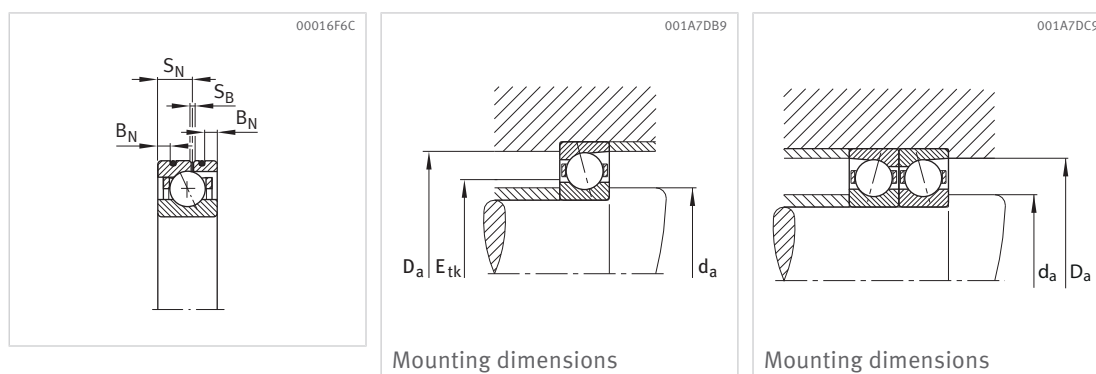
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71913-CDLR-T-P4S	0,161	65	90	13	1	1	2,8	7,2	1,4	15	70	85,5
HCB71913-EDLR-T-P4S	0,161	65	90	13	1	1	2,8	7,2	1,4	25	70	85,5
HC71913-EDLR-T-P4S	0,19	65	90	13	1	1	2,8	7,2	1,4	25	70	85,5
HCM71913-CDLR-T-P4S-XL	0,15	65	90	13	1	0,6	2,8	7,6	1,4	17	70	85,5
HCM71913-EDLR-T-P4S-XL	0,15	65	90	13	1	0,6	2,8	7,6	1,4	25	70	85,5
VCM71913-CDLR-T-P4S-XL	0,15	65	90	13	1	0,6	2,8	7,6	1,4	17	70	85,5
VCM71913-EDLR-T-P4S-XL	0,15	65	90	13	1	0,6	2,8	7,6	1,4	25	70	85,5
HCB7013-CDLR-T-P4S	0,343	65	100	18	1,1	1,1	4	10,4	1,4	15	72	93
HCB7013-EDLR-T-P4S	0,344	65	100	18	1,1	1,1	4	10,4	1,4	25	72	93
HC7013-EDLR-T-P4S	0,427	65	100	18	1,1	1,1	4	10,4	1,4	25	72	93
HCM7013-CDLR-T-P4S-XL	0,41	65	100	18	1,1	0,6	2,8	10,4	1,4	17	72	93
HCM7013-EDLR-T-P4S-XL	0,41	65	100	18	1,1	0,6	2,8	10,4	1,4	25	72	93
VCM7013-CDLR-T-P4S-XL	0,41	65	100	18	1,1	0,6	2,8	10,4	1,4	17	72	93
VCM7013-EDLR-T-P4S-XL	0,41	65	100	18	1,1	0,6	2,8	10,4	1,4	25	72	93
HCB71914-CDLR-T-P4S	0,268	70	100	16	1	1	3,1	9,3	1,4	15	76	94,5
HCB71914-EDLR-T-P4S	0,268	70	100	16	1	1	3,1	9,3	1,4	25	76	94,5
HC71914-EDLR-T-P4S	0,322	70	100	16	1	1	3,1	9,3	1,4	25	76	94,5
HCM71914-CDLR-T-P4S-XL	0,25	70	100	16	1	0,6	2,8	9,3	1,4	17	76	94,5
HCM71914-EDLR-T-P4S-XL	0,25	70	100	16	1	0,6	2,8	9,3	1,4	25	76	94,5
VCM71914-CDLR-T-P4S-XL	0,25	70	100	16	1	0,6	2,8	9,3	1,4	17	76	94,5
VCM71914-EDLR-T-P4S-XL	0,25	70	100	16	1	0,6	2,8	9,3	1,4	25	76	94,5
HCB7014-CDLR-T-P4S	0,48	70	110	20	1,1	1,1	4	11,6	1,4	15	77	102
HCB7014-EDLR-T-P4S	0,48	70	110	20	1,1	1,1	4	11,6	1,4	25	77	102
HC7014-EDLR-T-P4S	0,596	70	110	20	1,1	1,1	4	11,6	1,4	25	77	102
HCM7014-CDLR-T-P4S-XL	0,56	70	110	20	1,1	0,6	3	11,6	1,4	17	77	102
HCM7014-EDLR-T-P4S-XL	0,56	70	110	20	1,1	0,6	3	11,6	1,4	25	77	102
VCM7014-CDLR-T-P4S-XL	0,56	70	110	20	1,1	0,6	3	11,6	1,4	17	77	102
VCM7014-EDLR-T-P4S-XL	0,56	70	110	20	1,1	0,6	3	11,6	1,4	25	77	102



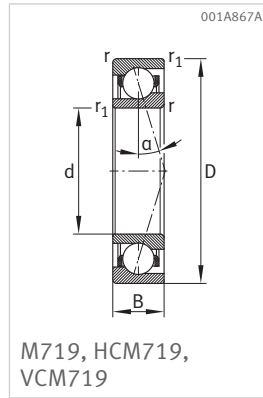
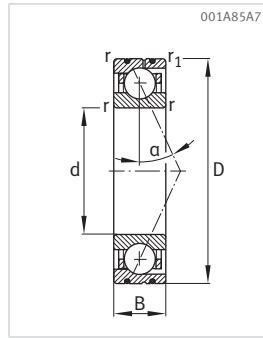
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
25000	16100	20000	32000	55	219	473	161	684	1562	46,6	81,7	116
23800	15300	19000	28000	58	309	723	165	904	2165	102	185	255
13000	8900	24000	36000	53	160	321	153	466	946	103	152	196
19800	11100	26500	38800	86	226	474	249	673	1453	57	81	110
18900	10600	25200	36200	123	323	671	353	934	1968	115	161	211
47500	15500	27100	42600	77	203	424	223	601	1292	56	81	108
45500	14800	25900	38800	111	290	602	317	837	1760	115	160	209
41500	24300	19000	30000	107	385	808	318	1213	2688	56,4	95,6	135
39500	23100	17000	26000	137	577	1276	392	1694	3836	131	219	297
18200	12200	22000	34000	74	223	445	213	647	1313	118	173	224
20100	11600	24900	36400	90	237	498	262	707	1528	59	85	115
19200	11100	23700	34000	129	339	705	371	981	2067	120	169	220
48000	16300	25500	40000	81	213	446	234	631	1358	59	84	113
46000	15500	24300	36400	116	304	632	333	879	1849	120	168	218
34500	22000	19000	28000	83	312	665	245	980	2200	55,5	95,3	135
32500	20800	17000	26000	98	459	1040	281	1343	3118	126	218	298
16800	11700	22000	34000	69	207	414	198	602	1221	117	173	223
27000	15000	24200	35300	116	306	641	337	910	1965	65	93	125
26000	14300	23000	33000	167	437	909	478	1265	2665	132	184	241
65000	21000	24800	38900	104	274	574	302	812	1747	64	92	123
62000	20100	23600	35300	150	393	816	429	1133	2383	131	183	239
50000	29500	18000	28000	139	487	1014	414	1538	3380	62,3	105	147
48000	28000	16000	24000	188	749	1633	540	2203	4915	147	242	326
23700	15600	20000	32000	98	293	587	280	853	1731	130	192	248
27500	15800	22800	33400	122	322	675	355	958	2069	68	97	131
26500	15100	21700	31200	176	460	956	503	1331	2804	138	193	252
66000	22100	23400	36700	110	289	605	318	855	1839	67	96	129
63000	21100	22300	33400	158	413	858	451	1192	2508	137	192	250

### 2.2.3 Spindle bearings, design DLR

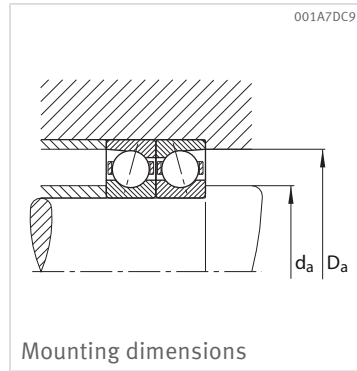
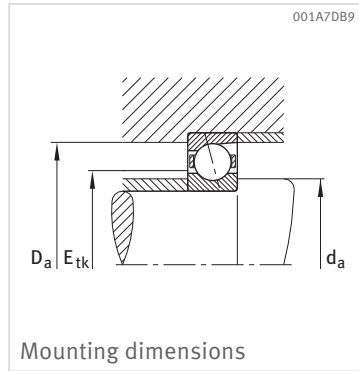
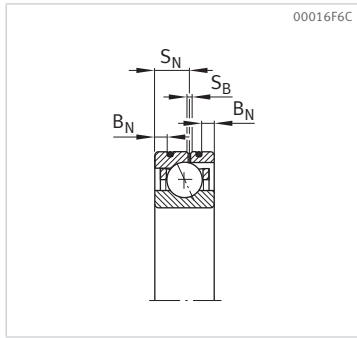
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71915-CDLR-T-P4S	0,277	75	105	16	1	1	3,1	9,3	1,4	15	81	99,5
HCB71915-EDLR-T-P4S	0,277	75	105	16	1	1	3,1	9,3	1,4	25	81	99,5
HC71915-EDLR-T-P4S	0,345	75	105	16	1	1	3,1	9,3	1,4	25	81	99,5
HCM71915-CDLR-T-P4S-XL	0,27	75	105	16	1	0,6	2,8	9,3	1,4	17	81	99,5
HCM71915-EDLR-T-P4S-XL	0,27	75	105	16	1	0,6	2,8	9,3	1,4	25	81	99,5
VCM71915-CDLR-T-P4S-XL	0,27	75	105	16	1	0,6	2,8	9,3	1,4	17	81	99,5
VCM71915-EDLR-T-P4S-XL	0,27	75	105	16	1	0,6	2,8	9,3	1,4	25	81	99,5
HCB7015-CDLR-T-P4S	0,5	75	115	20	1,1	1,1	4	11,6	1,4	15	82	107
HCB7015-EDLR-T-P4S	0,5	75	115	20	1,1	1,1	4	11,6	1,4	25	82	107
HC7015-EDLR-T-P4S	0,624	75	115	20	1,1	1,1	4	11,6	1,4	25	82	107
HCM7015-CDLR-T-P4S-XL	0,59	75	115	20	1,1	0,6	3	11,6	1,4	17	82	107
HCM7015-EDLR-T-P4S-XL	0,59	75	115	20	1,1	0,6	3	11,6	1,4	25	82	107
VCM7015-CDLR-T-P4S-XL	0,59	75	115	20	1,1	0,6	3	11,6	1,4	17	82	107
VCM7015-EDLR-T-P4S-XL	0,59	75	115	20	1,1	0,6	3	11,6	1,4	25	82	107
HCB71916-CDLR-T-P4S	0,295	80	110	16	1	1	3,1	9,3	1,4	15	86	104
HCB71916-EDLR-T-P4S	0,295	80	110	16	1	1	3,1	9,3	1,4	25	86	104
HC71916-EDLR-T-P4S	0,342	80	110	16	1	1	3,1	9,3	1,4	25	86	104
HCM71916-CDLR-T-P4S-XL	0,28	80	110	16	1	0,6	2,8	9,3	1,4	17	86	104
HCM71916-EDLR-T-P4S-XL	0,28	80	110	16	1	0,6	2,8	9,3	1,4	25	86	104
VCM71916-CDLR-T-P4S-XL	0,28	80	110	16	1	0,6	2,8	9,3	1,4	17	86	104
VCM71916-EDLR-T-P4S-XL	0,28	80	110	16	1	0,6	2,8	9,3	1,4	25	86	104
HCB7016-CDLR-T-P4S	0,69	80	125	22	1,1	1,1	4,7	12,2	2,2	15	88	117
HCB7016-EDLR-T-P4S	0,69	80	125	22	1,1	1,1	4,7	12,2	2,2	25	88	117
HC7016-EDLR-T-P4S	0,86	80	125	22	1,1	1,1	4,7	12,2	2,2	25	88	117
HCM7016-CDLR-T-P4S-XL	0,81	80	125	22	1,1	0,6	3,3	12,35	2,2	17	88	117
HCM7016-EDLR-T-P4S-XL	0,81	80	125	22	1,1	0,6	3,3	12,35	2,2	25	88	117
VCM7016-CDLR-T-P4S-XL	0,81	80	125	22	1,1	0,6	3,3	12,35	2,2	17	88	117
VCM7016-EDLR-T-P4S-XL	0,81	80	125	22	1,1	0,6	3,3	12,35	2,2	25	88	117



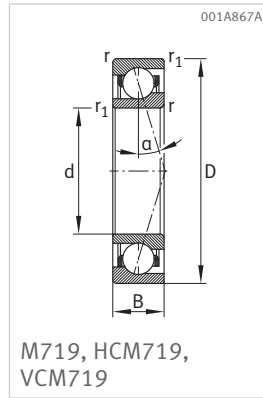
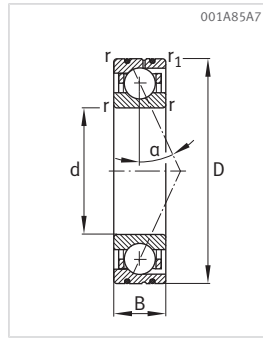
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N	N	N	N	N/μm	N/μm	N/μm
35000	23100	18000	28000	83	317	676	247	991	2229	57,1	98,2	139
33000	21900	16000	24000	95	454	1034	273	1328	3094	128	223	305
17300	12500	20000	32000	70	210	421	201	611	1240	123	181	233
27500	15800	22800	33400	122	322	675	355	958	2069	68	97	131
26500	15100	21700	31200	176	460	956	503	1331	2804	138	193	252
66000	22100	23400	36700	110	289	605	318	855	1839	67	96	129
63000	21100	22300	33400	158	413	858	451	1192	2508	137	192	250
52000	31500	17000	26000	145	508	1059	431	1603	3524	65,4	110	154
49500	29500	15000	24000	192	769	1679	551	2260	5050	153	253	341
24000	16200	19000	30000	99	298	597	285	868	1761	134	197	255
28000	16600	21600	31600	128	338	709	373	1006	2173	71	102	137
27000	15800	20600	29500	184	483	1003	528	1396	2943	144	202	263
67000	23200	22200	34800	115	303	635	334	898	1932	70	101	135
64000	22100	21100	31600	166	433	900	474	1251	2632	143	200	261
36000	24300	17000	26000	84	321	686	249	1004	2259	58,8	101	143
34000	23000	15000	24000	95	459	1049	273	1344	3137	132	230	315
19200	14000	19000	30000	79	236	473	226	686	1392	130	192	248
28000	16600	21600	31600	128	338	709	373	1006	2173	71	102	137
27000	15800	20600	29500	184	483	1003	528	1396	2943	144	202	263
67000	23200	22200	34800	115	303	635	334	898	1932	70	101	135
64000	22100	21100	31600	166	433	900	474	1251	2632	143	200	261
65000	39000	15000	24000	186	640	1327	554	2020	4415	74	123	173
61000	37500	14000	22000	252	977	2113	726	2872	6354	175	284	383
28500	19700	18000	28000	117	352	704	336	1023	2075	146	215	278
34000	21800	20000	29300	169	447	941	495	1348	2936	81	118	161
32500	20800	19100	27400	243	638	1328	698	1855	3929	164	231	304
82000	30500	20500	31900	152	401	842	443	1200	2604	81	117	158
78000	29000	19600	29300	218	572	1191	627	1661	3509	163	230	301

### 2.2.3 Spindle bearings, design DLR

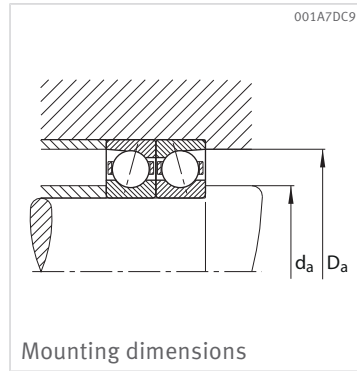
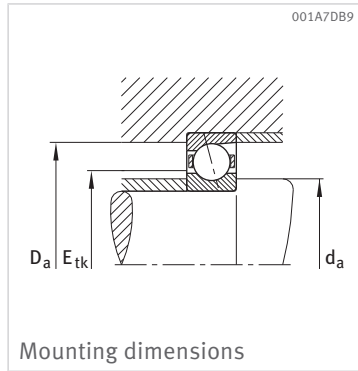
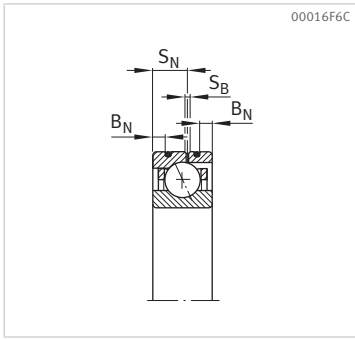
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71917-CDLR-T-P4S	0,43	85	120	18	1,1	1,1	4	10,4	2,2	15	92	114
HCB71917-EDLR-T-P4S	0,43	85	120	18	1,1	1,1	4	10,4	2,2	25	92	114
HC71917-EDLR-T-P4S	0,535	85	120	18	1,1	1,1	4	10,4	2,2	25	92	114
HCM71917-CDLR-T-P4S-XL	0,43	85	120	18	1,1	0,6	3,1	10,4	1,4	17	92	114
HCM71917-EDLR-T-P4S-XL	0,43	85	120	18	1,1	0,6	3,1	10,4	1,4	25	92	114
VCM71917-CDLR-T-P4S-XL	0,43	85	120	18	1,1	0,6	3,1	10,4	1,4	17	92	114
VCM71917-EDLR-T-P4S-XL	0,43	85	120	18	1,1	0,6	3,1	10,4	1,4	25	92	114
HCB7017-CDLR-T-P4S	0,72	85	130	22	1,1	1,1	4,7	12,2	2,2	15	93	122
HCB7017-EDLR-T-P4S	0,72	85	130	22	1,1	1,1	4,7	12,2	2,2	25	93	122
HC7017-EDLR-T-P4S	0,893	85	130	22	1,1	1,1	4,7	12,2	2,2	25	93	122
HCM7017-CDLR-T-P4S-XL	0,85	85	130	22	1,1	0,6	3,3	12,35	2,2	17	93	122
HCM7017-EDLR-T-P4S-XL	0,85	85	130	22	1,1	0,6	3,3	12,35	2,2	25	93	122
VCM7017-CDLR-T-P4S-XL	0,85	85	130	22	1,1	0,6	3,3	12,35	2,2	17	93	122
VCM7017-EDLR-T-P4S-XL	0,85	85	130	22	1,1	0,6	3,3	12,35	2,2	25	93	122
HCB71918-CDLR-T-P4S	0,445	90	125	18	1,1	1,1	4	10,4	2,2	15	97	119
HCB71918-EDLR-T-P4S	0,445	90	125	18	1,1	1,1	4	10,4	2,2	25	97	119
HC71918-EDLR-T-P4S	0,55	90	125	18	1,1	1,1	4	10,4	2,2	25	97	119
HCM71918-CDLR-T-P4S-XL	0,45	90	125	18	1,1	0,6	3,1	10,4	2,2	17	97	119
HCM71918-EDLR-T-P4S-XL	0,45	90	125	18	1,1	0,6	3,1	10,4	2,2	25	97	119
VCM71918-CDLR-T-P4S-XL	0,45	90	125	18	1,1	0,6	3,1	10,4	2,2	17	97	119
VCM71918-EDLR-T-P4S-XL	0,45	90	125	18	1,1	0,6	3,1	10,4	2,2	25	97	119
HCB7018-CDLR-T-P4S	0,93	90	140	24	1,5	1,5	5,5	14,5	2,2	15	100	131
HCB7018-EDLR-T-P4S	0,93	90	140	24	1,5	1,5	5,5	14,5	2,2	25	100	131
HC7018-EDLR-T-P4S	1,17	90	140	24	1,5	1,5	5,5	14,5	2,2	25	100	131
HCM7018-CDLR-T-P4S-XL	1,1	90	140	24	1,5	1	4	14,5	2,2	17	100	131
HCM7018-EDLR-T-P4S-XL	1,1	90	140	24	1,5	1	4	14,5	2,2	25	100	131
VCM7018-CDLR-T-P4S-XL	1,1	90	140	24	1,5	1	4	14,5	2,2	17	100	131
VCM7018-EDLR-T-P4S-XL	1,1	90	140	24	1,5	1	4	14,5	2,2	25	100	131



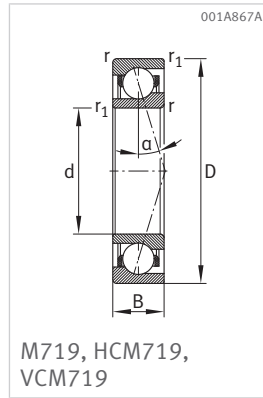
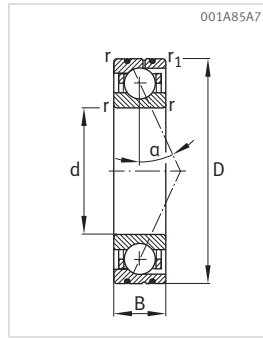
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
47000	32000	15000	24000	117	428	906	346	1341	2985	67,4	114	161
44500	30000	14000	22000	143	627	1403	409	1837	4197	154	262	356
20000	15300	18000	28000	82	247	493	236	716	1452	140	206	265
31500	18500	20000	29300	142	376	788	414	1118	2414	73	105	142
30000	17600	19100	27400	205	538	1118	588	1556	3278	149	209	273
75000	26000	20500	32200	128	337	706	371	998	2146	73	104	139
72000	24700	19600	29300	185	483	1003	528	1394	2932	148	208	270
67000	41500	15000	22000	189	653	1356	562	2058	4501	76,9	128	179
63000	39500	13000	20000	256	997	2159	736	2927	6484	181	296	398
29000	20500	17000	26000	120	359	718	343	1042	2115	150	221	286
35500	23800	19100	28000	184	488	1026	540	1470	3203	88	128	175
34000	22700	18200	26100	265	695	1448	761	2022	4283	178	251	330
85000	33500	19600	29100	165	437	918	483	1309	2841	88	127	171
81000	32000	18700	28000	238	624	1298	683	1811	3826	177	249	327
48000	33500	15000	22000	118	434	919	349	1357	3023	69,4	118	165
45500	31500	13000	20000	147	648	1450	421	1897	4337	160	272	369
22000	16900	17000	26000	90	269	538	257	781	1584	144	212	273
33000	20100	19100	28000	155	410	859	452	1220	2633	80	114	154
31500	19200	18200	26100	224	586	1219	641	1696	3574	162	227	296
79000	28000	19600	30600	139	367	769	405	1089	2341	79	113	151
75000	27000	18700	28000	201	526	1093	575	1520	3196	161	225	294
78000	49000	14000	22000	230	781	1613	685	2464	5361	82,3	136	191
74000	46500	12000	19000	319	1201	2577	916	3528	7745	195	316	423
34000	24000	16000	24000	141	423	845	404	1228	2490	163	241	310
39500	26500	17900	26100	205	542	1140	599	1632	3557	91	133	181
37500	25000	17000	24400	295	772	1608	846	2247	4759	184	260	341
95000	37000	18300	27600	184	485	1020	536	1454	3155	91	131	177
90000	35000	17400	26100	265	693	1443	759	2012	4250	183	258	338

### 2.2.3 Spindle bearings, design DLR

With large, medium or small balls

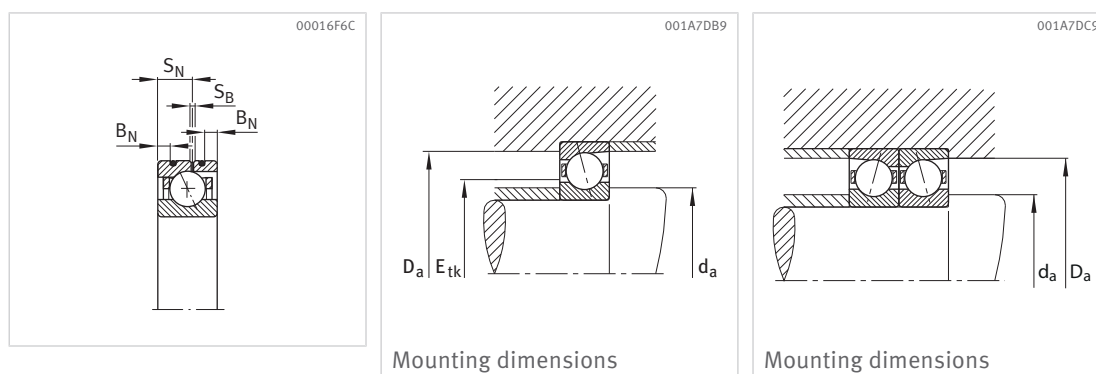
Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71919-CDLR-T-P4S	0,462	95	130	18	1,1	1,1	4	10,4	2,2	15	102	124
HCB71919-EDLR-T-P4S	0,463	95	130	18	1,1	1,1	4	10,4	2,2	25	102	124
HC71919-EDLR-T-P4S	0,57	95	130	18	1,1	1,1	4	10,4	2,2	25	102	124
HCM71919-CDLR-T-P4S-XL	0,47	95	130	18	1,1	0,6	3,1	10,4	2,2	17	102	124
HCM71919-EDLR-T-P4S-XL	0,47	95	130	18	1,1	0,6	3,1	10,4	2,2	25	102	124
VCM71919-CDLR-T-P4S-XL	0,47	95	130	18	1,1	0,6	3,1	10,4	2,2	17	102	124
VCM71919-EDLR-T-P4S-XL	0,47	95	130	18	1,1	0,6	3,1	10,4	2,2	25	102	124
HCB7019-CDLR-T-P4S	0,98	95	145	24	1,5	1,5	5,5	14,5	2,2	15	105	136
HCB7019-EDLR-T-P4S	0,98	95	145	24	1,5	1,5	5,5	14,5	2,2	25	105	136
HC7019-EDLR-T-P4S	1,22	95	145	24	1,5	1,5	5,5	14,5	2,2	25	105	136
HCM7019-CDLR-T-P4S-XL	1,2	95	145	24	1,5	1	4	14,5	2,2	17	105	136
HCM7019-EDLR-T-P4S-XL	1,2	95	145	24	1,5	1	4	14,5	2,2	25	105	136
VCM7019-CDLR-T-P4S-XL	1,2	95	145	24	1,5	1	4	14,5	2,2	17	105	136
VCM7019-EDLR-T-P4S-XL	1,2	95	145	24	1,5	1	4	14,5	2,2	25	105	136
HCB71920-CDLR-T-P4S	0,64	100	140	20	1,1	1,1	4	12	2,2	15	107	133
HCB71920-EDLR-T-P4S	0,64	100	140	20	1,1	1,1	4	12	2,2	25	107	133
HC71920-EDLR-T-P4S	0,8	100	140	20	1,1	1,1	4	12	2,2	25	107	133
HCM71920-CDLR-T-P4S-XL	0,67	100	140	20	1,1	0,6	3,4	12	2,2	17	107	133
HCM71920-EDLR-T-P4S-XL	0,67	100	140	20	1,1	0,6	3,4	12	2,2	25	107	133
VCM71920-CDLR-T-P4S-XL	0,67	100	140	20	1,1	0,6	3,4	12	2,2	17	107	133
VCM71920-EDLR-T-P4S-XL	0,67	100	140	20	1,1	0,6	3,4	12	2,2	25	107	133
HCB7020-CDLR-T-P4S	1,01	100	150	24	1,5	1,5	5,5	14,5	2,2	15	110	141
HCB7020-EDLR-T-P4S	1,01	100	150	24	1,5	1,5	5,5	14,5	2,2	25	110	141
HC7020-EDLR-T-P4S	1,27	100	150	24	1,5	1,5	5,5	14,5	2,2	25	110	141
HCM7020-CDLR-T-P4S-XL	1,2	100	150	24	1,5	1	4	14,5	2,2	17	110	141
HCM7020-EDLR-T-P4S-XL	1,2	100	150	24	1,5	1	4	14,5	2,2	25	110	141
VCM7020-CDLR-T-P4S-XL	1,2	100	150	24	1,5	1	4	14,5	2,2	17	110	141
VCM7020-EDLR-T-P4S-XL	1,2	100	150	24	1,5	1	4	14,5	2,2	25	110	141





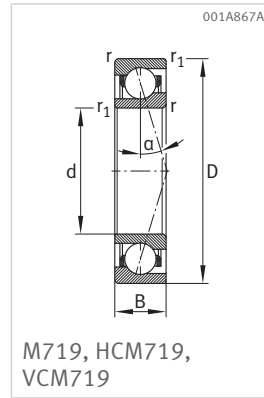
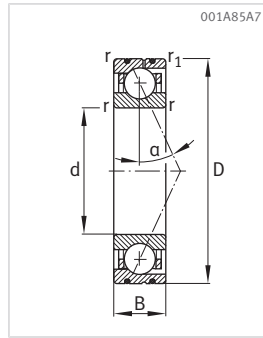
$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
<b>N</b>	<b>N</b>	<b>min<sup>-1</sup></b>	<b>min<sup>-1</sup></b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N/μm</b>	<b>N/μm</b>	<b>N/μm</b>
49000	35000	14000	22000	119	440	932	352	1373	3061	71,3	121	170
46000	33000	13000	19000	148	656	1470	423	1918	4393	164	280	380
22500	17900	16000	24000	92	276	552	263	801	1623	150	221	285
33500	21000	18300	26700	162	428	898	472	1275	2752	83	119	160
32000	20100	17400	24900	234	612	1272	670	1771	3732	168	236	308
80000	29500	18700	28100	146	384	804	423	1137	2446	82	118	158
76000	28000	17800	26700	210	550	1142	601	1587	3338	167	234	305
81000	52000	13000	20000	233	794	1643	693	2499	5442	85,3	141	197
77000	49500	12000	18000	322	1220	2622	924	3581	7871	203	328	439
34500	25000	15000	24000	141	423	845	404	1227	2488	167	246	317
42000	29500	17100	25000	231	610	1284	675	1839	4007	102	149	203
40000	28500	16300	23400	332	869	1811	952	2530	5359	207	292	383
101000	41500	17500	25400	207	547	1149	604	1638	3555	102	147	199
97000	39500	16700	25000	298	780	1624	854	2265	4786	206	289	379
60000	43000	13000	20000	160	572	1201	473	1789	3950	80,4	135	189
57000	40500	12000	18000	204	850	1876	584	2489	5611	187	311	421
27000	21200	15000	24000	109	328	656	313	951	1927	162	239	307
38500	24600	17100	25000	190	500	1049	551	1489	3217	89	129	173
36500	23500	16300	23400	273	715	1487	782	2070	4362	182	255	333
92000	34500	17500	26600	170	448	939	494	1329	2860	89	127	170
88000	33000	16700	25000	245	642	1334	702	1855	3901	181	253	330
83000	55000	13000	19000	241	823	1703	717	2587	5636	89,1	148	206
79000	52000	11000	17000	333	1266	2723	957	3715	8170	212	343	459
34500	26000	15000	22000	144	431	863	412	1252	2539	171	253	326
43000	31000	16400	23500	240	635	1336	703	1915	4174	106	154	210
41000	29500	15600	22400	345	905	1885	991	2633	5578	215	302	397
103000	43000	16800	23500	215	569	1196	629	1706	3702	105	152	206
98000	41000	16000	23500	310	812	1691	889	2358	4982	213	300	393

### 2.2.3 Spindle bearings, design DLR

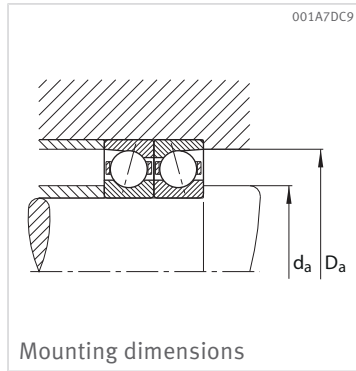
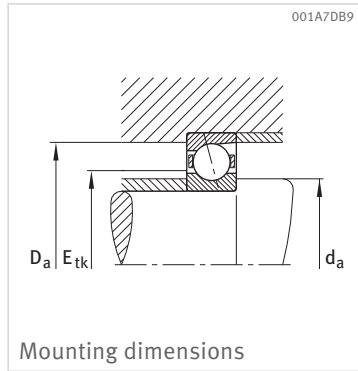
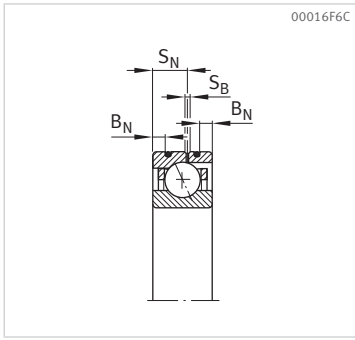
With large, medium or small balls

Ceramic balls

Steel rings or Vicrodur rings



Short designation	m	d	D	B	r <sub>min</sub>	r <sub>1 min</sub>	B <sub>N</sub>	S <sub>N</sub>	S <sub>B</sub>	α	d <sub>a</sub> h12	D <sub>a</sub> H12
	kg	mm	mm	mm	mm	mm	mm	mm	mm	°	mm	mm
HCB71921-CDLR-T-P4S	0,68	105	145	20	1,1	1,1	4	12	2,2	15	112	138
HCB71921-EDLR-T-P4S	0,68	105	145	20	1,1	1,1	4	12	2,2	25	112	138
HC71921-EDLR-T-P4S	0,82	105	145	20	1,1	1,1	4	12	2,2	25	112	138
HCM71921-CDLR-T-P4S-XL	0,69	105	145	20	1,1	0,6	3,4	12	2,2	17	112	138
HCM71921-EDLR-T-P4S-XL	0,69	105	145	20	1,1	0,6	3,4	12	2,2	25	112	138
VCM71921-CDLR-T-P4S-XL	0,69	105	145	20	1,1	0,6	3,4	12	2,2	17	112	138
VCM71921-EDLR-T-P4S-XL	0,69	105	145	20	1,1	0,6	3,4	12	2,2	25	112	138
HCB7021-CDLR-T-P4S	1,36	105	160	26	2	2	5,5	15,5	2,2	15	116	150
HCB7021-EDLR-T-P4S	1,36	105	160	26	2	2	5,5	15,5	2,2	25	116	150
HC7021-EDLR-T-P4S	1,56	105	160	26	2	2	5,5	15,5	2,2	25	116	150
HCM7021-CDLR-T-P4S-XL	1,5	105	160	26	2	1	4,2	15,5	2,2	17	116	150
HCM7021-EDLR-T-P4S-XL	1,5	105	160	26	2	1	4,2	15,5	2,2	25	116	150
VCM7021-CDLR-T-P4S-XL	1,5	105	160	26	2	1	4,2	15,5	2,2	17	116	150
VCM7021-EDLR-T-P4S-XL	1,5	105	160	26	2	1	4,2	15,5	2,2	25	116	150
HCB71922-CDLR-T-P4S	0,69	110	150	20	1,1	1,1	4	12	2,2	15	117	143
HCB71922-EDLR-T-P4S	0,69	110	150	20	1,1	1,1	4	12	2,2	25	117	143
HC71922-EDLR-T-P4S	0,82	110	150	20	1,1	1,1	4	12	2,2	25	117	143
HCM71922-CDLR-T-P4S-XL	0,72	110	150	20	1,1	0,6	3,4	12	2,2	17	117	143
HCM71922-EDLR-T-P4S-XL	0,72	110	150	20	1,1	0,6	3,4	12	2,2	25	117	143
VCM71922-CDLR-T-P4S-XL	0,72	110	150	20	1,1	0,6	3,4	12	2,2	17	117	143
VCM71922-EDLR-T-P4S-XL	0,72	110	150	20	1,1	0,6	3,4	12	2,2	25	117	143
HCB7022-CDLR-T-P4S	1,59	110	170	28	2	2	6	16,2	2,2	15	121	159
HCB7022-EDLR-T-P4S	1,59	110	170	28	2	2	6	16,2	2,2	25	121	159
HC7022-EDLR-T-P4S	2,02	110	170	28	2	2	6	16,2	2,2	25	121	159
HCM7022-CDLR-T-P4S-XL	1,9	110	170	28	2	1	5,2	16,2	2,2	17	121	159
HCM7022-EDLR-T-P4S-XL	1,9	110	170	28	2	1	5,2	16,2	2,2	25	121	159
VCM7022-CDLR-T-P4S-XL	2,09	110	170	28	2	1	5,2	16,2	2,2	17	121	159
VCM7022-EDLR-T-P4S-XL	2,09	110	170	28	2	1	5,2	16,2	2,2	25	121	159



$C_r$	$C_{0r}$	$n_G$ grease	$n_G$ oil	$F_V L$	$F_V M$	$F_V H$	$K_{aE} L$	$K_{aE} M$	$K_{aE} H$	$c_a L$	$c_a M$	$c_a H$
N	N	$\text{min}^{-1}$	$\text{min}^{-1}$	N	N	N	N	N	N	N/ $\mu\text{m}$	N/ $\mu\text{m}$	N/ $\mu\text{m}$
60000	43000	13000	19000	157	564	1185	466	1763	3895	80	134	188
57000	41000	11000	17000	204	850	1876	584	2489	5611	187	311	421
27500	22400	15000	22000	113	338	676	323	980	1987	170	250	321
39000	25500	16400	24000	198	521	1093	575	1553	3354	93	134	180
37000	24400	15600	22400	285	745	1549	815	2157	4546	189	265	346
94000	36000	16800	24700	177	467	979	515	1385	2981	92	132	177
89000	34000	16000	24000	256	669	1390	732	1933	4065	188	263	343
85000	58000	12000	18000	244	836	1732	725	2623	5718	92,1	153	213
81000	55000	11000	16000	336	1285	2768	966	3768	8297	219	355	476
45000	33000	14000	22000	184	552	1104	527	1602	3250	188	277	357
53000	38000	15500	22700	294	778	1638	861	2347	5116	113	165	225
51000	36000	14800	21200	422	1107	2306	1213	3222	6827	229	323	424
128000	53000	15900	23400	264	697	1465	770	2090	4537	112	163	220
122000	51000	15100	22700	379	994	2069	1088	2885	6097	228	320	420
61000	45000	12000	19000	158	570	1199	468	1777	3931	82,1	138	193
58000	42500	11000	17000	208	871	1923	596	2547	5747	193	322	435
32000	26000	14000	22000	131	393	787	375	1141	2312	178	262	337
39500	26500	15800	23000	206	542	1138	598	1616	3491	96	139	187
38000	25500	15000	21600	296	775	1612	848	2244	4730	196	275	359
95000	37500	16200	23000	185	486	1019	536	1442	3103	96	137	184
91000	35500	15400	23000	266	696	1446	761	2010	4230	195	273	356
112000	74000	12000	18000	337	1126	2314	1004	3540	7655	103	169	234
106000	70000	11000	16000	490	1779	3778	1409	5224	11341	248	395	527
45500	34000	13000	20000	187	561	1121	535	1627	3299	193	284	366
54000	39500	14700	21500	307	813	1711	900	2452	5346	118	171	234
51000	37500	14000	20000	441	1156	2408	1266	3365	7129	238	335	441
129000	55000	15000	21500	276	728	1530	805	2184	4742	117	169	229
123000	53000	14300	21500	396	1038	2160	1136	3012	6367	237	333	436

## 3 Super precision cylindrical roller bearings

### 3.1 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 separable and can thus be mounted separately from the rest of the bearing package. The inner ring is only separable 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. In these applications, they 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.

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.

#### Cylindrical roller bearings in X-life design with TVP cage

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 rating life. The newly developed roller-guided plastic cage gives lower friction than the previous standard design with brass cage.

The advantages of the X-life 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

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

As a result of the increase in the basic 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.

### 3.1.1 Single row super precision cylindrical roller bearings

In single row super precision cylindrical roller bearings of 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.



59 Single row super precision cylindrical roller bearing

#### High speed cylindrical roller bearings with PEEK cage in X-life design

Single row cylindrical roller bearings of series N10 in X-life design are also available with a PEEK high speed cage that is guided on the outer ring. This high speed cage has a geometry with optimised lubrication and allows up to 20 % higher speeds due to reduced friction. As a result of the optimised cage and ring geometry, the permissible displacement path is increased.

High speed cylindrical roller bearings are also available in a hybrid design with rollers made from high performance ceramic. This material gives a significant reduction in the friction and wear in the bearing.

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 are also available with half the number of rollers with suffix H193. Due to the reduction in the number of rollers, the speed can be increased further.



### 3.1.2 Double row super precision cylindrical roller bearings

Double row super precision cylindrical roller bearings are available with steel rollers. In bearings of series NN30, the rollers are guided on the inner ring and held at a spacing from each other by a cage made from polyamide or brass. The outer ring is ground cylindrically and is separable.

In bearings of series NNU49, the rollers are guided on the outer ring and held at a spacing from each other by a single-piece cage made from brass. The inner ring is removable. The bearings 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 product tables can be supplied by agreement.



### 3.1.3 Sealing

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

### 3.1.4 Lubrication

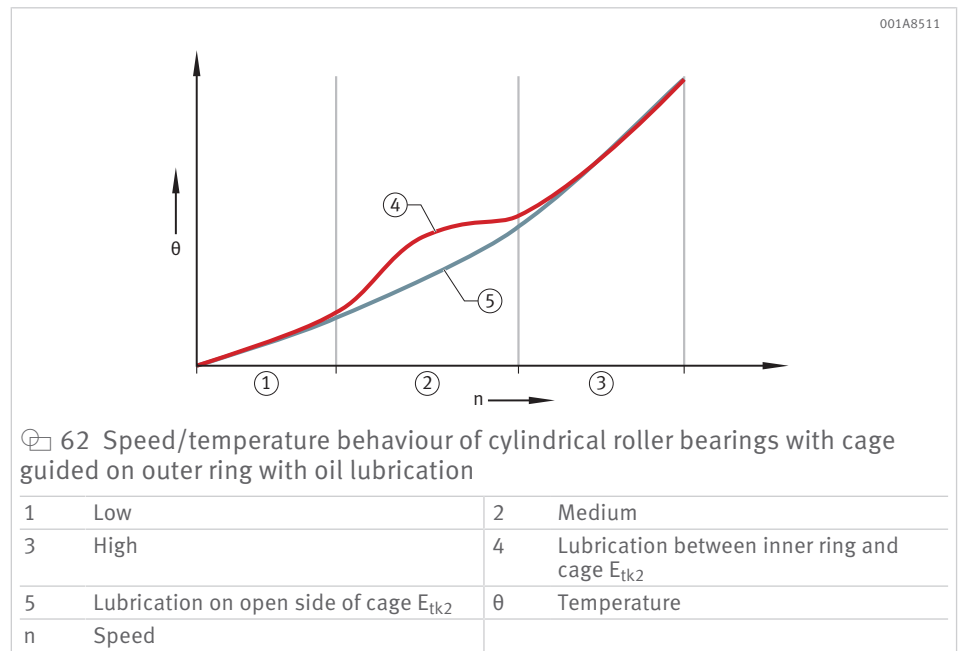
Due to the high surface quality of the raceways and rollers, FAG cylindrical roller bearings are particularly suitable for grease lubrication.

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 product 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 is carried out in preference on the open side of the cage between the outside diameter of the cage and the outer ring ( $E_{tk2}$ ). As an alternative, lubrication can be carried out on both sides between the rib on the outer ring and the inside diameter of the cage ( $E_{tk1}$ ).

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 between the outside diameter of the cage and the outer ring is then reliably conveyed out of the bearing, giving a highly uniform temperature behaviour of the bearing.



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

**!** Bearings with a modified internal construction (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.

### 3.1.5 Cages

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

Double row bearings have solid cages made from polyamide (TVP) or brass (M).



### 3.1.6 Designation and marking of bearings

001A8BEC

N 10 13 - D - K - -TVP - -SP - -XL  
HCN 10 13 - D - K - PVPA1 - -SP - H193 - -XL  
N 10 26 - -K - -M1 - -SP - -C2 - -XL

**Design**

**N** Cylindrical roller bearing, single row, steel rollers, ribs on inner ring, outer ring without ribs

**HCN** Cylindrical roller bearing, single row, ceramic rollers, ribs on inner ring, outer ring without ribs

**Dimension series**

**10** Medium series

**Bore code**

**13** 13 · 5 = 65 mm

**26** 26 · 5 = 130 mm

**Modification symbol**

**D** Internal construction variant

**Tapered bore**

**K** Tapered bore (taper 1:12)

**Premium brand**

**XL** X-life

**Radial internal clearance**

**C2** Radial internal clearance according to standard

**Specification**

**H193** Half the number of rollers (increased speed)

**Accuracy**

**SP** Special precision

**Cage**

**M1** Brass cage, guided by rollers

**PVPA1** Brass cage made from PEEK (polyether ether ketone), guidance on outer ring

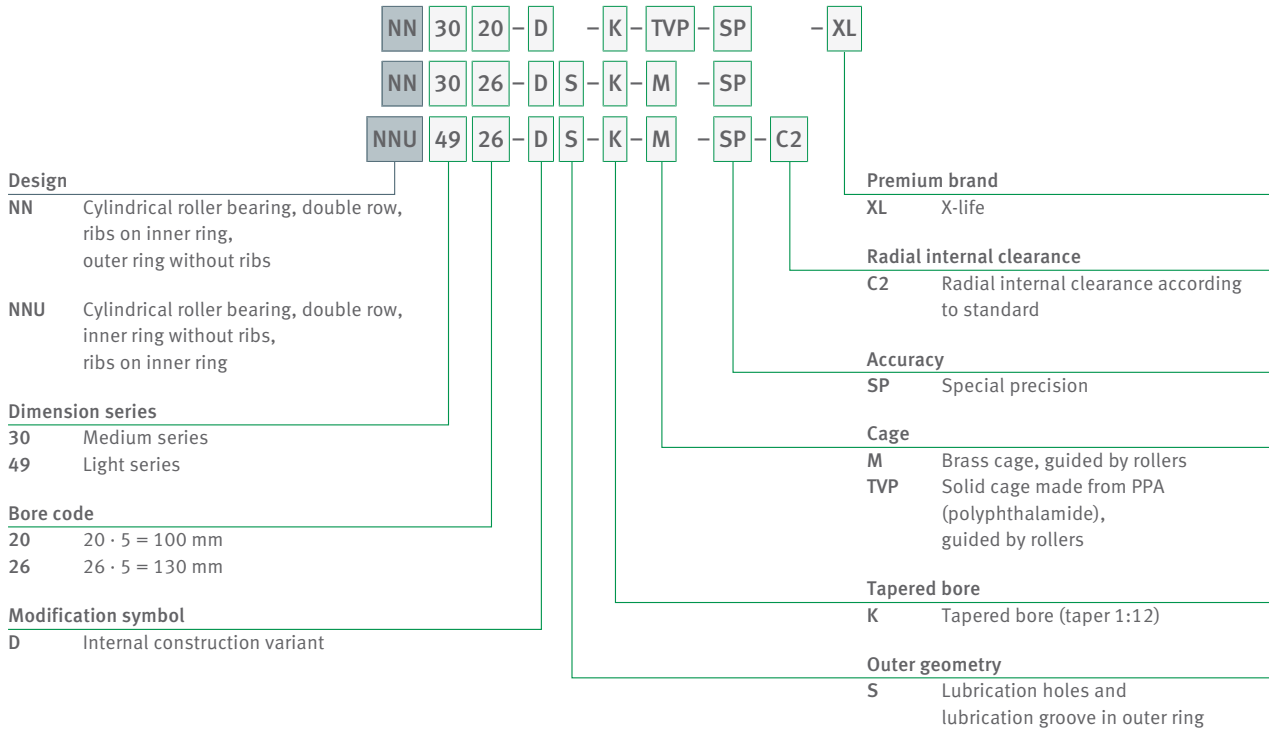
**TVP** Solid cage made from PPA (polyphthalamide), guided by rollers

63 Bearing designation, single row cylindrical roller bearings

001A4DC8

64 Example of marking for single row bearings with TVP 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	



65 Bearing designation, double row cylindrical roller bearings



66 Example of marking for double row bearings with TVP 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		

The marking is located on the end faces of the bearing rings.

## 3.2 Product tables

### 3.2.1 Explanations

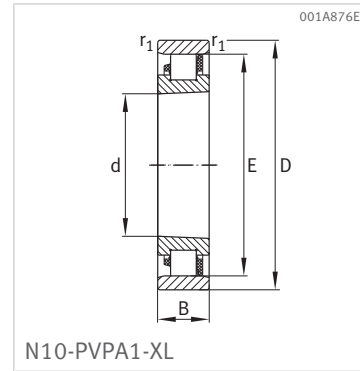
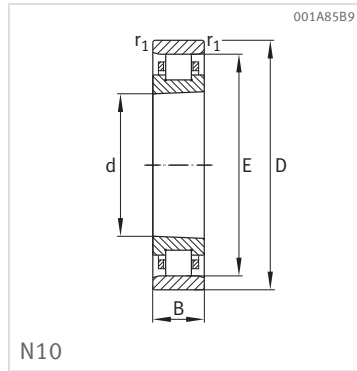
B	mm	Width
B <sub>1</sub>	mm	Shaft washer height
B <sub>N</sub>	mm	Ring groove spacing
C	mm	Outer ring width
C <sub>0a</sub>	N	Basic static load rating, axial
C <sub>0r</sub>	N	Basic static load rating, radial
c <sub>a</sub>	N/μm	Axial rigidity
C <sub>a</sub>	N	Basic dynamic load rating, axial
c <sub>a</sub> H	N/μm	Axial rigidity, high
c <sub>a</sub> L	N/μm	Axial rigidity, slight
c <sub>a</sub> M	N/μm	Axial rigidity, moderate
C <sub>r</sub>	N	Basic dynamic load rating, radial
d	mm	Bore diameter
D	mm	Outside diameter
d <sub>1</sub>	mm	Rib diameter on shaft washer
d <sub>a</sub>	mm	Abutment diameter, shaft shoulder
D <sub>a</sub>	mm	Abutment diameter, outer ring
D <sub>a</sub>	mm	Housing shoulder diameter
d <sub>s</sub>	mm	Lubrication hole diameter
E	mm	Raceway diameter of outer ring
E <sub>tk</sub>	mm	Injection pitch circle diameter
E <sub>tk1</sub>	mm	Injection pitch circle diameter 1
E <sub>tk2</sub>	mm	Injection pitch circle diameter 2
F	mm	Inner ring raceway diameter
F <sub>V</sub>	N	Preload force
F <sub>V</sub> H	N	Preload force, high
F <sub>V</sub> L	N	Preload force, slight
F <sub>V</sub> M	N	Preload force, moderate
K <sub>aE</sub>	N	Lift-off force
K <sub>aE</sub> H	N	Lift-off force, high
K <sub>aE</sub> L	N	Lift-off force, slight
K <sub>aE</sub> M	N	Lift-off force, moderate
m	kg	Mass
n <sub>G</sub>	min <sup>-1</sup>	Limiting speed
n <sub>G</sub> grease	min <sup>-1</sup>	Limiting speed for grease lubrication
n <sub>G</sub> oil	min <sup>-1</sup>	Limiting speed for oil lubrication
n <sub>s</sub>	mm	Lubrication groove width
r <sub>1 min</sub>	mm	Min. chamfer dimension
r <sub>min</sub>	mm	Min. chamfer dimension
s	mm	Displacement distance, axial
s <sub>1</sub>	mm	Displacement distance, axial
s <sub>2</sub>	mm	Displacement distance, axial
S <sub>B</sub>	mm	Lubrication groove width
S <sub>N</sub>	mm	Lubrication hole spacing
α	°	Contact angle

### 3.2.2 Super precision cylindrical roller bearings N10

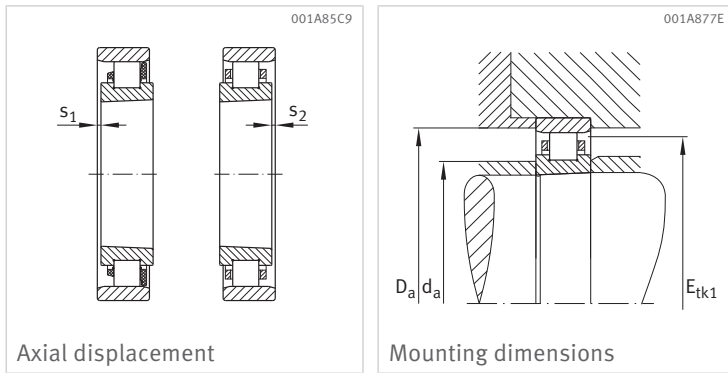
Single row

Steel rollers

Cage made from polyamide (TVP),  
brass (M1) or PEEK (PVPA1)



Short designation	m	d	D	B	r <sub>1 min</sub>	E	s <sub>1</sub>	s <sub>2</sub>
	kg	mm	mm	mm	mm	mm	mm	mm
N1006-D-K-TVP-SP-XL	0,12	30	55	13	0,6	48,5	2,8	2,8
N1007-D-K-TVP-SP-XL	0,16	35	62	14	0,6	55	2,8	2,8
N1008-D-K-TVP-SP-XL	0,2	40	68	15	0,6	61	3,1	3,1
N1008-D-K-PVPA1-SP-XL	0,19	40	68	15	0,6	61	1,1	3,1
N1009-D-K-TVP-SP-XL	0,24	45	75	16	0,6	67,5	3,1	3,1
N1009-D-K-PVPA1-SP-XL	0,24	45	75	16	0,6	67,5	1,2	3,1
N1010-D-K-TVP-SP-XL	0,27	50	80	16	0,6	72,5	3,1	3,1
N1010-D-K-PVPA1-SP-XL	0,27	50	80	16	0,6	72,5	1,2	3,1
N1011-D-K-TVP-SP-XL	0,4	55	90	18	1	81	3,4	3,4
N1011-D-K-PVPA1-SP-XL	0,4	55	90	18	1	81	1,6	3,4
N1012-D-K-TVP-SP-XL	0,43	60	95	18	1	86,1	3,4	3,4
N1012-D-K-PVPA1-SP-XL	0,42	60	95	18	1	86,1	1,6	3,4
N1013-D-K-TVP-SP-XL	0,45	65	100	18	1	91	3,4	3,4
N1013-D-K-PVPA1-SP-XL	0,45	65	100	18	1	91	1,6	3,4
N1014-D-K-TVP-SP-XL	0,64	70	110	20	1	100	3,8	3,8
N1014-D-K-PVPA1-SP-XL	0,61	70	110	20	1	100	1,8	3,8
N1015-D-K-TVP-SP-XL	0,67	75	115	20	1	105	3,8	3,8
N1016-D-K-TVP-SP-XL	0,9	80	125	22	1	113	4,1	4,1
N1017-D-K-TVP-SP-XL	0,95	85	130	22	1	118	4,1	4,1
N1018-D-K-TVP-SP-XL	1,23	90	140	24	1,1	127	4,4	4,4
N1018-D-K-PVPA1-SP-XL	1,2	90	140	24	1,1	127	2,2	4,4
N1019-D-K-TVP-SP-XL	1,29	95	145	24	1,1	132	4,4	4,4
N1020-D-K-TVP-SP-XL	1,34	100	150	24	1,1	137	4,4	4,4
N1020-D-K-PVPA1-SP-XL	1,29	100	150	24	1,1	137	2,2	4,4
N1021-D-K-TVP-SP-XL	1,67	105	160	26	1,1	146	4,5	4,5
N1022-D-K-TVP-SP-XL	2,06	110	170	28	1,1	155	4,8	4,8
N1024-D-K-TVP-SP-XL	2,22	120	180	28	1,1	165	4,8	4,8
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
N1038-K-M1-SP	10,6	190	290	46	2,1	265	5,6	5,6
N1040-K-M1-SP	13,7	200	310	51	2,1	281	6,4	6,4

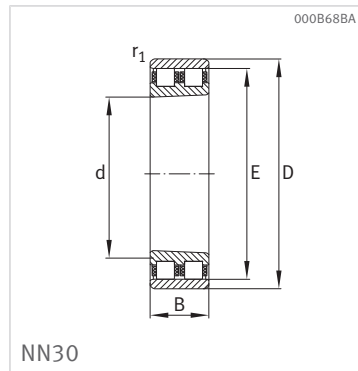


<b>d<sub>a</sub></b> <b>h12</b>	<b>D<sub>a</sub></b> <b>H12</b>	<b>E<sub>tk1</sub></b>	<b>E<sub>tk2</sub></b>	<b>C<sub>r</sub></b>	<b>C<sub>0r</sub></b>	<b>n<sub>G</sub> grease</b>	<b>n<sub>G</sub> oil</b>
mm	mm	Nom.	Nom.	N	N	min <sup>-1</sup>	min <sup>-1</sup>
38,5	49,5	47,5	–	17500	15600	21700	25500
43	56	53,9	–	23600	20900	18700	22000
49	62,1	59,8	–	27000	26000	17100	20100
49	62,1	59,3	52,5	25000	23500	27500	32000
53,5	68,6	66,2	–	34500	32500	15200	17800
53,5	68,6	65,6	57,4	34500	32500	24200	28500
58,5	73,6	71,2	–	36500	36500	14200	16800
58,5	73,6	70,6	62,4	36500	36500	22800	27000
65	82,2	79,3	–	48000	48500	12600	14800
65	82,2	78,5	69,4	44500	44000	20100	23700
70,1	87,3	84,4	–	51000	53000	11900	14000
70,1	87,3	83,5	74,5	47500	48500	19100	22500
75	92,2	89,3	–	53000	58000	11400	13400
75	92,2	88,5	79,4	47000	49000	18200	21400
82	101,3	98,2	–	66000	72000	10200	12000
82	101,3	97,5	86,5	58000	61000	16400	19200
87	106,3	103,2	–	65000	73000	9800	11500
93	114,4	111,4	–	81000	91000	9000	10600
98	119,4	116,3	–	80000	91000	8700	10200
105	128,5	124,9	–	95000	108000	8000	9400
105	128,5	124	111,1	89000	100000	12700	15000
110	133,5	129,8	–	99000	117000	7700	9100
115	138,5	134,8	–	99000	118000	7500	8800
115	138,5	134	121,1	99000	118000	11900	14100
120	147,5	143,5	–	132000	154000	6800	8000
127	156,6	152,4	–	153000	180000	6400	7500
137	166,6	162,4	–	160000	196000	6000	7100
148	184,1	177,8	–	179000	250000	4800	5600
158	194,1	187,8	–	183000	265000	4550	5400
169,5	207,8	201	–	210000	310000	4250	5000
180	222,4	215	–	245000	355000	3900	4600
193	239,7	231,5	–	295000	435000	3600	4250
205	257,8	248,8	–	360000	520000	3300	3850
215	267,8	258,8	–	370000	550000	3200	3750
229	284,3	274,5	–	395000	600000	3000	3500

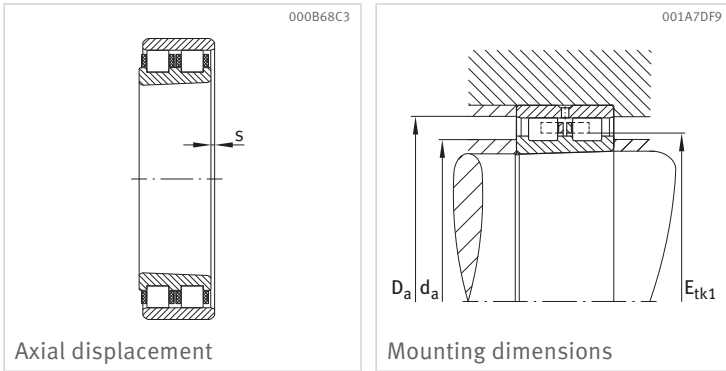
### 3.2.3 Super precision cylindrical roller bearings NN30

Double row

Steel rollers



Short designation	m	d	D	B	r <sub>1</sub> min	E	n <sub>s</sub>	d <sub>s</sub>
	kg	mm	mm	mm	mm	mm	mm	mm
NN3006-D-K-TVP-SP-XL	0,18	30	55	19	48,5	1	–	–
NN3007-D-K-TVP-SP-XL	0,24	35	62	20	55	1	–	–
NN3008-D-K-TVP-SP-XL	0,28	40	68	21	61	1	–	–
NN3009-D-K-TVP-SP-XL	0,36	45	75	23	67,5	1	–	–
NN3010-D-K-TVP-SP-XL	0,39	50	80	23	72,5	1	–	–
NN3011-D-K-TVP-SP-XL	0,59	55	90	26	81	1,1	–	–
NN3012-D-K-TVP-SP-XL	0,63	60	95	26	86,1	1,1	–	–
NN3013-D-K-TVP-SP-XL	0,67	65	100	26	91	1,1	–	–
NN3014-D-K-TVP-SP-XL	0,98	70	110	30	100	1,1	–	–
NN3015-D-K-TVP-SP-XL	1,02	75	115	30	105	1,1	–	–
NN3016-D-K-TVP-SP-XL	1,42	80	125	34	113	1,1	–	–
NN3017-D-K-TVP-SP-XL	1,48	85	130	34	118	1,1	–	–
NN3018-D-K-TVP-SP-XL	1,93	90	140	37	127	1,5	–	–
NN3019-D-K-TVP-SP-XL	2,03	95	145	37	132	1,5	–	–
NN3020-D-K-TVP-SP-XL	2,09	100	150	37	137	1,5	–	–
NN3021-D-K-TVP-SP-XL	2,68	105	160	41	146	2	–	–
NN3022-D-K-TVP-SP-XL	3,41	110	170	45	155	2	–	–
NN3024-D-K-TVP-SP-XL	3,72	120	180	46	165	2	–	–

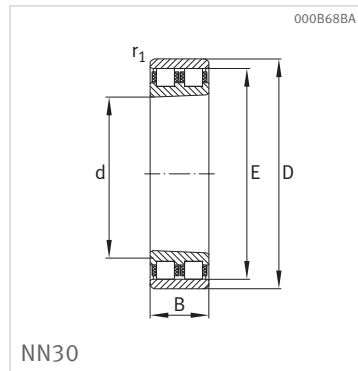


<b>s</b>	<b>d<sub>a</sub></b> <b>h12</b>	<b>D<sub>a</sub></b> <b>H12</b>	<b>C<sub>r</sub></b>	<b>C<sub>0r</sub></b>	<b>n<sub>G</sub> grease</b>	<b>n<sub>G</sub> oil</b>
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>N</b>	<b>N</b>	<b>min<sup>-1</sup></b>	<b>min<sup>-1</sup></b>
1,7	38,5	50	30000	31000	20600	24200
1,4	43	56,5	40500	41500	17800	20900
1,7	49	62,6	46500	52000	16200	19100
1,7	53,5	69,2	59000	65000	14400	16900
1,7	58,5	74,2	63000	73000	13500	15900
1,9	65	82,9	82000	97000	11900	14100
1,9	70,1	88	87000	106000	11300	13300
1,9	75	92,9	91000	116000	10800	12700
2,3	82	102,3	113000	145000	9700	11400
2,3	87	107,3	112000	146000	9300	11000
2,5	93	115,6	139000	182000	8500	10000
2,5	98	120,6	138000	183000	8200	9700
2,5	105	129,8	162000	216000	7600	8900
2,5	110	134,8	170000	234000	7300	8600
2,5	115	139,8	169000	235000	7100	8300
2,6	120	149	226000	310000	6500	7600
2,9	127	158,3	260000	360000	6000	7100
3,1	137	168,4	275000	390000	5700	6700

### 3.2.3 Super precision cylindrical roller bearings NN30

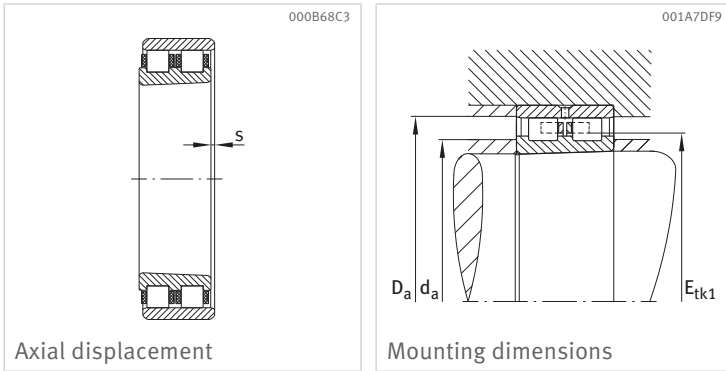
Double row

Steel rollers



Short designation	m	d	D	B	r <sub>1 min</sub>	E	n <sub>s</sub>	d <sub>s</sub>
	kg	mm	mm	mm	mm	mm	mm	mm
NN3026-AS-K-M-SP	5,84	130	200	52	182	2	9,5	4,8
NN3028-AS-K-M-SP	6,22	140	210	53	192	2	9,5	4,8
NN3030-AS-K-M-SP	7,59	150	225	56	206	2,1	9,5	4,8
NN3032-AS-K-M-SP	9,23	160	240	60	219	2,1	9,5	4,8
NN3034-AS-K-M-SP	12,5	170	260	67	236	2,1	9,5	4,8
NN3036-AS-K-M-SP	16,4	180	280	74	255	2,1	12,2	6,3
NN3038-AS-K-M-SP	17,3	190	290	75	265	2,1	12,2	6,3
NN3040-AS-K-M-SP	22,2	200	310	82	282	2,1	12,2	6,3
NN3044-AS-K-M-SP	29,1	220	340	90	310	3	15	8
NN3048-AS-K-M-SP	31,5	240	360	92	330	3	15	8
NN3052-AS-K-M-SP	46,2	260	400	104	364	4	15	8
NN3056-AS-K-M-SP	49,7	280	420	106	384	4	15	8
NN3060-AS-K-M-SP	68,5	300	460	118	418	4	17,7	9,5
NN3064-AS-K-M-SP	73,8	320	480	121	438	4	17,7	9,5
NN3068-AS-K-M-SP	99,3	340	520	133	473	5	17,7	9,5
NN3072-AS-K-M-SP	104	360	540	134	493	5	17,7	9,5
NN3076-AS-K-M-SP	110	380	560	135	513	5	17,7	9,5
NN3080-AS-K-M-SP	143	400	600	148	549	5	17,7	9,5
NN3084-AS-K-M-SP	150	420	620	150	569	5	17,7	9,5
NN3088-AS-K-M-SP	172	440	650	157	597	6	23,5	12,5
NN3092-AS-K-M-SP	197	460	680	163	624	6	23,5	12,5
NN3096-AS-K-M-SP	208	480	700	165	644	6	23,5	12,5
NN30/500-AS-K-M-SP	214	500	720	167	664	6	23,5	12,5



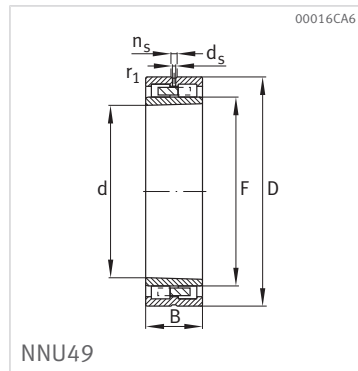


<b>s</b>	<b>d<sub>a</sub></b> <b>h12</b>	<b>D<sub>a</sub></b> <b>H12</b>	<b>C<sub>r</sub></b>	<b>C<sub>0r</sub></b>	<b>n<sub>G</sub> grease</b>	<b>n<sub>G</sub> oil</b>
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>N</b>	<b>N</b>	<b>min<sup>-1</sup></b>	<b>min<sup>-1</sup></b>
3,1	150	186	295000	500000	4100	4800
3,4	160	196	300000	520000	3900	4600
3,8	172	210	335000	590000	3650	4250
4,3	183	224	375000	670000	3400	4000
4,6	196	241	450000	800000	3100	3650
4,8	209	260	570000	1000000	2850	3300
4,8	219	271	580000	1040000	2750	3200
5,7	232	288	660000	1190000	2550	3000
5,7	254	317	810000	1450000	2290	2700
6,1	274	337	840000	1580000	2170	2550
6,6	300	372	1070000	2010000	1930	2280
6,9	320	392	1090000	2090000	1850	2170
7,5	346	427	1270000	2400000	1670	1970
8	366	447	1330000	2600000	1610	1890
8,8	393	483	1640000	3250000	1470	1730
8,8	413	503	1670000	3350000	1420	1670
9,1	433	523	1700000	3500000	1370	1620
9,5	459	560	2150000	4450000	1260	1480
10	479	580	2140000	4450000	1220	1440
10,2	501	609	2430000	5100000	1160	1360
10,9	524	636	2600000	5400000	1100	1300
11,2	544	656	2700000	5800000	1070	1260
11,7	564	677	2700000	5800000	1050	1230

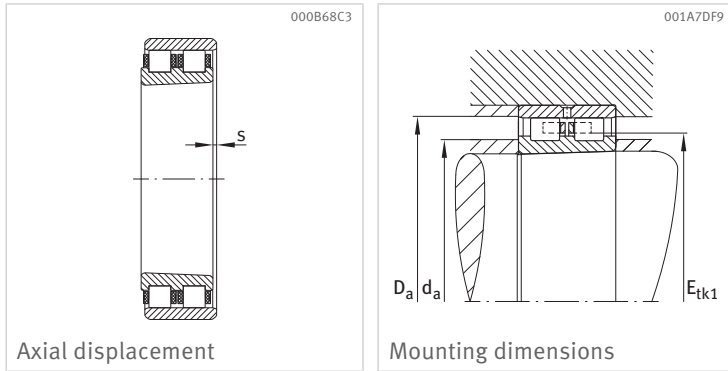
### 3.2.4 Super precision cylindrical roller bearings NNU49

Double row

Steel rollers



Short designation	m	d	D	B	r <sub>1 min</sub>	F	n <sub>s</sub>	d <sub>s</sub>
	kg	mm	mm	mm	mm	mm	mm	mm
NNU4920-S-K-M-SP	1,88	100	140	40	1,1	113	6,5	3,2
NNU4921-S-K-M-SP	1,93	105	145	40	1,1	118	6,5	3,2
NNU4922-S-K-M-SP	2,01	110	150	40	1,1	123	6,5	3,2
NNU4924-S-K-M-SP	2,78	120	165	45	1,1	134,5	6,5	3,2
NNU4926-S-K-M-SP	3,81	130	180	50	1,5	146	6,5	3,2
NNU4928-S-K-M-SP	4,04	140	190	50	1,5	156	6,5	3,2
NNU4930-S-K-M-SP	6,1	150	210	60	2	168,5	6,5	3,2
NNU4932-S-K-M-SP	6,46	160	220	60	2	178,5	6,5	3,2
NNU4934-S-K-M-SP	6,9	170	230	60	2	188,5	6,5	3,2
NNU4936-S-K-M-SP	9,96	180	250	69	2	202	9,5	4,8
NNU4938-S-K-M-SP	10,6	190	260	69	2	212	9,5	4,8
NNU4940-S-K-M-SP	14,7	200	280	80	2,1	225	12,2	6,3
NNU4944-S-K-M-SP	16,3	220	300	80	2,1	245	12,2	6,3
NNU4948-S-K-M-SP	17,1	240	320	80	2,1	265	12,2	6,3
NNU4952-S-K-M-SP	30,4	260	360	100	2,1	292	15	8
NNU4956-S-K-M-SP	32,5	280	380	100	2,1	312	15	8
NNU4960-S-K-M-SP	48,6	300	420	118	3	339	17,7	9,5
NNU4964-S-K-M-SP	52,5	320	440	118	3	359	17,7	9,5
NNU4968-S-K-M-SP	55,7	340	460	118	3	379	17,7	9,5
NNU4972-S-K-M-SP	57,3	360	480	118	3	399	17,7	9,5
NNU4976-S-K-M-SP	86,9	380	520	140	4	426	17,7	9,5
NNU4980-S-K-M-SP	91	400	540	140	4	446	17,7	9,5
NNU4984-S-K-M-SP	94,4	420	560	140	4	466	17,7	9,5
NNU4988-S-K-M-SP	130	440	600	160	4	490	17,7	9,5
NNU4992-S-K-M-SP	134	460	620	160	4	510	17,7	9,5
NNU4996-S-K-M-SP	158	480	650	170	5	534	17,7	9,5
NNU49/500-S-K-M-SP	163	500	670	170	5	554	17,7	9,5



<b>s</b>	<b>d<sub>a</sub></b> <b>h12</b>	<b>D<sub>a</sub></b> <b>H12</b>	<b>C<sub>r</sub></b>	<b>C<sub>0r</sub></b>	<b>n<sub>G</sub> grease</b>	<b>n<sub>G</sub> oil</b>
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>N</b>	<b>N</b>	<b>min<sup>-1</sup></b>	<b>min<sup>-1</sup></b>
2	112	129	128000	255000	5700	6700
2	117	134	130000	260000	5500	6500
2	122	139	132000	270000	5400	6300
2,3	133,4	154,5	175000	340000	4750	5600
2,7	144,7	166	188000	385000	4450	5300
2,7	155,1	176	190000	400000	4250	5000
2,7	167,2	196,5	330000	650000	3550	4200
2,7	177,2	206,5	335000	680000	3400	4000
2,7	187,2	216,5	340000	700000	3300	3850
3,2	200,5	232	405000	860000	3000	3550
3,2	210,5	242	410000	880000	2900	3450
4,3	223	259	490000	1040000	2700	3200
4,3	243	279	510000	1140000	2550	3000
4,3	263	299	530000	1210000	2400	2800
5,4	289,4	334	750000	1690000	2070	2430
5,4	309,4	354	770000	1790000	1970	2320
6,3	336	389	1040000	2380000	1740	2040
6,3	356	409	1070000	2550000	1670	1960
6,3	376	429	1100000	2650000	1600	1890
6,3	396	449	1130000	2800000	1540	1820
7,2	422,6	482	1440000	3600000	1380	1620
7,2	442,6	502	1490000	3800000	1330	1570
7,2	462,6	522	1530000	4000000	1290	1520
6,8	486,8	558	2040000	5200000	1150	1360
6,8	506,8	578	2110000	5500000	1120	1320
7,2	530,6	606	2350000	6100000	1060	1250
7,2	550,6	626	2330000	6100000	1030	1220

## 4 Axial angular contact ball bearings

### 4.1 Features

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.

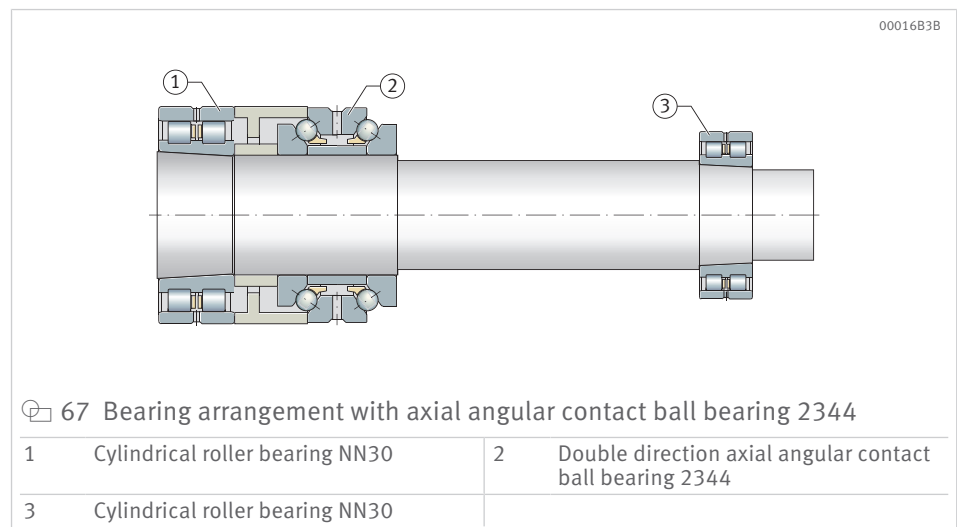
These bearings without self-retention comprise solid shaft locating washers, a spacer ring, a housing locating washer and ball and cage assemblies with solid cages. The bearing parts are matched to each other and can be fitted separately, but must not be interchanged with parts from bearings of the same 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.

Series 2344 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 bearings are typically combined with double row cylindrical roller bearings.



#### 4.1.1 Sealing

Axial angular contact ball bearings of series 2344 are available without seals.

### 4.1.2 Lubrication

The bearings can be lubricated with oil or grease.

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.

### 4.1.3 Cages

Each row of rolling elements has a ball-guided solid brass cage (suffix M).

### 4.1.4 Designation and marking of bearings

001A8B27

2344 - 24 - M - SP

**Series designation**  
 2344 Mounting on small taper diameter

**Bore code**

06	6 · 5 = 30 mm
10	10 · 5 = 50 mm
24	24 · 5 = 120 mm

**Cage**  
 M Brass cage

**Accuracy**  
 SP Special precision

68 Bearing designation

001A4E36

69 Example of marking

1 Data matrix code	2 Trademark
3 Short designation (bearing designation)	4 Country of manufacture
5 Manufacturing plant	6 Internal code

The marking is located on the end faces of the bearing rings.

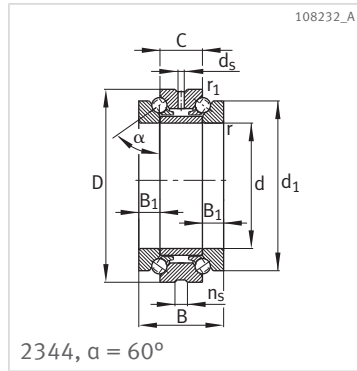
## 4.2 Product tables

### 4.2.1 Explanations

B	mm	Width
B <sub>1</sub>	mm	Shaft washer height
B <sub>N</sub>	mm	Ring groove spacing
C	mm	Outer ring width
C <sub>0a</sub>	N	Basic static load rating, axial
C <sub>0r</sub>	N	Basic static load rating, radial
c <sub>a</sub>	N/μm	Axial rigidity
C <sub>a</sub>	N	Basic dynamic load rating, axial
c <sub>a</sub> H	N/μm	Axial rigidity, high
c <sub>a</sub> L	N/μm	Axial rigidity, slight
c <sub>a</sub> M	N/μm	Axial rigidity, moderate
C <sub>r</sub>	N	Basic dynamic load rating, radial
d	mm	Bore diameter
D	mm	Outside diameter
d <sub>1</sub>	mm	Rib diameter on shaft washer
d <sub>a</sub>	mm	Abutment diameter, shaft shoulder
D <sub>a</sub>	mm	Abutment diameter, outer ring
D <sub>a</sub>	mm	Housing shoulder diameter
d <sub>s</sub>	mm	Lubrication hole diameter
E	mm	Raceway diameter of outer ring
E <sub>tk</sub>	mm	Injection pitch circle diameter
E <sub>tk1</sub>	mm	Injection pitch circle diameter 1
E <sub>tk2</sub>	mm	Injection pitch circle diameter 2
F	mm	Inner ring raceway diameter
F <sub>V</sub>	N	Preload force
F <sub>V</sub> H	N	Preload force, high
F <sub>V</sub> L	N	Preload force, slight
F <sub>V</sub> M	N	Preload force, moderate
K <sub>aE</sub>	N	Lift-off force
K <sub>aE</sub> H	N	Lift-off force, high
K <sub>aE</sub> L	N	Lift-off force, slight
K <sub>aE</sub> M	N	Lift-off force, moderate
m	kg	Mass
n <sub>G</sub>	min <sup>-1</sup>	Limiting speed
n <sub>G</sub> grease	min <sup>-1</sup>	Limiting speed for grease lubrication
n <sub>G</sub> oil	min <sup>-1</sup>	Limiting speed for oil lubrication
n <sub>s</sub>	mm	Lubrication groove width
r <sub>1 min</sub>	mm	Min. chamfer dimension
r <sub>min</sub>	mm	Min. chamfer dimension
s	mm	Displacement distance, axial
s <sub>1</sub>	mm	Displacement distance, axial
s <sub>2</sub>	mm	Displacement distance, axial
S <sub>B</sub>	mm	Lubrication groove width
S <sub>N</sub>	mm	Lubrication hole spacing
α	°	Contact angle

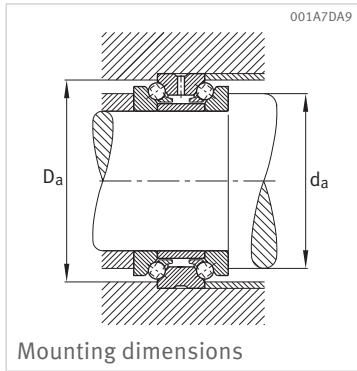
4.2.2 Axial angular contact ball bearings

Double direction



Short designation	m	d	D	B	C	d <sub>1</sub>	B <sub>1</sub>	r <sub>min</sub>	r <sub>1 min</sub>	d <sub>s</sub>	n <sub>s</sub>
	kg	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
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	324	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





$d_a$ h12	$D_a$ H12	$C_a$	$C_{0a}$	$n_G$ grease	$n_G$ oil	$F_V$	$K_{aE}$	$c_a$
mm	mm	N	N	min <sup>-1</sup>	min <sup>-1</sup>	N	N	N/μm
40,5	50,5	15700	38500	11000	16000	108	308	276
46,5	57	19100	46500	9500	1400	134	382	316
51,5	63,5	22800	58000	8500	12000	160	456	355
57,5	70	25000	67000	7500	10000	180	514	387
62,5	75	27500	79000	7000	9500	183	522	410
69	84,5	37500	102000	6300	8500	260	743	458
74	89,5	37000	102000	6000	8000	255	728	455
79	94,5	39500	115000	5600	7500	275	785	506
86,5	103,5	45500	133000	5300	7000	325	926	552
91,5	108,5	47500	144000	5000	6700	340	969	589
98,5	117	57000	173000	4500	6000	400	1140	640
103,5	122	57000	179000	4500	6000	400	1140	655
110,5	130,5	66000	213000	4000	5300	465	1326	708
115,5	135,5	67000	222000	4000	5300	465	1326	724
120,5	140,5	68000	229000	3800	5000	685	1956	843
128	150	74000	250000	3600	4800	530	1511	775
134,5	160	98000	325000	3400	4500	695	1983	854
144,5	170	101000	350000	3200	4300	960	2736	996
159	188	128000	440000	2800	3800	900	2570	978
169	198	132000	470000	2600	3600	930	2649	1034
181	211,5	143000	510000	2600	3600	1320	3764	1183
192,5	226	174000	630000	2400	3400	1180	3362	1149
206,5	245	213000	770000	2200	3200	1847	5270	1362
221	263	237000	880000	2000	3000	1660	4733	1315
231	273	246000	940000	1900	2800	2110	6021	1495
245	291,5	280000	1060000	1800	2600	2000	5704	1449
269	318	340000	1330000	1600	2200	2400	6848	1629
289	338	350000	1420000	1500	2000	2500	7134	1729
317,5	374,5	395000	1630000	1400	1900	2900	8257	1814
337,5	394,5	415000	1830000	1300	1800	3000	8542	1920

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