

# Super-precision bearings



## SKF mobile apps

SKF mobile apps are available from both Apple App Store and Google Play. These apps provide useful information and allow you to make critical calculations, providing SKF Knowledge Engineering at your fingertips.



*Apple AppStore*



*Google Play*

© SKF, BeyondZero, KMT and KMTA are registered trademarks of the SKF Group.

™ NitroMax is a trademark of the SKF Group.

Apple is a trademark of Apple Inc., registered in the US and other countries.

Google Play is a trademark of Google Inc.

© SKF Group 2016

The contents of this publication are the copyright of the publisher and may not be reproduced (even extracts) unless prior written permission is granted. Every care has been taken to ensure the accuracy of the information contained in this publication but no liability can be accepted for any loss or damage whether direct, indirect or consequential arising out of the use of the information contained herein.

**PUB BU/P1 13383/2 EN** · March 2016

This publication supersedes publication 6002.

Certain image(s) used under license from Shutterstock.com

Principles of bearing selection and application

1

Angular contact ball bearings

2

Cylindrical roller bearings

3

Double direction angular contact thrust ball bearings

4

Axial-radial cylindrical roller bearings

5

Angular contact thrust ball bearings for screw drives

6

Precision lock nuts

7

Gauges

8

Indexes

9

# Content

|                                                                |           |
|----------------------------------------------------------------|-----------|
| <b>This is SKF</b> .....                                       | <b>6</b>  |
| <b>SKF – the knowledge engineering company</b> .....           | <b>8</b>  |
| <b>Unit conversions</b> .....                                  | <b>10</b> |
| <b>Foreword</b> .....                                          | <b>11</b> |
| <b>1 Principles of bearing selection and application</b> ..... | <b>19</b> |
| Selecting super-precision bearings .....                       | 20        |
| Bearing types and designs .....                                | 21        |
| Basic selection criteria .....                                 | 23        |
| Bearing life and load ratings .....                            | 33        |
| Dynamic bearing loads and life .....                           | 33        |
| Permissible static loads .....                                 | 36        |
| Friction .....                                                 | 37        |
| Effects of clearance and preload on friction .....             | 37        |
| Effects of grease fill on friction .....                       | 37        |
| Frictional behaviour of hybrid bearings .....                  | 37        |
| Speeds .....                                                   | 38        |
| Permissible speeds .....                                       | 39        |
| Attainable speeds .....                                        | 44        |
| Attainable speeds for typical spindle bearing systems .....    | 44        |
| Bearing specifics .....                                        | 46        |
| Boundary dimensions .....                                      | 46        |
| Tolerances .....                                               | 47        |
| Preload and internal clearance .....                           | 50        |
| Materials .....                                                | 51        |
| Design considerations .....                                    | 57        |
| Bearing arrangements .....                                     | 57        |
| System rigidity .....                                          | 66        |
| Radial location of bearings .....                              | 70        |
| Axial location of bearings .....                               | 78        |
| Provisions for mounting and dismounting .....                  | 88        |
| Bearing preload .....                                          | 90        |
| Sealing solutions .....                                        | 95        |
| Lubrication .....                                              | 99        |
| Grease lubrication .....                                       | 99        |
| Oil lubrication .....                                          | 113       |
| Lubricant storage .....                                        | 122       |

|                                                                          |            |
|--------------------------------------------------------------------------|------------|
| Mounting and dismounting . . . . .                                       | 123        |
| Where to mount . . . . .                                                 | 123        |
| Methods and tools . . . . .                                              | 123        |
| Mounting recommendations . . . . .                                       | 123        |
| Test running . . . . .                                                   | 124        |
| Dismounting . . . . .                                                    | 124        |
| Reusing bearings . . . . .                                               | 124        |
| SKF spindle service . . . . .                                            | 125        |
| Bearing storage . . . . .                                                | 125        |
| <b>2 Angular contact ball bearings . . . . .</b>                         | <b>127</b> |
| Assortment . . . . .                                                     | 128        |
| Designs and variants . . . . .                                           | 128        |
| Bearing arrangement design . . . . .                                     | 141        |
| Markings on bearings and bearing sets . . . . .                          | 145        |
| Bearing data . . . . .                                                   | 146        |
| Preload . . . . .                                                        | 151        |
| Axial stiffness . . . . .                                                | 173        |
| Fitting and clamping bearing rings . . . . .                             | 183        |
| Load carrying capacity of bearing sets . . . . .                         | 189        |
| Equivalent bearing loads . . . . .                                       | 190        |
| Attainable speeds . . . . .                                              | 192        |
| Mounting . . . . .                                                       | 194        |
| Designation system . . . . .                                             | 196        |
| <b>Product table</b>                                                     |            |
| 2.1 Angular contact ball bearings . . . . .                              | 198        |
| <b>3 Cylindrical roller bearings . . . . .</b>                           | <b>263</b> |
| Designs and variants . . . . .                                           | 264        |
| Bearing data . . . . .                                                   | 269        |
| Radial internal clearance or preload in mounted bearings . . . . .       | 275        |
| Radial stiffness . . . . .                                               | 275        |
| Equivalent bearing loads . . . . .                                       | 277        |
| Attainable speeds . . . . .                                              | 277        |
| Design considerations . . . . .                                          | 278        |
| Mounting . . . . .                                                       | 280        |
| Designation system . . . . .                                             | 286        |
| <b>Product tables</b>                                                    |            |
| 3.1 Single row cylindrical roller bearings . . . . .                     | 288        |
| 3.2 Double row cylindrical roller bearings . . . . .                     | 294        |
| <b>4 Double direction angular contact thrust ball bearings . . . . .</b> | <b>301</b> |
| Designs and variants . . . . .                                           | 302        |
| Markings on bearings . . . . .                                           | 305        |
| Bearing data . . . . .                                                   | 306        |
| Preload . . . . .                                                        | 308        |
| Axial stiffness . . . . .                                                | 309        |
| Equivalent bearing loads . . . . .                                       | 310        |
| Attainable speeds . . . . .                                              | 310        |
| Mounting . . . . .                                                       | 310        |
| Designation system . . . . .                                             | 311        |
| <b>Product table</b>                                                     |            |
| 4.1 Double direction angular contact thrust ball bearings . . . . .      | 312        |

|                                                                             |            |
|-----------------------------------------------------------------------------|------------|
| <b>5 Axial-radial cylindrical roller bearings</b>                           | <b>319</b> |
| Designs and variants                                                        | 320        |
| Bearing data                                                                | 321        |
| Preload and stiffness                                                       | 322        |
| Friction                                                                    | 322        |
| Lubrication                                                                 | 324        |
| Design considerations                                                       | 324        |
| Load carrying capacity                                                      | 327        |
| Equivalent bearing loads                                                    | 327        |
| Permissible moment load                                                     | 328        |
| Mounting                                                                    | 330        |
| Designation system                                                          | 333        |
| <b>Product tables</b>                                                       |            |
| 5.1 Axial-radial cylindrical roller bearings                                | 334        |
| <b>6 Angular contact thrust ball bearings for screw drives</b>              | <b>337</b> |
| Designs and variants                                                        | 338        |
| Bearing arrangement design                                                  | 346        |
| Markings on bearings                                                        | 352        |
| Bearing data                                                                | 353        |
| Preload                                                                     | 355        |
| Axial stiffness                                                             | 358        |
| Frictional moment                                                           | 360        |
| Lifting force                                                               | 360        |
| Load carrying capacity of bearing sets                                      | 361        |
| Equivalent bearing loads                                                    | 361        |
| Axial load carrying capacity                                                | 362        |
| Mounting                                                                    | 362        |
| Attainable speeds                                                           | 363        |
| Designation system                                                          | 364        |
| <b>Product tables</b>                                                       |            |
| 6.1 Single direction angular contact thrust ball bearings                   | 366        |
| 6.2 Double direction angular contact thrust ball bearings                   | 368        |
| 6.3 Double direction angular contact thrust ball bearings for bolt mounting | 370        |
| 6.4 Cartridge units with a flanged housing                                  | 372        |
| <b>7 Precision lock nuts</b>                                                | <b>375</b> |
| Designs                                                                     | 376        |
| Product data                                                                | 378        |
| Installation and removal                                                    | 379        |
| Designation system                                                          | 382        |
| <b>Product tables</b>                                                       |            |
| 7.1 KMT precision lock nuts with locking pins                               | 384        |
| 7.2 KMTA precision lock nuts with locking pins                              | 386        |
| 7.3 KMD precision lock nuts with axial locking screws                       | 388        |

8 Gauges ..... 391

GRA 30 ring gauges ..... 393

Product table

8.1 GRA 30 ring gauges ..... 394

DMB taper gauges ..... 396

Product table

8.2 DMB taper gauges ..... 398

GB 30 and GB 10 internal clearance gauges ..... 400

Product tables

8.3 GB 30 and GB 10 internal clearance gauges for cylindrical roller bearings ..... 402

GB 49 internal clearance gauges ..... 404

Product tables

8.4 GB 49 internal clearance gauges for cylindrical roller bearings ..... 406

9 Indexes ..... 408

Text index ..... 409

Product index ..... 420

# This is SKF

From one simple but inspired solution to a misalignment problem in a textile mill in Sweden, and fifteen employees in 1907, SKF has grown to become a global industrial knowledge leader. Over the years, we have built on our expertise in bearings, extending it to seals, mechatronics, services and lubrication systems. Our knowledge network includes 46 000 employees, 15 000 distributor partners, offices in more than 130 countries, and a growing number of SKF Solution Factory sites around the world.



## Research and development

We have hands-on experience in over forty industries based on our employees' knowledge of real life conditions. In addition, our world-leading experts and university partners pioneer advanced theoretical research and development in areas including tribology, condition monitoring, asset management and bearing life theory. Our ongoing commitment to research and development helps us keep our customers at the forefront of their industries.



*SKF Solution Factory makes SKF knowledge and manufacturing expertise available locally to provide unique solutions and services to our customers.*



## Meeting the toughest challenges

Our network of knowledge and experience, along with our understanding of how our core technologies can be combined, helps us create innovative solutions that meet the toughest of challenges. We work closely with our customers throughout the asset life cycle, helping them to profitably and responsibly grow their businesses.

## Working for a sustainable future

Since 2005, SKF has worked to reduce the negative environmental impact from our operations and those of our suppliers. Our continuing technology development resulted in the introduction of the SKF BeyondZero portfolio of products and services which improve efficiency and reduce energy losses, as well as enable new technologies harnessing wind, solar and ocean power. This combined approach helps reduce the environmental impact both in our operations and our customers' operations.



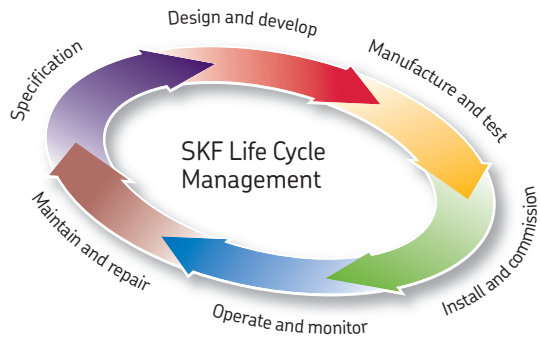
*Working with SKF IT and logistics systems and application experts, SKF Authorized Distributors deliver a valuable mix of product and application knowledge to customers worldwide.*



# SKF – the knowledge engineering company

## Our knowledge – your success

*SKF Life Cycle Management is how we combine our technology platforms and advanced services, and apply them at each stage of the asset life cycle, to help our customers to be more successful, sustainable and profitable.*



### Working closely with you

Our objective is to help our customers improve productivity, minimize maintenance, achieve higher energy and resource efficiency, and optimize designs for long service life and reliability.

### Innovative solutions

Whether the application is linear or rotary or a combination, SKF engineers can work with you at each stage of the asset life cycle to improve machine performance by looking at the entire

application. This approach doesn't just focus on individual components like bearings or seals. It looks at the whole application to see how each component interacts with each other.

### Design optimization and verification

SKF can work with you to optimize current or new designs with proprietary 3-D modelling software that can also be used as a virtual test rig to confirm the integrity of the design.



### **Bearings**

*SKF is the world leader in the design, development and manufacture of high performance rolling bearings, plain bearings, bearing units and housings.*



### **Machinery maintenance**

*Condition monitoring technologies and maintenance services from SKF can help minimize unplanned downtime, improve operational efficiency and reduce maintenance costs.*



### **Sealing solutions**

*SKF offers standard seals and custom engineered sealing solutions to increase uptime, improve machine reliability, reduce friction and power losses, and extend lubricant life.*



### **Mechatronics**

*SKF fly-by-wire systems for aircraft and drive-by-wire systems for off-road, agricultural and forklift applications replace heavy, grease or oil consuming mechanical and hydraulic systems.*



### **Lubrication solutions**

*From specialized lubricants to state-of-the-art lubrication systems and lubrication management services, lubrication solutions from SKF can help to reduce lubrication related downtime and lubricant consumption.*



### **Actuation and motion control**

*With a wide assortment of products – from actuators and ball screws to profile rail guides – SKF can work with you to solve your most pressing linear system challenges.*

# Unit conversions

| Unit conversions    |                        |                     |                                              |             |                                          |
|---------------------|------------------------|---------------------|----------------------------------------------|-------------|------------------------------------------|
| Quantity            | Unit                   | Conversion          |                                              |             |                                          |
| Length              | inch                   | 1 mm                | 0.03937 in.                                  | 1 in.       | 25,40 mm                                 |
|                     | foot                   | 1 m                 | 3.281 ft.                                    | 1 ft.       | 0,3048 m                                 |
|                     | yard                   | 1 m                 | 1.094 yd.                                    | 1 yd.       | 0,9144 m                                 |
|                     | mile                   | 1 km                | 0.6214 mi.                                   | 1 mi.       | 1,609 km                                 |
| Area                | square inch            | 1 mm <sup>2</sup>   | 0.00155 sq-in                                | 1 sq-in     | 645,16 mm <sup>2</sup>                   |
|                     | square foot            | 1 m <sup>2</sup>    | 10.76 sq-ft                                  | 1 sq-ft     | 0,0929 m <sup>2</sup>                    |
| Volume              | cubic inch             | 1 cm <sup>3</sup>   | 0.061 cu-in                                  | 1 cu-in     | 16,387 cm <sup>3</sup>                   |
|                     | cubic foot             | 1 m <sup>3</sup>    | 35 cu-ft                                     | 1 cu-ft     | 0,02832 m <sup>3</sup>                   |
|                     | imperial gallon        | 1 l                 | 0.22 gallon                                  | 1 gallon    | 4,5461 l                                 |
|                     | US gallon              | 1 l                 | 0.2642 US gallon                             | 1 US gallon | 3,7854 l                                 |
| Speed,<br>velocity  | foot per second        | 1 m/s               | 3.28 ft/s                                    | 1 ft/s      | 0,30480 m/s                              |
|                     | mile per hour          | 1 km/h              | 0.6214 mph                                   | 1 mph       | 1,609 km/h                               |
| Mass                | ounce                  | 1 g                 | 0.03527 oz.                                  | 1 oz.       | 28,350 g                                 |
|                     | pound                  | 1 kg                | 2.205 lb.                                    | 1 lb.       | 0,45359 kg                               |
|                     | short ton              | 1 tonne             | 1.1023 short ton                             | 1 short ton | 0,90719 tonne                            |
|                     | long ton               | 1 tonne             | 0.9842 long ton                              | 1 long ton  | 1,0161 tonne                             |
| Density             | pound per cubic inch   | 1 g/cm <sup>3</sup> | 0.0361 lb/cu-in                              | 1 lb/cu-in  | 27,680 g/cm <sup>3</sup>                 |
| Force               | pound-force            | 1 N                 | 0.225 lbf.                                   | 1 lbf.      | 4,4482 N                                 |
| Pressure,<br>stress | pounds per square inch | 1 MPa               | 145 psi                                      | 1 psi       | 6,8948 × 10 <sup>3</sup> Pa              |
|                     |                        | 1 N/mm <sup>2</sup> | 145 psi                                      |             |                                          |
|                     |                        | 1 bar               | 14.5 psi                                     | 1 psi       | 0,068948 bar                             |
| Moment              | pound-force inch       | 1 Nm                | 8.85 lbf-in                                  | 1 lbf-in    | 0,113 Nm                                 |
| Power               | foot-pound per second  | 1 W                 | 0.7376 ft-lbf/s                              | 1 ft-lbf/s  | 1,3558 W                                 |
|                     | horsepower             | 1 kW                | 1.36 hp                                      | 1 hp        | 0,736 kW                                 |
| Temperature         | degree                 | Celsius             | t <sub>C</sub> = 0.555 (t <sub>F</sub> - 32) | Fahrenheit  | t <sub>F</sub> = 1,8 t <sub>C</sub> + 32 |

# Foreword

This catalogue contains the standard assortment of SKF super-precision bearings typically used in machine tool applications. To provide the highest levels of quality and customer service, these products are available worldwide through SKF sales channels. For information about lead times and deliveries, contact your local SKF representative or SKF Authorized Distributor.

The data in this catalogue reflect SKF's state-of-the-art technology and production capabilities as of 2013. The data contained within may differ from that shown in earlier catalogues because of redesign, technological developments, or revised calculation methods. SKF reserves the right to continually improve its products with respect to materials, design and manufacturing methods, some of which are driven by technological developments.

## Getting started

This catalogue is divided into nine main chapters, marked with numbered blue tabs in the right margin:

- Chapter 1 provides design and application recommendations.
- Chapters 2 to 6 describe the various bearing types. Each chapter contains descriptions of the products, and product tables listing data for selecting a bearing and designing the bearing arrangement.
- Chapter 7 contains information about precision lock nuts.
- Chapter 8 presents special gauges.
- Chapter 9 contains indexes to quickly retrieve information about a specific product or topic.

## The latest developments

Compared to the previous catalogue, nearly each and every bearing has been redesigned to meet increasing application requirements. Many sizes and variants have been added to the assortment. The main content updates include:

### More angular contact ball bearing sizes

Angular contact ball bearings in the 18 dimension series are included for the first time. In the other dimension series, several sizes have been added to both ends of the size range. The number of sealed bearings is about three times the number in the previous catalogue and also the number of hybrid bearings has been increased.



*New super-precision angular contact ball bearings in the 18 dimension series*

## Foreword

### More angular contact ball bearing variants

Angular contact ball bearings offer more choice:

- variants for direct oil-air lubrication
- greater variety in preload classes
- bearings with ceramic balls and rings made of NitroMax steel

### New series of double direction angular contact thrust ball bearings

The previous bearing series 2344(00) has been replaced by the new BTW series. Bearings in the BTW series accommodate higher speeds with less friction, have a lower weight and are easier to mount.

### Axial-radial cylindrical roller bearings

Axial-radial cylindrical roller bearings have been added to the catalogue. These bearings are commonly used to support rotary tables, indexing heads and multi-spindle heads on machining centres.

### Bearings with PEEK cages

Cages made of reinforced PEEK enable bearings to accommodate higher speeds and run more quietly. Many more angular contact ball bearings and cylindrical roller bearings are available with cages made of this material.



*Bearings with ceramic balls and rings made of NitroMax steel*



*BTW series bearings replace the former 2344(00) series*



*Axial-radial cylindrical roller bearings*



*PEEK cages enable higher speeds and quieter running*

## How to use this catalogue

The catalogue is designed so that specific information can be found quickly. At the front of the catalogue there is the full table of contents. At the back, there is a product index and a full text index. Each chapter is clearly marked by a printed tab with the chapter number.

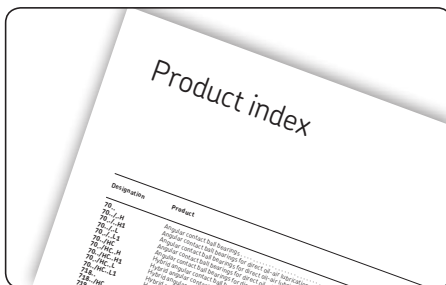
## Identify products

Product designations for SKF super-precision bearings typically contain information about the bearing and additional features. To specify an SKF bearing or to find more information about it, there are three options:

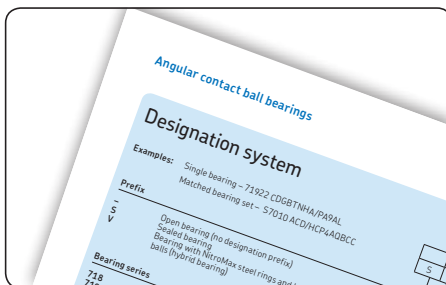
- **Product index**  
The product index at the end of the catalogue lists series designations, relates them to the bearing type and guides the reader to the relevant product chapter and product table.
- **Designation charts**  
Product designations in each product chapter are located on the pages preceding the product tables. These charts identify commonly used designation prefixes and suffixes.
- **Text index**  
The text index at the end of the catalogue contains designation suffixes in alphabetical order. They are printed bold for quick browsing.

### Units of measurement

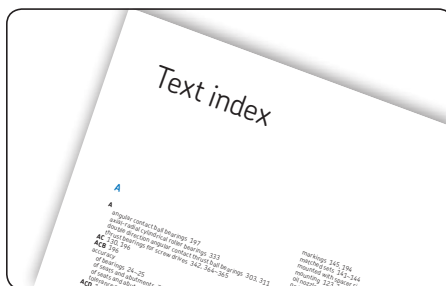
This catalogue is for global use. Therefore, the units of measurement are in accordance with ISO 80000-1. Unit conversions can be made using the conversion table (→ **page 10**). For easier use, temperature values are provided in both, °C and °F. Temperature values are typically rounded. Therefore, the two values do not always match exactly when using the conversion formula.



*The product index makes finding information based on a bearing's designation easy*



### Designation chart to decode designations



*Designation suffixes listed in the text index reduce search time*

### Other SKF products and services

SKF offers a wide range of products, services and solutions, not presented in this catalogue, but perhaps needed when using SKF super-precision bearings. For information about these products, contact SKF or visit [skf.com](http://skf.com). The offer includes:

#### Lubrication systems

SKF provides a range of automatic lubrication technologies, each offering a number of important advantages, from improved production and reduced total cost of ownership to a healthier, more environmentally friendly workplace. SKF can supply spindle lubrication systems that are suitable for most of the speed ranges and provides customized multi-point lubrication systems for linear guides, screw drives, bearings and auxiliary equipment as well as automated minimal quantity lubrication systems for machining processes that reduce environmental impact and create healthier work environments.

#### Coolant pumps

SKF offers a full range of space-saving centrifugal and screw spindle pumps, each engineered to provide a reliable and efficient supply of cooling fluid in specific machine tool applications. Due to immersed installation, most of these pumps operate without seals, reducing maintenance and, ultimately, total cost of ownership. Available in numerous designs for various media, flow rates and operating pressures, these pumps can be provided with assorted standard drive options and electrical connection ratings.



*Lubrication system*



*Coolant pumps*



### Linear motion technologies

By combining competencies in linear motion, bearings, sealing solutions, lubricants and lubrication systems with best practices, SKF offers solutions for linear drive and for guiding systems, including profile rail guides, precision rail guides, dovetail slides, standard linear slides and linear ball bearings. All are designed for ease of maintenance and reliability.

Linear drives for many machine tool axes are equipped with ball screws or roller screws. SKF ball and roller screws provide a fast and precise linear movement, even under high load conditions.

Roller screws fitted on machine axes provide the unique advantages of rapid acceleration, high linear speed and high load carrying capability combined with high axial stiffness. Satellite roller screws, which do not have recirculation systems and which do not exhibit friction between rolling elements, provide higher accuracy when machine tool axes reverse direction. Roller screws are also available with the support bearings pre-assembled on a screw shaft – ready to bolt in place, speeding up and simplifying assembly and alignment procedures.

### Custom sealing solutions

Decades of experience manufacturing seals, combined with advanced materials expertise, has made SKF a leading supplier of standard and custom-engineered sealing solutions. These include integrated solutions consisting of seals and advanced engineered plastic parts, as well as moulded seals for higher volume orders and high-performance machined seals for hydraulic and pneumatic applications like press-cylinders, valves or clamping devices as well as for rotary applications like rotary distributors, joints or indexing tables.

Due to flexible production processes, customers can benefit from short delivery times and just-in-time deliveries for standard and custom seals. A wide variety of high performance sealing materials – including hydrolysis-resistant and/or self-lubricated polyurethanes, fluoro-carbon-rubbers and different PTFE-compounds – provides high wear resistance, long service-life and chemical compatibility with various machine tool fluids. In addition, SKF supports customers with on-site solution analysis and application engineering support.



*Linear motion technologies*



*Seals*

## Foreword

### Spindle condition monitoring

The monitoring of spindle health is crucial to avoiding machining process disturbances and unplanned production stops. SKF provides a complete family of condition monitoring tools and technologies, from hand-held data collectors and analyzers to online surveillance and protection systems that provide reliable insight into machine condition including bearing, imbalance and lubrication issues.

These systems improve operational efficiency and reduce costs by eliminating unplanned downtime and enabling machine tool operators to schedule maintenance based on condition rather than time schedules. The data logging system can be integrated with the machine's control system for aligned corrective actions. For example, the SKF Spindle Assessment Kit is a complete solution for reliable, simplified, onboard condition monitoring. The kit includes an SKF Microlog Advisor Pro, acceleration sensor, laser tachometer, dial gauge with stand, belt tension gauge and a software package. SKF assists in the set up of measuring points on your machine tool spindles and also offers a consulting service as part of a service agreement.



*Spindle condition monitoring*

### Advanced calculation tools

SKF Spindle Simulator is an advanced simulation software program for the analysis of spindle applications. Based on the SKF Simulator platform and using the same advanced technology, it has been designed to be exceptionally user friendly.

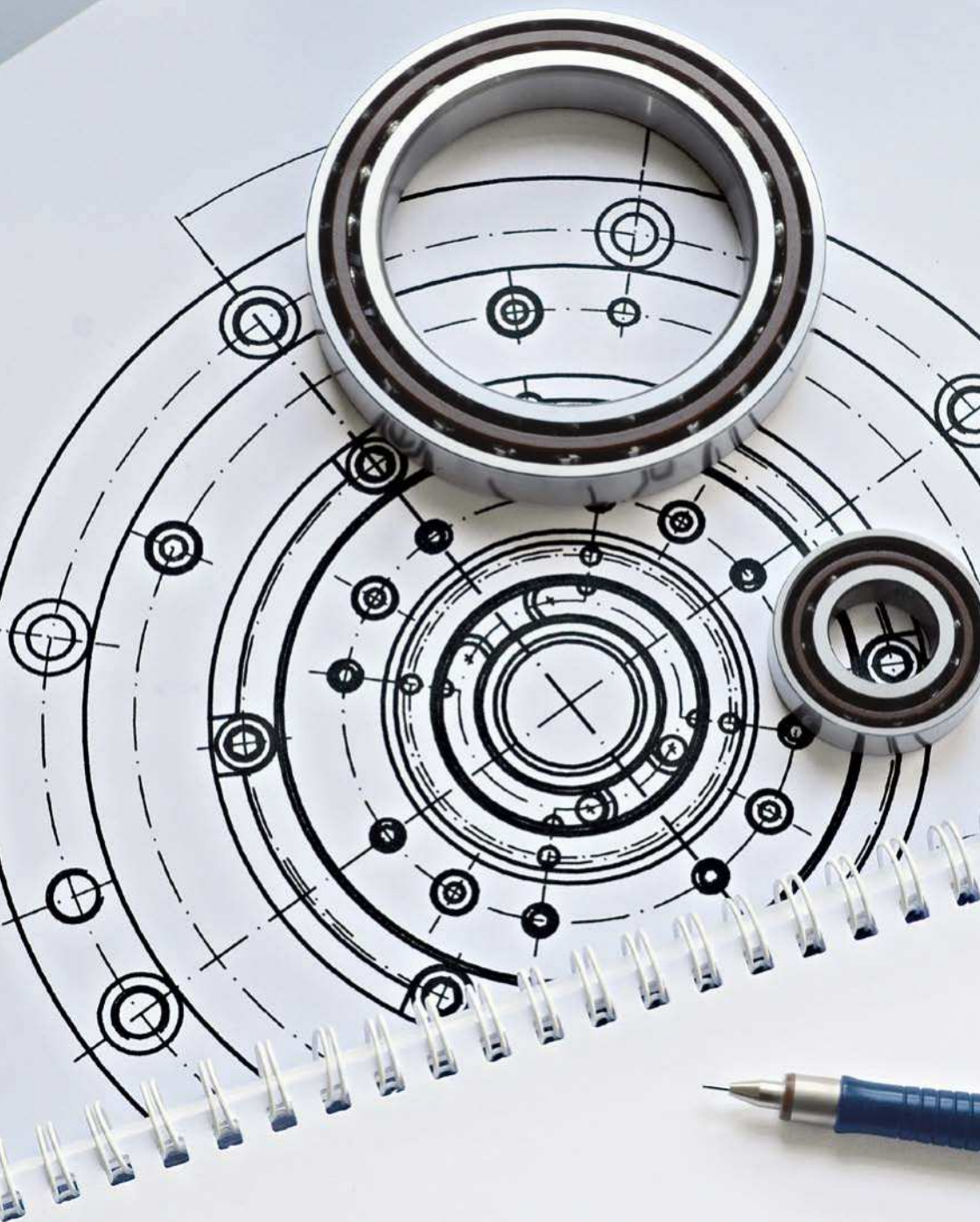
The software is able to simulate the effects of user-defined speed and temperature distribution on bearing shaft and housing fits and preload. In addition, at each step of the spindle's duty cycle, it analyzes the effect of the external loads on the shaft and the bearings and delivers highly accurate information about the contact for each rolling element in each bearing.

This program supports the analysis of spindles and contains detailed and up-to-date models of SKF super-precision bearings.



*SKF Spindle Simulator*





# Principles of bearing selection and application

|                                                   |           |                                              |            |
|---------------------------------------------------|-----------|----------------------------------------------|------------|
| <b>Selecting super-precision bearings . . .</b>   | <b>20</b> | <b>Design considerations . . . . .</b>       | <b>57</b>  |
| Bearing types and designs . . . . .               | 21        | Bearing arrangements . . . . .               | 57         |
| Basic selection criteria . . . . .                | 23        | System rigidity . . . . .                    | 66         |
|                                                   |           | Bearing stiffness . . . . .                  | 68         |
| <b>Bearing life and load ratings . . . . .</b>    | <b>33</b> | Radial location of bearings . . . . .        | 70         |
| Dynamic bearing loads and life . . . . .          | 33        | Recommended shaft and housing fits . . . . . | 70         |
| Basic dynamic load rating . . . . .               | 33        | Accuracy of seats and abutments . . . . .    | 75         |
| Equivalent dynamic bearing load . . . . .         | 33        | Axial location of bearings . . . . .         | 78         |
| Basic rating life . . . . .                       | 34        | Locating methods . . . . .                   | 78         |
| Rating life for hybrid bearings . . . . .         | 34        | Stepped sleeves . . . . .                    | 80         |
| Requisite minimum load . . . . .                  | 34        | Provisions for mounting and                  |            |
| Calculating life with variable operating          |           | dismounting . . . . .                        | 88         |
| conditions . . . . .                              | 35        | Bearing preload . . . . .                    | 90         |
| Permissible static loads . . . . .                | 36        | Sealing solutions . . . . .                  | 95         |
| Basic static load rating . . . . .                | 36        | External seals . . . . .                     | 95         |
| Equivalent static bearing load . . . . .          | 36        | Integral seals . . . . .                     | 98         |
| Required basic static load rating . . . . .       | 36        |                                              |            |
| <b>Friction . . . . .</b>                         | <b>37</b> | <b>Lubrication . . . . .</b>                 | <b>99</b>  |
| Effects of clearance and preload on               |           | Grease lubrication . . . . .                 | 99         |
| friction . . . . .                                | 37        | Oil lubrication . . . . .                    | 113        |
| Effects of grease fill on friction . . . . .      | 37        | Lubricant storage . . . . .                  | 122        |
| Frictional behaviour of hybrid bearings . . . . . | 37        |                                              |            |
| <b>Speeds . . . . .</b>                           | <b>38</b> | <b>Mounting and dismounting . . . . .</b>    | <b>123</b> |
| Permissible speeds . . . . .                      | 39        | Where to mount . . . . .                     | 123        |
| Attainable speeds . . . . .                       | 44        | Methods and tools . . . . .                  | 123        |
| Attainable speeds for typical spindle             |           | Mounting recommendations . . . . .           | 123        |
| bearing systems . . . . .                         | 44        | Test running . . . . .                       | 124        |
|                                                   |           | Dismounting . . . . .                        | 124        |
|                                                   |           | Reusing bearings . . . . .                   | 124        |
|                                                   |           | SKF spindle service . . . . .                | 125        |
| <b>Bearing specifics . . . . .</b>                | <b>46</b> |                                              |            |
| Boundary dimensions . . . . .                     | 46        | <b>Bearing storage . . . . .</b>             | <b>125</b> |
| Tolerances . . . . .                              | 47        |                                              |            |
| Preload and internal clearance . . . . .          | 50        |                                              |            |
| Materials . . . . .                               | 51        |                                              |            |
| Materials for bearing rings and rolling           |           |                                              |            |
| elements . . . . .                                | 51        |                                              |            |
| Cage materials . . . . .                          | 55        |                                              |            |
| Seal materials . . . . .                          | 56        |                                              |            |

## Selecting super-precision bearings

A shaft system consists of more than just bearings. Associated components like the shaft and housings are integral parts of the overall system. The lubricant and sealing elements also play a crucial role. To maximize bearing performance, the correct amount of an appropriate lubricant must be present to reduce friction in the bearing and protect it from corrosion. Sealing elements are important because they keep the lubricant in and contaminants out of the bearing. This is particularly important since cleanliness has a profound effect on bearing service life. Therefore, SKF manufactures and sells a wide range of industrial seals and lubrication systems.

There are a number of factors that go into the bearing selection process:

- available space
- loads (magnitude and direction)
- precision and stiffness
- speeds
- operating temperature
- vibration levels
- contamination levels
- lubrication type and method

Once a suitable bearing has been selected, there are several other factors that need to be considered:

- suitable form and design of other components in the arrangement
- appropriate fits and bearing internal clearance or preload
- locking devices
- adequate seals
- mounting and dismounting methods

When designing an application, every decision affects the performance, reliability and economy of the shaft system.

As the leading bearing supplier, SKF manufactures a wide assortment of super-precision bearing types, series, designs, variants and sizes. The most common of them are introduced under *Bearing types and designs*.

Under *Principles of bearing selection and application*, the designer of a bearing system can find the necessary basic information, presented in the order in which it is generally required. Obviously, it is impossible to include all the information needed to cover every conceivable application. For this reason, in many places, reference is made to the SKF application engineering service. This technical service can perform complex calculations, diagnose and solve bearing performance issues, and help with the bearing selection process. SKF also recommends this service to anyone working to improve the performance of their application.

The information provided under *Principles of bearing selection and application* is general and applies to most super-precision bearings. Information specific to one bearing type is provided in the relevant product chapter.

It should be noted that many of the values listed in the product tables are rounded.

## Bearing types and designs

SKF's comprehensive assortment of super-precision bearings is designed for machine tool spindles and other applications that require a high level of running accuracy at high to extremely high speeds. Each bearing type incorporates unique features to make it suitable for specific operating conditions. For details about the different bearing types, refer to the relevant product chapter.

### Angular contact ball bearings (→ page 21)

high-capacity (D design) (1)

high-speed (E design) (2)

high-speed (B design) (3)

all designs in different variants:

- for single mounting or matched bearing sets
- for universal matching or universally matchable sets
- bearings with steel balls or hybrid bearings
- open or with seals (3)

### Cylindrical roller bearings (→ page 21)

single row (N design)

- basic design (4)
- high-speed designs (5)
- hybrid bearings

double row (NN design) (6)

- bearings with steel rollers
- hybrid bearings

double row (NNU design) (7)

### Double direction angular contact thrust ball bearings (→ page 21)

basic design (BTW series) (8)

- bearings with steel balls
- hybrid bearings

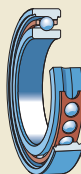
high-speed design (BTM series) (9)

- bearings with steel balls
- hybrid bearings

1



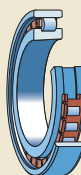
2



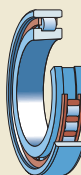
3



4



5



6



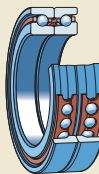
7



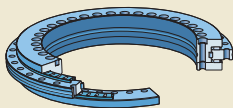
8



9







10

**Axial-radial cylindrical roller bearings**  
(→ page 22)

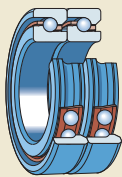
basic design (NRT series) (10)

**Angular contact thrust ball bearings for screw drives** (→ page 22)

single direction (BSA and BSD series) (11),  
universally matchable for mounting as sets (12)



11



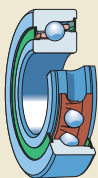
12

– bearings with seals (13)

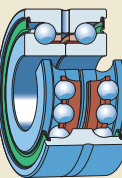
double direction with seals (BEAS series) (14)

– for bolt mounting (BEAM series) (15)

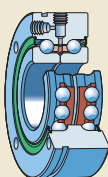
cartridge units with a flanged housing (FBSA series) (16)



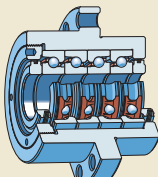
13



14



15



16



## Cages

The super-precision bearings shown in this catalogue all contain a cage. For some special applications, however, bearings without a cage (full complement) may be offered. The primary purposes of a cage are to:

- Separate the rolling elements to reduce the frictional moment and frictional heat in the bearing.
- Keep the rolling elements evenly spaced to optimize load distribution and enable quiet and uniform operation.
- Guide the rolling elements in the unloaded zone, to improve the rolling conditions and to help avoid damaging sliding movements.
- Retain the rolling elements of separable bearings when one bearing ring is removed during mounting or dismounting.

Cages are mechanically stressed by frictional, strain and inertial forces. They can also be degraded by high temperatures and chemicals like certain lubricants, lubricant additives or by-products of their ageing, organic solvents or coolants. Therefore, both the design and material of a cage have a significant influence on the suitability of a rolling bearing for a particular application. As a result, SKF has developed a variety of cages, made of different materials, for different bearing types and operating conditions.

In each product chapter, information about standard cages and possible alternatives is provided. Standard cages are those considered most suitable for the majority of applications. If a bearing with a non-standard cage is required, check availability prior to ordering.

## Basic selection criteria

Bearing selection is paramount when dealing with machine tool spindles and other applications that require a high degree of running accuracy at high speeds. The SKF super-precision bearing assortment comprises different bearing types, each with features designed to meet specific application requirements.

Since several factors have to be considered and weighed when selecting a super-precision bearing, no general rules can be given. The following factors are the most important to be considered when selecting a super-precision bearing:

- precision (→ page 23)
- rigidity (→ page 23)
- available space (→ page 23)
- speeds (→ page 23)
- loads (→ page 23)
- axial displacement (→ page 23)
- sealing solutions (→ page 23)

The total cost of a shaft system and inventory considerations can also influence bearing selection.

Some of the most important criteria to consider when designing a bearing arrangement are covered in depth in separate sections of this catalogue. Detailed information on the individual bearing types, including their characteristics and the available designs, is provided in each product chapter.

Where demands on precision and productivity are exceptionally high, it may be necessary to contact the SKF application engineering service. For highly demanding applications, SKF offers special solutions such as:

- hybrid bearings (→ page 23)
- bearings made of NitroMax steel (→ page 23)
- coated bearings

Precision

When dealing with rolling bearings, precision is described by tolerance classes for running accuracy and dimensional accuracy. **Table 1** shows a comparison of the tolerance classes used by SKF and different standards organisations.

Most SKF super-precision bearings are manufactured to P4A, P4C or SP tolerance classes. Standard and optional tolerance

classes for SKF super-precision bearings are listed in **table 2**.

Each product chapter provides information about the tolerance classes to which the bearings are manufactured.

Table 1

| Comparison of the tolerance classes |                                                                   |                         |                   |                      |                         |                   |
|-------------------------------------|-------------------------------------------------------------------|-------------------------|-------------------|----------------------|-------------------------|-------------------|
| SKF tolerance class                 | Standard tolerance classes in accordance with different standards |                         |                   | Dimensional accuracy |                         |                   |
|                                     | Running accuracy ISO <sup>1)</sup>                                | ANSI/ABMA <sup>2)</sup> | DIN <sup>3)</sup> |                      | ANSI/ABMA <sup>2)</sup> | DIN <sup>3)</sup> |
| P4A                                 | 2 <sup>4)</sup>                                                   | ABEC 9 <sup>4)</sup>    | P2 <sup>4)</sup>  | 4                    | ABEC 7                  | P4                |
| P4                                  | 4                                                                 | ABEC 7                  | P4                | 4                    | ABEC 7                  | P4                |
| P5                                  | 5                                                                 | ABEC 5                  | P5                | 5                    | ABEC 5                  | P5                |
| P2                                  | 2                                                                 | ABEC 9                  | P2                | 2                    | ABEC 9                  | P2                |
| PA9A                                | 2                                                                 | ABEC 9                  | P2                | 2                    | ABEC 9                  | P2                |
| P4C                                 | 4                                                                 | ABEC 7                  | P4                | 4                    | ABEC 7                  | P4                |
| SP                                  | 4                                                                 | ABEC 7                  | P4                | 5                    | ABEC 5                  | P5                |
| UP <sup>5)</sup>                    | 2                                                                 | ABEC 9                  | P2                | 4                    | ABEC 7                  | P4                |

1) ISO 492 or ISO 199  
2) ANSI/ABMA Std. 20  
3) DIN 620-2 or DIN 620-3  
4) d > 120 mm → ISO 4 or better, ABEC 7 or better, DIN P4 or better  
5) Depending on bearing size, accuracy might be even better.

Table 2

| Standard and optional tolerance classes for SKF super-precision bearings |                          |                          |
|--------------------------------------------------------------------------|--------------------------|--------------------------|
| Bearing type                                                             | Standard tolerance class | Optional tolerance class |
| Angular contact ball bearings                                            | P4A or P4 <sup>1)</sup>  | PA9A or P2 <sup>1)</sup> |
| Cylindrical roller bearings                                              | SP                       | UP                       |
| Double direction angular contact thrust ball bearings in the BTW series  | SP                       | UP                       |
| Double direction angular contact thrust ball bearings in the BTM series  | P4C                      | –                        |
| Angular contact thrust ball bearings for screw drives                    | P4A                      | –                        |
| Axial-radial cylindrical roller bearings <sup>2)</sup>                   | –                        | –                        |

1) Only for 718 D series  
2) Radial run-out equal to or better than P4, axial run-out close to P4. Reduced axial and radial run-out on request.

### Running accuracy

The running accuracy of a shaft system depends on the accuracy of all the components within the system. Running accuracy of a bearing is mainly affected by the accuracy of the form and position of the raceways on the bearing rings.

When selecting the appropriate tolerance class for a particular bearing, the maximum radial or axial run-out (depending on the bearing type) of the inner ring is usually the determining factor for most applications.

**Diagram 1** compares relative values of the maximum radial run-out of the inner ring for different tolerance classes.

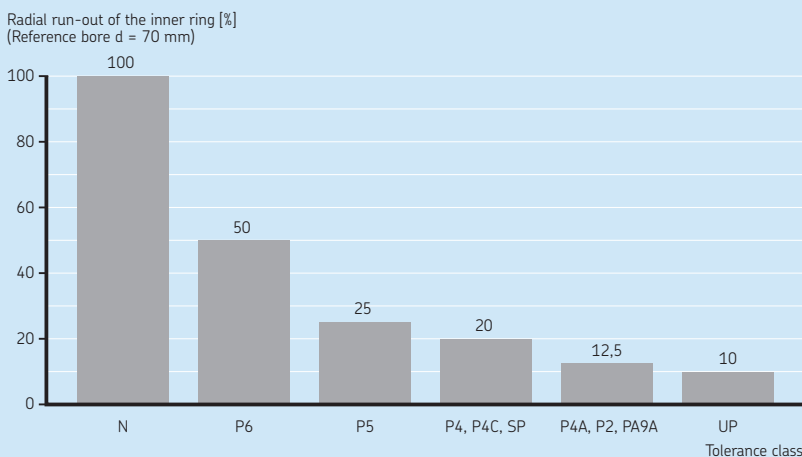
### Dimensional accuracy

The accuracy of the boundary dimensions of both a bearing and its mating components is very important to achieve the appropriate fit. The fits between the bearing inner ring and shaft or outer ring and housing influence the internal clearance or preload of the mounted bearing.

Cylindrical roller bearings with a tapered bore have slightly larger permissible dimensional deviations than other types of super-precision bearings. That is because the clearance or preload is determined during mounting, by driving the inner ring up on its tapered seat.

Diagram 1

#### Relative radial run-out limits for different tolerance classes



### Rigidity

In machine tool applications, the rigidity of the spindle is extremely important as the magnitude of elastic deformation under load heavily influences the productivity and accuracy of the tool. Although bearing stiffness contributes to system rigidity, there are other influencing factors including tool overhang as well as the number and position of the bearings.

Factors that determine bearing stiffness include:

- **The rolling element type**

Roller bearings are stiffer than ball bearings. Ceramic rolling elements are stiffer than those made of steel.

- **The number and size of the rolling elements**

A larger number of smaller diameter rolling elements increases the degree of stiffness.

- **The contact angle**

A contact angle close to the load angle results in a higher degree of stiffness.

- **The internal design**

A close osculation results in a higher degree of stiffness for angular contact ball bearings.

In applications requiring a high degree of radial rigidity, cylindrical roller bearings are typically the best option. However, angular contact ball bearings with a minimal contact angle can also be used.

In applications where a high degree of axial rigidity is required, angular contact thrust ball bearings with a large contact angle are preferred. Rigidity can be increased by preload, but this can limit the permissible speed.

For additional information about system rigidity and bearing stiffness, refer to *System rigidity* (→ **page 26**).

## Available space

High-precision applications generally call for bearings with a low cross-sectional height due to limited space and high requirements for rigidity and running accuracy. Bearings with a low cross-sectional height are able to accommodate relatively large-diameter shafts to provide the necessary rigidity within a relatively small bearing envelope.

Angular contact ball bearings, cylindrical roller bearings and angular contact thrust ball bearings commonly used in machine tool applications are almost exclusively bearings in the ISO 9 and 0 diameter series (→ **fig. 1**).

Angular contact ball bearings in the 2 diameter series are rarely used in new designs, but are still common in existing applications. When a compact cross section is a key requirement, angular contact ball bearings in the 8 diameter series are the preferred solution.

By selecting bearings in the 9 or 0 diameter series, it is possible to achieve an optimal bearing arrangement regarding rigidity and load carrying capacity for a particular application within the same radial space.

Angular contact thrust ball bearings for screw drives have larger cross-sectional heights. Diameter series 2 and 3 are common for these bearings. The available space is typically not a major concern, but load carrying capacity is extremely important.

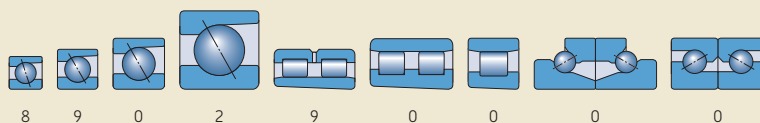


Fig. 1

### Speeds

The attainable speeds for super-precision bearings are primarily dependent on bearing type, design and material, type and magnitude of load as well as lubricant and lubrication method. For the permissible speed, operating temperature is an additional limit.

Super-precision bearing arrangements in high-speed applications require bearings that generate the least amount of friction and frictional heat. Super-precision angular contact ball bearings and cylindrical roller bearings are best suited for these applications. For extremely high speeds, hybrid bearings (bearings with ceramic rolling elements) may be necessary.

When compared to other super-precision bearing types, angular contact ball bearings enable the highest speeds. **Diagram 2** compares the relative speed capability of SKF angular contact ball bearings in the different series. For details about the bearing series, refer to *Designation system* on **page 28**.

Thrust bearings cannot accommodate speeds as high as radial bearings.

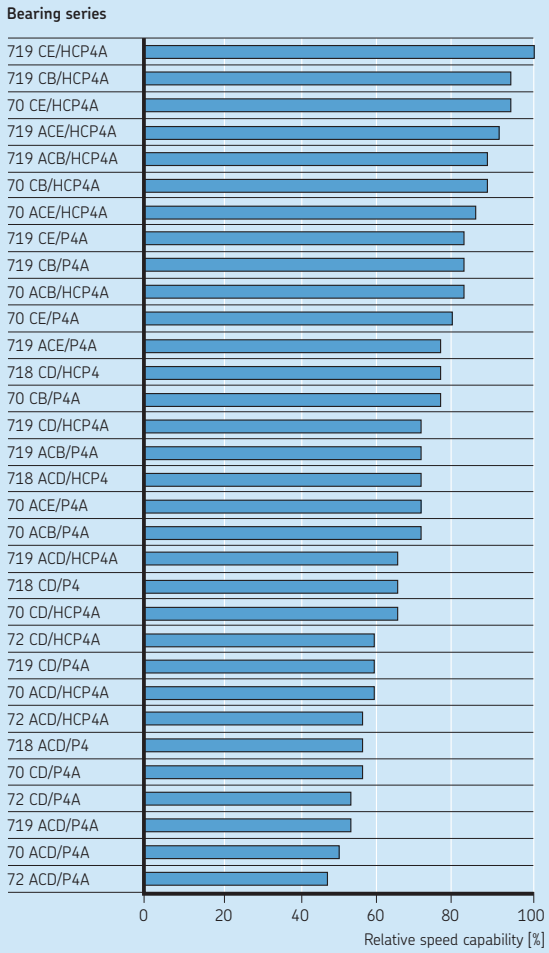
It is a general rule that a certain loss of rigidity must be tolerated to attain higher speeds.

For additional information about attainable speeds, refer to *Speeds* (→ **page 28**).

Diagram 2

1

Relative speed capability of angular contact ball bearings



- AC 25° contact angle
- C 15° contact angle
- B High-speed B design
- E High-speed E design
- D High-capacity D design
- HC Ceramic balls

### Loads

When selecting SKF super-precision bearings for high-speed applications, calculated rating life (and therefore basic load rating) is typically not a limiting factor. Other criteria such as stiffness, size of the required bore in a hollow shaft, machining speed and accuracy are normally the decisive factors.

When selecting the bearing type, the magnitude and direction of the load play an important role.

### Radial loads

Super-precision cylindrical roller bearings can accommodate heavier radial loads than same-size ball bearings. They are incapable of supporting axial loads but can accommodate a limited amount of axial displacement between their inner and outer rings because there are no flanges on either the inner or outer ring, depending on the specific design.

### Axial loads

Double direction angular contact ball bearings in the BTW and BTM series are designed to support axial loads only, acting in either direction. Sets of angular contact ball bearings are also a viable solution, particularly in high-speed applications.

For large size bearing arrangements or those subjected to very heavy axial loads, special single direction thrust ball bearings or cylindrical roller thrust bearings are recommended. For detailed information about these special bearings, contact the SKF application engineering service.

To be sure that an axial bearing is only subjected to axial loads, the housing washer should be mounted with radial clearance.

### Combined loads

A combined load consists of a radial and axial load acting simultaneously (→ **fig. 2**). A very effective way to accommodate combined loads is by using bearing types that can accommodate both radial and axial loads.

Super-precision bearings with these characteristics include:

- angular contact ball bearings in the 718, 719, 70 and 72 series
- single direction angular contact thrust ball bearings for screw drives in the BSA and BSD series
- double direction angular contact thrust ball bearings for screw drives in the BEAS and BEAM series
- axial-radial cylindrical roller bearings in the NRT series

The ability of a bearing to accommodate an axial or radial load is determined by the contact angle  $\alpha$  (→ **fig. 2**). A bearing with a  $0^\circ$  contact angle can accommodate pure radial loads only. As the contact angle increases, the axial load carrying capacity increases proportionately. When the contact angle reaches  $90^\circ$ , the bearing becomes a full thrust bearing, capable of accommodating only axial loads. Speed capability, however, is inversely proportional to the contact angle, meaning that as the contact angle increases, speed capability decreases.

Axial-radial cylindrical roller bearings accommodate the axial and radial components of a combined load with separate rows of rollers perpendicular to each other.

In applications where there are combined loads with a very heavy axial load component, the radial and axial loads can be supported by separate bearings.

Fig. 2





## Axial displacement

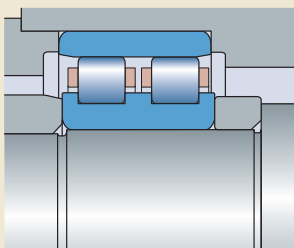
In most applications where thermal expansion and contraction of the shaft must be accommodated without inducing an axial load on the bearings, a locating/non-locating bearing system is typically used.

The bearing in the locating position must be able to locate the shaft axially in both directions. In machine tool applications, a set of angular contact ball bearings or a pair of angular contact thrust ball bearings can be used.

Non-locating bearings must accommodate thermal expansion and contraction of the shaft. Cylindrical roller bearings are well suited for this because they accommodate shaft movements relative to the housing, within the bearing (→ **fig. 3**). This enables the bearing to be mounted with an interference fit on both the inner and outer rings.

If paired angular contact ball bearings are used in the non-locating position, either the inner or outer ring of both bearings must have a loose fit so that they can slide on the shaft or in the housing. A loose fit, however, has a negative effect on system rigidity.

Fig. 3



### Sealing solutions

To keep lubricant in and contaminants out of the bearing, SKF can supply some super-precision bearings with integral seals:

- non-contact seals (→ **fig. 4**)
- contact seals (→ **fig. 5**)

Sealed bearings can provide cost-effective and space-saving solutions for many applications. Sealed bearings include:

- angular contact ball bearings with non-contact seals
- single direction angular contact thrust ball bearings for screw drives with non-contact seals
- double direction angular contact thrust ball bearings for screw drives with contact or non-contact seals

Bearings sealed on both sides are typically lubricated for the life of the bearing and should not be washed. They are filled with the appropriate amount of high-quality grease under clean conditions. They cannot be relubricated except for certain bearings for screw drives which are equipped with relubrication features.

Fig. 4

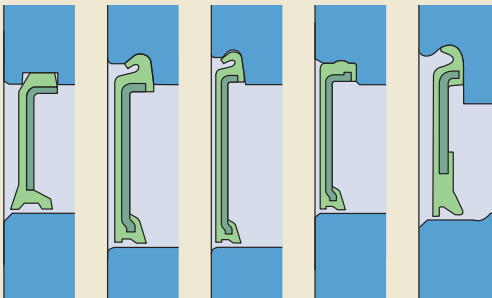
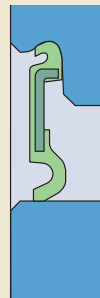


Fig. 5



## Bearing life and load ratings

In industrial applications, bearing size is usually determined by its load carrying capacity relative to the load, required life and required reliability of the application. For machine tool applications, bearing size is almost always determined by other factors such as system rigidity, fixed dimensions of the spindle as well as the speed and feed parameters of the application.

For super-precision bearing arrangements, determining the actual load is particularly complex as it involves many influencing factors. *SKF Spindle Simulator* is a sophisticated computer program to analyse statically indeterminate spindle bearing systems. It supports the analysis of spindles and contains detailed models of super-precision bearings. For additional information, contact the SKF application engineering service or visit *SKF Engineering Consultancy Services* at [skf.com](http://skf.com).

### Dynamic bearing loads and life

The general information about bearing life calculation and basic load ratings provided under *Selecting bearing size* in the SKF catalogue *Rolling bearings*, or at [skf.com](http://skf.com), is also valid for super-precision bearings. It should be noted that all life calculations based on ISO 281 are valid for normal speeds. For applications where the speed factor  $A \geq 500\,000$  mm/min, contact the SKF application engineering service.

$$A = n d_m$$

where

$A$  = speed factor [mm/min]

$d_m$  = bearing mean diameter [mm]  
=  $0,5 (d + D)$

$n$  = rotational speed [r/min]

Rated bearing life can be calculated for fatigue conditions based on statistical assumptions. For detailed information, refer to *Basic rating life* in the SKF catalogue *Rolling bearings*, or visit [skf.com](http://skf.com).

### Basic dynamic load rating

The basic dynamic load rating  $C$  is used for life calculations involving dynamically stressed bearings, i.e. bearings that rotate under load. It expresses the bearing load that will result in an ISO 281 basic rating life  $L_{10}$  of 1 000 000 revolutions. It is assumed that the load is constant in magnitude and direction and is radial for radial bearings and axial, acting centrically, for thrust bearings.

Values for the basic dynamic load rating  $C$  are listed in the product tables.

### Equivalent dynamic bearing load

To calculate the basic rating life for a bearing using basic dynamic load ratings, it is necessary to convert the actual dynamic loads into an equivalent dynamic bearing load. The equivalent dynamic bearing load  $P$  is defined as a hypothetical load, constant in magnitude and direction, that acts radially on radial bearings and axially and centrically on thrust bearings. This hypothetical load, when applied, would have the same influence on bearing life as the actual loads to which the bearing is subjected.

Information and data required for calculating the equivalent dynamic bearing load is provided in each product chapter.

### Basic rating life

The basic rating life of a bearing in accordance with ISO 281 is

$$L_{10} = \left( \frac{C}{P} \right)^p$$

If the speed is constant, it is often preferable to calculate the life expressed in operating hours using

$$L_{10h} = \frac{10^6}{60 n} L_{10}$$

where

$L_{10}$  = basic rating life (at 90% reliability)  
[million revolutions]

$L_{10h}$  = basic rating life (at 90% reliability)  
[operating hours]

$C$  = basic dynamic load rating [kN]

$P$  = equivalent dynamic bearing load [kN]

$n$  = rotational speed [r/min]

$p$  = exponent of the life equation

= 3 for ball bearings

= 10/3 for roller bearings

### Rating life for hybrid bearings

When calculating the rating life for hybrid bearings, the same life values can be used as for bearings with steel rolling elements. The ceramic rolling elements in hybrid bearings are much harder and stiffer than steel rolling elements. Although this increased level of hardness and stiffness creates a higher degree of contact stress between the ceramic rolling elements and the steel raceway, field experience and laboratory tests show that the same rating lives can be used for both bearing types.

Extensive experience and testing show that in typical machine tool applications, the service life of a hybrid bearing is significantly longer than the service life of a bearing with steel rolling elements. The extended service life of hybrid bearings is due to the hardness, low density and surface finish of the rolling elements. Low density minimizes internal loading from centrifugal and inertial forces while increased hardness makes the rolling elements less susceptible to wear. Their surface finish enables the bearing to optimize the effects of the lubricant.

### Requisite minimum load

In bearings that operate at high speeds or are subjected to rapid accelerations or rapid changes in the direction of load, the inertial forces of the rolling elements and the friction in the lubricant can have a detrimental effect on the rolling conditions in the bearing arrangement and may cause damaging sliding movements to occur between the rolling elements and raceways. To provide satisfactory operation, rolling bearings must always be subjected to a given minimum load. A general "rule of thumb" indicates that minimum loads of 0,01  $C$  should be imposed on ball bearings and 0,02  $C$  on roller bearings.

### Calculating life with variable operating conditions

In some applications, the operating conditions, such as the magnitude and direction of loads, speeds, temperatures and lubrication conditions are continually changing. In these types of applications, bearing life cannot be calculated without first reducing the load spectrum or duty cycle of the application to a limited number of simplified load cases.

In case of continuously changing loads, each different load level can be accumulated and the load spectrum reduced to a histogram of constant load blocks (→ **diagram 3**). Each block should characterize a given percentage or time-fraction during operation. Note that heavy and normal loads consume bearing life at a faster rate than light loads. Therefore, it is important to have shock and peak loads well represented in the load diagram, even if the occurrence of these loads is relatively rare and limited to a few revolutions.

Within each duty interval, the bearing load and operating conditions can be averaged to some constant value. The number of operating hours or revolutions expected from each duty interval showing the life fraction required by that particular load condition should also be included. Therefore, if  $N_1$  equals the number of revolutions required under the load condition  $P_1$ , and  $N$  is the expected number of revolutions for the completion of all variable loading cycles, then the cycle fraction  $U_1 = N_1/N$  is used by the load condition  $P_1$ , which has a cal-

culated life of  $L_{101}$ . Under variable operating conditions, bearing life can be rated using

$$L_{10} = \frac{1}{\frac{U_1}{L_{101}} + \frac{U_2}{L_{102}} + \frac{U_3}{L_{103}} + \dots}$$

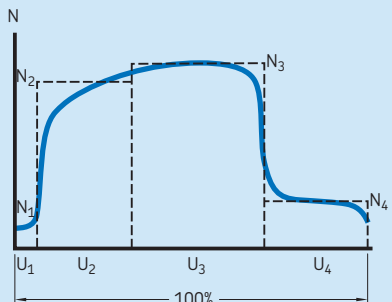
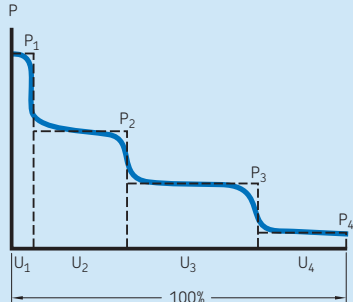
where

- $L_{10}$  = basic rating life (at 90% reliability) [million revolutions]
- $L_{101}, L_{102}, \dots$  = basic rating lives (at 90% reliability) under constant conditions 1, 2, ... [million revolutions]
- $U_1, U_2, \dots$  = life cycle fraction under the conditions 1, 2, ...  
Note:  $U_1 + U_2 + \dots + U_n = 1$

The use of this calculation method depends very much on the availability of representative load diagrams for the application. Note that this type of load history can also be derived from a similar type of application.

Diagram 3

Histogram of constant load blocks



### Permissible static loads

Very heavy loads or shock loads can permanently deform the raceways or rolling elements. In the case of super-precision bearing arrangements, permanent deformation must not occur. To make sure that static loads do not lead to permanent deformation, the basic static load rating of the bearing and equivalent static bearing load can be compared to determine if a bearing is at risk of permanent deformation. For very heavily loaded super-precision angular contact ball bearings, the contact ellipse truncation should be checked to avoid edge stress, which also could lead to permanent deformation. For additional information, contact the SKF application engineering service.

### Basic static load rating

The basic static load rating  $C_0$  as defined in ISO 76 corresponds to a calculated contact stress at the centre of the most heavily loaded rolling element / raceway contact. This stress produces a total permanent deformation of the rolling element and raceway, which is approximately 0,0001 of the rolling element diameter. The loads are purely radial for radial bearings and axial, centrally acting, for thrust bearings.

Values for basic static load rating  $C_0$  are listed in the product tables.

### Equivalent static bearing load

To compare actual loads with the basic static load rating, the actual loads must be converted into an equivalent load. The equivalent static bearing load  $P_0$  is defined as that hypothetical load (radial for radial bearings and axial for thrust bearings) which, if applied, would cause the same maximum rolling element load in the bearing as the actual loads to which the bearing is subjected.

Information and data required for calculating the equivalent static bearing load are provided in each product chapter.

### Required basic static load rating

The required basic static load rating  $C_0$ , to protect the bearing from permanent deformation, can be determined from

$$C_0 \geq s_0 P_0$$

where

$C_0$  = basic static load rating [kN]

$P_0$  = equivalent static bearing load [kN]

$s_0$  = static safety factor

Guidelines for minimum values:

- 2 for super-precision angular contact ball bearings with steel balls (including thrust ball bearings)
- 3 for super-precision cylindrical roller bearings with steel rollers
- 4 for super precision axial-radial cylindrical roller bearings

For hybrid bearings, the static safety factor should be increased by 10%.

For angular contact thrust ball bearings for screw drives, safety factors down to  $s_0 = 1$  can be used.

## Friction

Friction in a bearing can be described as the total resistance to rotation. Contributing factors include, but are not limited to:

- elastic deformation of the rolling elements and raceways under load
- speeds
- lubricant and lubrication method
- sliding friction between the rolling elements and cage, flanges and guide rings, and between the seals and their counterfaces

Each of these contributes to the frictional heat generated by the bearing. The bearing operating temperature is attained when frictional heat and heat dissipated by the application are in balance.

For detailed information about friction in super-precision bearings, contact the SKF application engineering service.

### Effects of clearance and preload on friction

High operating temperatures or high speeds can reduce the internal clearance or increase the preload in a bearing. Either of these changes can increase friction. This is particularly important for super-precision bearing arrangements because they are typically preloaded and are extremely sensitive to changes in preload.

For applications that are sensitive to changes in clearance or preload, contact the SKF engineering application service.

### Effects of grease fill on friction

During initial start-up, or after relubrication, the frictional moment of a grease lubricated bearing can be exceptionally high during the first few hours or days of operation. This high initial frictional moment, which can be seen as a temperature spike, is caused by the uneven distribution of grease within the bearing free space.

After a running-in period, the frictional moment and bearing operating temperature are typically similar to the values for oil lubricated bearings. Bearings filled with an excessive amount of grease may have higher frictional values.

### Frictional behaviour of hybrid bearings

The lower density of silicon nitride rolling elements, compared with steel, reduces internal centrifugal forces. This, combined with their low coefficient of friction, significantly reduces bearing temperatures at high speeds. Cooler running extends the service life of both the bearing and the lubricant.

# Speeds

The maximum speed at which a rolling bearing can operate is largely determined by its permissible operating temperature. The operating temperature of a bearing depends on the frictional heat generated by the bearing, any externally applied heat, and the amount of heat that can be transferred away from the bearing.

Super-precision bearings that generate low levels of friction are, therefore, best suited for high-speed applications due to their corresponding low operating temperatures. When compared to similarly-sized roller bearings, ball bearings have a lower load carrying capacity but their smaller rolling contact area enables them to operate at much higher speeds. However, hybrid bearings provide additional benefits for all bearing types. **Diagram 4** compares the temperature rise in grease lubricated spindles for different bearing types. The curves for the bearings can be considered representative for the whole bearing series.

Guideline values for attainable speeds per bearing series, are provided in **diagram 5** (→ **page 38**) for oil-air lubrication and in **diagram 6** (→ **page 38**) for grease lubrication. Both diagrams are based on the speed factor A. For details about the bearing series, refer to the designation system of:

- angular contact ball bearings (→ **page 38**)
- cylindrical roller bearings (→ **page 38**)
- double direction angular contact thrust ball bearings (→ **page 38**)
- angular contact thrust ball bearings for screw drives (→ **page 38**)

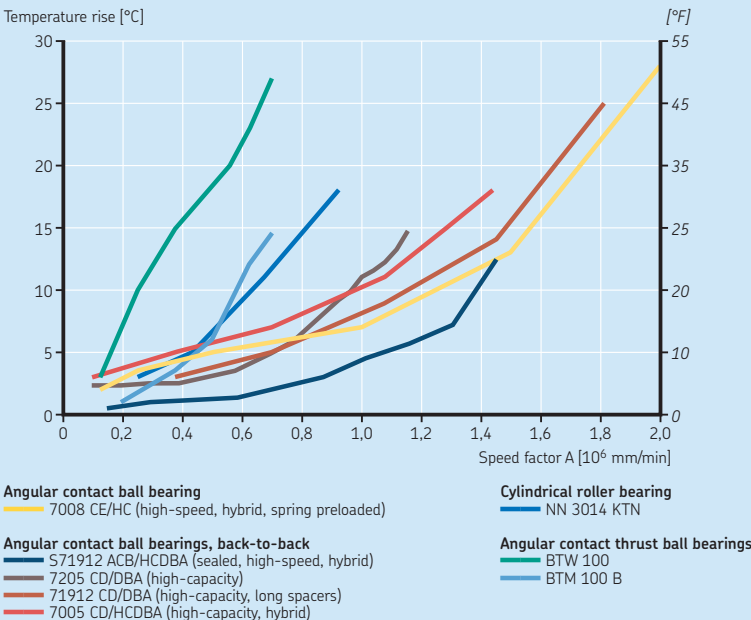
Generally, bearings with a lower cross-sectional height can attain higher speeds because of the smaller value for mean diameter  $d_m$ .

## Permissible speeds

The permissible speed of a bearing depends on the frictional heat generated by the bearing,

Diagram 4

Temperature rise in grease lubricated spindle bearings





any externally applied heat and the amount of heat that can be transferred away from the bearing. In applications where heat dissipation is not adequate, either because of design considerations or high ambient temperatures, additional cooling methods might be needed in order to keep bearing temperatures within a permissible range.

Cooling can be accomplished through different lubrication methods. In oil jet and circulating oil systems, for example, the oil is filtered and, if required, cooled before being returned to the bearing.

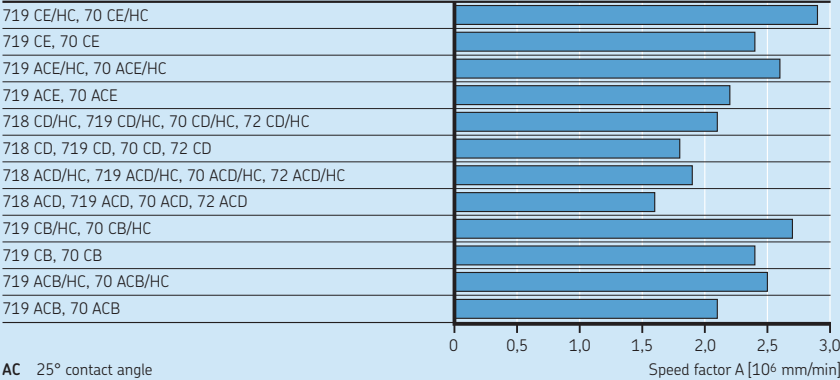
The product tables list attainable speeds, but not speed limits, because the permissible speed is influenced by factors other than the bearing.

Diagram 5

## Guideline values for attainable speeds – oil-air lubrication

### Angular contact ball bearings

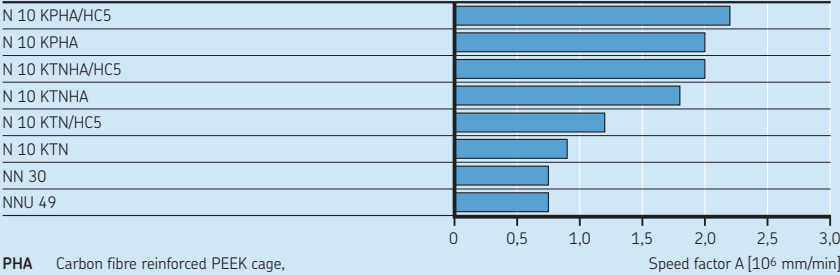
Bearing series



- AC** 25° contact angle
- C** 15° contact angle
- B** High-speed B design
- E** High-speed E design
- D** High-capacity D design
- HC** Ceramic balls

### Cylindrical roller bearings

Bearing series

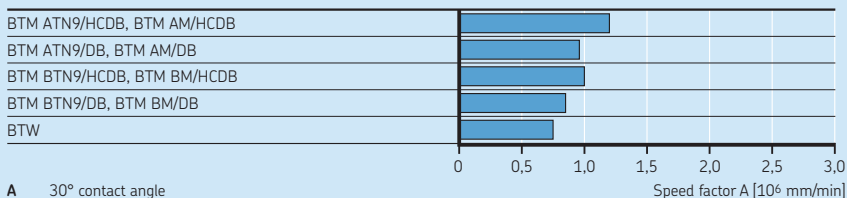


- PHA** Carbon fibre reinforced PEEK cage, outer ring centred
- TN** PA66 cage, roller centred
- TNHA** Glass fibre reinforced PEEK cage, outer ring centred
- HC5** Ceramic rollers

## Guideline values for attainable speeds – oil-air lubrication

## Double direction angular contact thrust ball bearings

Bearing series

**A** 30° contact angle**B** 40° contact angle**M** Machined brass cage, ball centred**TN9** Glass fibre reinforced PA66 cage, ball centred**HC** Ceramic balls**DB** Back-to-back arrangementSpeed factor A [10<sup>6</sup> mm/min]

## Angular contact thrust ball bearings for screw drives

Bearing series

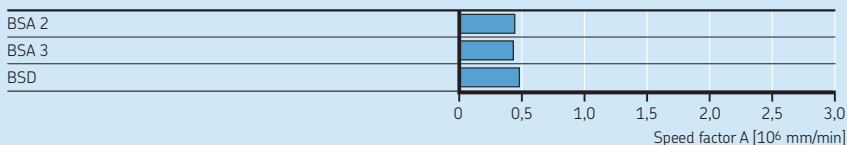
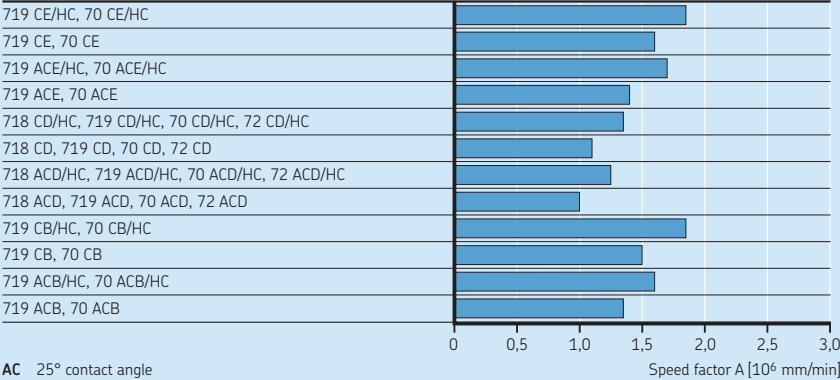
Speed factor A [10<sup>6</sup> mm/min]

Diagram 6

## Guideline values for attainable speeds – grease lubrication

### Angular contact ball bearings

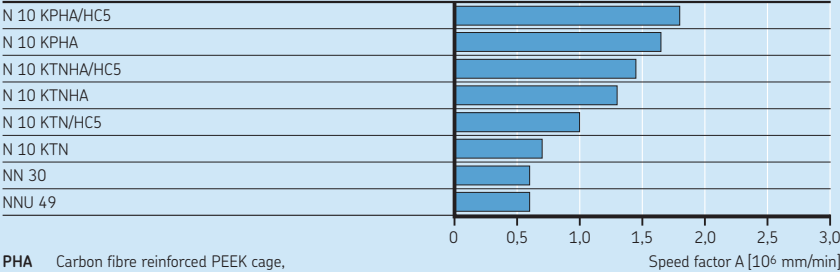
Bearing series



- AC** 25° contact angle
- C** 15° contact angle
- B** High-speed B design
- E** High-speed E design
- D** High-capacity D design
- HC** Ceramic balls

### Cylindrical roller bearings

Bearing series

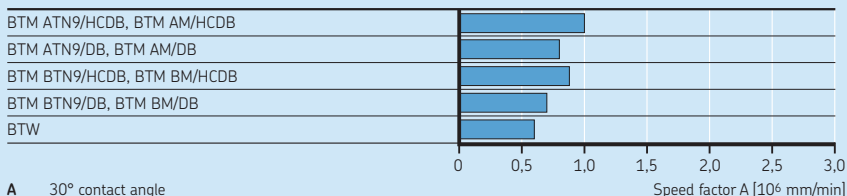


- PHA** Carbon fibre reinforced PEEK cage, outer ring centred
- TN** PA66 cage, roller centred
- TNHA** Glass fibre reinforced PEEK cage, outer ring centred
- HC5** Ceramic rollers

## Guideline values for attainable speeds – grease lubrication

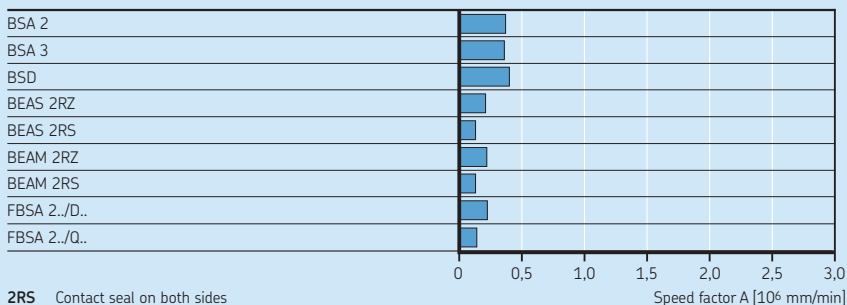
## Double direction angular contact thrust ball bearings

Bearing series

**A** 30° contact angle**B** 40° contact angle**M** Machined brass cage, ball centred**TN9** Glass fibre reinforced PA66 cage, ball centred**HC** Ceramic balls**DB** Back-to-back arrangementSpeed factor A [10<sup>6</sup> mm/min]

## Angular contact thrust ball bearings for screw drives

Bearing series

**2RS** Contact seal on both sides**2RZ** Non-contact seal on both sides**/D** Unit with two bearings**/Q** Unit with four bearingsSpeed factor A [10<sup>6</sup> mm/min]

### Attainable speeds

The attainable speeds listed in the product tables are guideline values and are valid under the following conditions:

- shaft seat and housing bore machined to the recommended diameter and geometric tolerances (→ *Recommended shaft and housing fits*, **page 44**)
- light loads ( $P \leq 0,05 \text{ C}$ )
- good heat dissipation away from the bearings
- suitable lubricant and lubrication method
- light spring preload for angular contact ball bearings

The values listed in the product tables for grease lubrication can be attained using an appropriate fill of a suitable, high-quality, soft consistency grease.

The values listed in the product tables for oil-air lubrication can be adapted to apply to other oil lubrication methods. The following reduction factors should be applied:

- 0,3 to 0,4 for oil bath lubrication
- 0,95 for oil mist lubrication

Speeds in excess of the attainable speeds listed in the product tables can be achieved when an oil jet circulating oil system with an oil cooler is used.

For additional information, contact the SKF application engineering service.

### Attainable speeds for typical spindle bearing systems

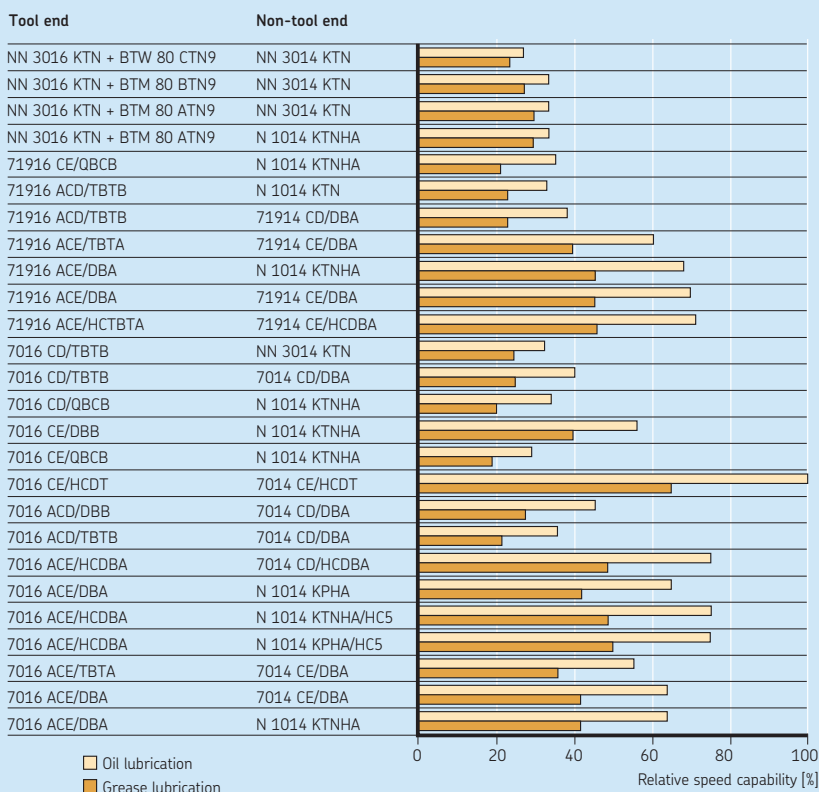
A typical spindle bearing system, which can contain various bearing types, comprises a bearing arrangement on the tool end and another arrangement on the non-tool end. The arrangement on the tool end is usually the critical one. It typically uses larger bearings, forcing a higher speed factor A. **Diagram 7** provides a comparison of possible bearing systems and their relative speed capability. The comparison is based on bearings with an 80 mm bore on the tool end and 70 mm bore on the non-tool end. For details about the bearing series, refer to the designation system of:

- angular contact ball bearings (→ **page 44**)
- cylindrical roller bearings (→ **page 44**)
- double direction angular contact thrust ball bearings (→ **page 44**)

Diagram 7

1

## Relative speed capability of typical spindle bearing systems



## Angular contact ball bearings

- AC 25° contact angle
- C 15° contact angle
- E High-speed E design
- D High-capacity D design
- HC Ceramic balls
- DB Two bearings, back-to-back <>
- DT Two bearings, tandem <<
- TBT Three bearings, back-to-back and tandem <>>
- QBC Four bearings, tandem back-to-back <>>,>
- A Light preload
- B Moderate preload

## Cylindrical roller bearings

- PHA Carbon fibre reinforced PEEK cage, outer ring centred
- K Tapered bore
- TN PA66 cage, roller centred
- TNHA Glass fibre reinforced PEEK cage, outer ring centred
- HCS Ceramic rollers

## Double direction angular contact thrust ball bearings

- A 30° contact angle
- B 40° contact angle
- C 60° contact angle
- TN9 Glass fibre reinforced PA66 cage, ball centred

## Bearing specifics

SKF super-precision bearings are manufactured to several general specifications. Those specifications concerning dimensions, tolerances, preload or clearance and materials are described in the following. Additional information is provided in each product chapter.

### Boundary dimensions

Boundary dimensions of SKF super-precision bearings follow the ISO 15 general plan for radial rolling bearings, or, in certain circumstances, conform to boundary dimensions accepted by industry.

### ISO 15 general plan

The ISO 15 general plan for boundary dimensions of radial bearings contains a progressive series of standardized outside diameters for every standard bore diameter, arranged in a diameter series. Within each diameter series, different width series have also been established.

Dimension series are formed by combining the number for the width series with the number for the diameter series.

For super-precision bearings, only a limited number of dimension series are used (→ **table 3**).

Specific information about compliance to dimension standards is provided in each product chapter.

### Chamfer dimensions

Minimum values for the chamfer dimensions (→ **fig. 6**) in the radial direction ( $r_1, r_3$ ) and the axial direction ( $r_2, r_4$ ) are listed in the product tables. These values are in accordance with the general plans of ISO 15, ISO 12043 and ISO 12044.

The appropriate maximum chamfer dimensions are in accordance with ISO 582 and are listed under *Chamfer dimension limits*.

Table 3

| Diameter and width series for SKF super-precision bearings |              |                    |                                                      |
|------------------------------------------------------------|--------------|--------------------|------------------------------------------------------|
| ISO 15 dimension series                                    |              | SKF bearing series | Bearing type                                         |
| Diameter series                                            | Width series |                    |                                                      |
| 8                                                          | 1            | 718                | Angular contact ball bearing                         |
|                                                            | 1            | 719                | Angular contact ball bearing                         |
| 9                                                          | 4            | NNU 49             | Double row cylindrical roller bearing                |
|                                                            | 1            | 70                 | Angular contact ball bearing                         |
| 0                                                          | 1            | N 10               | Single row cylindrical roller bearing                |
|                                                            | 3            | NN 30              | Double row cylindrical roller bearing                |
|                                                            | –            | BTW                | Double direction angular contact thrust ball bearing |
|                                                            | –            | BTM                | Double direction angular contact thrust ball bearing |
| 2                                                          | 0            | 72                 | Angular contact ball bearing                         |
|                                                            | 0            | BSA 2              | Angular contact thrust ball bearing for screw drives |
| 3                                                          | 0            | BSA 3              | Angular contact thrust ball bearing for screw drives |



## Tolerances

SKF super-precision bearings are manufactured to tolerance classes similar to internationally standardized tolerance classes. Standards for rolling bearing tolerances are:

- ISO 492 for radial rolling bearings
- ISO 199 for thrust rolling bearings

For available bearing types and tolerance classes, refer to *Precision* (→ **page 47**). Actual tolerance values are listed under *Tolerances* in each product chapter.

## Tolerance symbols

The tolerance symbols and their definitions are provided in **table 4** (→ **page 47**).

## Chamfer dimension limits

The maximum chamfer limits (→ **fig. 7**) for the relevant minimum chamfer dimensions (→ **product tables**) are listed in **table 5** (→ **page 47**). The values are in accordance with ISO 582.

Double direction angular contact thrust ball bearings in the BTM and BTW series and single direction angular contact thrust ball bearings for screw drives in the BSA series have the same maximum chamfer dimensions as radial bearings.

Fig. 6

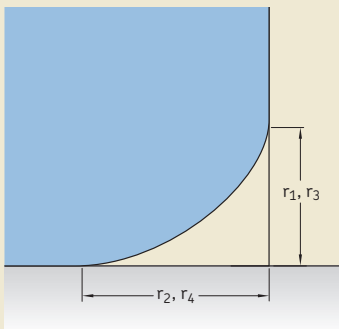


Fig. 7

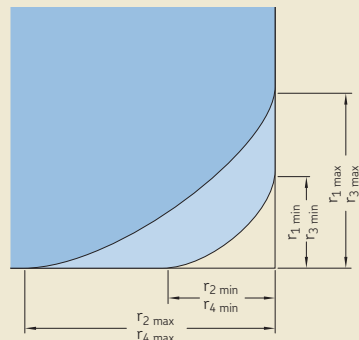


Table 4

## Tolerance symbols

Tolerance symbol      Definition

### Bore diameter

|                   |                                                                                                                                                                                                                                                                                  |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $d$               | Nominal bore diameter                                                                                                                                                                                                                                                            |
| $d_1$             | Nominal diameter at the theoretical large end of a tapered bore                                                                                                                                                                                                                  |
| $d_s$             | Single bore diameter                                                                                                                                                                                                                                                             |
| $d_{mp}$          | <ol style="list-style-type: none"> <li>Mean bore diameter; arithmetical mean of the largest and smallest single bore diameters in one plane</li> <li>Mean diameter at the small end of a tapered bore; arithmetical mean of the largest and smallest single diameters</li> </ol> |
| $\Delta_{d_s}$    | Deviation of a single bore diameter from the nominal ( $\Delta_{d_s} = d_s - d$ )                                                                                                                                                                                                |
| $\Delta_{d_{mp}}$ | Deviation of the mean bore diameter from the nominal ( $\Delta_{d_{mp}} = d_{mp} - d$ )                                                                                                                                                                                          |
| $\Delta_{d1mp}$   | Deviation of the mean bore diameter at the theoretical large end of a tapered bore from the nominal ( $\Delta_{d1mp} = d_{1mp} - d_1$ )                                                                                                                                          |
| $V_{dp}$          | Bore diameter variation; difference between the largest and smallest single bore diameters in one plane                                                                                                                                                                          |
| $V_{dmp}$         | Mean bore diameter variation; difference between the largest and smallest mean bore diameters                                                                                                                                                                                    |

### Outside diameter

|                   |                                                                                                               |
|-------------------|---------------------------------------------------------------------------------------------------------------|
| $D$               | Nominal outside diameter                                                                                      |
| $D_s$             | Single outside diameter                                                                                       |
| $D_{mp}$          | Mean outside diameter; arithmetical mean of the largest and smallest single outside diameters in one plane    |
| $\Delta_{D_s}$    | Deviation of a single outside diameter from the nominal ( $\Delta_{D_s} = D_s - D$ )                          |
| $\Delta_{D_{mp}}$ | Deviation of the mean outside diameter from the nominal ( $\Delta_{D_{mp}} = D_{mp} - D$ )                    |
| $V_{Dp}$          | Outside diameter variation; difference between the largest and smallest single outside diameters in one plane |
| $V_{Dmp}$         | Mean outside diameter variation; difference between the largest and smallest mean outside diameters           |

### Chamfer limits

|              |                                                                      |
|--------------|----------------------------------------------------------------------|
| $r_s$        | Single chamfer dimension                                             |
| $r_{s \min}$ | Smallest single chamfer dimension of $r_s, r_1, r_2, r_3, r_4 \dots$ |
| $r_1, r_3$   | Radial direction chamfer dimensions                                  |
| $r_2, r_4$   | Axial direction chamfer dimensions                                   |

**Tolerance symbols**

| <b>Tolerance symbol</b>                 | <b>Definition</b>                                                                                                                                                                                                                                                           |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Width or height</b>                  |                                                                                                                                                                                                                                                                             |
| <b>B, C</b>                             | Nominal width of an inner ring and outer ring, respectively                                                                                                                                                                                                                 |
| <b>B<sub>s</sub>, C<sub>s</sub></b>     | Single width of an inner ring and outer ring, respectively                                                                                                                                                                                                                  |
| <b>B<sub>1s</sub>, C<sub>1s</sub></b>   | Single width of an inner ring and outer ring, respectively, of a bearing specifically manufactured for paired mounting <sup>1)</sup>                                                                                                                                        |
| <b>ΔB<sub>s</sub>, ΔC<sub>s</sub></b>   | Deviation of a single inner ring width or single outer ring width from the nominal (ΔB <sub>s</sub> = B <sub>s</sub> - B; ΔC <sub>s</sub> = C <sub>s</sub> - C)                                                                                                             |
| <b>ΔB<sub>1s</sub>, ΔC<sub>1s</sub></b> | Deviation of a single inner ring width or single outer ring width, of a bearing specifically manufactured for paired mounting <sup>1)</sup> , from the nominal (ΔB <sub>1s</sub> = B <sub>1s</sub> - B <sub>1</sub> ; ΔC <sub>1s</sub> = C <sub>1s</sub> - C <sub>1</sub> ) |
| <b>V<sub>Bs</sub>, V<sub>Cs</sub></b>   | Ring width variation; difference between the largest and smallest single widths of an inner ring and outer ring, respectively                                                                                                                                               |
| <b>T</b>                                | Nominal height H of a thrust bearing                                                                                                                                                                                                                                        |
| <b>2C</b>                               | Total nominal height of outer ring of a thrust bearing                                                                                                                                                                                                                      |
| <b>T<sub>s</sub></b>                    | Single height                                                                                                                                                                                                                                                               |
| <b>ΔT<sub>s</sub></b>                   | Deviation of the height of a single direction thrust bearing from the nominal                                                                                                                                                                                               |
| <b>ΔT<sub>2s</sub></b>                  | Deviation of the height of a double direction thrust bearing from the nominal                                                                                                                                                                                               |
| <b>H<sub>s</sub></b>                    | Single bearing height                                                                                                                                                                                                                                                       |
| <b>H<sub>1s</sub></b>                   | Single cross section height                                                                                                                                                                                                                                                 |
| <b>ΔH<sub>s</sub></b>                   | Deviation of a single bearing height                                                                                                                                                                                                                                        |
| <b>ΔH<sub>1s</sub></b>                  | Deviation of a single cross section height                                                                                                                                                                                                                                  |
| <b>Running accuracy</b>                 |                                                                                                                                                                                                                                                                             |
| <b>K<sub>ia</sub>, K<sub>ea</sub></b>   | Radial run-out of an inner ring and outer ring, respectively, of an assembled bearing                                                                                                                                                                                       |
| <b>S<sub>d</sub></b>                    | Side face run-out with reference to the bore (of an inner ring)                                                                                                                                                                                                             |
| <b>S<sub>D</sub></b>                    | Outside inclination variation; variation in inclination of the outside cylindrical surface to the outer ring side face                                                                                                                                                      |
| <b>S<sub>ia</sub>, S<sub>ea</sub></b>   | Axial run-out of an inner ring and outer ring, respectively, of an assembled bearing                                                                                                                                                                                        |
| <b>S<sub>i</sub></b>                    | Thickness variation, measured from the middle of the raceway to the back (seat) face of the shaft washer (axial run-out)                                                                                                                                                    |
| <b>S<sub>e</sub></b>                    | Thickness variation, measured from the middle of the raceway to the back (seat) face of the housing washer (axial run-out)                                                                                                                                                  |

<sup>1)</sup> Does not apply to universally matchable angular contact ball bearings.

Table 5

| Maximum chamfer limits           |                               |       |                            |                        |
|----------------------------------|-------------------------------|-------|----------------------------|------------------------|
| Minimum single chamfer dimension | Nominal bearing bore diameter |       | Maximum chamfer dimensions |                        |
|                                  | d over                        | incl. | Radial bearings            |                        |
| r <sub>s</sub> min               |                               |       | r <sub>1, 3</sub> max.     | r <sub>2, 4</sub> max. |
| mm                               | mm                            |       | mm                         |                        |
| 0,15                             | –                             | –     | 0,3                        | 0,6                    |
| 0,2                              | –                             | –     | 0,5                        | 0,8                    |
| 0,3                              | –                             | 40    | 0,6                        | 1                      |
|                                  | 40                            | –     | 0,8                        | 1                      |
| 0,6                              | –                             | 40    | 1                          | 2                      |
|                                  | 40                            | –     | 1,3                        | 2                      |
| 1                                | –                             | 50    | 1,5                        | 3                      |
|                                  | 50                            | –     | 1,9                        | 3                      |
| 1,1                              | –                             | 120   | 2                          | 3,5                    |
|                                  | 120                           | –     | 2,5                        | 4                      |
| 1,5                              | –                             | 120   | 2,3                        | 4                      |
|                                  | 120                           | –     | 3                          | 5                      |
| 2                                | –                             | 80    | 3                          | 4,5                    |
|                                  | 80                            | 220   | 3,5                        | 5                      |
|                                  | 220                           | –     | 3,5                        | 6                      |
| 2,1                              | –                             | 280   | 4                          | 6,5                    |
|                                  | 280                           | –     | 4,5                        | 7                      |
| 2,5                              | –                             | 100   | 3,8                        | 6                      |
|                                  | 100                           | 280   | 4,5                        | 6                      |
|                                  | 280                           | –     | 5                          | 7                      |
| 3                                | –                             | 280   | 5                          | 8                      |
|                                  | 280                           | –     | 5,5                        | 8                      |
| 4                                | –                             | –     | 6,5                        | 9                      |
| 5                                | –                             | –     | 8                          | 10                     |
| 6                                | –                             | –     | 10                         | 13                     |
| 7,5                              | –                             | –     | 12,5                       | 17                     |

Preload and internal clearance

Angular contact ball and thrust ball bearings

SKF super-precision universally matchable angular contact ball bearings, sets of angular contact ball bearings and angular contact thrust ball bearings are manufactured so that a predetermined amount of preload results when assembled immediately adjacent to each other. The preload values listed in the relevant product chapter represent the axial force required to press together the rings or washers of new unmounted bearings.

When mounted, and further when in operation, the preload will change. The main reasons are:

- An interference fit in the housing contracts the outer ring raceway while an interference fit on the shaft expands the inner ring raceway.
- Pressing the inner rings or shaft washers of bearings or bearing sets against each other causes deformation of the rings or washers. Especially when mounted on a solid shaft, the bore diameter cannot decrease and the lateral expansion increases preload.
- Differences in thermal expansion of the bearing rings or washers, and mating components typically increase preload in operation.

For details about the preload in unmounted bearings and ways to estimate the preload in operation, refer to the relevant product chapter.

Cylindrical roller bearings

SKF super-precision cylindrical roller bearings are manufactured with radial internal clearance. Radial internal clearance is defined as the total distance through which one bearing ring can be moved relative to the other in the radial direction.

It is necessary to distinguish between initial internal clearance in the bearing prior to mounting and operating internal clearance, which applies to a bearing in operation that has reached a stable temperature.

In almost all applications, the initial clearance in a bearing is greater than its operating clearance. The difference can be attributed to

interference fits on the shaft and/or in the housing, combined with thermal expansion of the bearing and mating components. In some cases, these factors can reduce clearance enough to create radial preload in the bearing.

For details about the internal clearance in new bearings prior to mounting and recommendations about clearance or preload in operation, refer to *Radial internal clearance* (→ page 51).

## Materials

The materials from which bearing components are made, determine, to a large extent, the performance and reliability of the bearing. For the bearing rings and rolling elements, typical considerations include hardness, fatigue resistance in the rolling contact area, under clean or contaminated lubrication conditions, and the dimensional stability of the bearing components. For the cage, considerations include friction, strain, temperatures, inertial forces, and in some cases, the chemical action of certain lubricants, lubricant additives, solvents, coolants and refrigerants.

Seals integrated in rolling bearings can also have a considerable impact on the performance and reliability of the bearings. Their materials must be able to withstand oxidation (ageing), wear and chemical attack over a wide temperature range.

SKF has the competence and facilities to provide a variety of materials, processes and coatings. Therefore, SKF application engineers can assist in selecting the bearing, cage and seal materials that best meet the needs of a particular application.

## Materials for bearing rings and rolling elements

### Standard bearing steel

The steel used for standard SKF super-precision bearings is an extremely clean, through-hardened carbon chromium steel (100Cr6), containing approximately 1% carbon and 1,5% chromium, in accordance with ISO 683-17. The composition of this bearing steel provides an optimum balance between manufacturing and application performance. This steel normally undergoes a martensitic or bainitic heat treatment to obtain a hardness between 58 and 65 HRC.

SKF super-precision bearings are heat stabilized up to 150 °C (300 °F). But other factors like cage material, seal material or lubricant might limit the permissible operating temperature.

For information about material properties, refer to **table 6** (→ page 51).

### NitroMax steel (high-nitrogen stainless steel)

NitroMax is a new generation of ultra clean, high nitrogen stainless steel. When compared to standard carbon chromium bearing steel (100Cr6), NitroMax steel provides the following:

- enhanced fatigue/wear resistance under poor lubrication conditions ( $\kappa < 1$ )
- higher degree of fracture toughness
- superior corrosion resistance

Each of these characteristics is beneficial when speed is higher than  $A = 1$  to  $1,15 \times 10^6$  mm/min.

Enhanced fatigue/wear resistance enables the bearings to operate longer under all lubrication conditions and particularly those of thin-film operation that result from kinematic lubricant starvation at very high speeds.

Increased fracture toughness reduces the risk of inner ring fracture due to increased ten-

sile hoop stresses caused by centrifugal forces when operating at very high speeds.

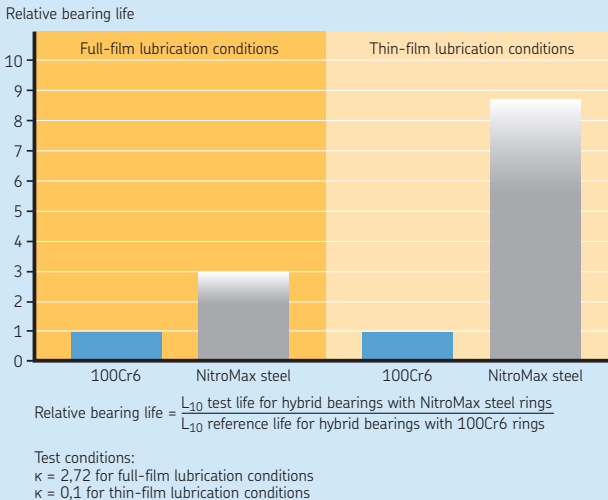
Compared with bearings made of carbon chromium steel, this ultra-clean, high nitrogen content steel can significantly extend bearing service life when operating under full-film lubrication conditions ( $\kappa \geq 1$ ). Under thin-film lubrication conditions, this life extending effect is even more significant (→ **diagram 8**).

NitroMax steel is superior not only to conventional carbon chromium bearing steels but also to other high-nitrogen stainless steels. To illustrate why this is the case, it is necessary to understand the way that nitrogen influences the microstructure of the steel and how this is optimized during heat treatment.

When carbon chromium steel is heat treated, the process produces large, brittle chromium and chromium-molybdenum carbides that deplete the surrounding steel matrix of chromium and molybdenum, thereby reducing its corrosion pitting resistance. On the other hand, when NitroMax steel is hardened

Diagram 8

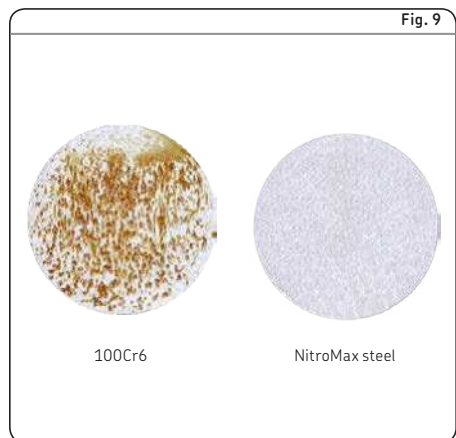
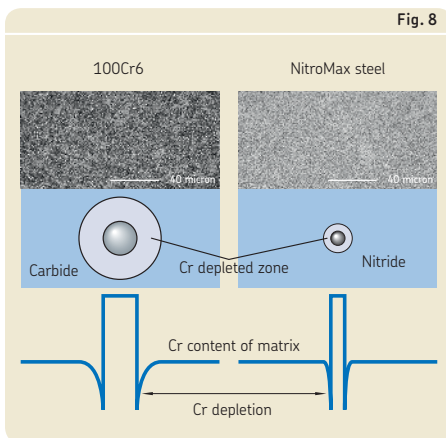
Relative life of hybrid bearings with NitroMax steel rings



and tempered, small, fine chromium nitrides are formed (→ **fig. 8**). This occurs because when the nitrogen partly replaces the carbon in the steel alloy, a much higher content of chromium is dissolved in the steel matrix. The resulting, smaller chromium-depleted zones around the nitrides make NitroMax steel much more corrosion resistant (→ **fig. 9**).

The enhanced fatigue strength of NitroMax steel is associated with its coherent microstructure and fine distribution of chromium nitride precipitates with few, if any, undissolved secondary carbides in the microstructure. The fineness of the NitroMax structure compares favourably to the standard bearing steel 100Cr6, which helps in explaining the superior performance of the NitroMax steel structure. High impact toughness, dimensional stability, and hardness (> 58 HRC) result from the final quenching and tempering stages of heat treatment.

Another benefit of NitroMax steel is that it has a lower coefficient of thermal expansion than 100Cr6. This benefit, when paired with the extremely low coefficient of thermal expansion of ceramic rolling elements, used as standard in SKF bearings with NitroMax steel rings, enables bearings combining the two materials to be less sensitive to temperature differences between the inner and outer rings. The level of preload therefore remains much more stable even over the extremes of operating conditions, resulting in reduced frictional losses, lower operating temperatures and extended grease service life.



Ceramics

The ceramic material used for rolling elements in SKF super-precision bearings is a bearing grade silicon nitride in accordance with ISO 26602. It consists of fine elongated grains of beta-silicon nitride in a glassy phase matrix. It provides a combination of favourable properties especially for high-speed bearings:

- high hardness
- high modulus of elasticity
- low density
- low coefficient of thermal expansion
- high electrical resistivity
- low dielectric constant
- no response to magnetic fields

For information about material properties, refer to **table 6**.

Bearings with steel rings and ceramic rolling elements are called hybrid bearings.

Table 6

| Comparison of the material properties of bearing grade silicon nitride and bearing steel 100Cr6 |                                 |                                       |
|-------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------------|
| Material properties                                                                             | Bearing grade silicon nitride   | Bearing steel                         |
| <b>Mechanical properties</b>                                                                    |                                 |                                       |
| Density [g/cm <sup>3</sup> ]                                                                    | 3,2                             | 7,9                                   |
| Hardness                                                                                        | 1 600 HV10                      | 700 HV10                              |
| Modulus of elasticity [kN/mm <sup>2</sup> ]                                                     | 310                             | 210                                   |
| Thermal expansion [10 <sup>-6</sup> /K]                                                         | 3                               | 12                                    |
| <b>Electrical properties (at 1 MHz)</b>                                                         |                                 |                                       |
| Electrical resistivity [Ωm]                                                                     | 10 <sup>12</sup><br>(Insulator) | 0,4 × 10 <sup>-6</sup><br>(Conductor) |
| Dielectric strength [kV/mm]                                                                     | 15                              | –                                     |
| Relative dielectric constant                                                                    | 8                               | –                                     |



## Cage materials

### Phenolic resin

Cotton fabric reinforced phenolic resin is a lightweight material. Cages made of this material can withstand heavy inertial forces and operating temperatures up to 120 °C (250 °F). The material tends to absorb oil, assisting the lubrication of the cage / rolling element contact and providing a safety margin for run down, should there be an interruption of lubricant supply.

Cotton fabric reinforced phenolic resin is the standard cage material for super-precision angular contact ball bearings.

### Polyamide 66

Polyamide 66 (PA66), with or without glass fibre reinforcement, is characterized by a favourable combination of strength and elasticity. Due to its excellent sliding properties on lubricated steel surfaces and the superior finish of the contact surfaces, PA66 cages reduce friction, frictional heat and wear. PA66 can be used at operating temperatures up to 120 °C (250 °F). However, some synthetic oils and greases with a synthetic oil base and lubricants containing EP additives, when used at high temperatures, can have a detrimental effect on PA66 cages. For information about the suitability of cages, refer to *Cages* and *Cage materials* in the SKF catalogue *Rolling bearings*, or visit [skf.com](http://skf.com).

PA66 is the standard cage material for many super-precision cylindrical roller bearings and angular contact thrust ball bearings.

### Polyetheretherketone

Glass or carbon fibre reinforced polyetheretherketone (PEEK) is popular for demanding applications where there are either high speeds or high temperatures or a need for chemical resistance. The maximum temperature for high-speed use is limited to 150 °C (300 °F) as this is the softening temperature of the polymer. The material does not show signs of ageing by temperature or oil additives up to 200 °C (390 °F).

PEEK is the standard cage material for some super-precision angular contact ball and for high-speed design cylindrical roller bearings.

### Brass

Brass is unaffected by most common bearing lubricants, including synthetic oils and greases, and can be cleaned using normal organic solvents. Brass cages can be used at operating temperatures up to 250 °C (480 °F).

Machined brass cages are used in a number of super-precision double row cylindrical roller bearings and double direction angular contact thrust ball bearings and are standard for large super-precision angular contact ball bearings ( $d \geq 300$  mm).

### Other cage materials

In addition to the materials described above, SKF super-precision bearings for special applications can be fitted with cages made of other engineered polymers, light alloys or silver-plated steel. For information about alternative cage materials, contact the SKF application engineering service.

### Seal materials

Seals integrated in SKF super-precision bearings are typically made of sheet steel reinforced elastomers.

#### Acrylonitrile-butadiene rubber

Acrylonitrile-butadiene rubber (NBR) is the "universal" seal material. This copolymer, manufactured from acrylonitrile and butadiene, has good resistance to the following media:

- most mineral oils and greases with a mineral oil base
- normal fuels, such as petrol, diesel and light heating oils
- animal and vegetable oils and fats
- hot water

The permissible operating temperature range is  $-40$  to  $+100$  °C ( $-40$  to  $+210$  °F). The seal lip can tolerate dry running within this temperature range for short periods. Temperatures up to  $120$  °C ( $250$  °F) can be tolerated for brief periods. At higher temperatures, the material hardens.

#### Fluoro rubber

Fluoro rubbers (FKM) are characterized by their high thermal and chemical resistance. Their resistance to ageing and ozone is very good and their gas permeability is very low. They have exceptionally good wear characteristics even under harsh environmental conditions. The permissible operating temperature range is  $-30$  to  $+230$  °C ( $-20$  to  $+445$  °F). The seal lip can tolerate dry running within this temperature range for short periods.

FKM is resistant to oils and hydraulic fluids, fuels and lubricants, mineral acids and aliphatic as well as aromatic hydrocarbons which would cause seals made of other materials to fail. FKM should not be used in the presence of esters, ethers, ketones, certain amines and hot anhydrous hydrofluorides.

Seals made of FKM exposed to an open flame or temperatures above  $300$  °C ( $570$  °F) are a health and environmental hazard! They remain dangerous even after they have cooled. Read and follow the safety precautions (→ **WARNING**).

### WARNING: HAZARDOUS FUMES

#### Safety precautions for fluoro rubber

Fluoro rubber (FKM) is very stable and harmless up to normal operating temperatures of  $200$  °C ( $390$  °F). However, if exposed to temperatures above  $300$  °C ( $570$  °F), such as fire or the open flame of a cutting torch, FKM seals give off hazardous fumes. These fumes can be harmful if inhaled, as well as if they contact the eyes. In addition, once the seals have been heated to such temperatures, they are dangerous to handle even after they have cooled. Therefore, they should never come in contact with the skin.

If it is necessary to handle bearings with seals that have been subjected to high temperatures, such as when dismounting the bearing, the following safety precautions should be observed:

- Always wear protective goggles, gloves and appropriate breathing apparatus.
- Place all of the remains of the seals in an airtight plastic container marked with a symbol for "material will etch".
- Follow the safety precautions in the material safety data sheet (MSDS).

If there is contact with the seals, wash hands with soap and plenty of water and, if contact has been made with the eyes, flush the eyes with plenty of water and consult a doctor immediately. If the fumes have been inhaled, consult a doctor immediately.

The user is responsible for the correct use of the product during its service life and its proper disposal. SKF takes no responsibility for the improper handling of FKM seals, or for any injury resulting from their use.

## Design considerations

The majority of super-precision bearings are used in machine tool spindles. Most of the information required when designing a bearing arrangement for maximum bearing performance can be found in the following sections.

### Bearing arrangements

A bearing system, which is typically used to support a rotating shaft, generally requires two bearing arrangements. Depending on the requirements, such as stiffness or load directions, a bearing arrangement consists of one or more (matched) bearings.

### Bearing arrangements for heavy loads

Lathe spindles are typically used to cut metals at relatively slow speeds. Depth of cut and feed rates are usually pushed to the limit depending on the required surface finish. In a lathe, power is normally transmitted to the spindle by a pulley or gears, resulting in heavy radial loads at the non-tool end. On the tool end of the spindle, where there are heavy combined loads, a high degree of rigidity and high load carrying capacity are important operational requirements.

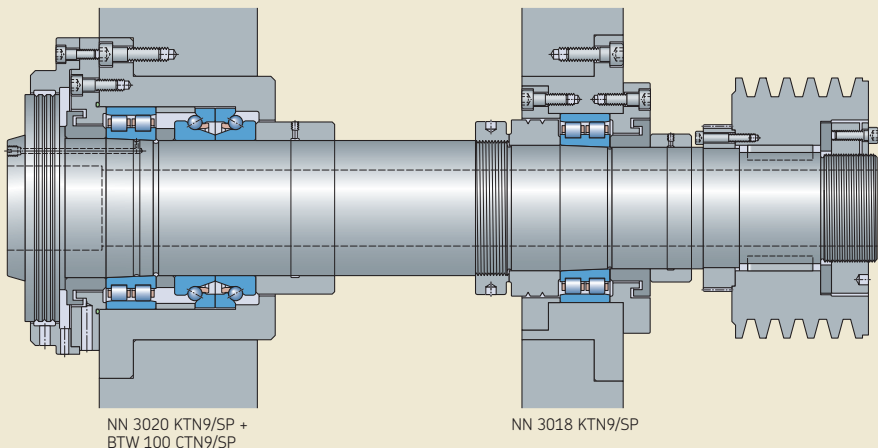
In a lathe spindle, it is common to have a double row cylindrical roller bearing in combination with a double direction angular contact thrust ball bearing at the tool end and a double row cylindrical roller bearing at the non-tool end (→ **fig. 10**).

The outside diameter of the thrust bearing housing washer is manufactured to a special tolerance. This tolerance enables the bearing to be radially free when mounted in a housing of appropriate bore diameter tolerance for the adjacent double row cylindrical roller bearing. This clearance is sufficient to relieve the thrust bearing from carrying significant radial load. This bearing arrangement provides a long calculated life and a high degree of rigidity and stability, both essential to the manufacture of good quality workpieces.

A good rule of thumb is to have the distance between the tool end and non-tool end bearing centres in the range 3 to 3,5 times the bore diameter of the bearing(s) at the tool end. This rule is particularly important when heavy loads are involved. For additional information, refer to *System rigidity* (→ **page 57**).

Fig. 10

Belt-driven CNC lathe spindle for large diameter bar stock



Additional arrangements for CNC lathes and conventional milling machines (→ **figs. 11** and **12**) and live centres (→ **fig. 13**) are provided.

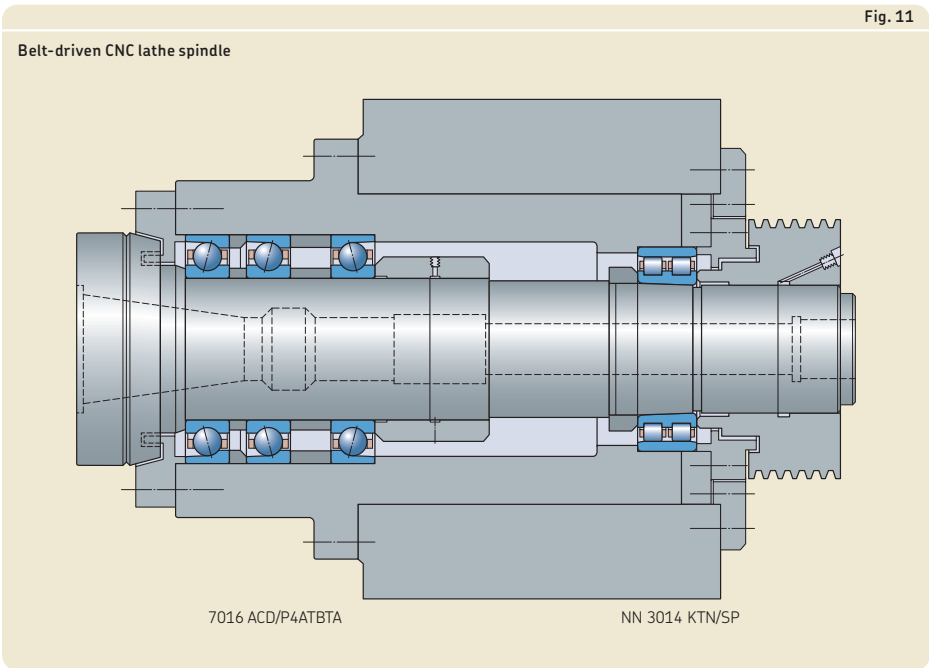
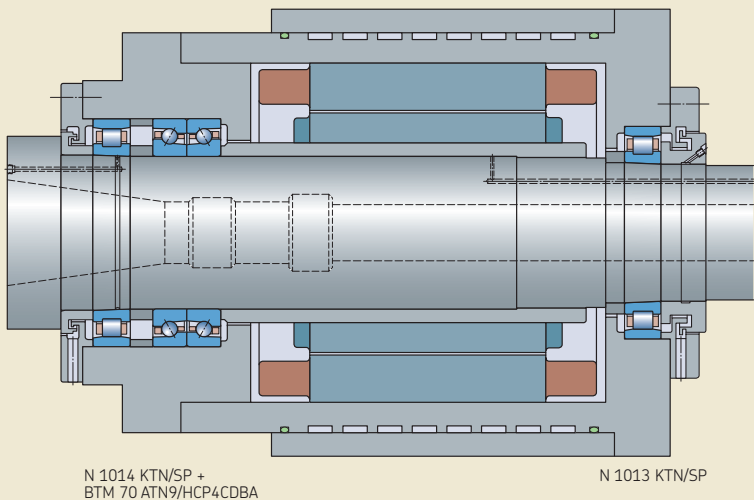


Fig. 12

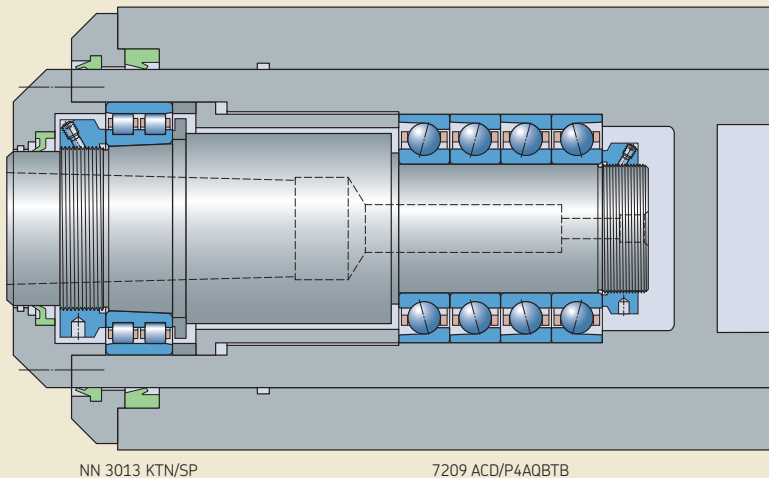
Conventional milling machine spindle



1

Fig. 13

Live centre spindle



## Principles of bearing selection and application

For applications where available space is limited, super-precision angular contact ball bearings in the 718 or 719 series may be more suitable (→ **figs. 14** and **15**).

Fig. 14

### Multispindle drilling head

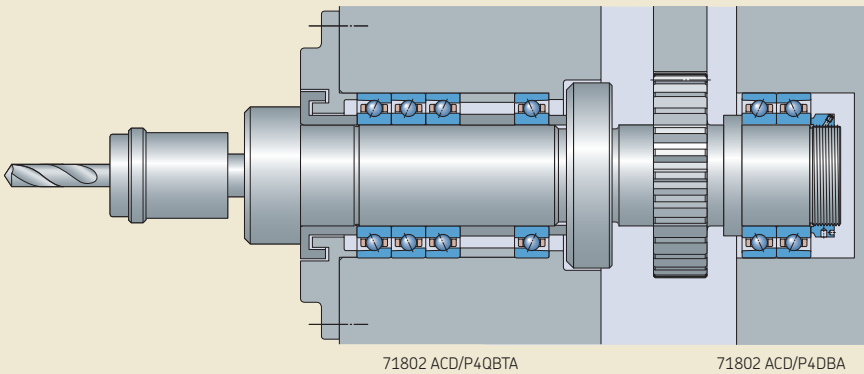
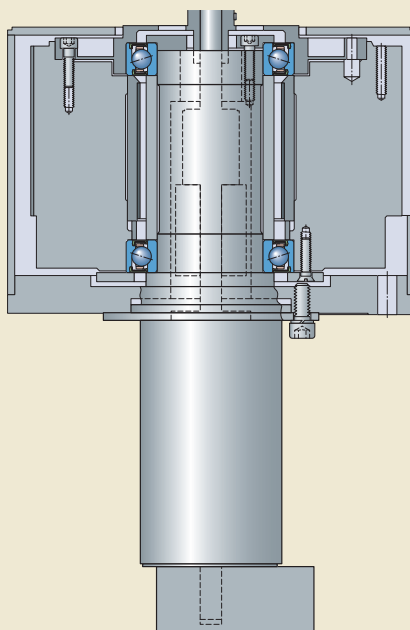


Fig. 15

Unit for detecting defects on silicon wafer chips



S71906 CD/P4ADBA

### Bearing arrangements for greater rigidity and higher speeds

When higher speeds are required, as is the case for high-speed machining centres ( $A > 1\,200\,000\text{ mm/min}$ ), there is typically a compromise between rigidity and load carrying capacity. In these applications, the spindle is usually driven directly by a motor (motorized spindles or electro-spindles), or through a coupling. Therefore, there are no radial loads on the non-tool end as is the case with a belt driven spindle. Consequently, single row angular contact ball bearings mounted in sets and single row cylindrical roller bearings are frequently used (→ **fig. 16**). In this bearing system, the tool end bearing set is axially located, while the cylindrical roller bearing on the non-tool end accommodates thermal expansion of the spindle shaft relative to the housing within the bearing.

Other arrangement examples for spindles in high-speed machining centres and milling machines are shown in **figs. 17** and **18**.

If enhanced performance is required, SKF recommends using hybrid bearings equipped

with rolling elements made of bearing grade silicon nitride ( $\text{Si}_3\text{N}_4$ ).

Fig. 16

Electro-spindle in a horizontal machining centre

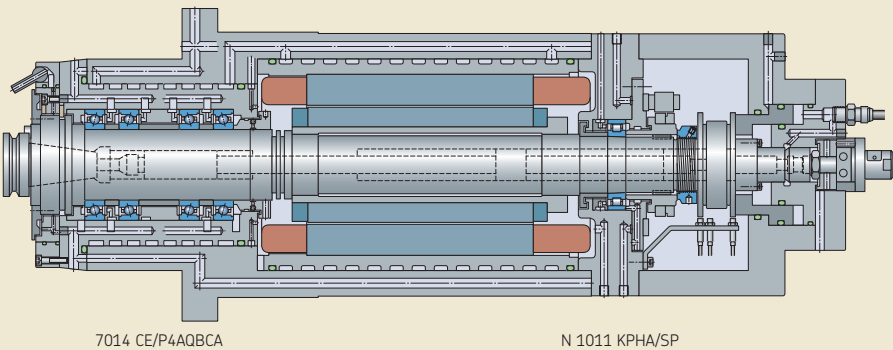




Fig. 17

Spindle in a horizontal machining centre

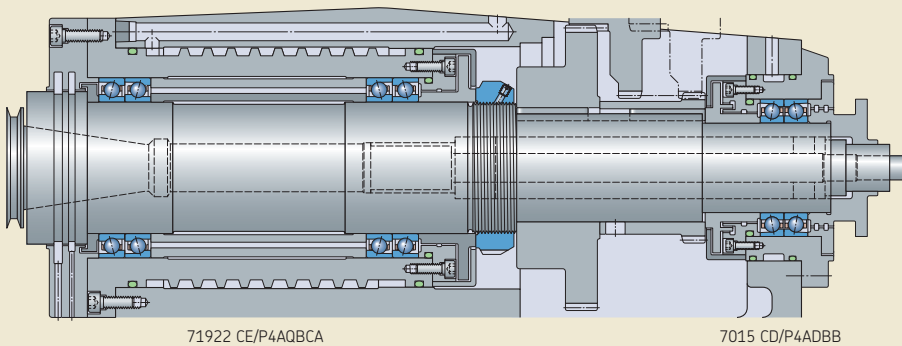
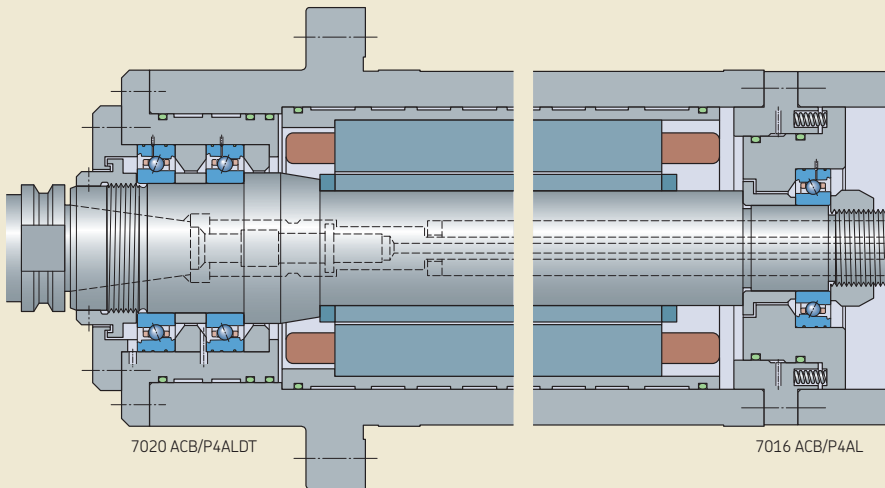


Fig. 18

Electro-spindle in a high-speed metal cutting machine



### Bearing arrangements for maximum speed

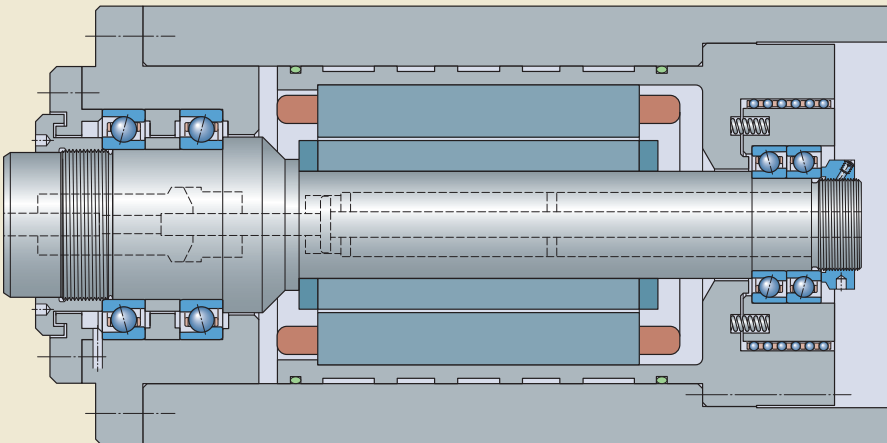
When sets of angular contact ball bearings are mounted with a fixed preload (without springs), that preload tends to increase when in service due to differential thermal expansion. As speeds rise the significance of this effect tends to increase.

To avoid the damaging effects of excessive preload, particularly in exceptionally high speed applications ( $A > 2\,000\,000\text{ mm/min}$ ), it is quite common to use angular contact ball bearings preloaded by springs (→ **fig. 19**). Springs control preload independent of the effects of relative thermal expansion and minimize the amount of frictional heat generated in the bearings.

An even better solution than springs is to preload angular contact ball bearings with a hydraulic system. A hydraulic system adjusts the amount of preload according to the speed of the spindle to obtain the best combination of rigidity, frictional heat and bearing service life.

Fig. 19

Electro-spindle for an internal grinding machine





### System rigidity

System rigidity in machine tool applications is extremely important because deflection under load has a major impact on machining accuracy. Bearing stiffness is only one factor that influences system rigidity. Others include:

- shaft stiffness
- tool overhang
- housing stiffness
- number and position of bearings and the influence of fits

Some general guidelines for designing high-speed precision applications include:

- Select the largest possible shaft diameter.
- Minimize the distance between the tool end bearing position and the spindle nose.
- Keep the distance between the two bearing sets short (→ **fig. 20**). A guideline for the spacing is:

$$l \approx 3 \dots 3,5 d$$

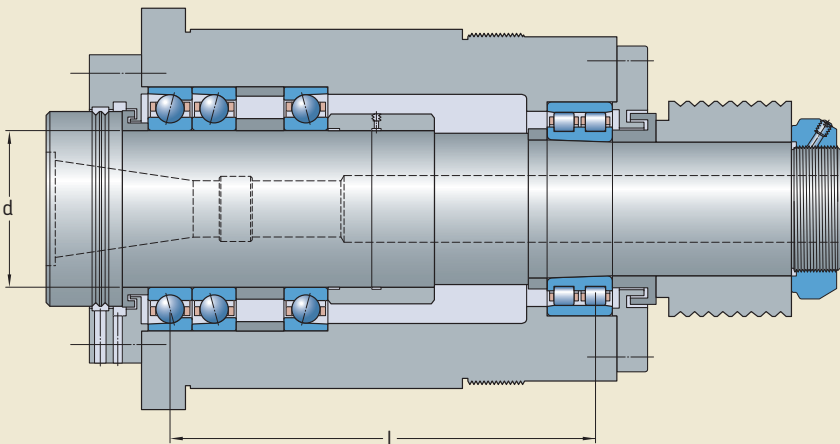
where

$l$  = distance between the first tool end bearing row and the rearmost non-tool end bearing row

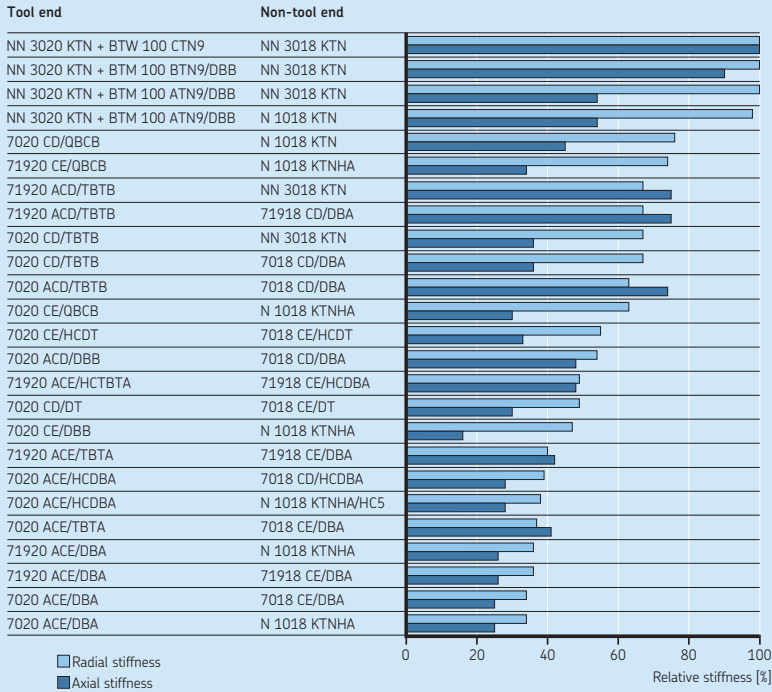
$d$  = tool end bearing bore diameter

**Diagram 9** provides an overview of the relative stiffness of different bearing systems. For details about the bearing series, refer to *Designation system* in the relevant product chapter. The comparison is based on preloaded bearings with 100 mm bore on the tool end and 90 mm bore on the non-tool end. These guideline values cannot substitute for precise system rigidity calculations. For advanced system analysis, contact the SKF application engineering service.

Fig. 20



## Relative stiffness of typical spindle bearing systems



## Angular contact ball bearings

- AC** 25° contact angle
- C** 15° contact angle
- D** High-capacity D design
- E** High-speed E design
- HC** Ceramic balls
- DB** Two bearings, back-to-back <>
- DT** Two bearings, tandem <<
- TBT** Three bearings, back-to-back and tandem <>>
- QBC** Four bearings, tandem back-to-back <<>>
- A** Extra light or light preload
- B** Light or moderate preload

## Cylindrical roller bearings

- K** Tapered bore
- TN** PA66 cage, roller centred
- TNHA** Glass fibre reinforced PEEK cage, outer ring centred
- HCS** Ceramic rollers

## Double direction angular contact thrust ball bearings

- A** 30° contact angle
- B** 40° contact angle
- C** 60° contact angle
- TN9** Glass fibre reinforced PA66 cage, ball centred

### Bearing stiffness

The stiffness of a rolling bearing is characterized by the magnitude of the elastic deformation (deflection) in the bearing under load. It is expressed as the ratio of load to deflection and depends on the bearing type, design and size. The most important parameters are:

- type of rolling elements; roller bearings have a higher degree of stiffness than ball bearings because of the contact conditions between the rolling elements and raceways
- rolling element material (→ **diagram 10**)
- number and size of rolling elements
- contact angle (→ **diagram 11**)
- preload class (→ **diagram 12**)

Bearing stiffness can be further enhanced by applying a preload (→ *Bearing preload*, **page 68**). Preloading bearings is standard practice in machine tool applications.

A loose fit on a mating component can have a negative influence on the stiffness of a bearing arrangement. However, a loose housing fit may be necessary for bearing arrangements

using angular contact ball bearings in the non-locating position. Typically the non-locating bearing position is on the non-tool end of a spindle shaft and, therefore, the influence on system rigidity for the tool end is limited. If a high degree of stiffness is also desired for the non-tool end, a cylindrical roller bearing with a tapered bore should be used. This arrangement can accommodate axial displacement of the spindle shaft relative to the housing within the bearing and enables an interference fit for both the inner and outer rings.

Diagram 10

#### Radial stiffness of spring preloaded bearings

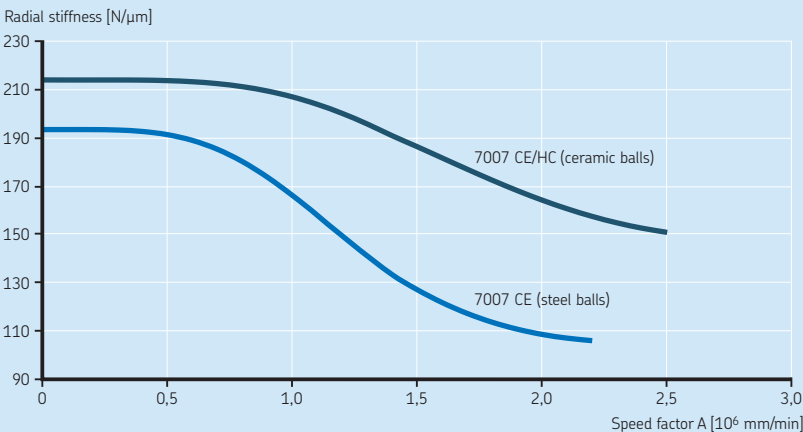


Diagram 11

Axial displacement of back-to-back bearing sets with different contact angles

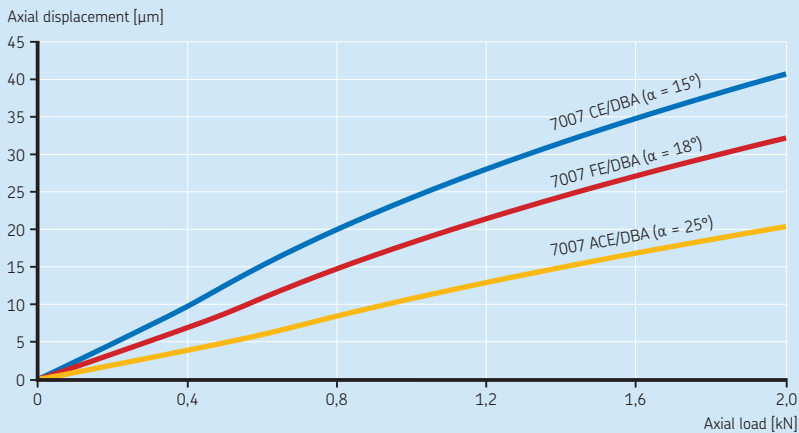
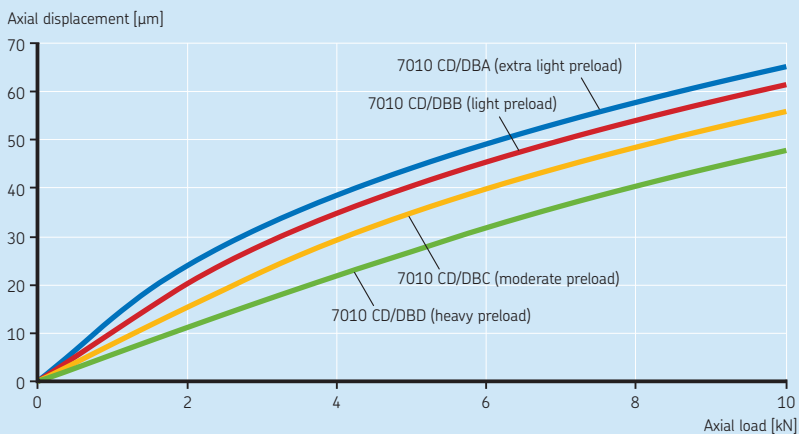


Diagram 12

Axial displacement of back-to-back bearing sets with different preload



### Radial location of bearings

If the load carrying capacity of a bearing is to be fully exploited, its rings or washers should be fully supported around their complete circumference and across the entire width of the raceway. The support, which should be firm and even, can be provided by a cylindrical or tapered seat, as appropriate or, for thrust bearing washers, by a flat (plane) support surface. This means that bearing seats should be manufactured to adequate tolerance classes and uninterrupted by grooves, holes or other features, unless the seat is prepared for the oil injection method. This is particularly important for super-precision bearings that have relatively thin rings which tend to reproduce the shape of the shaft or housing seat. In addition, the bearing rings should be reliably secured to prevent them from turning on or in their seats under load.

In general, satisfactory radial location and adequate support can only be obtained when the rings are mounted with an appropriate degree of interference. Inadequately or incorrectly secured bearing rings generally cause damage to the bearing and mating components. However, when axial displacement (as with a non-locating bearing) or easy mounting and dismounting are required, an interference fit cannot always be used. In cases where a loose fit is necessary, but an interference fit would normally be required, special precautions are necessary to limit the fretting wear that inevitably results from creep (the bearing ring turning on its seat). This can be done, for example, by surface hardening the bearing seat and abutments.

### Recommended shaft and housing fits

#### Diameter tolerances for bearing seats

Shaft and housing seats for super-precision angular contact ball bearings, cylindrical roller bearings and double direction angular contact thrust ball bearings should be manufactured to the diameter tolerances recommended in:

- **table 7** for shaft seat tolerances
- **table 8 (→ page 70)** for housing seat tolerances

For recommendations for other super-precision bearings, refer to the relevant section of:

- angular contact thrust ball bearings for screw drives (→ *Associated components*, **page 70**)
- axial-radial cylindrical roller bearings (→ *Design considerations*, **page 70**)

Values of appropriate ISO tolerance classes for super-precision bearings are listed in:

- **table 9 (→ page 70)** for shaft tolerances
- **table 10 (→ page 70)** for housing tolerances

The location of the commonly used tolerance classes relative to the bearing bore and outside diameter surface are shown in **fig. 21**.



Table 7

1

Diameter tolerances for bearing seats on steel shafts

| Bearing type                                                 | Shaft diameter |       | Tolerance class <sup>1)</sup>                    |              | Deviations |      |
|--------------------------------------------------------------|----------------|-------|--------------------------------------------------|--------------|------------|------|
|                                                              | over           | incl. | Bearings to tolerance class                      |              | high       | low  |
|                                                              |                |       | P4, P4A, P4C, SP                                 | P2, PA9A, UP |            |      |
| –                                                            | mm             |       | –                                                |              | μm         |      |
|                                                              |                |       |                                                  |              |            |      |
| <b>Angular contact ball bearings</b>                         |                |       |                                                  |              |            |      |
| with rotating outer ring load                                | –              | 400   | h4                                               | h3           | –          | –    |
| with rotating inner ring load                                | –              | 30    | –                                                | –            | +1         | –3   |
|                                                              | 30             | 80    | –                                                | –            | +2         | –3   |
|                                                              | 80             | 120   | –                                                | –            | +3         | –3   |
|                                                              | 120            | 180   | –                                                | –            | +4         | –4   |
|                                                              | 180            | 250   | –                                                | –            | +5         | –5   |
|                                                              | 250            | 315   | –                                                | –            | +6         | –6   |
|                                                              | 315            | 400   | –                                                | –            | +6,5       | –6,5 |
|                                                              |                |       |                                                  |              |            |      |
| <b>Cylindrical roller bearings</b>                           |                |       |                                                  |              |            |      |
| with a cylindrical bore                                      | –              | 40    | js4                                              | –            | –          | –    |
|                                                              | 40             | 280   | k4                                               | –            | –          | –    |
|                                                              | 280            | 500   | k4 <sup>2)</sup>                                 | –            | –          | –    |
|                                                              | 500            | –     | Contact the SKF application engineering service. |              |            |      |
|                                                              |                |       |                                                  |              |            |      |
| <b>Double direction angular contact thrust ball bearings</b> | –              | 200   | h4                                               | h3           | –          | –    |

For hollow shafts, when A > 1 000 000 mm/min, contact the SKF application engineering service.  
1) All ISO tolerance classes are valid with the envelope requirement (such as h4(ES)) in accordance with ISO 14405-1.  
2) General guideline only. SKF recommends contacting the SKF application engineering service.

Fig. 21

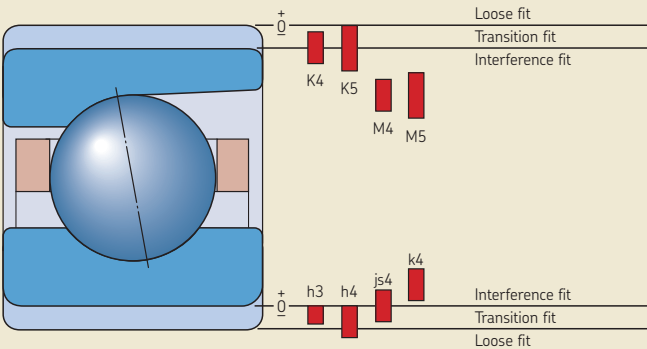


Table 8

## Diameter tolerances for bearing seats in cast iron and steel housings

| Bearing type                                                 | Conditions                                                         | Housing bore |       | Tolerance class <sup>1)</sup><br>Bearings to tolerance class<br>P4, P4A, P4C, SP |    | Deviations |     |
|--------------------------------------------------------------|--------------------------------------------------------------------|--------------|-------|----------------------------------------------------------------------------------|----|------------|-----|
|                                                              |                                                                    | over         | incl. |                                                                                  |    | high       | low |
| –                                                            | –                                                                  | mm           | –     |                                                                                  |    | µm         |     |
| <b>Angular contact ball bearings</b>                         | Locating bearings, axial displacement of outer ring unnecessary    | –            | 18    | –                                                                                | –  | +4         | –1  |
|                                                              |                                                                    | 18           | 30    | –                                                                                | –  | +5         | –1  |
|                                                              |                                                                    | 30           | 50    | –                                                                                | –  | +6         | –1  |
|                                                              |                                                                    | 50           | 80    | –                                                                                | –  | +7         | –1  |
|                                                              |                                                                    | 80           | 120   | –                                                                                | –  | +7         | –3  |
|                                                              |                                                                    | 120          | 180   | –                                                                                | –  | +9         | –3  |
|                                                              |                                                                    | 180          | 250   | –                                                                                | –  | +10        | –4  |
|                                                              |                                                                    | 250          | 315   | –                                                                                | –  | +12        | –4  |
|                                                              |                                                                    | 315          | 400   | –                                                                                | –  | +13        | –5  |
|                                                              |                                                                    | 400          | 500   | –                                                                                | –  | +14        | –6  |
|                                                              | Non-locating bearings, axial displacement of outer ring desirable  | –            | 18    | –                                                                                | –  | +7         | +2  |
|                                                              |                                                                    | 18           | 30    | –                                                                                | –  | +8         | +2  |
|                                                              |                                                                    | 30           | 50    | –                                                                                | –  | +9         | +2  |
|                                                              |                                                                    | 50           | 80    | –                                                                                | –  | +10        | +2  |
|                                                              |                                                                    | 80           | 120   | –                                                                                | –  | +13        | +3  |
|                                                              |                                                                    | 120          | 180   | –                                                                                | –  | +16        | +4  |
|                                                              |                                                                    | 180          | 250   | –                                                                                | –  | +19        | +5  |
|                                                              |                                                                    | 250          | 315   | –                                                                                | –  | +21        | +5  |
|                                                              |                                                                    | 315          | 400   | –                                                                                | –  | +24        | +6  |
|                                                              |                                                                    | 400          | 500   | –                                                                                | –  | +27        | +7  |
| <b>Cylindrical roller bearings</b>                           | Rotating outer ring load                                           | –            | 500   | M5                                                                               | M4 | –          | –   |
|                                                              | Light to normal loads ( $P \leq 0,1 C$ )                           | –            | 900   | K5                                                                               | K4 | –          | –   |
|                                                              | Heavy loads ( $0,1 C < P \leq 0,15 C$ ), rotating outer ring loads | –            | 900   | M5                                                                               | M4 | –          | –   |
| <b>Double direction angular contact thrust ball bearings</b> |                                                                    | –            | 315   | K5                                                                               | K4 | –          | –   |

<sup>1)</sup> All ISO tolerance classes are valid with the envelope requirement (such as M4 ) in accordance with ISO 14405-1.

Table 9

1

Values of ISO tolerance classes for shafts

| Shaft diameter<br>d |       | Tolerance classes<br>h3Ⓜ |      | h4Ⓜ                |     | js4Ⓜ               |      | k4Ⓜ                |     |
|---------------------|-------|--------------------------|------|--------------------|-----|--------------------|------|--------------------|-----|
| Nominal<br>over     | incl. | Deviations<br>high       | low  | Deviations<br>high | low | Deviations<br>high | low  | Deviations<br>high | low |
| mm                  |       | μm                       |      |                    |     |                    |      |                    |     |
| –                   | 3     | 0                        | –2   | 0                  | –3  | +1,5               | –1,5 | +3                 | 0   |
| 3                   | 6     | 0                        | –2,5 | 0                  | –4  | +2                 | –2   | +5                 | +1  |
| 6                   | 10    | 0                        | –2,5 | 0                  | –4  | +2                 | –2   | +5                 | +1  |
| 10                  | 18    | 0                        | –3   | 0                  | –5  | +2,5               | –2,5 | +6                 | +1  |
| 18                  | 30    | 0                        | –4   | 0                  | –6  | +3                 | –3   | +8                 | +2  |
| 30                  | 50    | 0                        | –4   | 0                  | –7  | +3,5               | –3,5 | +9                 | +2  |
| 50                  | 80    | 0                        | –5   | 0                  | –8  | +4                 | –4   | +10                | +2  |
| 80                  | 120   | 0                        | –6   | 0                  | –10 | +5                 | –5   | +13                | +3  |
| 120                 | 180   | 0                        | –8   | 0                  | –12 | +6                 | –6   | +15                | +3  |
| 180                 | 250   | 0                        | –10  | 0                  | –14 | +7                 | –7   | +18                | +4  |
| 250                 | 315   | 0                        | –12  | 0                  | –16 | +8                 | –8   | +20                | +4  |
| 315                 | 400   | 0                        | –13  | 0                  | –18 | +9                 | –9   | +22                | +4  |
| 400                 | 500   | –                        | –    | –                  | –   | –                  | –    | +25                | +5  |

Table 10

Values of ISO tolerance classes for housings

| Housing bore diameter<br>D |       | Tolerance classes<br>K4Ⓜ |     | K5Ⓜ                |     | M4Ⓜ                |     | M5Ⓜ                |     |
|----------------------------|-------|--------------------------|-----|--------------------|-----|--------------------|-----|--------------------|-----|
| Nominal<br>over            | incl. | Deviations<br>high       | low | Deviations<br>high | low | Deviations<br>high | low | Deviations<br>high | low |
| mm                         |       | μm                       |     |                    |     |                    |     |                    |     |
| 10                         | 18    | +1                       | –4  | +2                 | –6  | –5                 | –10 | –4                 | –12 |
| 18                         | 30    | 0                        | –6  | +1                 | –8  | –6                 | –12 | –5                 | –14 |
| 30                         | 50    | +1                       | –6  | +2                 | –9  | –6                 | –13 | –5                 | –16 |
| 50                         | 80    | +1                       | –7  | +3                 | –10 | –8                 | –16 | –6                 | –19 |
| 80                         | 120   | +1                       | –9  | +2                 | –13 | –9                 | –19 | –8                 | –23 |
| 120                        | 180   | +1                       | –11 | +3                 | –15 | –11                | –23 | –9                 | –27 |
| 180                        | 250   | 0                        | –14 | +2                 | –18 | –13                | –27 | –11                | –31 |
| 250                        | 315   | 0                        | –16 | +3                 | –20 | –16                | –32 | –13                | –36 |
| 315                        | 400   | +1                       | –17 | +3                 | –22 | –16                | –34 | –14                | –39 |
| 400                        | 500   | 0                        | –20 | +2                 | –25 | –18                | –38 | –16                | –43 |
| 500                        | 630   | 0                        | –22 | 0                  | –32 | –26                | –48 | –26                | –58 |
| 630                        | 800   | 0                        | –25 | 0                  | –36 | –30                | –55 | –30                | –66 |
| 800                        | 1 000 | 0                        | –28 | 0                  | –40 | –34                | –62 | –34                | –74 |

Selecting bearings to achieve preferred fits

Angular contact ball bearings and cylindrical roller bearings operating under normal loads and moderate speeds, should be selected to attain the interference/clearance values listed in:

- **table 11** for shaft fits
- **table 12** for housing fits

Diameter deviations of the bearings are provided on the package of super-precision angular contact ball bearings.

For extreme conditions, such as very high speeds or heavy loads, contact the SKF application engineering service.

For double direction angular contact thrust ball bearings (BTM and BTW series), the outside diameter of the housing washer is manufactured to tolerances such that sufficient radial clearance in the housing seat is obtained. Therefore, for bearings in the BTW and BTM series mounted adjacent to an appropriate cylindrical roller bearing in the same housing seat, tolerances tighter than those recommended in **table 8** (→ **page 74**) should not be used. For additional information, refer to *Double direction angular contact thrust ball bearings* (→ **page 74**).

Table 11

Preferred shaft fits

| Bearing type                  | Bearing bore |       | Interference |
|-------------------------------|--------------|-------|--------------|
|                               | over         | incl. |              |
| –                             | mm           |       | µm           |
| Angular contact ball bearings | –            | 50    | 0 to 2       |
|                               | 50           | 80    | 1 to 3       |
|                               | 80           | 120   | 1 to 4       |
|                               | 120          | 180   | 2 to 5       |
|                               | 180          | 250   | 2 to 6       |
|                               | 250          | 315   | 2 to 7       |
|                               | 315          | 400   | 3 to 8       |
|                               |              |       |              |

Table 12

Preferred housing fits

| Bearing type                  | Bearing outside diameter |       | Clearance |              | Interference |
|-------------------------------|--------------------------|-------|-----------|--------------|--------------|
|                               | over                     | incl. | locating  | non-locating |              |
| –                             | mm                       |       | µm        |              | µm           |
| Angular contact ball bearings | –                        | 50    | 2 to 6    | 6 to 10      | –            |
|                               | 50                       | 80    | 2 to 6    | 6 to 11      | –            |
|                               | 80                       | 120   | 2 to 7    | 8 to 13      | –            |
|                               | 120                      | 180   | 2 to 9    | 10 to 16     | –            |
|                               | 180                      | 250   | 4 to 10   | 12 to 19     | –            |
|                               | 250                      | 315   | 4 to 10   | 14 to 22     | –            |
|                               | 315                      | 500   | 5 to 12   | 16 to 25     | –            |
|                               |                          |       |           |              |              |
| Cylindrical roller bearings   | –                        | 460   | –         | –            | 0 to 2       |

## Accuracy of seats and abutments

### Geometrical and running accuracy

Maximum running accuracy, high speeds and low operating temperatures can only be achieved, even with super-precision bearings, if the mating parts and other associated components are made with equal precision as the bearings. Deviations from geometric form of associated seats and abutments should therefore be kept to a minimum when machining mating parts. Form and position recommendations in accordance with ISO 1101 are provided in **table 13** (→ **page 75**).

Thin-walled bearing rings adapt themselves to the form of their seat. Any errors of form on the shaft or housing seat can therefore affect the bearing raceways and bearing performance, e.g. angular misalignment of one bearing ring relative to the other, can cause loss of running accuracy, load concentration and high operating temperatures, particularly at high speeds.

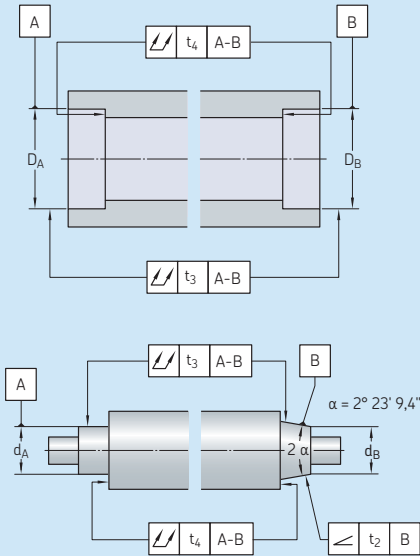
The numerical values of IT tolerance grades in accordance with ISO 286-1 are listed in **table 14** (→ **page 75**).

### Surface roughness

The surface roughness of a bearing seat does not have the same degree of influence on bearing performance as the dimensional and geometrical tolerances of the seat. However, obtaining a desired interference fit depends on the roughness of the mating surfaces, which is directly proportional to fit accuracy. Guideline values for the mean surface roughness  $R_a$  are listed in **table 15** (→ **page 75**) for different bearing tolerance classes. These recommendations apply to ground seats.

Table 13

Geometrical tolerances for bearing seats on shafts and in housings



| Surface<br>Characteristic                       | Symbol | Tolerance<br>zone | Permissible deviations                          |              |
|-------------------------------------------------|--------|-------------------|-------------------------------------------------|--------------|
|                                                 |        |                   | Bearings to tolerance class<br>P4, P4A, P4C, SP | P2, PA9A, UP |
| <b>Cylindrical seat</b><br>Total radial run-out |        | $t_3$             | IT2/2                                           | IT1/2        |
| <b>Flat abutment</b><br>Total axial run-out     |        | $t_4$             | IT1                                             | IT0          |
| <b>Angularity</b>                               |        | $t_2$             | IT3/2                                           | IT2/2        |

Table 14

Values of ISO tolerance grades

| Nominal dimension |       | Tolerance grades |     | IT2 | IT3 | IT4 | IT5 |
|-------------------|-------|------------------|-----|-----|-----|-----|-----|
| over              | incl. | IT0<br>max.      | IT1 |     |     |     |     |
| mm                |       | µm               |     |     |     |     |     |
| –                 | 3     | 0,5              | 0,8 | 1,2 | 2   | 3   | 4   |
| 3                 | 6     | 0,6              | 1   | 1,5 | 2,5 | 4   | 5   |
| 6                 | 10    | 0,6              | 1   | 1,5 | 2,5 | 4   | 6   |
| 10                | 18    | 0,8              | 1,2 | 2   | 3   | 5   | 8   |
| 18                | 30    | 1                | 1,5 | 2,5 | 4   | 6   | 9   |
| 30                | 50    | 1                | 1,5 | 2,5 | 4   | 7   | 11  |
| 50                | 80    | 1,2              | 2   | 3   | 5   | 8   | 13  |
| 80                | 120   | 1,5              | 2,5 | 4   | 6   | 10  | 15  |
| 120               | 180   | 2                | 3,5 | 5   | 8   | 12  | 18  |
| 180               | 250   | 3                | 4,5 | 7   | 10  | 14  | 20  |
| 250               | 315   | 4                | 6   | 8   | 12  | 16  | 23  |
| 315               | 400   | 5                | 7   | 9   | 13  | 18  | 25  |
| 400               | 500   | 6                | 8   | 10  | 15  | 20  | 27  |
| 500               | 630   | –                | 9   | 11  | 16  | 22  | 32  |
| 630               | 800   | –                | 10  | 13  | 18  | 25  | 36  |
| 800               | 1 000 | –                | 11  | 15  | 21  | 28  | 40  |

Table 15

Surface roughness of bearing seats

| Seat diameter |       | Recommended R <sub>a</sub> value for ground seats |              | Housing bore                |              |
|---------------|-------|---------------------------------------------------|--------------|-----------------------------|--------------|
| over          | incl. | Shaft                                             |              | Bearings to tolerance class |              |
|               |       | P4, P4A, P4C, SP<br>max.                          | P2, PA9A, UP | P4, P4A, P4C, SP<br>max.    | P2, PA9A, UP |
| mm            |       | µm                                                |              | µm                          |              |
| –             | 80    | 0,2                                               | 0,1          | 0,4                         | 0,4          |
| 80            | 250   | 0,4                                               | 0,2          | 0,4                         | 0,4          |
| 250           | 500   | 0,8                                               | 0,4          | 0,8                         | 0,8          |
| 500           | 800   | 0,8                                               | 0,8          | 0,8                         | 0,8          |
| 800           | 1 000 | 0,8                                               | 0,8          | 1,6                         | 1,6          |

### Axial location of bearings

In general, an interference fit alone is inadequate to locate a bearing ring on a cylindrical seat. Under load, a bearing ring can creep on its seat. Some suitable means to secure the bearing axially is needed.

For a locating bearing, both rings should be secured axially on both sides.

For non-separable bearings in the non-locating position, the ring with an interference fit, typically the inner ring, should be secured axially on both sides. The other ring must be free to move axially on its seat to accommodate axial displacement.

Cylindrical roller bearings in the non-locating position are exceptions. The inner and outer rings of these bearings must be secured axially in both directions.

In machine tool applications, bearings at the tool end generally locate the shaft by transmitting the axial load from the shaft to the housing. In general, then, tool end bearings are located axially, while non-tool end bearings are axially free.

### Locating methods

#### Lock nuts

Bearing inner rings that are mounted with an interference fit typically abut a shoulder on the shaft on one side. On the opposite side, they are normally secured by a precision lock nut (→ **fig. 22**).

Bearings with a tapered bore, mounted directly on a tapered shaft seat, are generally retained on the shaft by a spacer seated against a fixed abutment at the large end of the taper and a precision lock nut at the small end of the taper. The spacer width is adjusted to limit the drive-up distance of the bearing on its tapered seat.

For detailed information about precision lock nuts, refer to *Precision lock nuts* (→ **page 78**).

#### Spacer sleeves

Instead of integral shaft or housing shoulders, spacer sleeves or collars can be used between the bearing rings or between a bearing ring and an adjacent component (→ **fig. 23**). In these cases, the dimensional and form tolerances for abutments apply.

Fig. 22

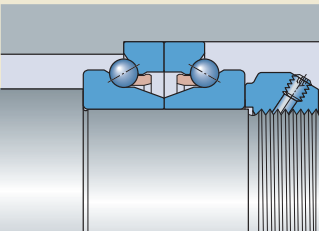
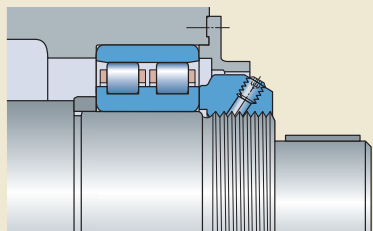


Fig. 23





### Stepped sleeves

Another way to locate a bearing axially is to use a stepped sleeve (→ **fig. 24**) with a tight interference fit on the shaft. These sleeves are particularly suitable for super-precision bearing arrangements, as they have very small run-out and provide superior accuracy compared to threaded lock nuts. Therefore, stepped sleeves are typically used in very high-speed spindles where the accuracy provided by conventional locking devices may be inadequate.

For detailed information about stepped sleeves, refer to *Stepped sleeves* (→ **page 79**).

### Housing covers

Bearing outer rings that are mounted with an interference fit typically abut a shoulder in the housing on one side. On the opposite side, they are normally located by a housing cover.

Housing covers and their securing screws can, in some cases, have a negative impact on bearing form and performance. If the wall thickness between the bearing seat and the bolt holes is too small, and/or the bolts are tightened too much, the outer ring raceway may deform. Bearings in the lightest ISO dimension series 18 and 19 are more susceptible to this than those in the ISO dimension series 10 or above.

It is advisable to use a larger number of small diameter bolts. Using only three or four bolts should be avoided because a small number of tightening points may produce lobes in the housing bore. This can result in noise, vibration, unstable preload or premature failure due to load concentrations. For complex spindle designs where space is limited, only thin-section bearings and a limited number of bolts may be possible. In these cases, SKF recommends an FEM (finite element method) analysis to accurately predict deformation.

As a guideline to achieve an appropriate clamping force between the cover spigot end face and the side face of the bearing outer ring, the cover spigot length should be adjusted so that, before the bolts are tightened, the axial gap between the cover and the housing side face is between 15 and 20  $\mu\text{m}$  per 100 mm housing bore diameter (→ **fig. 25**).

Fig. 24

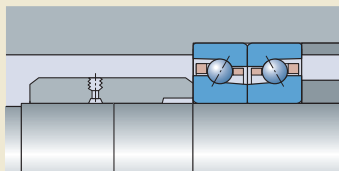
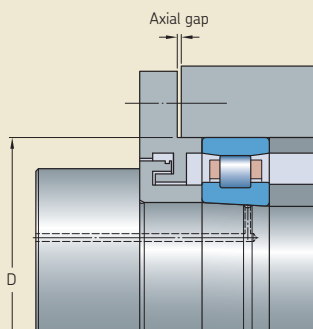


Fig. 25



### Stepped sleeves

Stepped sleeves are pressure joints with two slightly different inside diameters that mate with a stepped shaft. An interference fit maintains the sleeve's position axially and determines its axial load carrying capacity. The stepped design of the fitting surface simplifies alignment during mounting but also facilitates dismounting when using the oil injection method.

Stepped sleeves do not create any stresses that might reduce the running accuracy of a shaft, but do enhance shaft stiffness. They are typically used in very high speed, lightly loaded applications where there are minimal shock loads. Compared to threaded lock nuts, stepped sleeves provide superior mounting accuracy, provided the sleeve and its seats are manufactured to the appropriate specifications, and the sleeve is mounted correctly.

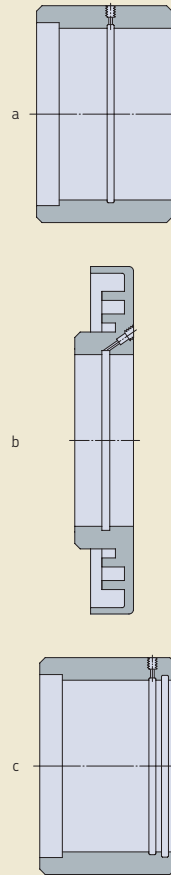
SKF does not supply or manufacture stepped sleeves, but design recommendations and suitable dimensions are provided on the pages that follow.

#### Designs

Stepped sleeves (→ **fig. 26**) can have either a conventional sleeve form (**a**) or they can be ring shaped (**b**). Ring-shaped stepped sleeves are typically used in applications where the sleeve will also be used to form part of a labyrinth seal (→ *Special stepped sleeve designs*, **page 80**).

In applications where there are relatively light axial loads, the end of the sleeve with the smaller diameter can have a loose fit on the shaft. However, if the oil injection method will be used to dismount the sleeve, the end of the sleeve with the loose fit should be sealed with an O-ring (**c**).

Fig. 26



**Recommended dimensions**

Recommended dimensions are listed in:

- **table 16** (→ **page 81**) for stepped sleeves (without O-ring) and their seats (bearing arrangement example → **fig. 27**)
- **table 17** (→ **page 81**) for stepped sleeves with O-ring and their seats (bearing arrangement example → **fig. 28**)

When machining bores and shaft seats for stepped sleeves, it is very important that the actual degree of interference fit is as close as possible for both the major and minor diameters. Experience has shown that removal becomes much more difficult when there is even a small difference in interference.

Thin-walled hollow shafts may deform as a result of high contact pressures. Therefore, the sleeves for these shafts should have a relief closest to the bearing to avoid deformation of the bearing seat. The length of the relief should be 15 to 20% of the shaft diameter.

Fig. 27

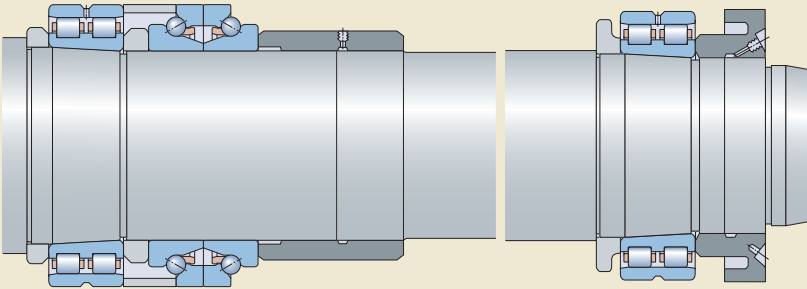


Fig. 28

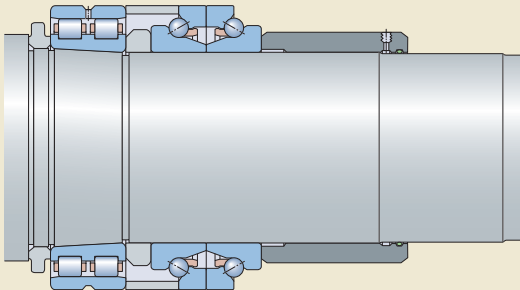
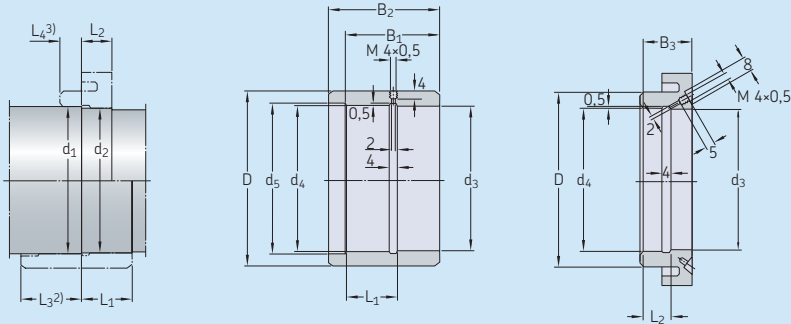


Table 16

Recommended dimensions for stepped sleeves and their seats



| Dimensions<br>Shaft    |                        | Stepped sleeve         |                        |                        |     |                |                |                |                        |                        |  | Temperature<br>difference <sup>1)</sup> |     |
|------------------------|------------------------|------------------------|------------------------|------------------------|-----|----------------|----------------|----------------|------------------------|------------------------|--|-----------------------------------------|-----|
| d <sub>1</sub><br>h4/Ⓔ | d <sub>2</sub><br>h4/Ⓔ | d <sub>3</sub><br>H4/Ⓔ | d <sub>4</sub><br>H4/Ⓔ | d <sub>5</sub><br>+0,5 | D   | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | L <sub>1</sub><br>±0,1 | L <sub>2</sub><br>±0,1 |  | °C                                      | °F  |
| mm                     |                        |                        |                        |                        |     |                |                |                |                        |                        |  |                                         |     |
| 17                     | 16,968                 | 16,95                  | 16,977                 | 19                     | 27  | 26             | 31             | 13             | 15                     | 8,5                    |  | 150                                     | 270 |
| 20                     | 19,964                 | 19,94                  | 19,971                 | 22                     | 30  | 28             | 33             | 14             | 16                     | 9                      |  | 150                                     | 270 |
| 25                     | 24,956                 | 24,92                  | 24,954                 | 27                     | 35  | 30             | 35             | 15             | 17                     | 9,5                    |  | 150                                     | 270 |
| 30                     | 29,946                 | 29,91                  | 29,954                 | 32                     | 40  | 32             | 38             | 16             | 18                     | 10                     |  | 140                                     | 252 |
| 35                     | 34,937                 | 34,9                   | 34,943                 | 37                     | 47  | 34             | 40             | 17             | 19                     | 10,5                   |  | 140                                     | 252 |
| 40                     | 39,937                 | 39,9                   | 39,943                 | 42                     | 52  | 36             | 42             | 18             | 20                     | 11                     |  | 130                                     | 234 |
| 45                     | 44,927                 | 44,88                  | 44,933                 | 47                     | 58  | 38             | 46             | 19             | 21                     | 11,5                   |  | 130                                     | 234 |
| 50                     | 49,917                 | 49,86                  | 49,923                 | 52                     | 63  | 40             | 48             | 20             | 22                     | 12                     |  | 130                                     | 234 |
| 55                     | 54,908                 | 54,85                  | 54,922                 | 57                     | 70  | 42             | 50             | 21             | 23                     | 12,5                   |  | 120                                     | 216 |
| 60                     | 59,908                 | 59,85                  | 59,922                 | 62                     | 75  | 44             | 54             | 22             | 24                     | 13                     |  | 120                                     | 216 |
| 65                     | 64,898                 | 64,83                  | 64,912                 | 67                     | 80  | 46             | 56             | 23             | 25                     | 13,5                   |  | 120                                     | 216 |
| 70                     | 69,898                 | 69,83                  | 69,912                 | 72                     | 86  | 48             | 58             | 24             | 26                     | 14                     |  | 110                                     | 198 |
| 75                     | 74,898                 | 74,83                  | 74,912                 | 77                     | 91  | 50             | 60             | 25             | 27                     | 14,5                   |  | 100                                     | 180 |
| 80                     | 79,888                 | 79,82                  | 79,912                 | 82                     | 97  | 52             | 62             | 26             | 28                     | 15                     |  | 100                                     | 180 |
| 85                     | 84,88                  | 84,81                  | 84,9                   | 87                     | 102 | 54             | 64             | 27             | 29                     | 15,5                   |  | 100                                     | 180 |
| 90                     | 89,88                  | 89,8                   | 89,9                   | 92                     | 110 | 56             | 68             | 28             | 30                     | 16                     |  | 100                                     | 180 |
| 95                     | 94,87                  | 94,79                  | 94,9                   | 97                     | 114 | 58             | 70             | 29             | 31                     | 16,5                   |  | 90                                      | 162 |
| 100                    | 99,87                  | 99,79                  | 99,9                   | 102                    | 120 | 60             | 72             | 30             | 32                     | 17                     |  | 90                                      | 162 |
| 105                    | 104,87                 | 104,78                 | 104,89                 | 107                    | 125 | 62             | 74             | 31             | 33                     | 17,5                   |  | 90                                      | 162 |
| 110                    | 109,86                 | 109,77                 | 109,89                 | 112                    | 132 | 64             | 76             | 32             | 34                     | 18                     |  | 90                                      | 162 |
| 120                    | 119,86                 | 119,77                 | 119,89                 | 122                    | 142 | 68             | 80             | 34             | 36                     | 19                     |  | 80                                      | 144 |
| 130                    | 129,852                | 129,75                 | 129,868                | 132                    | 156 | 72             | 84             | 36             | 38                     | 20                     |  | 90                                      | 162 |
| 140                    | 139,852                | 139,74                 | 139,858                | 142                    | 166 | 76             | 88             | 38             | 40                     | 21                     |  | 90                                      | 162 |
| 150                    | 149,842                | 149,73                 | 149,858                | 152                    | 180 | 80             | 95             | 40             | 42                     | 22                     |  | 80                                      | 144 |
| 160                    | 159,842                | 159,73                 | 159,858                | 162                    | 190 | 84             | 99             | 42             | 44                     | 23                     |  | 80                                      | 144 |
| 170                    | 169,842                | 169,72                 | 169,848                | 172                    | 205 | 88             | 103            | 44             | 46                     | 24                     |  | 80                                      | 144 |
| 180                    | 179,832                | 179,71                 | 179,848                | 182                    | 220 | 92             | 110            | 46             | 48                     | 25                     |  | 80                                      | 144 |
| 190                    | 189,834                | 189,7                  | 189,836                | 192                    | 230 | 96             | 114            | 48             | 50                     | 26                     |  | 80                                      | 144 |
| 200                    | 199,834                | 199,7                  | 199,836                | 202                    | 245 | 100            | 118            | 50             | 52                     | 27                     |  | 70                                      | 126 |

<sup>1)</sup> The difference in temperature between shaft and sleeve or ring when installing

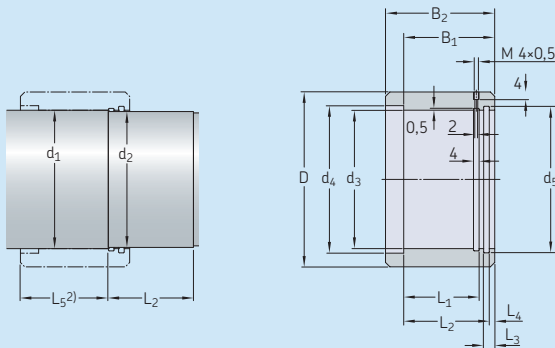
<sup>2)</sup> L<sub>3</sub> = length of stepped sleeve over diameter d<sub>1</sub> = L<sub>1</sub> + B<sub>2</sub> - B<sub>1</sub> - 4 [mm]

<sup>3)</sup> L<sub>4</sub> = length of stepped ring over diameter d<sub>1</sub> = L<sub>2</sub> - 4 + recessed d<sub>4</sub> section [mm]

Table 17

1

Recommended dimensions for stepped sleeves with O-ring and their seats



| Dimensions<br>Shaft   |                       |                       |                        |                      |     |                |                |                        |                        |                |                        | Appropriate<br>O-ring | Temperature<br>difference <sup>1)</sup> |     |
|-----------------------|-----------------------|-----------------------|------------------------|----------------------|-----|----------------|----------------|------------------------|------------------------|----------------|------------------------|-----------------------|-----------------------------------------|-----|
| Stepped sleeve        |                       |                       |                        |                      |     |                |                |                        |                        |                |                        |                       | °C                                      | °F  |
| d <sub>1</sub><br>h4Ⓔ | d <sub>2</sub><br>f7Ⓔ | d <sub>3</sub><br>H4Ⓔ | d <sub>4</sub><br>+0,5 | d <sub>5</sub><br>H9 | D   | B <sub>1</sub> | B <sub>2</sub> | L <sub>1</sub><br>±0,1 | L <sub>2</sub><br>±0,1 | L <sub>3</sub> | L <sub>4</sub><br>+0,2 |                       |                                         |     |
| mm                    |                       |                       |                        |                      |     |                |                |                        |                        |                |                        | –                     | °C                                      | °F  |
| 17                    | 16,95                 | 16,977                | 19                     | 20,6                 | 27  | 26             | 31             | 17                     | 22,9                   | 6,5            | 3,1                    | 16,3x2,4              | 150                                     | 270 |
| 20                    | 19,95                 | 19,971                | 22                     | 23,6                 | 30  | 28             | 33             | 19                     | 24,9                   | 6,5            | 3,1                    | 19,3x2,4              | 150                                     | 270 |
| 25                    | 24,9                  | 24,954                | 27                     | 29,5                 | 35  | 30             | 35             | 21                     | 26,1                   | 7              | 3,9                    | 24,2x3                | 150                                     | 270 |
| 30                    | 29,9                  | 29,954                | 32                     | 34,5                 | 40  | 32             | 38             | 24                     | 28,1                   | 7              | 3,9                    | 29,2x3                | 140                                     | 252 |
| 35                    | 34,9                  | 34,943                | 37                     | 39,5                 | 47  | 34             | 40             | 26                     | 30,1                   | 7              | 3,9                    | 34,2x3                | 140                                     | 252 |
| 40                    | 39,9                  | 39,943                | 42                     | 44,5                 | 52  | 36             | 42             | 28                     | 32,1                   | 7              | 3,9                    | 39,2x3                | 130                                     | 234 |
| 45                    | 44,9                  | 44,933                | 47                     | 49,5                 | 58  | 38             | 46             | 32                     | 34,1                   | 7              | 3,9                    | 44,2x3                | 130                                     | 234 |
| 50                    | 49,9                  | 49,923                | 52                     | 54,5                 | 63  | 40             | 48             | 34                     | 36,1                   | 7              | 3,9                    | 49,2x3                | 130                                     | 234 |
| 55                    | 54,9                  | 54,922                | 57                     | 59,5                 | 70  | 42             | 50             | 36                     | 38,1                   | 7              | 3,9                    | 54,2x3                | 120                                     | 216 |
| 60                    | 59,9                  | 59,922                | 62                     | 64,5                 | 75  | 44             | 54             | 40                     | 40,1                   | 7              | 3,9                    | 60x3                  | 120                                     | 216 |
| 65                    | 64,85                 | 64,912                | 67                     | 69,5                 | 80  | 46             | 56             | 42                     | 42,1                   | 7              | 3,9                    | 65x3                  | 120                                     | 216 |
| 70                    | 69,85                 | 69,912                | 72                     | 74,5                 | 86  | 48             | 58             | 42                     | 44,1                   | 8              | 3,9                    | 69,5x3                | 110                                     | 198 |
| 75                    | 74,85                 | 74,912                | 77                     | 79,5                 | 91  | 50             | 60             | 44                     | 46,1                   | 8              | 3,9                    | 74,5x3                | 100                                     | 180 |
| 80                    | 79,85                 | 79,912                | 82                     | 84,5                 | 97  | 52             | 62             | 46                     | 48,1                   | 8              | 3,9                    | 79,5x3                | 100                                     | 180 |
| 85                    | 84,85                 | 84,9                  | 87                     | 89,5                 | 102 | 54             | 64             | 48                     | 50,1                   | 8              | 3,9                    | 85x3                  | 100                                     | 180 |
| 90                    | 89,85                 | 89,9                  | 92                     | 94,5                 | 110 | 56             | 68             | 52                     | 52,1                   | 8              | 3,9                    | 90x3                  | 100                                     | 180 |
| 95                    | 94,85                 | 94,9                  | 97                     | 99,5                 | 114 | 58             | 70             | 54                     | 54,1                   | 8              | 3,9                    | 94,5x3                | 90                                      | 162 |
| 100                   | 99,85                 | 99,9                  | 102                    | 104,5                | 120 | 60             | 72             | 54                     | 56,1                   | 9              | 3,9                    | 100x3                 | 90                                      | 162 |
| 105                   | 104,85                | 104,89                | 107                    | 109,5                | 125 | 62             | 74             | 56                     | 58,1                   | 9              | 3,9                    | 105x3                 | 90                                      | 162 |
| 110                   | 109,85                | 109,89                | 112                    | 114,5                | 132 | 64             | 76             | 58                     | 60,1                   | 9              | 3,9                    | 110x3                 | 90                                      | 162 |
| 120                   | 119,85                | 119,89                | 122                    | 124,5                | 142 | 68             | 80             | 62                     | 64,1                   | 9              | 3,9                    | 120x3                 | 80                                      | 144 |
| 130                   | 129,8                 | 129,868               | 132                    | 134,4                | 156 | 72             | 84             | 66                     | 68,1                   | 9              | 3,9                    | 130x3                 | 90                                      | 162 |
| 140                   | 139,8                 | 139,858               | 142                    | 144,4                | 166 | 76             | 88             | 70                     | 72,1                   | 9              | 3,9                    | 140x3                 | 90                                      | 162 |
| 150                   | 149,8                 | 149,858               | 152                    | 159                  | 180 | 80             | 95             | 73                     | 72,6                   | 13             | 7,4                    | 149,2x5,7             | 80                                      | 144 |
| 160                   | 159,8                 | 159,858               | 162                    | 169                  | 190 | 84             | 99             | 77                     | 76,6                   | 13             | 7,4                    | 159,2x5,7             | 80                                      | 144 |
| 170                   | 169,8                 | 169,848               | 172                    | 179                  | 205 | 88             | 103            | 81                     | 80,6                   | 13             | 7,4                    | 169,2x5,7             | 80                                      | 144 |
| 180                   | 179,8                 | 179,848               | 182                    | 189                  | 220 | 92             | 110            | 88                     | 84,6                   | 13             | 7,4                    | 179,2x5,7             | 80                                      | 144 |
| 190                   | 189,8                 | 189,836               | 192                    | 199                  | 230 | 96             | 114            | 92                     | 88,6                   | 13             | 7,4                    | 189,2x5,7             | 80                                      | 144 |
| 200                   | 199,8                 | 199,836               | 202                    | 209                  | 245 | 100            | 118            | 96                     | 92,6                   | 13             | 7,4                    | 199,2x5,7             | 70                                      | 126 |

<sup>1)</sup> The difference in temperature between shaft and sleeve when installing

<sup>2)</sup> L<sub>5</sub> = length of stepped sleeve over diameter d<sub>1</sub> = L<sub>1</sub> + B<sub>2</sub> - B<sub>1</sub> - 4 [mm]

### Material

SKF recommends using a heat-treatable steel with a yield point of at least  $550 \text{ N/mm}^2$ . The mating surfaces of both the sleeve and shaft should be hardened and ground.

### Axial load carrying capacity

The degree of the actual interference fit(s) determines the axial load carrying capacity of a stepped sleeve. When stepped sleeves are made to the recommended dimensions listed in **tables 16** and **17** (→ **pages 84** and **84**), the surface pressure between a solid or thick-walled hollow shaft and sleeve, and the axial retaining force per millimetre hub width can be estimated using the approximate values listed in **table 18**. Stepped sleeves with a loose fit for the smaller diameter, exert only half of the axial retaining force of stepped sleeves with an interference fit for both diameters.

When designing stepped sleeves, axial shock forces on the sleeve must also be taken into consideration. If necessary, a threaded nut

which is lightly tightened and which can also serve as a mounting aid can be used to secure the sleeve.

### Special stepped sleeve designs

Stepped sleeves are used to secure and join other components. They enable hubs to be mounted and dismantled simply and can also replace various types of driver plates, dogs etc. The V-belt pulley shown in **fig. 29**, for example, is designed as a stepped sleeve with an integral labyrinth seal. In this case, the sleeve not only locates the bearing axially, it is also used to transmit torque.

Fig. 29

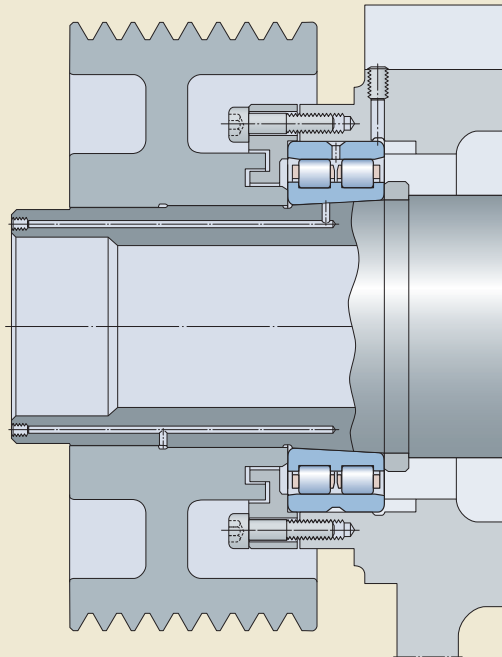


Table 18

Approximate surface pressure and axial retaining force of stepped sleeves<sup>1)</sup>

| Approximate shaft diameter<br>d | Approximate surface pressure | Approximate axial retaining force per mm hub width |
|---------------------------------|------------------------------|----------------------------------------------------|
| mm                              | N/mm <sup>2</sup>            | N/mm                                               |
| 30                              | 40                           | 300                                                |
| 100                             | 35                           | 550                                                |
| 200                             | 22                           | 1 000                                              |

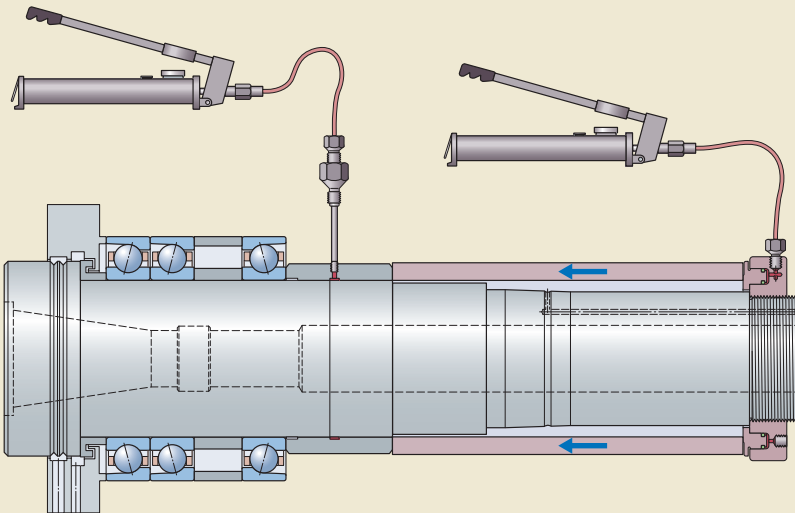
<sup>1)</sup> When made to the recommended dimensions listed in tables 16 and 17 (→ pages 85 and 85).

### Installation

The following procedure can be used to install stepped sleeves. If stepped sleeves are to be installed against bearings that are already greased, care should be taken that the injected oil / mounting fluid does not mix with the grease and impair its lubricating properties.

- 1 Heat the sleeve to obtain the required temperature difference listed in **tables 16** and **17** (→ **pages 86** and **86**).
- 2 Push the sleeve onto the shaft seat.
- 3 After the sleeve has cooled, inject oil or an SKF mounting fluid between the sleeve and shaft using suitable oil injection equipment (→ **fig. 30** and *Oil injection equipment and pressure media*). To avoid local stress peaks, the oil should be injected slowly and the oil pressure regulated.
- 4 Use a hydraulic nut and suitable distance sleeve to bring the sleeve to its final position (→ **fig. 30**). When using a hydraulic nut, the force of the nut against the bearing arrangement can be controlled by the oil pressure. As the sleeve “floats” on the oil film, any stresses produced during the shrinking of the sleeve (produced as the sleeve cooled) are relieved and the components can be correctly positioned relative to each other. When the required axial force has been obtained, the final position is reached.
- 5 With the tool still in position, release the oil pressure between the mating surfaces and allow the oil to drain. Normally it takes about 24 hours before the sleeve can support its full load.

Fig. 30





### Removal

To remove a stepped sleeve, inject oil or an SKF dismounting fluid between the sleeve and shaft using suitable oil injection equipment (→ *Oil injection equipment and pressure media*). When sufficient oil pressure has been built up to separate the mating surfaces, an axial force will result due to the different bore diameters, and the sleeve will slide from its seat without requiring any additional external force.

#### **WARNING**

To avoid the risk of serious injury, attach a provision such as a lock nut to the shaft end to limit the sleeve travel when it suddenly comes loose.

### Oil injection equipment and pressure media

SKF supplies oil injection equipment for installing and removing sleeves. For additional information, visit [skf.com/mapro](http://skf.com/mapro).

When selecting a suitable pump, keep in mind that the maximum permissible pressure should be considerably higher than the calculated surface pressure.

For installation, SKF recommends using the SKF mounting fluid LHM 300. The fluid has a viscosity of 300 mm<sup>2</sup>/s at 20 °C (70 °F). The advantage of this mounting fluid is that when installation is complete, the fluid will leave the joint quickly and completely so that metal-to-metal contact is restored relatively quickly.

For removal, SKF recommends using the SKF dismounting fluid LHDF 900. With a viscosity of 900 mm<sup>2</sup>/s at 20 °C (70 °F), the fluid will provide an adequate oil film, even if the mating surface of the sleeve or shaft is scratched. Keep in mind that the fluid has a low flow rate and the permissible pressure of the oil injection equipment should never be exceeded.

### Provisions for mounting and dismounting

It is often necessary to make provisions during the design stage to facilitate mounting and dismounting of a bearing. If, for example, slots or recesses are machined in the shaft and/or housing shoulders, it is possible to apply withdrawal tools (→ **fig. 31**). Threaded holes in the housing shoulders also enable the use of bolts to push a bearing from its seat (→ **fig. 32**).

If the oil injection method is to be used to mount or dismount bearings on a tapered seat, or to dismount bearings from a cylindrical seat, ducts and grooves should be provided in the shaft (→ **fig. 33**). Recommended dimensions for the appropriate grooves, ducts and threaded holes to connect the oil supply are listed in **tables 19** and **20**.

Fig. 31

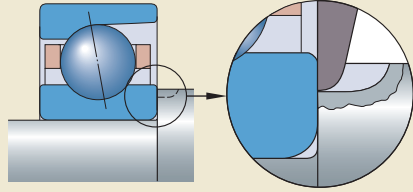


Fig. 32

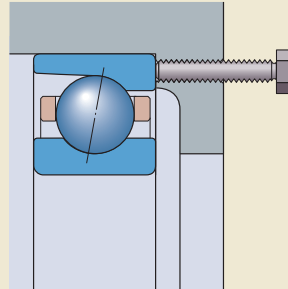


Fig. 33

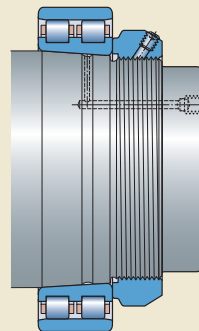
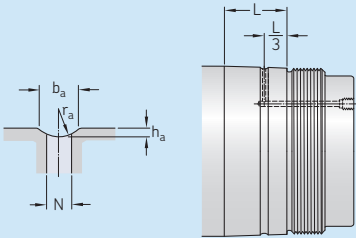


Table 19

Recommended dimensions for oil supply ducts and distribution grooves

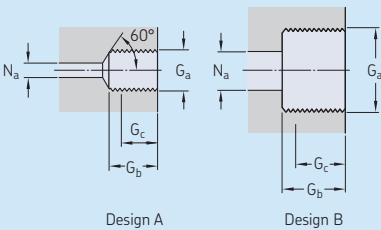


| Seat diameter |       | Dimensions |       |       |     |
|---------------|-------|------------|-------|-------|-----|
| over          | incl. | $b_a$      | $h_a$ | $r_a$ | $N$ |
| mm            |       | mm         |       |       |     |
| –             | 50    | 2,5        | 0,5   | 2     | 2   |
| 50            | 100   | 3          | 0,5   | 2,5   | 2,5 |
| 100           | 150   | 4          | 0,8   | 3     | 3   |
| 150           | 200   | 4          | 0,8   | 3     | 3   |
| 200           | 250   | 5          | 1     | 4     | 4   |
| 250           | 300   | 5          | 1     | 4     | 4   |
| 300           | 400   | 6          | 1,25  | 4,5   | 5   |
| 400           | 500   | 7          | 1,5   | 5     | 5   |
| 500           | 650   | 8          | 1,5   | 6     | 6   |
| 650           | 800   | 10         | 2     | 7     | 7   |

L = width of bearing seat

Table 20

Design and recommended dimensions for threaded holes for connecting oil supply



| Thread  | Design | Dimensions |            |            |
|---------|--------|------------|------------|------------|
| $G_a$   |        | $G_b$      | $G_c^{1)}$ | $N_a$ max. |
| –       | –      | mm         |            |            |
| M 4x0,5 | A      | 5          | 4          | 2          |
| M 6     | A      | 10         | 8          | 3          |
| G 1/8   | A      | 12         | 10         | 3          |
| G 1/4   | A      | 15         | 12         | 5          |
| G 3/8   | B      | 15         | 12         | 8          |
| G 1/2   | B      | 18         | 14         | 8          |
| G 3/4   | B      | 20         | 16         | 8          |

<sup>1)</sup> Effective threaded length

### Bearing preload

Preload is a force acting between the rolling elements and bearing rings that is not caused by an external load. Preload can be regarded as negative internal clearance. Reasons to apply preload include:

- enhanced stiffness
- reduced noise level
- improved shaft guidance
- extended bearing service life
- improved running accuracy
- prevent skidding in high-speed applications during rapid starts and stops and under very light or no-load conditions

In the majority of high-precision applications, preload is needed to enhance system rigidity.

### Angular contact ball bearings

Single row angular contact ball bearings are generally mounted as sets, in a back-to-back (→ **figs. 34** and **35**) or face-to-face arrangement (→ **fig. 36**), that are normally subjected to an axial preload. The preload is produced by displacing one bearing ring axially, relative to the other (→ **figs. 34** and **36**), by an amount corresponding to the desired preload force or by springs (→ **fig. 35**).

The standout of matched and universally matchable bearings is precision ground so that when two bearings are mounted immediately adjacent to each other, a given preload is obtained without further adjustment. Keep in mind that this preload is also influenced by the interference fit and the operating conditions. For additional information, refer to *Preload in mounted bearing sets* (→ **page 90**).

If it is necessary to change the preload, spacers between the bearing rings can be used. For additional information, refer to *Individual adjustment of preload* (→ **page 90**).

Fig. 34

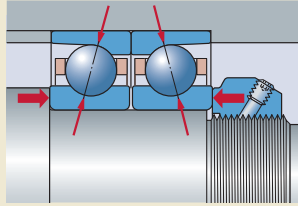


Fig. 35

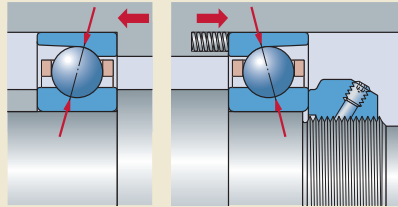
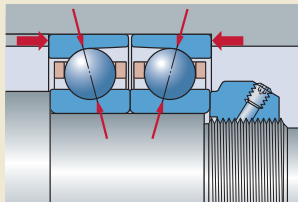


Fig. 36



### Influence of an external load on preloaded bearing sets

The influence of an external axial load on preloaded bearing sets is illustrated in **diagram 13**. The curves represent the spring characteristics of two bearings in a back-to-back arrangement. The blue curve represents bearing A, which is subjected to an external axial force  $K_a$ . The red curve represents bearing B, which becomes unloaded by the axial force.

The two bearings are each preloaded by an axial displacement  $\delta_0$  of one bearing ring relative to the other, resulting in a preload force  $F_0$  acting on both bearings. When bearing A is subjected to an external axial force  $K_a$ , the load on that bearing increases to  $F_{aA}$  while load on bearing B decreases to  $F_{aB}$ . Axial displacement of the bearing rings follows the spring curves.  $\delta_{K_a}$  is the displacement of the bearing set while  $\delta_{K_b}$  is the remaining preload [ $\mu\text{m}$ ] on bearing B.

When the axial forces on the spindle reach the natural lifting force  $K_{a1}$ , bearing B becomes completely unloaded. When this happens, there is a significant risk that the unloaded balls stop rolling and start skidding, which if it occurs for any length of time will result in premature bearing failure.

The lifting force varies depending on the preload and bearing arrangement ( $\rightarrow$  **table 21, page 91**). It is possible to avoid the lifting force phenomena in one of two ways: either increase the preload, or use bearing sets with different contact angles. For additional information, contact the SKF application engineering service.

Diagram 13

#### Influence of an external load on preloaded bearing sets

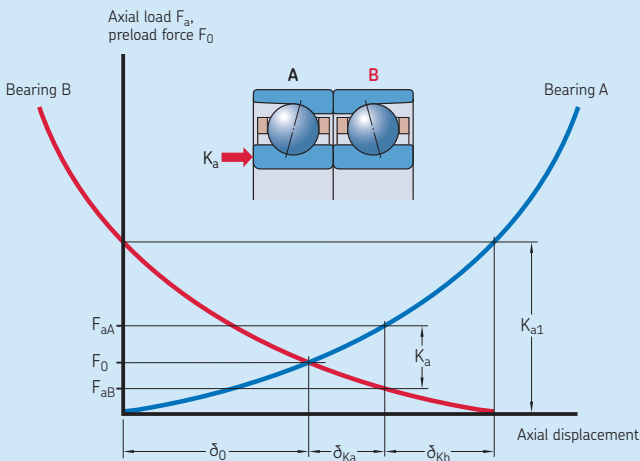


Table 21

## Lifting forces for angular contact ball bearing sets

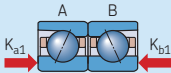
Arrangement

Lifting forces

$K_{a1}$

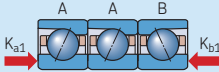
$K_{b1}$

Same contact angles ( $\alpha_A = \alpha_B$ )



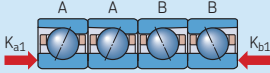
$2,83 F_0$

$2,83 F_0$



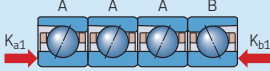
$4,16 F_0$

$2,08 F_0$



$2,83 F_0$

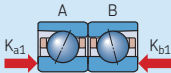
$2,83 F_0$



$5,4 F_0$

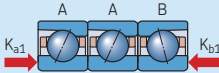
$1,8 F_0$

Different contact angles ( $\alpha_A = 25^\circ$ ,  $\alpha_B = 15^\circ$ )



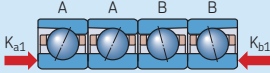
$5,9 F_0$

$1,75 F_0$



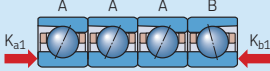
$9,85 F_0$

$1,45 F_0$



$5,9 F_0$

$1,75 F_0$



$13,66 F_0$

$1,33 F_0$

$F_0$  = preload force

**Preloading with springs**

Using springs to apply preload to angular contact ball bearings is common, especially in high-speed grinding spindles. The springs act on the outer ring of one of the two bearings. This outer ring must be able to be displaced axially. The preload force remains practically constant, even when there is axial displacement of the bearing as a result of thermal shaft expansion. For additional information concerning preloading with springs and values for preload force, refer to *Preload with a constant force* (→ **page 93**).

Preloading with springs is not suitable for applications where a high degree of stiffness is required, where the direction of load changes, or where indeterminate shock loads can occur.

### Cylindrical roller bearings

Cylindrical roller bearings can only be preloaded radially (→ **fig. 37**). Bearings with a tapered bore are preloaded by driving the bearing inner ring up onto its tapered seat. The resulting interference fit causes the inner ring to expand and to obtain the necessary preload. To accurately set preload, internal clearance gauges should be used. For additional information, refer to *Mounting* (→ **page 94**) or *Adjusting for clearance or preload* (→ **page 94**).

### Angular contact thrust ball bearings

Angular contact thrust ball bearings can only be preloaded axially (→ **fig. 38**). The standout of angular contact thrust ball bearings is precision ground so that when the two halves of the bearing are assembled, a given preload is obtained without further adjustment. Keep in mind that preload is also influenced by the interference fit and the operating conditions.

Under load, angular contact thrust ball bearings exhibit similar characteristics as angular contact ball bearings. Therefore, the information provided for angular contact ball bearings is also valid for these bearings. The lifting force for single direction angular contact thrust ball bearings for screw drives in the BSA and BSD series is the same as for angular contact ball bearings (→ **table 21, page 94**).

For double direction angular contact thrust ball bearings in the BTW and BTM series, the lifting force can be estimated from

$$K_{a1} = 2,85 F_0$$

where

$K_{a1}$  = lifting force

$F_0$  = preload on bearings before external axial load is applied

Fig. 37

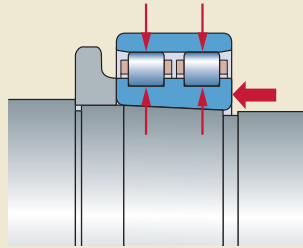
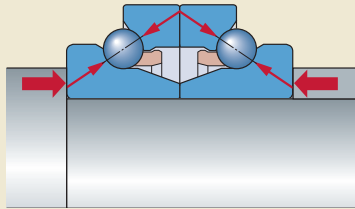


Fig. 38





## Sealing solutions

Contaminants and moisture can negatively affect bearing service life and performance. This is particularly important for machine tool applications where coolant and swarf are an integral part of the operating environment. Therefore, an effective sealing arrangement is essential if a spindle is to operate reliably. To protect the bearings, SKF offers a wide assortment of external and integral seals.

### External seals

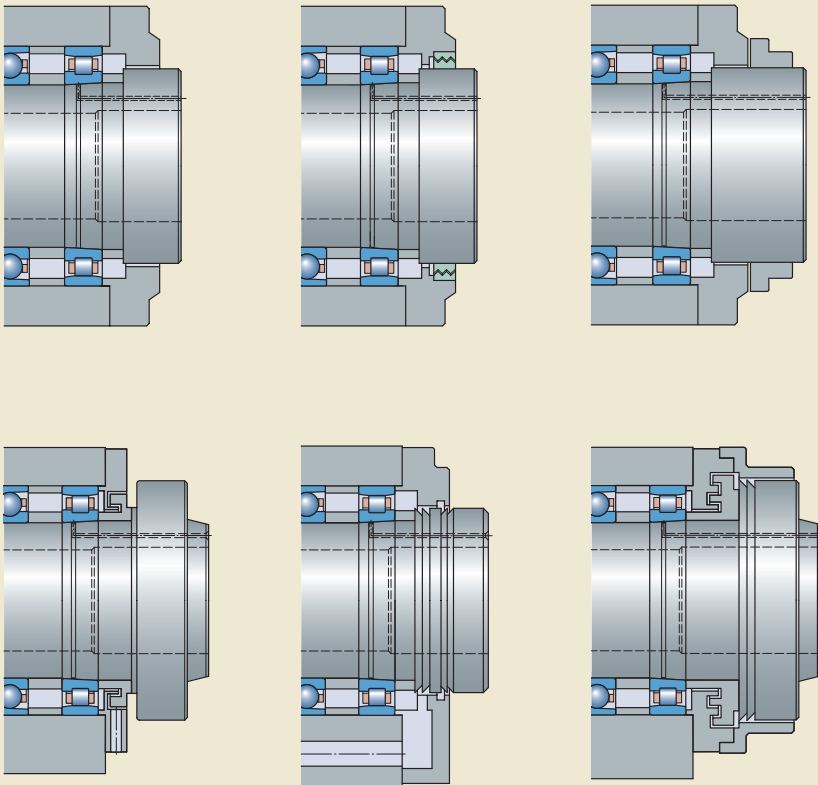
For bearing arrangements where the effectiveness of the seal under specific operating conditions is more important than space considerations or cost, there are two types of external seals available: non-contact seals

(→ fig. 39) and contact seals (→ fig. 41, page 95).

For seals that are not supplied by SKF, the information provided in the following section should be used as a guideline only. Make sure to understand the seal's performance criteria before incorporating that seal into an application. SKF does not accept liability for the performance of any products not supplied by SKF.

1

Fig. 39



### Non-contact seals

Non-contact seals are almost always used in high-speed precision applications. Their effectiveness depends, in principle, on the sealing action of the narrow gap between the shaft and housing. Because there is no contact, these seals generate almost no friction and do not, in practice, limit speeds, making them an excellent solution for machine tool applications.

Seal variants range from simple gap-type seals to multi-stage labyrinth seals (→ **fig. 39, page 96**). Compared to gap-type seals, multi-stage labyrinth seals are considerably more effective as their series of axially and radially intersecting components make it more difficult for contaminants and cutting fluid to enter the bearing.

In highly contaminated environments, a complex labyrinth seal design is often required. Labyrinth seals can have three or more stages to keep lubricant in and contaminants out of the bearing arrangement. The principle of a highly effective labyrinth seal, outlined in **fig. 40**, consists of three stages:

- the primary stage
- the secondary stage
- the final stage

This design, with drainage chambers and collecting provisions, is derived from studies done by the Technical University of Stuttgart, Germany.

The primary stage consists of a splash guard (1), a housing cover (2) and the shaft to form a labyrinth. The splash guard uses centrifugal force to direct contaminants away from the cover, while the housing cover prevents contaminants from entering the labyrinth directly. A radial gap (3) between the housing cover and the shaft should be between 0,1 and 0,2 mm.

The secondary stage is designed to collect any fluid that manages to pass the primary barrier and drain it away. Starting with annular groove(s) in the shaft (4), the main design features of this stage include a large drainage chamber (5) and an outlet hole (6). Annular groove(s) deter fluid from travelling along the shaft under non-rotating conditions, causing it to drip into the drainage chamber instead. When the shaft is rotating, fluid is flung from it and collected in the drainage chamber and drained through the outlet hole. Large drain-

age holes (~ 250 mm<sup>2</sup>) in the collection area limit the amount of fluid that collects in the chamber.

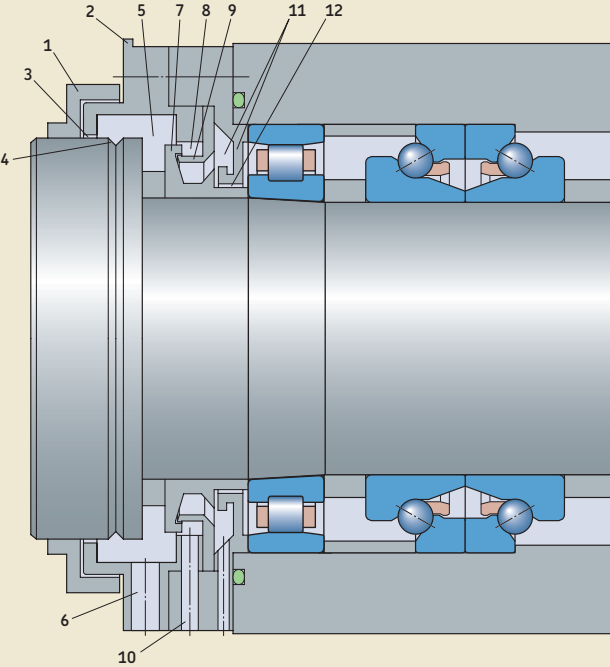
Features used in the previous stages are incorporated again in the final stage. This section consists of labyrinth rings (7) with radial gaps between 0,2 and 0,3 mm, a fluid retardation chamber (8), a collector (9) to guide the fluid toward the drainage area and an outlet hole (10) with a drainage area of ~ 150 mm<sup>2</sup>. An additional chamber, collector and a ~ 50 mm<sup>2</sup> drainage hole (11) can be incorporated if space permits. A final radial labyrinth gap (12) of ~ 1 mm avoids capillary action.

When designing these types of sealing arrangements, the following should be taken into consideration:

- In order to avoid inward pumping effects, the labyrinth components should progressively decrease in diameter from the outside.
- Machine lead on rotating components can move fluids in either axial direction very effectively depending on the hand of the lead and the direction of rotation. This can, in uni-directional applications, be exploited to reinforce the effectiveness of gap or labyrinth seals if carefully incorporated into the design. Machine lead on rotating components of gap and labyrinth seals should be avoided when the application rotates in both directions or for uni-directional applications where its action would work against the effectiveness of the seal.
- Under severe operating conditions, an air barrier can be created by applying air, under pressure, between the labyrinth gaps or inside the spindle itself. The air flow must however be balanced so that the dominant flow is always outward.
- A sealing system that takes up considerable axial space is favourable, as this enables large drainage areas and collectors to be incorporated into the system. In these cases, however, the spindle is less rigid as a result of the long overhang from the front bearings (and cutting force position).

Fig. 40

1



### Contact seals

Contact seals (→ **fig. 41**) are generally very reliable. Their effectiveness, however, depends on a number of factors including:

- the seal design
- the seal material
- the contact pressure
- the surface finish of the seal counterface
- the condition of the seal lip
- the presence of lubricant between the seal lip and counterface

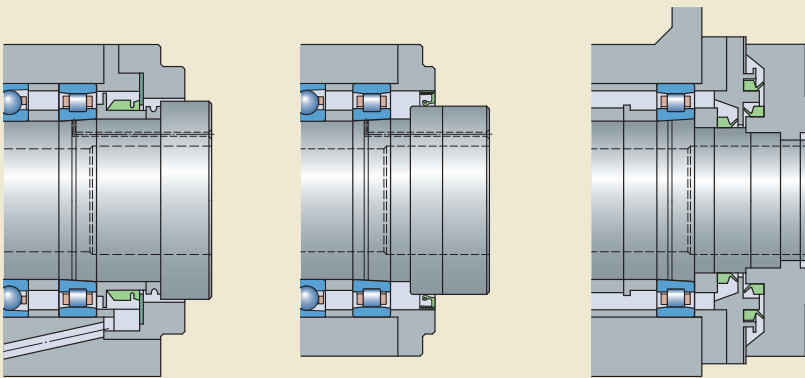
Friction between the seal lip and counterface can generate a significant amount of heat at higher speeds ( $A \geq 200\,000$  mm/min). As a result, these seals can only be used in lower speed spindles and/or in applications where the additional heat does not significantly affect spindle performance.

### Integral seals

Sealed bearings are generally used for arrangements where a sufficiently effective external sealing solution cannot be provided for cost reasons or because of space limitations.

SKF supplies a wide assortment of super-precision bearings fitted with a seal on each side. For details, refer to *Sealing solutions* in the relevant product chapter.

Fig. 41



# Lubrication

Selecting a suitable lubricant and lubrication method for a super-precision bearing arrangement depends primarily on the operating conditions such as the required speed or permissible operating temperature. However, other factors like vibration, loads and the lubrication of adjacent components, such as gears, can also influence the selection process.

To generate an adequate hydrodynamic film between the rolling elements and raceways, only a very small amount of lubricant is required. Therefore, using grease as a lubricant for spindle bearing arrangements is becoming increasingly popular. With a properly designed grease lubrication system, the hydrodynamic frictional losses are low and operating temperatures can be kept to a minimum. However, where speeds are very high, grease service life may be too short and oil lubrication may be required. Typically, oil lubrication is accomplished with an oil-air system or an oil circulation system which can also provide the added benefit of cooling.

## Grease lubrication

Grease lubricated bearing arrangements are suitable for a wide range of speeds. Lubricating super-precision bearings with suitable quantities of good quality grease permits relatively high speed operation without an excessive rise in temperature.

The use of grease also means that the design of a bearing arrangement can be relatively simple because grease is more easily retained in a bearing arrangement than oil, particularly where shafts are inclined or vertical. Grease can also contribute to sealing the arrangement against solid and liquid contaminants as well as moisture.

## Selecting grease

In most spindle applications with super-precision bearings, grease with a mineral base oil and lithium thickener is suitable. These greases adhere well to the bearing surfaces and can be used in applications where temperatures range from  $-30$  to  $+110$  °C ( $-20$  to  $+230$  °F). For applications with high speeds and high temperatures or where long service life is required, grease with a synthetic base oil e.g.

SKF diester oil based grease LGLT 2 has been proven to be effective.

For angular contact thrust ball bearings for screw drives, grease with an ester or mineral base oil and calcium complex thickener can be used under most operating conditions.

Alternative greases may be required under any of the following conditions:

- operating temperatures  $< 10$  °C ( $50$  °F) or  $> 100$  °C ( $210$  °F)
- bearing speed is very high or very low
- static operation, infrequent rotation or oscillation
- bearings are subjected to vibration
- bearings are subjected to heavy loads or shock loads
- water resistance is important
- screw drive bearings at low speeds, under heavy loads or exposed to vibration should be lubricated with a lithium soap grease with a mineral base oil and EP additives like SKF LGEP 2

An appropriate grease selection process comprises four steps.

### 1. Select the consistency grade

Greases are divided into various consistency grades in accordance with the National Lubricating Grease Institute (NLGI). Greases with a high consistency, i.e. stiff greases, are assigned high NLGI grades, while those with low consistency, i.e. soft greases, are assigned low NLGI grades. In rolling bearing applications, three consistency grades are recommended:

- The most common greases, used in normal bearing applications, have an NLGI grade of 2.
- Low consistency rolling bearing greases, classified as NLGI 1 greases, are preferred for low ambient temperatures and oscillating applications.
- NLGI 3 greases are recommended for large bearings, vertical shaft arrangements, high ambient temperatures or the presence of vibration.

### 2. Determine the required base oil viscosity

For detailed information about calculating the required base oil viscosity, refer to *Lubrication conditions – the viscosity ratio  $\kappa$*  in the SKF cata-

logue *Rolling bearings* or at [skf.com](http://skf.com). The graphs in this catalogue are based on the elasto-hydrodynamic theory of lubrication (EHL) with full-film conditions.

It has been found, however, that when using greases containing very low or very high viscosity base oils, a thinner oil film than that predicted by EHL theories results. Therefore, when using the graphs to determine the required base oil viscosity for grease lubricated super-precision bearings, corrections may be necessary. From practical experience, determine the required viscosity  $v$  at reference temperature 40 °C (150 °F) and then adjust as follows:

- $v \leq 20 \text{ mm}^2/\text{s} \rightarrow$  multiply the viscosity by a factor of 1 to 2  
In this low range, the viscosity of the oil is too thin to form a sufficiently thick oil film.
- $20 \text{ mm}^2/\text{s} < v \leq 250 \text{ mm}^2/\text{s} \rightarrow$  no correction factor is used
- $v > 250 \text{ mm}^2/\text{s} \rightarrow$  contact the SKF application engineering service

Calculations can also be made using the SKF program, Viscosity, available online at [skf.com/bearingcalculator](http://skf.com/bearingcalculator).

High viscosity greases increase friction and heat generated by the bearing but may be necessary, for example, for ball screw support bearings in low-speed applications or in applications where there is a risk of false brinelling.

### 3. Verify the presence of EP additives

Grease with EP additives may be appropriate if super-precision bearings are subjected to any of the following conditions:

- very heavy loads ( $P > 0,15 \text{ C}$ )
- shock loads
- low speeds
- periods of static loading
- frequent starts and stops during a work cycle

Lubricants with EP additives should only be used when necessary and always within their operating temperature range. Some EP additives are not compatible with bearing materials particularly at higher temperatures. For additional information, contact the SKF application engineering service.

### 4. Check additional requirements

In some applications, operating conditions may put additional requirements on the grease, requiring it to have unique characteristics. The following recommendations are provided as guidelines:

- For superior resistance to water wash-out, consider grease with a calcium thickener over a lithium thickener.
- For good rust protection, select an appropriate additive.
- If there are high vibration levels, choose grease with a high mechanical stability.

To select the appropriate grease for a specific bearing type and application, the grease selection program, SKF LubeSelect, available online at [skf.com/lubrication](http://skf.com/lubrication), can be used.

### Initial grease fill

Super-precision bearings operating at high speeds should have less than 30% of the free space in the bearings filled with grease.

Open angular contact thrust ball bearings for screw drives should be lubricated with a grease quantity that fills ~ 25 to 35% of the free space in the bearing.

Freshly greased bearings should be operated at low speeds during the running-in period (→ *Running-in of grease lubricated bearings*, **page 101**). This enables excess grease to be displaced and the remainder to be evenly distributed within the bearing. If this running-in phase is neglected, there is a risk that temperature peaks can lead to premature bearing failure.

The initial grease fill depends on the bearing type, series and size as well as the speed factor A.

$$A = n \cdot d_m$$

where

A = speed factor [mm/min]

$d_m$  = bearing mean diameter [mm]

$$= 0,5 \cdot (d + D)$$

n = rotational speed [r/min]

The initial grease fill for open bearings can be estimated using

$$G = K \cdot G_{\text{ref}}$$

where

G = initial grease fill [cm<sup>3</sup>]

$G_{\text{ref}}$  = reference grease quantity [cm<sup>3</sup>]

– for angular contact ball bearings

→ **table 22, page 101**

– for cylindrical roller bearings

→ **table 23, page 101**

– for double direction angular contact thrust ball bearings → **table 24, page 101**

– for single direction angular contact thrust ball bearings for screw drives

→ **table 25, page 101**

K = a calculation factor dependent on the bearing type and the speed factor A (→ **diagram 14, page 101**)

Sealed bearings are filled with a high grade, low viscosity grease that fills ~ 15% of the free space in the bearing. They are considered to be relubrication-free under normal operating conditions. The grease is characterized by:

- high-speed capability
- excellent resistance to ageing
- very good rust inhibiting properties

The technical specifications of the grease are listed in **table 26, page 101**.

Table 22

Reference grease quantity for angular contact ball bearings

| Bore diameter<br>d | Size | Reference grease quantity $G_{ref}$ for bearings in the series |                   |                   |                   |                 | 70 CE<br>70 ACE | 70 CB<br>70 ACB | 72 CD<br>72 ACD |
|--------------------|------|----------------------------------------------------------------|-------------------|-------------------|-------------------|-----------------|-----------------|-----------------|-----------------|
|                    |      | 718 CD<br>718 ACD                                              | 719 CD<br>719 ACD | 719 CE<br>719 ACE | 719 CB<br>719 ACB | 70 CD<br>70 ACD |                 |                 |                 |
| mm                 | –    | cm <sup>3</sup>                                                |                   |                   |                   |                 |                 |                 |                 |
| 6                  | 6    | –                                                              | –                 | –                 | –                 | 0,09            | 0,09            | –               | –               |
| 7                  | 7    | –                                                              | –                 | –                 | –                 | 0,12            | 0,11            | –               | 0,16            |
| 8                  | 8    | –                                                              | –                 | 0,09              | –                 | 0,15            | 0,17            | –               | 0,23            |
| 9                  | 9    | –                                                              | –                 | 0,09              | –                 | 0,18            | 0,19            | –               | 0,26            |
| 10                 | 00   | 0,06                                                           | 0,12              | 0,1               | –                 | 0,24            | 0,28            | –               | 0,36            |
| 12                 | 01   | 0,07                                                           | 0,12              | 0,1               | –                 | 0,27            | 0,31            | –               | 0,51            |
| 15                 | 02   | 0,08                                                           | 0,21              | 0,2               | –                 | 0,39            | 0,5             | –               | 0,73            |
| 17                 | 03   | 0,09                                                           | 0,24              | 0,2               | –                 | 0,54            | 0,68            | –               | 1               |
| 20                 | 04   | 0,18                                                           | 0,45              | 0,5               | –                 | 0,9             | 1,1             | –               | 1,5             |
| 25                 | 05   | 0,21                                                           | 0,54              | 0,6               | –                 | 1               | 1,3             | –               | 1,9             |
| 30                 | 06   | 0,24                                                           | 0,63              | 0,6               | 0,72              | 1,6             | 1,7             | 1,4             | 2,8             |
| 35                 | 07   | 0,28                                                           | 0,93              | 0,8               | 0,96              | 2               | 2,4             | 1,8             | 3,9             |
| 40                 | 08   | 0,31                                                           | 1,4               | 1,4               | 1,4               | 2,4             | 2,8             | 2,2             | 4,7             |
| 45                 | 09   | 0,36                                                           | 1,6               | 1,5               | 1,8               | 3,3             | 3,4             | 2,9             | 5,9             |
| 50                 | 10   | 0,5                                                            | 1,7               | 1,7               | 1,9               | 3,6             | 4,1             | 3,1             | 6,7             |
| 55                 | 11   | 0,88                                                           | 2,5               | 2,3               | 2,6               | 5,1             | 5               | 4,7             | 8,6             |
| 60                 | 12   | 1,2                                                            | 2,7               | 2,5               | 2,8               | 5,4             | 5,3             | 5               | 10              |
| 65                 | 13   | 1,3                                                            | 2,9               | 2,6               | 3                 | 5,7             | 6,2             | 5,5             | 12              |
| 70                 | 14   | 1,4                                                            | 4,5               | 4,3               | 4,5               | 8,1             | 8,2             | 7,3             | 14              |
| 75                 | 15   | 1,5                                                            | 5,1               | 4,5               | 4,8               | 8,4             | 8,6             | 7,7             | 15              |
| 80                 | 16   | 1,6                                                            | 5,1               | 4,8               | 5,3               | 11              | 12              | 10              | 18              |
| 85                 | 17   | 2,7                                                            | 7,2               | 7                 | 6,5               | 12              | 12              | 11              | 22              |
| 90                 | 18   | 2,9                                                            | 7,5               | 7                 | 7,4               | 15              | 14              | 14              | 28              |
| 95                 | 19   | 3,1                                                            | 7,8               | 7,3               | 7,5               | 16              | 17              | 15              | 34              |
| 100                | 20   | 3,2                                                            | 11                | 10                | 10                | 16              | 17              | 15              | 41              |
| 105                | 21   | 4                                                              | 11                | –                 | –                 | 20              | –               | –               | 48              |
| 110                | 22   | 5,1                                                            | 11                | 11                | 11                | 26              | 23              | 22              | 54              |
| 120                | 24   | 5,5                                                            | 15                | 15                | 14                | 27              | 28              | 24              | 69              |
| 130                | 26   | 9,3                                                            | 20                | –                 | –                 | 42              | –               | –               | 72              |
| 140                | 28   | 9,9                                                            | 22                | –                 | –                 | 45              | –               | –               | 84              |
| 150                | 30   | 13                                                             | 33                | –                 | –                 | 54              | –               | –               | –               |
| 160                | 32   | 14                                                             | 33                | –                 | –                 | 66              | –               | –               | –               |
| 170                | 34   | –                                                              | 36                | –                 | –                 | 84              | –               | –               | –               |
| 180                | 36   | –                                                              | 54                | –                 | –                 | 111             | –               | –               | –               |
| 190                | 38   | –                                                              | 57                | –                 | –                 | 114             | –               | –               | –               |
| 200                | 40   | –                                                              | 81                | –                 | –                 | 153             | –               | –               | –               |
| 220                | 44   | –                                                              | 84                | –                 | –                 | 201             | –               | –               | –               |
| 240                | 48   | –                                                              | 93                | –                 | –                 | 216             | –               | –               | –               |
| 260                | 52   | –                                                              | 150               | –                 | –                 | 324             | –               | –               | –               |
| 280                | 56   | –                                                              | 159               | –                 | –                 | –               | –               | –               | –               |
| 300                | 60   | –                                                              | 265               | –                 | –                 | –               | –               | –               | –               |
| 320                | 64   | –                                                              | 282               | –                 | –                 | –               | –               | –               | –               |
| 340                | 68   | –                                                              | 294               | –                 | –                 | –               | –               | –               | –               |
| 360                | 72   | –                                                              | 313               | –                 | –                 | –               | –               | –               | –               |

Values refer to 30% filling grade.



Table 23

1

Reference grease quantity for cylindrical roller bearings

| Bore diameter<br>d | Size | Reference grease quantity $G_{ref}$ for bearings in the series |           |          |                     |                      |
|--------------------|------|----------------------------------------------------------------|-----------|----------|---------------------|----------------------|
|                    |      | N 10 TN                                                        | N 10 TNHA | N 10 PHA | NN 30 <sup>1)</sup> | NNU 49 <sup>1)</sup> |
| mm                 | —    | cm <sup>3</sup>                                                |           |          |                     |                      |
| 25                 | 05   | —                                                              | —         | —        | 0,9                 | —                    |
| 30                 | 06   | —                                                              | —         | —        | 1                   | —                    |
| 35                 | 07   | —                                                              | —         | —        | 1,9                 | —                    |
| 40                 | 08   | 2,3                                                            | 2,5       | 3,1      | 1,8                 | —                    |
| 45                 | 09   | 2,9                                                            | 3,2       | 4,1      | 2,4                 | —                    |
| 50                 | 10   | 3,2                                                            | 3,5       | 4,4      | 2,7                 | —                    |
| 55                 | 11   | 4,4                                                            | 4,9       | 6,1      | 3,6                 | —                    |
| 60                 | 12   | 4,7                                                            | 5,2       | 6,5      | 3,8                 | —                    |
| 65                 | 13   | 5                                                              | 5,5       | 6,9      | 4,1                 | —                    |
| 70                 | 14   | 6,7                                                            | 7,2       | 9,2      | 5,9                 | —                    |
| 75                 | 15   | 7,1                                                            | 7,7       | 9,6      | 6,3                 | —                    |
| 80                 | 16   | 9                                                              | 9,8       | 13       | 8,3                 | —                    |
| 85                 | 17   | 9,2                                                            | 10        | —        | 8,4                 | —                    |
| 90                 | 18   | 12                                                             | 14        | —        | 11                  | —                    |
| 95                 | 19   | 13                                                             | 14        | —        | 12                  | —                    |
| 100                | 20   | 13                                                             | 14        | —        | 12                  | 13                   |
| 105                | 21   | 18                                                             | 18        | —        | 17                  | 15                   |
| 110                | 22   | 21                                                             | 21        | —        | 20                  | 17                   |
| 120                | 24   | 22                                                             | 34        | —        | 23                  | 27                   |
| 130                | 26   | —                                                              | —         | —        | 34                  | 31                   |
| 140                | 28   | —                                                              | —         | —        | 52                  | 45                   |
| 150                | 30   | —                                                              | —         | —        | 63                  | 57                   |
| 160                | 32   | —                                                              | —         | —        | 78                  | 63                   |
| 170                | 34   | —                                                              | —         | —        | 105                 | 72                   |
| 180                | 36   | —                                                              | —         | —        | 138                 | 81                   |
| 190                | 38   | —                                                              | —         | —        | 144                 | 85                   |
| 200                | 40   | —                                                              | —         | —        | 191                 | 117                  |
| 220                | 44   | —                                                              | —         | —        | 260                 | 150                  |
| 240                | 48   | —                                                              | —         | —        | 288                 | 171                  |
| 260                | 52   | —                                                              | —         | —        | 392                 | 366                  |
| 280                | 56   | —                                                              | —         | —        | 420                 | 384                  |

Values refer to 30% filling grade.  
<sup>1)</sup> For bearings in the NN 30 and NNU 49 series with d > 280 mm, contact the SKF application engineering service.

Table 24

Reference grease quantity for double direction angular contact thrust ball bearings

| Bore diameter<br>d | Size | Reference grease quantity $G_{ref}$<br>for bearings in the series |      |
|--------------------|------|-------------------------------------------------------------------|------|
|                    |      | BTW                                                               | BTM  |
| mm                 | –    | cm <sup>3</sup>                                                   |      |
| 35                 | 07   | 1,9                                                               | –    |
| 40                 | 08   | 2,5                                                               | –    |
| 45                 | 09   | 3,1                                                               | –    |
| 50                 | 10   | 3,3                                                               | –    |
| 55                 | 11   | 4,8                                                               | –    |
| 60                 | 12   | 5,2                                                               | 7,8  |
| 65                 | 13   | 5,6                                                               | 8,4  |
| 70                 | 14   | 7,4                                                               | 11   |
| 75                 | 15   | 7,8                                                               | 11,8 |
| 80                 | 16   | 11                                                                | 16   |
| 85                 | 17   | 11                                                                | 16,8 |
| 90                 | 18   | 14                                                                | 22   |
| 95                 | 19   | 15                                                                | 22   |
| 100                | 20   | 16                                                                | 22   |
| 105                | 21   | –                                                                 | –    |
| 110                | 22   | 27                                                                | 38   |
| 120                | 24   | 28                                                                | 40   |
| 130                | 26   | 40                                                                | 58   |
| 140                | 28   | 45                                                                | 62   |
| 150                | 30   | 56                                                                | 80   |
| 160                | 32   | 67                                                                | 94   |
| 170                | 34   | 90                                                                | 126  |
| 180                | 36   | 117                                                               | 160  |
| 190                | 38   | 122                                                               | –    |
| 200                | 40   | 157                                                               | –    |

Values refer to 30% filling grade.

Table 25

Reference grease quantity for single direction angular contact thrust ball bearings for screw drives

| Designation | Reference grease quantity $G_{ref}$ |
|-------------|-------------------------------------|
| –           | cm <sup>3</sup>                     |
| BSA 201 C   | 0,4                                 |
| BSA 202 C   | 0,5                                 |
| BSA 203 C   | 0,7                                 |
| BSA 204 C   | 1,2                                 |
| BSA 205 C   | 1,5                                 |
| BSA 206 C   | 2,2                                 |
| BSA 207 C   | 3                                   |
| BSA 208 C   | 3,7                                 |
| BSA 209 C   | 4,5                                 |
| BSA 210 C   | 5,2                                 |
| BSA 212 C   | 8,5                                 |
| BSA 215 C   | 11,1                                |
| BSA 305 C   | 2,4                                 |
| BSA 306 C   | 2,1                                 |
| BSA 307 C   | 4,2                                 |
| BSA 308 C   | 6,4                                 |
| BSD 2047 C  | 1,4                                 |
| BSD 2562 C  | 2                                   |
| BSD 3062 C  | 2                                   |
| BSD 3572 C  | 2,5                                 |
| BSD 4072 C  | 2,5                                 |
| BSD 4090 C  | 5,2                                 |
| BSD 45100 C | 5,9                                 |
| BSD 4575 C  | 2,7                                 |
| BSD 50100 C | 6,5                                 |
| BSD 55100 C | 6,5                                 |
| BSD 55120 C | 7,5                                 |
| BSD 60120 C | 7,5                                 |

Values refer to 35% filling grade.

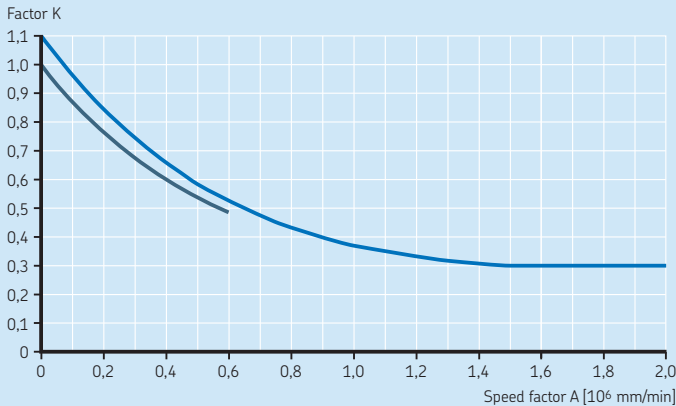
Table 26

Technical specifications of the grease in sealed bearings

| Properties                                                                          | Grease specification       |
|-------------------------------------------------------------------------------------|----------------------------|
| Thickener                                                                           | Special lithium soap       |
| Base oil type                                                                       | Ester/PAO                  |
| NLGI consistency class                                                              | 2                          |
| Temperature range<br>[°C]<br>[°F]                                                   | –40 to +120<br>–40 to +250 |
| Kinematic viscosity [mm <sup>2</sup> /s]<br>at 40 °C (105 °F)<br>at 100 °C (210 °F) | 25<br>6                    |

Diagram 14

Factor K for initial grease fill estimation



- Angular contact ball bearings, cylindrical roller bearings, double direction angular contact thrust ball bearings
- Angular contact thrust ball bearings for screw drives

Speed factor limits depend on the bearing type and series.

### Applying grease

When greasing bearings, the grease should be distributed evenly in the free space between the rolling elements and bearing rings. The bearings should be turned by hand until all internal surfaces are covered.

Small angular contact thrust ball bearings for screw drives often require very small quantities of grease. When a very small grease quantity has to be applied, the bearing should be immersed in a grease solution (3 to 5% grease in a solvent) first. After the solvent has drained and evaporated, grease can be applied. Immersing the bearing in a grease solution ensures that all surfaces are covered with a thin layer of the lubricant.

### Grease service life and relubrication intervals

There are several interactive factors influencing grease service life, the effects of which are extremely complex to calculate for any particular application. It is, therefore, standard practice to use estimated grease service life based on empirical data.

The estimated relubrication interval for grease lubricated bearings is based on the estimated grease service life. Various methods can be used, however, SKF recommends the following to assist in making the best estimate for super-precision bearings.

**Diagram 15** shows the relubrication interval  $t_f$  for super-precision bearings in various executions. The diagram is valid under the following conditions:

- bearing with steel rolling elements
- horizontal shaft
- operating temperature  $\leq 70\text{ °C}$  ( $160\text{ °F}$ )
- high-quality grease with a lithium thickener
- relubrication interval at the end of which 90% of the bearings are still reliably lubricated ( $L_{10}$  life)

If necessary, the relubrication interval obtained from **diagram 15** should be adjusted by correction factors depending on the bearing type, variant and operating conditions.

The relubrication interval can be estimated using

$$T_{\text{relub}} = t_f C_1 C_2 \dots C_8$$

The curves for angular contact ball and thrust ball bearings are for single bearings only. Values for matched sets should be adjusted according to the arrangement, number of bearings in the set and preload, by multiplying the relubrication interval by factor  $C_1$  (→ **table 27, page 106**). When sets comprising more than four bearings are used, contact the SKF application engineering service.

For hybrid bearings, the estimated grease service life can be revised by multiplying the calculated value for a bearing with steel rolling elements by the correction factor  $C_2$  (→ **table 28, page 106**).

Depending on the operating conditions, the relubrication interval should be multiplied by each of the relevant correction factors from  $C_3$  to  $C_8$  (→ **table 29, page 106**).

Other conditions, not included here, such as the presence of water, cutting fluids and vibration may also affect grease service life.

Machine tool spindles often operate under conditions of varying speed, load and operating temperature. If the speed/load spectrum is known and is sufficiently cyclic, the relubrication interval for each speed/load interval can be estimated as above. A relubrication interval for the total duty cycle can then be calculated from

$$t_{f \text{ tot}} = \frac{100}{\sum (a_i / t_{fi})}$$

where

$t_{f \text{ tot}}$  = total relubrication interval [hours]

$a_i$  = part of the total cycle time at speed  $n_i$  [%]

$t_{fi}$  = relubrication interval at speed  $n_i$  [hours]

Diagram 15

1

Grease relubrication interval guidelines

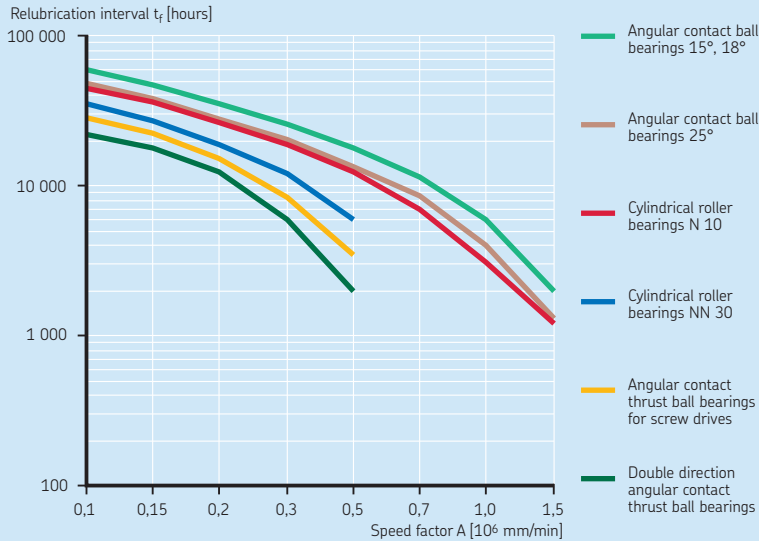


Table 27

| Correction factor for bearing sets and different preload classes |                                   |                   |                                          |      |      |      |      |      |      |
|------------------------------------------------------------------|-----------------------------------|-------------------|------------------------------------------|------|------|------|------|------|------|
| Bearing type<br>Bearing series                                   | Arrangement                       | Design.<br>suffix | Correction factor $C_1$<br>Preload class |      |      |      |      |      |      |
|                                                                  |                                   |                   | A                                        | L    | B    | M    | C    | F    | D    |
| Angular contact ball bearings                                    |                                   |                   |                                          |      |      |      |      |      |      |
| 719 D, 70 D, 72 D                                                | Set of 2, back-to-back            | DB                | 0,81                                     | –    | 0,75 | –    | 0,65 | –    | 0,4  |
|                                                                  | Set of 2, face-to-face            | DF                | 0,77                                     | –    | 0,72 | –    | 0,61 | –    | 0,36 |
|                                                                  | Set of 3, back-to-back and tandem | TBT               | 0,7                                      | –    | 0,63 | –    | 0,49 | –    | 0,25 |
|                                                                  | Set of 3, face-to-face and tandem | TFT               | 0,63                                     | –    | 0,56 | –    | 0,42 | –    | 0,17 |
|                                                                  | Set of 4, tandem back-to-back     | QBC               | 0,64                                     | –    | 0,6  | –    | 0,53 | –    | 0,32 |
|                                                                  | Set of 4, tandem face-to-face     | QFC               | 0,62                                     | –    | 0,58 | –    | 0,48 | –    | 0,27 |
| 718 D, 719 E, 70 E                                               | Set of 2, back-to-back            | DB                | 0,8                                      | –    | 0,65 | –    | 0,4  | –    | –    |
|                                                                  | Set of 2, face-to-face            | DF                | 0,77                                     | –    | 0,61 | –    | 0,36 | –    | –    |
|                                                                  | Set of 3, back-to-back and tandem | TBT               | 0,69                                     | 0,72 | 0,49 | 0,58 | 0,25 | 0,36 | –    |
|                                                                  | Set of 3, face-to-face and tandem | TFT               | 0,63                                     | 0,66 | 0,42 | 0,49 | 0,17 | 0,24 | –    |
|                                                                  | Set of 4, tandem back-to-back     | QBC               | 0,64                                     | –    | 0,53 | –    | 0,32 | –    | –    |
|                                                                  | Set of 4, tandem face-to-face     | QFC               | 0,62                                     | –    | 0,48 | –    | 0,27 | –    | –    |
| 719 B, 70 B                                                      | Set of 2, back-to-back            | DB                | 0,83                                     | –    | 0,78 | –    | 0,58 | –    | –    |
|                                                                  | Set of 2, face-to-face            | DF                | 0,8                                      | –    | 0,74 | –    | 0,54 | –    | –    |
|                                                                  | Set of 3, back-to-back and tandem | TBT               | 0,72                                     | –    | 0,66 | –    | 0,4  | –    | –    |
|                                                                  | Set of 3, face-to-face and tandem | TFT               | 0,64                                     | –    | 0,56 | –    | 0,3  | –    | –    |
|                                                                  | Set of 4, tandem back-to-back     | QBC               | 0,67                                     | –    | 0,64 | –    | 0,48 | –    | –    |
|                                                                  | Set of 4, tandem face-to-face     | QFC               | 0,64                                     | –    | 0,6  | –    | 0,41 | –    | –    |
| Double direction angular contact thrust ball bearings            |                                   |                   |                                          |      |      |      |      |      |      |
| BTW                                                              | –                                 | –                 | 1                                        | –    | –    | –    | –    | –    |      |
| BTM                                                              | –                                 | –                 | 1                                        | –    | 0,5  | –    | –    | –    |      |
| Angular contact thrust ball bearings for screw drives            |                                   |                   |                                          |      |      |      |      |      |      |
| BSA, BSD                                                         | Set of 2                          | –                 | 0,8                                      | –    | 0,4  | –    | –    | –    | –    |
|                                                                  | Set of 3                          | –                 | 0,65                                     | –    | 0,3  | –    | –    | –    | –    |
|                                                                  | Set of 4                          | –                 | 0,5                                      | –    | 0,25 | –    | –    | –    | –    |

Table 28

| Correction factor for hybrid bearings                 |                                                                    |     |   |     |
|-------------------------------------------------------|--------------------------------------------------------------------|-----|---|-----|
| Bearing type                                          | Correction factor $C_2$<br>Speed factor A [10 <sup>6</sup> mm/min] |     |   |     |
|                                                       | 0,5                                                                | 0,7 | 1 | 1,5 |
| Angular contact ball bearings                         | 3                                                                  | 3,5 | 3 | 2,8 |
| Double direction angular contact thrust ball bearings | 3                                                                  | –   | – | –   |
| Cylindrical roller bearings                           | 3                                                                  | 3   | 3 | 2,5 |

Table 29

| Table 29                                    |                   |      |
|---------------------------------------------|-------------------|------|
| Correction factors for operating conditions |                   |      |
| Operating condition                         | Correction factor |      |
| <b>Shaft orientation</b>                    |                   |      |
| Vertical                                    | C <sub>3</sub>    | 0,5  |
| Horizontal                                  |                   | 1    |
| <b>Bearing load</b>                         |                   |      |
| P < 0,05 C                                  | C <sub>4</sub>    | 1    |
| P < 0,1 C                                   |                   | 0,7  |
| P < 0,125 C                                 |                   | 0,5  |
| P < 0,2 C                                   |                   | 0,3  |
| P < 0,5 C                                   |                   | 0,2  |
| P < C                                       |                   | 0,1  |
| <b>Reliability</b>                          |                   |      |
| L <sub>1</sub>                              | C <sub>5</sub>    | 0,37 |
| L <sub>10</sub>                             |                   | 1    |
| L <sub>50</sub>                             |                   | 2    |
| <b>Air flow through the bearing</b>         |                   |      |
| Low                                         | C <sub>6</sub>    | 1    |
| Moderate                                    |                   | 0,3  |
| Strong                                      |                   | 0,1  |
| <b>Moisture and dust</b>                    |                   |      |
| Low                                         | C <sub>7</sub>    | 1    |
| Moderate                                    |                   | 0,5  |
| High                                        |                   | 0,3  |
| Very high                                   |                   | 0,1  |
| <b>Operating temperature</b>                |                   |      |
| 40 °C (105 °F)                              | C <sub>8</sub>    | 2    |
| 55 °C (130 °F)                              |                   | 2    |
| 70 °C (125 °F)                              |                   | 1    |
| 85 °C (185 °F)                              |                   | 0,5  |
| 100 °C (210 °F)                             |                   | 0,25 |

Miscibility

When an alternative grease is being considered for an existing application, check the compatibility of the new grease with the current grease relative to the base oil (→ **table 30**) and thickener (→ **table 31, page 109**). These tables are based on grease composition and should only be used as guidelines. SKF recommends verifying miscibility with a grease expert and then testing the new grease in the application.

Before applying a new grease type, remove as much of the old grease as possible from the bearing arrangement. If the new grease is incompatible with the existing grease, or if the old grease contains a PTFE thickener or is silicone based, the bearings should be washed thoroughly using an appropriate solvent. Once the new grease is applied, monitor the bearings carefully to be sure that the new grease functions properly.

Table 30

| Compatibility of base oil types                                 |             |           |            |                 |                 |                 |
|-----------------------------------------------------------------|-------------|-----------|------------|-----------------|-----------------|-----------------|
|                                                                 | Mineral oil | Ester oil | Polyglycol | Silicone-methyl | Silicone-phenyl | Polyphenylether |
| Mineral oil                                                     | +           | +         | –          | –               | +               | o               |
| Ester oil                                                       | +           | +         | +          | –               | +               | o               |
| Polyglycol                                                      | –           | +         | +          | –               | –               | –               |
| Silicone-methyl                                                 | –           | –         | –          | +               | +               | –               |
| Silicone-phenyl                                                 | +           | +         | –          | +               | +               | +               |
| Polyphenylether                                                 | o           | o         | –          | –               | +               | +               |
| + compatible<br>– incompatible<br>o individual testing required |             |           |            |                 |                 |                 |

Table 31

Compatibility of thickener types

|                        | Lithium soap | Calcium soap | Sodium soap | Lithium complex soap | Calcium complex soap | Sodium complex soap | Barium complex soap | Aluminium complex soap | Clay | Polyurea |
|------------------------|--------------|--------------|-------------|----------------------|----------------------|---------------------|---------------------|------------------------|------|----------|
| Lithium soap           | +            | 0            | –           | +                    | –                    | 0                   | 0                   | –                      | 0    | 0        |
| Calcium soap           | 0            | +            | 0           | +                    | –                    | 0                   | 0                   | –                      | 0    | 0        |
| Sodium soap            | –            | 0            | +           | 0                    | 0                    | +                   | +                   | –                      | 0    | 0        |
| Lithium complex soap   | +            | +            | 0           | +                    | +                    | 0                   | 0                   | +                      | –    | –        |
| Calcium complex soap   | –            | –            | 0           | +                    | +                    | 0                   | –                   | 0                      | 0    | +        |
| Sodium complex soap    | 0            | 0            | +           | 0                    | 0                    | +                   | +                   | –                      | –    | 0        |
| Barium complex soap    | 0            | 0            | +           | 0                    | –                    | +                   | +                   | +                      | 0    | 0        |
| Aluminium complex soap | –            | –            | –           | +                    | 0                    | –                   | +                   | +                      | –    | 0        |
| Clay                   | 0            | 0            | 0           | –                    | 0                    | –                   | 0                   | –                      | +    | 0        |
| Polyurea               | 0            | 0            | 0           | –                    | +                    | 0                   | 0                   | 0                      | 0    | +        |

+ compatible  
 – incompatible  
 0 individual testing required



## Running-in of grease lubricated bearings

Grease lubricated super-precision bearings initially run with a relatively high frictional moment. If they are run at high speeds without a running-in period, the temperature rise can be considerable. The high frictional moment is due to the churning of excess grease, which takes time to work its way out of the contact zone. For open bearings, this time period can be minimized by applying the required quantity of grease distributed evenly on both sides of the bearing during assembly. Spacers between adjacent bearings can also reduce the running-in period.

The time required to stabilize the operating temperature depends on the following factors:

- the type of grease
- the initial grease fill
- how the grease is applied to the bearings
- the number and arrangement of bearings in a set
- the available space for excess grease to accumulate on either side of the bearing
- the running-in procedure

Super-precision bearings can typically operate with a minimum quantity of lubricant when properly run-in, enabling the lowest frictional moment and operating temperature to be achieved. Grease that collects on each side of the bearing acts as a reservoir, enabling oil to bleed into the raceway to provide effective lubrication for a long time.

Running-in can be done in several ways. Wherever possible and regardless of the procedure chosen, running-in should involve operating the bearing in both a clockwise and counter-clockwise direction.

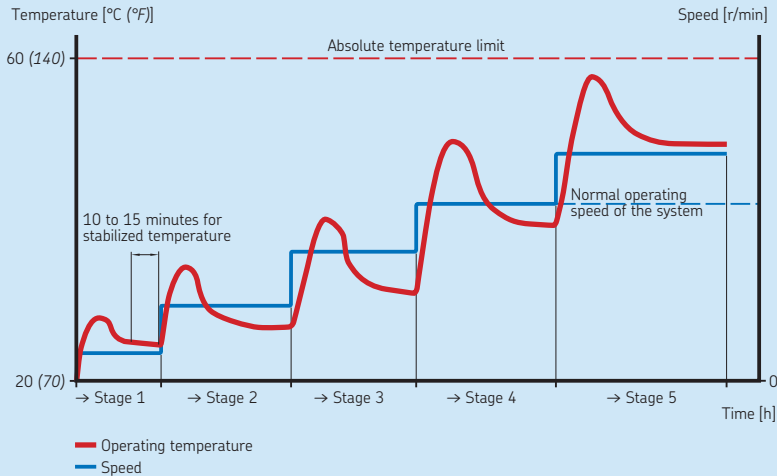
## Standard running-in procedure

The most common running-in procedure can be summarized as follows:

- 1 Select a low start-up speed and a relatively small speed increment.
- 2 Decide on an absolute temperature limit, usually 60 to 65 °C (140 to 150 °F). SKF recommends setting the machine with limit switches that stop the spindle if the temperature rise exceeds the set limit.
- 3 Start operation at the selected start-up speed.
- 4 Monitor the temperature rise by taking measurements at the bearing outer ring position, and wait for the temperature to stabilize. If the temperature reaches the limit, stop the spindle and allow the bearing to cool. Repeat the process at the same speed and run the spindle until the temperature stabilizes below the limit.
- 5 Once the bearing temperature has stabilized, continue to run the spindle for an additional 10 to 15 minutes. Then, increase the speed by one increment and repeat step 4.
- 6 Continue increasing the speed incrementally, allowing the temperature to stabilize at each stage, until the spindle reaches one speed interval above the operating speed of the system. This results in a lower temperature rise during normal operation. The bearing is now properly run-in.

This standard running-in procedure is time-consuming. For a medium- to high-speed spindle, each stage can take anywhere from 30 minutes to 2 hours before the temperature stabilizes. The total time for the running-in procedure can be 8 to 10 hours (→ diagram 16, page 111).

Graphic representation of a running-in procedure



### Short running-in procedure

An alternative to the standard running-in procedure reduces the number of stages and shortens the overall running-in time. The main steps can be summarized as follows:

- 1 Select a start-up speed approximately 20 to 25% of the attainable speed for grease lubrication (→ **product tables**) and choose a relatively large speed increment.
- 2 Decide on an absolute temperature limit, usually 60 to 65 °C (140 to 150 °F). It is advisable to set the machine with limit switches that stop the spindle if the temperature rise exceeds the limits set.
- 3 Start operation at the chosen start-up speed.
- 4 Monitor the temperature by taking measurements at the bearing outer ring position until the temperature reaches the limit. Care should be taken as the temperature increase may be very rapid.
- 5 Stop operation and let the outer ring of the bearing cool down by 5 to 10 °C (10 to 20 °F).
- 6 Start operation at the same speed a second time and monitor the temperature until the limit is reached again.
- 7 Repeat steps 5 and 6 until the temperature stabilizes for 10 to 15 minutes below the limit. The bearing is run-in at that particular speed.
- 8 Increase the speed by one increment and repeat steps 4 to 7.
- 9 Proceed until the bearing is running at one speed increment above the operating speed of the system. This results in a lower temperature rise during normal operation. The bearing is now properly run-in.

Although each stage may have to be repeated several times, each cycle is just a few minutes long. The total time for this running-in procedure is substantially less than for the standard procedure.

## Oil lubrication

Oil lubrication is recommended for many applications, as different supply methods can be adapted to suit different operating conditions and the machine's design. When selecting the most appropriate oil lubrication method for a bearing arrangement, the following application requirements should be considered:

- required quantity and viscosity of the oil
- speed and hydrodynamic frictional losses
- permissible bearing temperature

The typical relationship between oil quantity / oil flow rate, frictional losses and bearing temperature is shown in **diagram 17**. The diagram illustrates the conditions in different regions:

- **Region A**  
The oil quantity is insufficient to create a hydrodynamic film between the rolling elements and raceways. Metal-to-metal contact leads to increased friction, high bearing temperatures, wear and surface fatigue.
- **Region B**  
A larger quantity of oil is available and a cohesive, load-carrying oil film of sufficient thickness to separate the rolling elements and raceways can be formed. Here, the con-

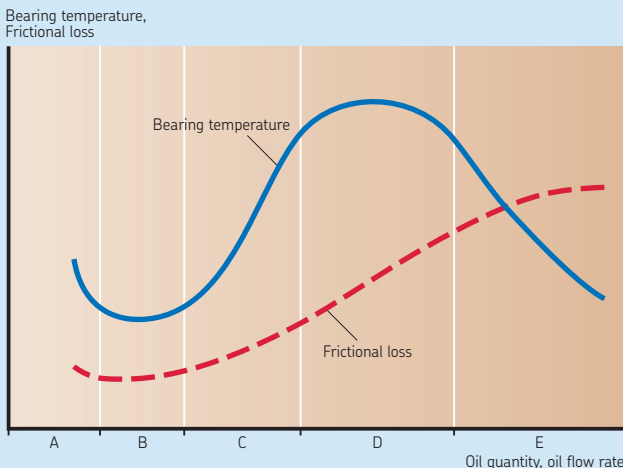
dition is reached where friction and temperature are at a minimum.

- **Region C**  
A further increase in oil quantity increases frictional heat due to churning and bearing temperature rises.
- **Region D**  
The oil flow quantity increases such that equilibrium between frictional heat generation at the bearing and heat removal by the oil flow is achieved. Bearing temperature peaks.
- **Region E**  
With increasing oil flow, the rate at which heat is removed exceeds the frictional heat generated by the bearing. Bearing temperature decreases.

Maintaining low operating temperatures at extremely high speeds generally requires either an oil-air lubrication system or a circulating oil lubrication system with cooling capabilities. With these systems, the operating conditions shown in regions B (oil-air) or E (circulating oil) can be maintained.

Diagram 17

Bearing temperature and frictional losses as a function of oil quantity



Oil lubrication methods

Oil bath

The simplest method of oil lubrication is the oil bath. The oil, which is picked up by the rotating components of the bearing, is distributed within the bearing and then flows back to a sump in the housing. Typically, the oil level should almost reach the centre of the lowest rolling element when the bearing is stationary. Oil bath lubrication is particularly suitable for low speeds. At high speeds, however, too much oil is supplied to the bearings, increasing friction and causing the operating temperature to rise.

Circulating oil

In general, high-speed operation increases frictional heat, elevates operating temperatures and accelerates ageing of the oil. To reduce operating temperatures and avoid frequent oil changes, the circulating oil lubrication method is generally preferred (→ fig. 42). Cir-

culution is usually controlled by a pump. After the oil has passed through the bearing, it generally settles in a tank where it is filtered and cooled before being returned to the bearing. Proper filtering decreases the contamination level and extends bearing service life. In bigger systems with several different bearing sizes, the main volume flow from the pump can be split into several smaller flows. The flow rate in each sub-circuit in the system can be checked by SKF flow monitoring devices.

Guideline values for oil flow rates are listed in **table 32**. For a more accurate analysis, contact the SKF application engineering service.

For information about the SKF CircOil system and SKF flow monitoring devices, refer to the product information available online at [skf.com/lubrication](http://skf.com/lubrication).

Fig. 42

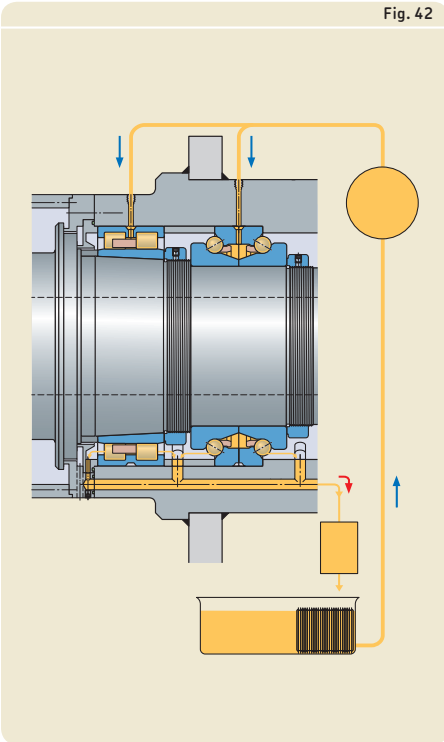


Table 32

Oil flow rate guidelines  
(valid for single bearings)

| Bore diameter<br>d |       | Oil flow rate<br>Q |      |
|--------------------|-------|--------------------|------|
| over               | incl. | low                | high |
| mm                 |       | l/min              |      |
| –                  | 50    | 0,3                | 1    |
| 50                 | 120   | 0,8                | 3,6  |
| 120                | 400   | 1,8                | 6    |

### Oil jet

The oil jet lubrication method (→ **fig. 43**) is an extension of circulating oil systems. A jet of oil under high pressure is directed at the side of the bearing. The velocity of the oil jet should be sufficiently high ( $\geq 15 \text{ m/s}$ ) to penetrate the turbulence surrounding the rotating bearing. Oil jet lubrication is used for very high speed operation, where a sufficient, but not excessive, amount of oil should be supplied to the bearing without increasing the operating temperature unnecessarily.

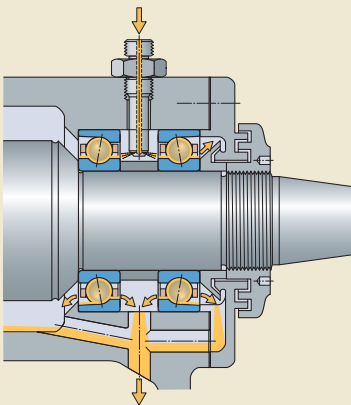
### Oil drop

With the oil drop method, an accurately metered quantity of oil is supplied to the bearing at given intervals. The delivered quantity may be relatively small, keeping frictional losses at high speeds to a minimum. However, it is difficult to ascertain whether the oil is able to penetrate the bearing at high speeds and, therefore, individual testing is always recommended. Whenever possible, the oil-air method should be preferred over the oil drop method.

### Oil mist

Modern application specific oil mist systems, such as those offered by SKF, matched with a suitable non-toxic and non-carcinogenic oil formulated for minimum stray mist emissions and suitable sealing systems, address environmental and health concerns. These systems, when well maintained, provide a cost-effective, environmentally clean way to continuously and effectively atomise oil and deliver metered minimum required quantities to the bearings. Modern oil mist systems suspend oil droplets 1 to 5  $\mu\text{m}$  in size in dry instrument air. The oil to air ratio, which is typically 1:200 000, creates a very lean but effective mixture that is delivered under 0,005 MPa pressure.

Fig. 43



### Oil-air

Oil-air lubrication systems are appropriate for high-precision applications with very high operating speeds and requisite low operating temperatures. For information about the SKF Oil+Air lubrication systems, refer to the product information available online at [skf.com/lubrication](http://skf.com/lubrication).

The oil-air method (→ **fig. 44**), also called the oil-spot method, uses compressed air to transport small, accurately metered quantities of oil as small droplets along the inside of feed lines to an injector nozzle, where it is delivered to the bearing (→ **fig. 45**). This minimum quantity lubrication method enables bearings to operate at very high speeds with relatively low operating temperature. The compressed air serves to cool the bearing and also produces an excess pressure in the bearing housing to prevent contaminants from entering. Because the air is only used to transport the oil and is not mixed with it, the oil is retained within the housing. Oil-air systems are con-

sidered to be environmentally safe, provided that any residual used oil is disposed of correctly.

For bearings used in sets, each bearing should be supplied by a separate injector. Most designs include special spacers that incorporate the oil nozzles.

Guideline values for the oil quantity to be supplied to an angular contact ball bearing for high-speed operation can be obtained from

$$Q = 1,3 d_m$$

Guideline values for the oil quantity to be supplied to a cylindrical roller bearing or double direction angular contact thrust ball bearing can be obtained from

$$Q = \frac{q d B}{100}$$

where

$Q$  = oil flow rate [ $\text{mm}^3/\text{h}$ ]

$B$  = bearing width [mm]

$d$  = bearing bore diameter [mm]

$d_m$  = bearing mean diameter [mm]  
 $= 0,5 (d + D)$

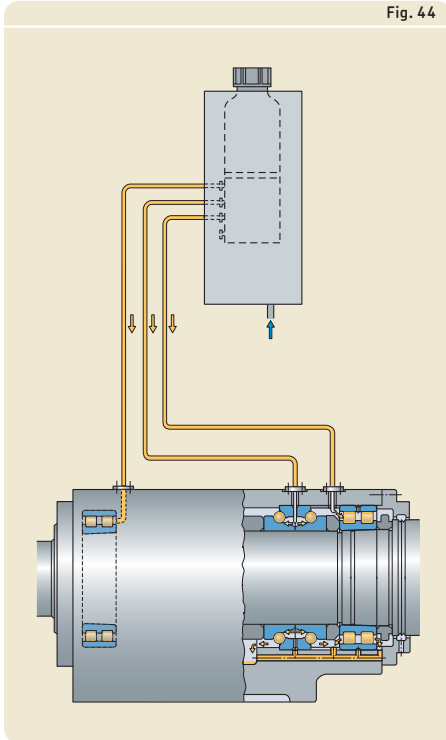
$q$  = factor

= 1 to 2 for cylindrical roller bearings

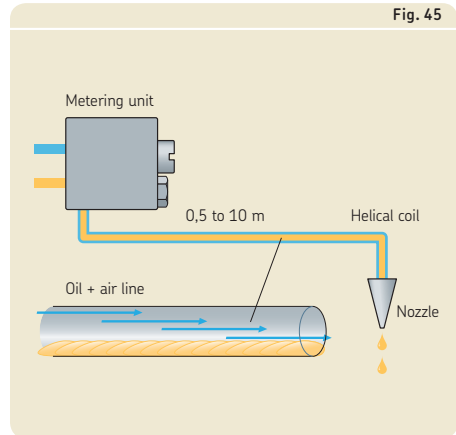
= 2 to 5 for double direction angular contact thrust ball bearings

Individual testing is, however, always recommended in order to optimize the conditions.

**Fig. 44**



**Fig. 45**



Different bearing designs show varying sensitivity to oil quantity changes. For example, roller bearings are very sensitive, whereas for ball bearings, the quantity can be changed substantially without any major rise in bearing temperature.

A factor influencing temperature rise and reliability of oil-air lubrication is the lubrication interval, i.e. the time in between two measures from the oil-air lubricator. Generally, the lubrication interval is determined by the oil flow rate generated by each injector and the oil quantity supplied per hour. The interval can vary from one minute to one hour, with the most common interval being 15 to 20 minutes.

Feed lines from the lubricator are 1 to 5 m in length, depending on the lubrication interval. A filter that prevents particles  $> 5 \mu\text{m}$  from reaching the bearings should be incorporated. The air pressure should be 0,2 to 0,3 MPa, but should be increased for longer runs to compensate for the pressure drop along the pipe's length.

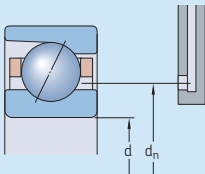
To maintain the lowest possible operating temperature, ducts must be able to drain any excess oil away from the bearing. With horizontal shafts it is relatively easy to arrange drainage ducts on each side of the bearings. For vertical shafts the oil passing the upper bearing(s) should be prevented from reaching the lower bearings, which would otherwise receive too much lubricant. Drainage, together with a sealing device, should be incorporated beneath each bearing. An effective seal should also be located at the spindle nose to prevent lubricant from reaching the work piece.

The oil nozzles should be positioned so that oil can be introduced into the contact area between the rolling elements and raceways without interference by the cage. For the diameter (measured on the bearing) where oil injection should take place, refer to **tables 33** and **34** ( $\rightarrow$  **pages 117** and **117**). For bearings equipped with alternative cages that are not listed, contact the SKF application engineering service.

The attainable speeds listed in the product tables for oil lubrication refer specifically to oil-air lubrication.

Table 33

Oil nozzle position for angular contact ball bearings



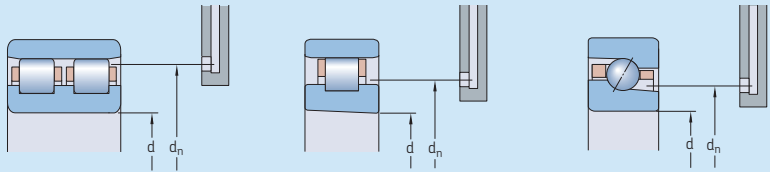
| Bore diameter<br>d | Size | Oil nozzle position $d_n$ for bearings in the series |                   |                   |                   |                 |                 |                 |                 |
|--------------------|------|------------------------------------------------------|-------------------|-------------------|-------------------|-----------------|-----------------|-----------------|-----------------|
|                    |      | 718 CD<br>718 ACD                                    | 719 CD<br>719 ACD | 719 CE<br>719 ACE | 719 CB<br>719 ACB | 70 CD<br>70 ACD | 70 CE<br>70 ACE | 70 CB<br>70 ACB | 72 CD<br>72 ACD |
| mm                 | —    | mm                                                   |                   |                   |                   |                 |                 |                 |                 |
| 6                  | 6    | —                                                    | —                 | —                 | —                 | 10,3            | 10,1            | —               | —               |
| 7                  | 7    | —                                                    | —                 | —                 | —                 | 11,7            | 11,4            | —               | 13,6            |
| 8                  | 8    | —                                                    | —                 | 12,2              | —                 | 13,6            | 13,3            | —               | 14,3            |
| 9                  | 9    | —                                                    | —                 | 13,3              | —                 | 15,1            | 14,8            | —               | 16,3            |
| 10                 | 00   | 13,4                                                 | 14,8              | 14,8              | —                 | 16              | 16,5            | —               | 18,3            |
| 12                 | 01   | 15,4                                                 | 16,8              | 16,8              | —                 | 18              | 18,5            | —               | 20              |
| 15                 | 02   | 18,4                                                 | 20,1              | 20                | —                 | 21,5            | 21,9            | —               | 23              |
| 17                 | 03   | 20,4                                                 | 22,1              | 22                | —                 | 23,7            | 24,1            | —               | 25,9            |
| 20                 | 04   | 24,5                                                 | 26,8              | 26,7              | —                 | 28,4            | 28,1            | —               | 31,1            |
| 25                 | 05   | 29,5                                                 | 31,8              | 31,8              | —                 | 33,4            | 33,1            | —               | 36,1            |
| 30                 | 06   | 34,5                                                 | 36,8              | 36,8              | 36,6              | 39,3            | 39,9            | 40              | 42,7            |
| 35                 | 07   | 39,5                                                 | 43                | 43                | 43                | 45,3            | 45,6            | 46,1            | 49,7            |
| 40                 | 08   | 44,5                                                 | 48,7              | 48                | 49,1              | 50,8            | 51,6            | 51,6            | 56,2            |
| 45                 | 09   | 50                                                   | 54,2              | 54,2              | 54,2              | 56,2            | 57,6            | 57,2            | 60,6            |
| 50                 | 10   | 55,6                                                 | 58,7              | 58,4              | 58,7              | 61,2            | 62,3            | 61,8            | 65,6            |
| 55                 | 11   | 61,3                                                 | 64,7              | 64,6              | 64,8              | 68,1            | 69,6            | 69,2            | 72,6            |
| 60                 | 12   | 66,4                                                 | 69,7              | 69,6              | 69,8              | 73,1            | 74,6            | 74,2            | 80,1            |
| 65                 | 13   | 72,4                                                 | 74,7              | 74,5              | 74,8              | 78,1            | 79,3            | 79              | 86,6            |
| 70                 | 14   | 77,4                                                 | 81,7              | 81,5              | 81,9              | 85              | 86,5            | 86,1            | 91,6            |
| 75                 | 15   | 82,4                                                 | 86,7              | 86,5              | 86,9              | 90              | 91,5            | 91,1            | 96,6            |
| 80                 | 16   | 87,4                                                 | 91,7              | 91,5              | 91,7              | 96,9            | 98,5            | 98              | 103,4           |
| 85                 | 17   | 94,1                                                 | 98,6              | 98,6              | 99,2              | 101,9           | 103,5           | 103             | 111,5           |
| 90                 | 18   | 99,1                                                 | 103,3             | 103,5             | 103,9             | 108,7           | 111             | 110             | 117,5           |
| 95                 | 19   | 104,1                                                | 108,6             | 108,5             | 109               | 113,7           | 115,4           | 115             | 124,4           |
| 100                | 20   | 109,1                                                | 115,6             | 115,4             | 116,1             | 118,7           | 120,4           | 120             | 131,4           |
| 105                | 21   | 114,6                                                | 120,6             | —                 | —                 | 125,6           | —               | —               | 138,4           |
| 110                | 22   | 120,9                                                | 125,6             | 125,4             | 125,7             | 132,6           | 135,4           | 134,6           | 145,9           |
| 120                | 24   | 130,9                                                | 137,6             | 137,4             | 138,2             | 142,6           | 144,9           | 144,7           | 158,2           |
| 130                | 26   | 144                                                  | 149,5             | —                 | —                 | 156,4           | —               | —               | 170,7           |
| 140                | 28   | 153,2                                                | 159,5             | —                 | —                 | 166,3           | —               | —               | 184,8           |
| 150                | 30   | 165,6                                                | 173,5             | —                 | —                 | 178,2           | —               | —               | —               |
| 160                | 32   | 175,6                                                | 183,5             | —                 | —                 | 191,4           | —               | —               | —               |
| 170                | 34   | —                                                    | 193,5             | —                 | —                 | 205,8           | —               | —               | —               |
| 180                | 36   | —                                                    | 207,4             | —                 | —                 | 219,7           | —               | —               | —               |
| 190                | 38   | —                                                    | 217,4             | —                 | —                 | 229,7           | —               | —               | —               |
| 200                | 40   | —                                                    | 231,4             | —                 | —                 | 243,2           | —               | —               | —               |
| 220                | 44   | —                                                    | 251,4             | —                 | —                 | 267,1           | —               | —               | —               |
| 240                | 48   | —                                                    | 271,4             | —                 | —                 | 287             | —               | —               | —               |
| 260                | 52   | —                                                    | 299,7             | —                 | —                 | 315             | —               | —               | —               |
| 280                | 56   | —                                                    | 319,7             | —                 | —                 | —               | —               | —               | —               |
| 300                | 60   | —                                                    | 347               | —                 | —                 | —               | —               | —               | —               |
| 320                | 64   | —                                                    | 367               | —                 | —                 | —               | —               | —               | —               |
| 340                | 68   | —                                                    | 387               | —                 | —                 | —               | —               | —               | —               |
| 360                | 72   | —                                                    | 407               | —                 | —                 | —               | —               | —               | —               |



Table 34

1

Oil nozzle position for cylindrical roller and double direction angular contact thrust ball bearings



| Bore diameter<br>d | Size | Oil nozzle position $d_n$ for bearings in the series <sup>1)</sup> |          |        |       |
|--------------------|------|--------------------------------------------------------------------|----------|--------|-------|
|                    |      | N 10<br>NN 30                                                      | N 10 PHA | NNU 49 | BTM   |
| mm                 | –    | mm                                                                 |          |        |       |
| 25                 | 05   | 40,5                                                               | –        | –      | –     |
| 30                 | 06   | 47,6                                                               | –        | –      | –     |
| 35                 | 07   | 54                                                                 | –        | –      | –     |
| 40                 | 08   | 60                                                                 | 52,1     | –      | –     |
| 45                 | 09   | 66,4                                                               | 57,9     | –      | –     |
| 50                 | 10   | 71,4                                                               | 63       | –      | –     |
| 55                 | 11   | 79,8                                                               | 70,1     | –      | –     |
| 60                 | 12   | 85                                                                 | 75,2     | –      | 73,8  |
| 65                 | 13   | 89,7                                                               | 80,1     | –      | 78,8  |
| 70                 | 14   | 98,5                                                               | 87,7     | –      | 86,1  |
| 75                 | 15   | 103,5                                                              | 92,7     | –      | 91,1  |
| 80                 | 16   | 111,4                                                              | 99,3     | –      | 97,9  |
| 85                 | 17   | 116,5                                                              | –        | –      | 102,9 |
| 90                 | 18   | 125,4                                                              | –        | –      | 109,7 |
| 95                 | 19   | 130,3                                                              | –        | –      | 114,7 |
| 100                | 20   | 135,3                                                              | –        | 113,8  | 119,7 |
| 105                | 21   | 144,1                                                              | –        | 119    | –     |
| 110                | 22   | 153                                                                | –        | 124    | 134,1 |
| 120                | 24   | 162,9                                                              | –        | 136,8  | 144,1 |
| 130                | 26   | 179,6                                                              | –        | 147    | 158,3 |
| 140                | 28   | 188                                                                | –        | 157    | 168,3 |
| 150                | 30   | 201,7                                                              | –        | 169,9  | 179,9 |
| 160                | 32   | 214,4                                                              | –        | 179,8  | 191,6 |
| 170                | 34   | 230,8                                                              | –        | 189,8  | 205,4 |
| 180                | 36   | 248,9                                                              | –        | 203,5  | 219,9 |
| 190                | 38   | 258,9                                                              | –        | 213    | –     |
| 200                | 40   | 275,3                                                              | –        | 227    | –     |
| 220                | 44   | 302,4                                                              | –        | 247    | –     |
| 240                | 48   | 322,4                                                              | –        | 267    | –     |
| 260                | 52   | 355,2                                                              | –        | 294,5  | –     |
| 280                | 56   | 375,3                                                              | –        | 313,5  | –     |

The illustrations show examples only. Position depends on design and series.

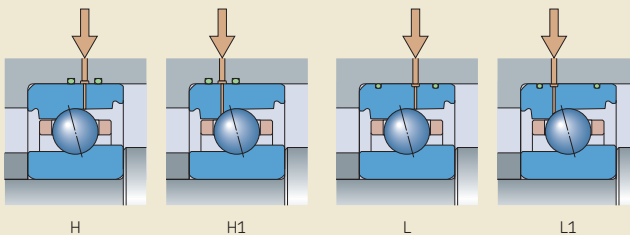
<sup>1)</sup> For bearings in the N 10 series equipped with an TNH A cage, bearings in the NN 30 and NNU 49 series with  $d > 280$  mm, contact the SKF application engineering service.

### Direct oil-air lubrication

For super-precision angular contact ball bearings operating at very high speeds, the injection of small amounts of oil-air directly through the outer ring is beneficial. With this method, lubricant dispersion is prevented, as the lubricant is supplied directly and safely to the ball/raceway contact area. As a result, lubricant consumption is minimized and bearing performance is improved. The different variants (→ **fig. 45**) for direct oil-air lubrication provide different benefits:

- Bearings with an annular groove and O-rings in the outer ring (designation suffix L or L1) prevent lubricant leakage between the bearing and its seat in the housing. For bearings without these features (designation suffix H or H1), SKF recommends machining the housing bore and incorporating O-rings into the bearing arrangement design.
- Bearings with lubrication holes on the thick side of the bearing shoulder (designation suffix H1 or L1) enable the lubricant to be supplied very close to the ball/raceway contact area. The locations of these lubrication holes enable the bearings to achieve maximum speeds.

Fig. 45



### Direct minimum quantity lubrication with minimal air consumption

The use of a continuous air flow in an oil-air lubrication system includes some system-related disadvantages like the high cost of compressed air, high noise levels and a complex dosing and control process. The SKF Microdosage system (→ **fig. 46**) virtually eliminates these disadvantages and offers better control and a lower cost of ownership.

Designed for ultra high speed spindles where the speed factor  $A \geq 2\,000\,000$  mm/min, this system delivers precisely metered amounts of oil to each bearing based on the machine tool's CAM program. The SKF Microdosage system also automatically re-calibrates when conditions like temperature or oil viscosity change. With this technology, oil consumption can typically be reduced to 0,5 to 5 mm<sup>3</sup>/min with a minimal amount of compressed air.

For information about the SKF Microdosage system, refer to the product information available online at [skf.com/lubrication](http://skf.com/lubrication).

### Lubricating oils

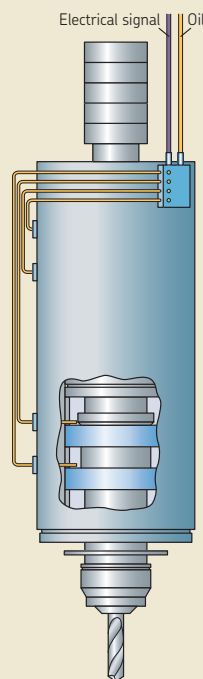
To lubricate super-precision bearings, high-quality lubricating oils without EP additives are generally recommended. The requisite viscosity of the oil can be determined following the recommendations under *Lubrication conditions – the viscosity ratio  $\kappa$*  in the SKF catalogue *Rolling bearings* or at [skf.com](http://skf.com), and is essentially a function of bearing size, speed and operating temperature.

Calculations can be made using the SKF program, Viscosity, available online at [skf.com/bearingcalculator](http://skf.com/bearingcalculator).

With oil-air lubrication systems, many oil types are suitable. Oils with a viscosity of 40 to 100 mm<sup>2</sup>/s at 40 °C (105 °F) are typically used as are oils with EP additives which are preferable, especially for roller bearings. Oils with a viscosity of 10 to 15 mm<sup>2</sup>/s at 40 °C (105 °F) are typically used for oil jet lubrication, whereas oil mist lubrication systems typically use oils with a viscosity of 32 mm<sup>2</sup>/s at 40 °C (105 °F).

The intervals at which the oil should be changed when using an oil bath, circulating oil or oil jet lubrication system, depend mainly on the operating conditions and the quantity of oil involved. When oil drop, oil mist or oil-air lubrication systems are used, the lubricant is supplied to the bearings only once.

Fig. 46



### Oil cleanliness

Oil cleanliness, which affects bearing service life and performance, requires an effective sealing system. Even with effective seals, however, the condition of the oil should be monitored on a regular basis. This is particularly true for oil re-circulation systems where the ingress of coolants, cutting oils, and other liquid contaminants can alter the lubricating properties of the oil.

Oil cleanliness requirements can be described by the number of particles per millilitre of oil for different particle sizes. ISO 4406 provides a coding system for the level of solid contaminants. The oil cleanliness requirements for high-precision applications like electro-spindles go beyond this coding. The maximum particle size should not exceed 5 µm. The acceptable contamination levels can be specified as an extrapolation of the contamination codes to ISO 4406 (→ **diagram 18**):

- 10/7, for new spindles
- 13/10, after long use (~ 2 000 hours)

### Lubricant storage

The conditions under which lubricants are stored can have an adverse effect on their performance. Inventory control can also play an important role. Therefore, SKF recommends a “first in, first out” inventory policy.

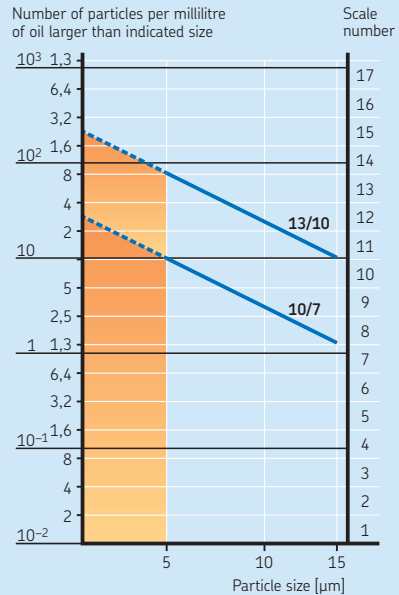
Lubricant properties may vary considerably during storage due to exposure to air/oxygen, temperature, light, water, moisture and other contaminants, or oil separation. Therefore, lubricants should be stored in a cool, dry, indoor area and should never be exposed to direct sunlight. The lubricants should be stored in their original containers, which should be kept closed until needed. After use, the containers should be resealed immediately.

The recommended maximum storage time is two years for greases and ten years for lubricating oils; assuming reasonable stock keeping practices and protection from excessive heat and cold.

Grease or oil that has exceeded the recommended shelf life is not necessarily unsuitable for service. However, it is advisable to confirm that the lubricant still meets the product requirements and specifications.

Diagram 18

Acceptable oil contamination levels



## Mounting and dismounting

When mounting or dismounting super-precision bearings, all recommendations and guidelines valid for rolling bearings should be considered. For recommendations and guidelines, refer to *Mounting, dismounting and bearing care* in the SKF catalogue *Rolling bearings* or at [skf.com](http://skf.com) and to the *SKF bearing maintenance handbook* (ISBN 978-91-978966-4-1). For mounting and dismounting instructions for individual bearings, visit [skf.com/mount](http://skf.com/mount).

### Where to mount

Bearings should be mounted in a dry, dust-free area away from machines producing swarf and dust. When bearings have to be mounted in an unprotected area, steps should be taken to protect the bearing and mounting position from contaminants like dust, dirt and moisture. This can be done by covering or wrapping the bearings and machine components with plastic or foil.

### Methods and tools

Super-precision bearings are reliable machine elements that can provide long service life, provided they are mounted and maintained properly. Proper mounting requires experience, accuracy, a clean work environment and the appropriate tools.

To promote proper mounting techniques, speed, accuracy and safety, SKF offers a comprehensive assortment of high-quality mounting and maintenance products. The assortment includes everything from mechanical and hydraulic tools to bearing heaters and grease. Detailed information about maintenance products is available online at [skf.com](http://skf.com).

To be sure that bearings are mounted and maintained properly, SKF offers seminars and hands-on training courses as part of the SKF Reliability Systems concept. Mounting and maintenance assistance may also be available from your local SKF company or SKF Authorized Distributor.

## Mounting recommendations

Compared to other rolling bearings, mounting super-precision bearings requires more accuracy, more caution and more advanced skills.

### Mounting bearings with thin-walled rings

Super-precision bearings often have rings that are thin relative to their size. For these bearings, only limited mounting forces should be applied. Therefore, SKF recommends using hot mounting methods for all super-precision bearings with thin-walled rings. For bearings in the NNU 49 series with a tapered bore, SKF recommends using the oil injection method.

### Hot mounting

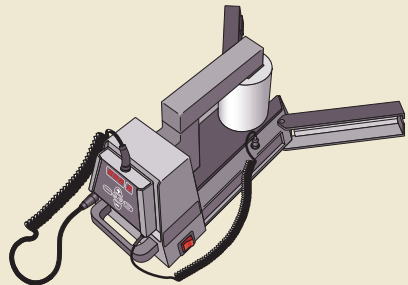
Super-precision bearings are typically mounted with a low degree of interference. That means a relatively small difference in temperature between the bearing ring and its mating components is required. The following temperature differences are often sufficient:

- 20 to 30 °C (35 to 55 °F) between the inner ring and shaft
- 10 to 30 °C (20 to 55 °F) between the housing bore and outer ring

To heat bearings evenly and reliably, SKF recommends using SKF electric induction heaters (→ fig. 47).

Stepped sleeves are sometimes used to locate bearings on a shaft and are therefore installed with a tight interference fit. Because of this, stepped sleeves require a greater dif-

Fig. 47



ference in temperature between mating components during installation. Temperature differences for installation are listed for:

- stepped sleeves without O-rings (→ **table 16, page 124**)
- stepped sleeves with O-rings (→ **table 17, page 124**)

### Test running

Once assembly is complete, an application should undergo a test run to determine that all components are operating properly. During a test run, the bearing(s) should run under partial load and, where there is a wide speed range, at low or moderate speeds. A rolling bearing should never be started up unloaded and then accelerated to high speed, as there is a significant risk that the rolling elements will slide and damage the raceways, or that the cage will be subjected to impermissible stresses.

Any noise or vibration can be checked using an SKF electronic stethoscope. Normally, bearings produce an even “purring” noise. Whistling or screeching indicates inadequate lubrication. An uneven rumbling or hammering is in most cases due to the presence of contaminants in the bearing or to bearing damage caused during mounting.

An increase in bearing temperature immediately after start-up is normal. In the case of grease lubrication, the temperature does not drop until the grease has been evenly distributed in the bearing arrangement, after which an equilibrium temperature is reached. For additional information about running-in of grease lubricated bearings, refer to *Running-in of grease lubricated bearings* (→ **page 124**).

Unusually high temperatures or constant peaking indicate that the preload is too heavy, that there is too much lubricant in the arrangement or that the bearing is radially or axially distorted. Other causes could be that associated components have not been made or mounted correctly, or that the seals are generating too much heat.

During the test run, or immediately afterwards, check the seals, any lubrication systems and all fluid levels. If noise and vibration levels are severe, it is advisable to check the lubricant for signs of contamination.

### Dismounting

Because the degree of the interference fit is relatively low for super-precision bearings, lower ring dismounting forces are needed compared to other rolling bearings.

#### Dismounting forces

For bearings in spindle applications, the dismounting forces can be estimated as follows:

- dismounting a set of three angular contact ball bearings from the housing →  $F \sim 0,02 D$
- dismounting a set of three angular contact ball bearings from the shaft →  $F \sim 0,07 d$
- dismounting a cylindrical roller bearing from its tapered seat →  $F \sim 0,3 d$

where

$F$  = dismounting force [kN]

$D$  = bearing outside diameter [mm]

$d$  = bearing bore diameter [mm]

### Reusing bearings

To determine if a bearing can be reused, it must be inspected carefully. A detailed inspection requires disassembling the bearing. Angular contact ball bearings cannot be disassembled without damage unless special tools are used. Cylindrical roller bearings can only be partly disassembled.

SKF does not recommend reusing super-precision bearings. In most cases, the risk for unplanned downtime or unsatisfactory performance outweighs the cost of new bearings.

Bearings should be dismounted carefully, regardless of whether they will be reused, because careless dismounting could damage associated components. Also, if the bearing is dismounted carefully, it can then be used for condition and damage analysis if required.

## SKF spindle service

Machine tool spindles often require special tools and skills for maintenance and repair. SKF supports customers with a worldwide network of SKF Spindle Service Centres (→ [skf.com](https://www.skf.com)). The services offered include spindle reconditioning, from bearing replacement to shaft and nose restorations, performance upgrades and analysis. SKF can also provide complete monitoring services as well as preventative maintenance services for machine tool spindles.

## Bearing storage

The conditions under which bearings and seals are stored can have an adverse effect on their performance. Inventory control can also play an important role in performance, particularly if seals are involved. Therefore, SKF recommends a “first in, first out” inventory policy.

### Storage conditions

To maximize the service life of bearings, SKF recommends the following basic housekeeping practices:

- Store bearings flat, in a vibration-free, dry area with a cool, steady temperature.
- Control and limit the relative humidity of the storage area as follows:
  - 75% at 20 °C (68 °F)
  - 60% at 22 °C (72 °F)
  - 50% at 25 °C (77 °F)
- Keep bearings in their original unopened packages until immediately prior to mounting to prevent the ingress of contaminants and corrosion.
- Bearings that are not stored in their original packaging should be well protected against corrosion and contaminants.

### Shelf life of open bearings

SKF bearings are coated with a rust-inhibiting compound and suitably packaged before distribution. For open bearings, the preservative provides protection against corrosion for approximately three years, provided the storage conditions are appropriate.

### Shelf life of sealed bearings

The maximum storage interval for sealed SKF bearings is dictated by the lubricant inside the bearings. Lubricant deteriorates over time as a result of ageing, condensation, and separation of the oil and thickener. Therefore, sealed bearings should not be stored for more than three years.





# Angular contact ball bearings

|                                                       |            |                                                          |            |
|-------------------------------------------------------|------------|----------------------------------------------------------|------------|
| <b>Assortment</b> .....                               | <b>128</b> | <b>Fitting and clamping bearing rings</b> ...            | <b>183</b> |
| <b>Designs and variants</b> .....                     | <b>128</b> | Calculating the required tightening torque .....         | 184        |
| Bearing series .....                                  | 130        | Locking procedure .....                                  | 185        |
| Contact angles .....                                  | 130        | <b>Load carrying capacity of bearing sets</b> .....      | <b>189</b> |
| High-capacity D design bearings .....                 | 131        | <b>Equivalent bearing loads</b> .....                    | <b>190</b> |
| High-speed E design bearings .....                    | 132        | Equivalent dynamic bearing load .....                    | 190        |
| High-speed B design bearings .....                    | 132        | Equivalent static bearing load .....                     | 191        |
| Hybrid bearings .....                                 | 133        | <b>Attainable speeds</b> .....                           | <b>192</b> |
| Cages .....                                           | 134        | <b>Mounting</b> .....                                    | <b>194</b> |
| Sealing solutions .....                               | 136        | Pressing bearing sets together during hot mounting ..... | 194        |
| Direct oil-air lubrication .....                      | 136        | Package markings .....                                   | 194        |
| Bearings made of NitroMax steel .....                 | 141        | <b>Designation system</b> .....                          | <b>196</b> |
| <b>Bearing arrangement design</b> .....               | <b>141</b> | <b>Product table</b>                                     |            |
| Single bearings and bearing sets .....                | 141        | <b>2.1</b> Angular contact ball bearings .....           | 198        |
| Single bearings .....                                 | 141        |                                                          |            |
| Bearing sets .....                                    | 142        |                                                          |            |
| Bearing arrangements .....                            | 142        |                                                          |            |
| <b>Markings on bearings and bearing sets</b> .....    | <b>145</b> |                                                          |            |
| <b>Bearing data</b> .....                             | <b>146</b> |                                                          |            |
| (Boundary dimensions, chamfer dimensions, tolerances) |            |                                                          |            |
| <b>Preload</b> .....                                  | <b>151</b> |                                                          |            |
| Bearings manufactured pre-set for preload .....       | 151        |                                                          |            |
| Preload in mounted bearing sets .....                 | 162        |                                                          |            |
| Preload with a constant force .....                   | 165        |                                                          |            |
| Preload by axial displacement .....                   | 166        |                                                          |            |
| Individual adjustment of preload .....                | 166        |                                                          |            |
| Spacer rings .....                                    | 167        |                                                          |            |
| Effect of rotational speed on preload .....           | 167        |                                                          |            |
| <b>Axial stiffness</b> .....                          | <b>173</b> |                                                          |            |

## More information

|                                     |     |
|-------------------------------------|-----|
| Bearing life and load ratings ..... | 127 |
| Requisite minimum load .....        | 127 |
| Chamfer dimension limits .....      | 127 |
| Materials .....                     | 127 |
| Design considerations .....         | 127 |
| Lubrication .....                   | 127 |
| Mounting and dismounting .....      | 127 |
| Bearing storage .....               | 127 |

## Assortment

SKF manufactures super-precision angular contact ball bearings for shaft diameters from 6 to 360 mm. Application requirements vary, and as a result, the SKF assortment of super-precision angular contact ball bearings includes four ISO dimension series, in numerous executions. The wide selection of designs and variants enables them to be incorporated into virtually every machine tool application as well as other applications where precision bearings are required.

SKF can supply super-precision angular contact ball bearings with a variety of design features:

- three different contact angles
- three different ball sizes
  - D design (→ **page 131**)
  - E design (→ **page 132**)
  - B design (→ **page 132**)
- two different ball materials (hybrid variant)
- sealing solutions
- direct oil-air lubrication features
- two different ring materials (NitroMax steel variant)

The assortment of super-precision angular contact ball bearings is shown in **table 1**.

## Designs and variants

Single row SKF super-precision angular contact ball bearings (→ **fig. 1**) are non-separable and, like all angular contact ball bearings, have raceways in the inner and outer rings that are displaced relative to each other in the direction of the bearing axis. This means that in addition to radial loads, these bearings can also accommodate axial loads in one direction. Radial loads induce axial forces in these bearings that need to be balanced by counterforces. An angular contact ball bearing is, therefore, always adjusted against a second bearing or used in sets.

The ring shoulders can have a different height on one or both bearing rings. Every bearing has the largest possible number of balls, which are guided by a window-type cage.

Fig. 1

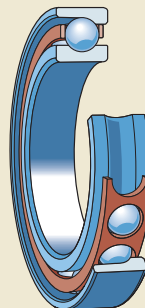
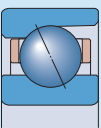
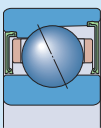
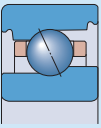
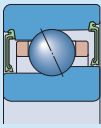
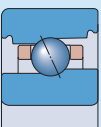
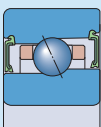
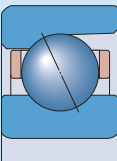
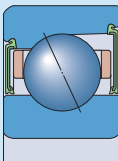


Table 1

## Super-precision angular contact ball bearings – assortment

| ISO dimension series | Bearing design          | Open variant                                                                        |                                      | Sealed variant                                                                      |                                      |
|----------------------|-------------------------|-------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|
| 18                   | High-capacity, D design |    | d = 10 to 160 mm<br>D = 19 to 200 mm | –                                                                                   | –                                    |
| 19                   | High-capacity, D design |    | d = 10 to 360 mm<br>D = 22 to 480 mm |    | d = 10 to 150 mm<br>D = 22 to 210 mm |
|                      | High-speed, E design    |    | d = 8 to 120 mm<br>D = 19 to 165 mm  |    | d = 20 to 120 mm<br>D = 37 to 165 mm |
|                      | High-speed, B design    |    | d = 30 to 120 mm<br>D = 47 to 165 mm |    | d = 30 to 120 mm<br>D = 47 to 165 mm |
| 10                   | High-capacity, D design |    | d = 6 to 260 mm<br>D = 17 to 400 mm  |    | d = 10 to 150 mm<br>D = 26 to 225 mm |
|                      | High-speed, E design    |   | d = 6 to 120 mm<br>D = 17 to 180 mm  |   | d = 10 to 120 mm<br>D = 26 to 180 mm |
|                      | High-speed, B design    |  | d = 30 to 120 mm<br>D = 55 to 180 mm |  | d = 30 to 120 mm<br>D = 55 to 180 mm |
| 02                   | High-capacity, D design |  | d = 7 to 140 mm<br>D = 22 to 250 mm  |  | d = 10 to 80 mm<br>D = 30 to 140 mm  |

### Bearing series

The SKF assortment of super-precision angular contact ball bearings includes bearings in the following dimension series:

- ultra light 718 series
- extremely light 719 series
- light 70 series
- robust 72 series

The cross sections of the four bearing series are compared in **fig. 2** for the same bore and same outside diameters. Each bearing series has characteristic features that make it particularly suitable for certain bearing applications.

Where a low cross-sectional height is a critical design parameter, bearings in the 718 series should be selected. If more radial space is available, and loads are not very heavy, bearings in the 719 or 70 series could be used. Bearings in the 72 series have the largest cross-sectional height for a given bore diameter and are suitable for heavy loads at relatively low speeds.

If a high degree of stiffness is required, bearings in the 718 and 719 series are typically used. Bearings in these two series contain the largest number of balls, relative to the

selected bore size, and can also accommodate the largest shaft diameter, relative to their outside diameter. Both characteristics are particularly important for system rigidity, as the rigidity of a spindle increases with its shaft diameter, and the rigidity of a bearing arrangement increases with the number of balls.

### Contact angles

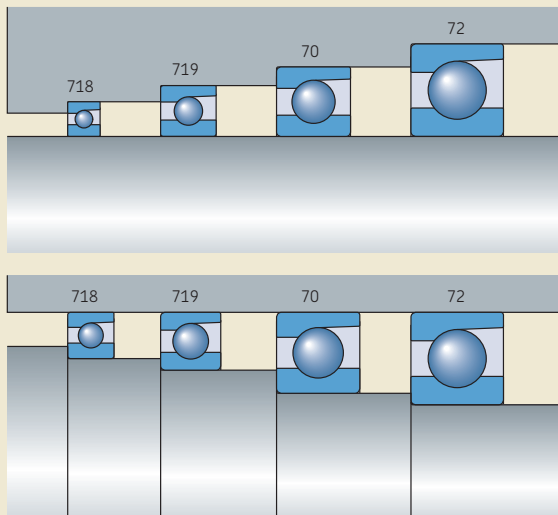
Super-precision angular contact ball bearings are manufactured with the following contact angles (→ **fig. 3**):

- a 15° contact angle, designation suffix C
- a 25° contact angle, designation suffix AC

For some series, bearings with an 18° contact angle, designation suffix F, are available on request.

A larger contact angle provides a higher degree of axial stiffness and a higher axial load carrying capacity. However, speed capability, radial stiffness, and radial load carrying capacity are reduced.

Fig. 2



## High-capacity D design bearings

D design bearings (→ **fig. 4**) are designed to accommodate heavy loads at relatively high speeds under low to moderate operating temperatures. When compared to other precision angular contact ball bearings, D design bearings contain the maximum number and size of balls. Their close osculation provides a relatively high degree of stiffness and the highest possible load carrying capacity.

### Applications

Typical applications for bearings in the 718 .. D series include:

- machine tools, e.g. multispindle drilling heads (→ **fig. 14, page 131**)
- robotics
- printing
- measuring systems
- racing car wheels

Typical applications for bearings in the 719 .. D and 70 .. D series include:

- machining centres (horizontal and vertical) (→ **fig. 17, page 131**)
- milling machines
- lathes (→ **fig. 11, page 131**)
- external and surface grinding machines
- boring machines
- machines for cutting or polishing stones and glass
- semiconductor industry, e.g. units for detecting defects on silicon wafer chips (→ **fig. 15, page 131**)
- boat gyrostabilizers
- telescopes
- microturbines
- racing/super car wheels
- medical equipment

Typical applications for bearings in the 72 .. D series include:

- machine tool spindles, e.g. live centre spindles (→ **fig. 13, page 131**)
- lathes (main spindles, tailstock)
- grinding machines
- boring machines
- Parallel Kinematic Machines (PKM)
- dynamometers for engine testing
- high-speed turbochargers

Fig. 3

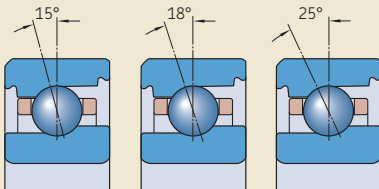
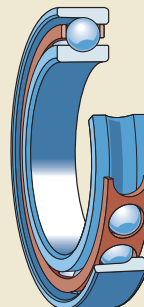


Fig. 4



### High-speed E design bearings

E design bearings (→ **fig. 5**), when compared to D design bearings, have a more open osculation and a maximum number of smaller balls. They can therefore accommodate very high speeds but do not have the same high load carrying capacity as D design bearings. Compared to B design bearings, E design bearings have a slightly higher speed capability and can accommodate heavier loads.

#### Applications

Typical applications for bearings in the 719 .. E and 70 .. E series include:

- electro-spindles (→ **fig. 16, page 132**)
- high-speed machining centres (horizontal and vertical) (→ **fig. 17, page 132**)
- high-speed milling machines
- high-speed internal grinding machines (→ **fig. 19, page 132**)
- high-speed spindles for PCB drilling
- woodworking machines

### High-speed B design bearings

B design bearings (→ **fig. 6**) are designed for high-speed operation and are best suited for lighter loads and lower operating temperatures. When compared to E and D design bearings, B design bearings are equipped with the maximum number of very small balls. The smaller, lighter balls reduce the centrifugal loads acting on the outer ring raceway and therefore reduce the stresses on the rolling contact surfaces. As smaller balls require less space, the bearing rings have a larger cross-sectional height, making them less susceptible to distortion resulting from irregularities of the bearing seat, either on the shaft or in the housing.

#### Applications

Typical applications for bearings in the 719 .. B and 70 .. B series include:

- electro-spindles (→ **fig. 18, page 132**)
- metal cutting machines (→ **fig. 18**)
- woodworking machines
- milling machines
- machining centres

Fig. 5

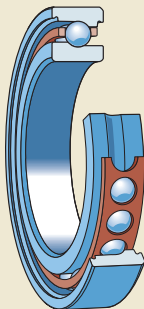
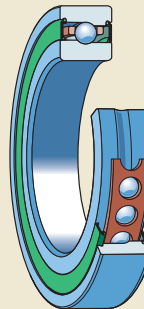


Fig. 6



## Hybrid bearings

Hybrid angular contact ball bearings (designation suffix HC) have rings made of bearing steel and rolling elements made of bearing grade silicon nitride (ceramic). As ceramic balls are lighter and have a higher modulus of elasticity and lower coefficient of thermal expansion than steel balls, hybrid bearings can provide the following advantages:

- higher degree of rigidity
- higher speed capability
- reduced centrifugal and inertial forces within the bearing
- minimized stress at the outer ring rolling contacts at high speeds
- reduced frictional heat
- less energy consumption
- extended bearing and grease service life
- less prone to skid smearing damage and cage damage when subject to frequent rapid starts and stops
- less sensitive to temperature differences within the bearing
- more accurate preload/clearance control

For additional information about silicon nitride, refer to *Materials for bearing rings and rolling elements* (→ **page 133**).

### Cages

Depending on their series and size, single row super-precision angular contact ball bearings are fitted as standard with one of the following cages (→ **matrix 1**):

- a cotton fabric reinforced phenolic resin cage, window-type, outer ring centred, no designation suffix (→ **fig. 7**)
- a glass fibre reinforced PEEK cage, window-type, outer ring centred, designation suffix TNHA (→ **fig. 8**)
- a carbon fibre reinforced PEEK cage, window-type, outer ring centred, no designation suffix (→ **fig. 9**)
- a machined brass cage, window-type, outer ring centred, designation suffix MA

The lightweight polymer cages reduce inertial and centrifugal forces while maximizing the effectiveness of the lubricant.

Other cage materials and designs are available on request. Contact the SKF application engineering service.

For additional information about materials, refer to *Cage materials* (→ **page 134**).

Fig. 7



Fig. 8



Fig. 9





Matrix 1

| Bore diameter [mm] | Cage materials<br>for bearings in the series |          |         |          |         |          |         |         | Size |
|--------------------|----------------------------------------------|----------|---------|----------|---------|----------|---------|---------|------|
|                    | 718 .. D                                     | 719 .. D | 70 .. D | 719 .. E | 70 .. E | 719 .. B | 70 .. B | 72 .. D |      |
| 6                  |                                              |          |         |          |         |          |         |         | 6    |
| 7                  |                                              |          |         |          |         |          |         |         | 7    |
| 8                  |                                              |          |         |          |         |          |         |         | 8    |
| 9                  |                                              |          |         |          |         |          |         |         | 9    |
| 10                 |                                              |          |         |          |         |          |         |         | 00   |
| 12                 |                                              |          |         |          |         |          |         |         | 01   |
| 15                 |                                              |          |         |          |         |          |         |         | 02   |
| 17                 |                                              |          |         |          |         |          |         |         | 03   |
| 20                 |                                              |          |         |          |         |          |         |         | 04   |
| 25                 |                                              |          |         |          |         |          |         |         | 05   |
| 30                 |                                              |          |         |          |         |          |         |         | 06   |
| 35                 |                                              |          |         |          |         |          |         |         | 07   |
| 40                 |                                              |          |         |          |         |          |         |         | 08   |
| 45                 |                                              |          |         |          |         |          |         |         | 09   |
| 50                 |                                              |          |         |          |         |          |         |         | 10   |
| 55                 |                                              |          |         |          |         |          |         |         | 11   |
| 60                 |                                              |          |         |          |         |          |         |         | 12   |
| 65                 |                                              |          |         |          |         |          |         |         | 13   |
| 70                 |                                              |          |         |          |         |          |         |         | 14   |
| 75                 |                                              |          |         |          |         |          |         |         | 15   |
| 80                 |                                              |          |         |          |         |          |         |         | 16   |
| 85                 |                                              |          |         |          |         |          |         |         | 17   |
| 90                 |                                              |          |         |          |         |          |         |         | 18   |
| 95                 |                                              |          |         |          |         |          |         |         | 19   |
| 100                |                                              |          |         |          |         |          |         |         | 20   |
| 105                |                                              |          |         |          |         |          |         |         | 21   |
| 110                |                                              |          |         |          |         |          |         |         | 22   |
| 120                |                                              |          |         |          |         |          |         |         | 24   |
| 130                |                                              |          |         |          |         |          |         |         | 26   |
| 140                |                                              |          |         |          |         |          |         |         | 28   |
| 150                |                                              |          |         |          |         |          |         |         | 30   |
| 160                |                                              |          |         |          |         |          |         |         | 32   |
| 170                |                                              |          |         |          |         |          |         |         | 34   |
| 180                |                                              |          |         |          |         |          |         |         | 36   |
| 190                |                                              |          |         |          |         |          |         |         | 38   |
| 200                |                                              |          |         |          |         |          |         |         | 40   |
| 220                |                                              |          |         |          |         |          |         |         | 44   |
| 240                |                                              |          |         |          |         |          |         |         | 48   |
| 260                |                                              |          |         |          |         |          |         |         | 52   |
| 280                |                                              |          |         |          |         |          |         |         | 56   |
| 300                |                                              |          |         |          |         |          |         |         | 60   |
| 320                |                                              |          |         |          |         |          |         |         | 64   |
| 340                |                                              |          |         |          |         |          |         |         | 68   |
| 360                |                                              |          |         |          |         |          |         |         | 72   |

- Cotton fabric reinforced phenolic resin
- Glass fibre reinforced PEEK
- Carbon fibre reinforced PEEK
- Machined brass

### Sealing solutions

The most common bearings can be supplied with an integral seal fitted on both sides (designation prefix S). The seal forms an extremely narrow gap with the inner ring shoulder (→ **fig. 10**), and therefore speed capability is not compromised.

The seals are made standard of an oil- and wear-resistant NBR and are reinforced with sheet steel. On request, bearings can be supplied with seals made of FKM. For additional information, refer to *Seal materials* (→ **page 136**).

Sealed bearings are filled as standard with a high-quality, low-viscosity grease that has a lithium soap thickener and a synthetic ester base oil. The quantity of grease fills ~ 15% of the free space in the bearing. The temperature range for the grease is  $-55$  to  $+110$  °C ( $-65$  to  $+230$  °F). On request, the bearings can be supplied with other greases. For additional information, contact the SKF application engineering service.

When compared to bearing arrangements with open bearings and external seals, sealed bearings can provide a number of advantages, including:

- potential for extended bearing service life
- extended maintenance intervals
- reduced inventory
- reduced risk of lubricant contamination during mounting and operation

Sealed bearings are lubricated for life. They should not be washed or heated to temperatures above  $80$  °C ( $175$  °F). If a sealed bearing is to be heated for mounting, an induction heater must be used and the bearing should be fitted immediately to minimize the time that the bearing is exposed to high temperatures. For information about the storage interval of sealed bearings, refer to *Shelf life of sealed bearings* (→ **page 136**).

### Direct oil-air lubrication

Some very high speed applications require open bearings in the 719 .. D and 70 .. D series, 719 .. E and 70 .. E series, and 719 .. B and 70 .. B series to be lubricated with minimal amounts of oil, directly through their outer rings.

On request, bearings can be supplied with two lubrication holes in their outer rings. Bearings with an annular groove or an annular groove and two annular O-ring grooves, complete with O-rings to seal to the bearing housing bore, are also available. The positions of these features are listed in the following tables:

- **table 2** for bearings in the 719 .. D and 70 .. D series
- **table 3** (→ **page 136**) for bearings in the 719 .. E and 70 .. E series
- **table 4** (→ **page 136**) for bearings in the 719 .. B and 70 .. B series

Fig. 10

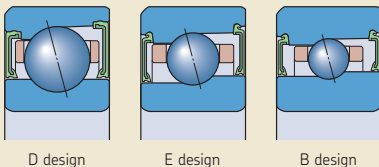
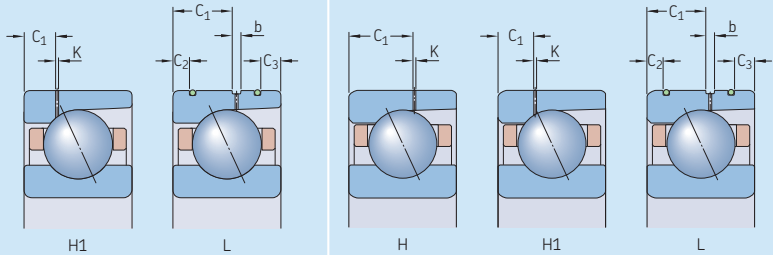


Table 2

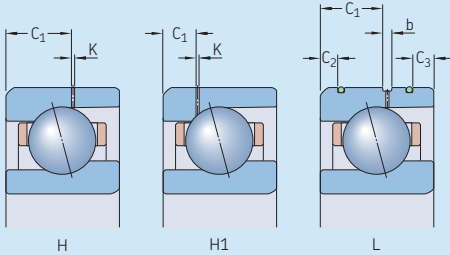
Dimensions for direct oil-air lubrication – 719 .. D and 70 .. D series



| Bore<br>diam-<br>eter<br>d | Size | Dimensions<br>Variants for bearings in the 719 .. D series |     |                |                |                |     | Variants for bearings in the 70 .. D series |     |                |                |                |     |     |
|----------------------------|------|------------------------------------------------------------|-----|----------------|----------------|----------------|-----|---------------------------------------------|-----|----------------|----------------|----------------|-----|-----|
|                            |      | H1                                                         | L   |                |                |                |     | H                                           | H1  | L              | C <sub>2</sub> | C <sub>3</sub> | b   |     |
|                            |      | C <sub>1</sub>                                             | K   | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | b   | C <sub>1</sub>                              | K   | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | b   |     |
| mm                         | –    | mm                                                         |     |                |                |                |     |                                             |     |                |                |                |     |     |
| 6                          | 6    | –                                                          | –   | –              | –              | –              | –   | 3,65                                        | 0,5 | –              | –              | –              | –   | –   |
| 7                          | 7    | –                                                          | –   | –              | –              | –              | –   | 3,65                                        | 0,5 | –              | –              | –              | –   | –   |
| 8                          | 8    | –                                                          | –   | –              | –              | –              | –   | 4,25                                        | 0,5 | –              | –              | –              | –   | –   |
| 9                          | 9    | –                                                          | –   | –              | –              | –              | –   | 4,25                                        | 0,5 | –              | –              | –              | –   | –   |
| 10                         | 00   | –                                                          | –   | –              | –              | –              | –   | 4,75                                        | 0,5 | –              | –              | –              | –   | –   |
| 12                         | 01   | –                                                          | –   | –              | –              | –              | –   | 4,9                                         | 0,5 | –              | –              | –              | –   | –   |
| 15                         | 02   | –                                                          | –   | –              | –              | –              | –   | 5,35                                        | 0,5 | –              | –              | –              | –   | –   |
| 17                         | 03   | –                                                          | –   | –              | –              | –              | –   | 6,05                                        | 0,5 | –              | –              | –              | –   | –   |
| 20                         | 04   | –                                                          | –   | –              | –              | –              | –   | 7,15                                        | 0,5 | –              | –              | –              | –   | –   |
| 25                         | 05   | –                                                          | –   | –              | –              | –              | –   | 7,25                                        | 0,5 | –              | –              | –              | –   | –   |
| 30                         | 06   | –                                                          | –   | –              | –              | –              | –   | 7,8                                         | 0,5 | –              | –              | –              | –   | –   |
| 35                         | 07   | –                                                          | –   | –              | –              | –              | –   | 8,4                                         | 0,5 | –              | –              | –              | –   | –   |
| 40                         | 08   | –                                                          | –   | –              | –              | –              | –   | 8,95                                        | 0,5 | –              | –              | –              | –   | –   |
| 45                         | 09   | –                                                          | –   | –              | –              | –              | –   | 9,45                                        | 0,5 | –              | –              | –              | –   | –   |
| 50                         | 10   | –                                                          | –   | –              | –              | –              | –   | 9,6                                         | 0,5 | –              | –              | –              | –   | –   |
| 55                         | 11   | –                                                          | –   | 6,5            | 3,2            | 2              | 2,2 | –                                           | –   | 4,88           | 0,5            | 9              | 4,3 | 3,8 |
| 60                         | 12   | –                                                          | –   | 6,5            | 3,2            | 2              | 2,2 | –                                           | –   | 4,88           | 0,5            | 9              | 4,3 | 3,8 |
| 65                         | 13   | –                                                          | –   | 6,5            | 3,2            | 2              | 2,2 | –                                           | –   | 4,9            | 0,5            | 9,7            | 4,3 | 3,8 |
| 70                         | 14   | 4,46                                                       | 0,5 | 8,6            | 3,5            | 2,8            | 2   | –                                           | –   | 5,39           | 0,5            | 10,9           | 4,4 | 3,9 |
| 75                         | 15   | 4,46                                                       | 0,5 | 8,6            | 3,5            | 2,8            | 2   | –                                           | –   | 5,4            | 0,5            | 10,9           | 3,9 | 3,4 |
| 80                         | 16   | 4,46                                                       | 0,5 | 8,6            | 3,5            | 2,8            | 2   | –                                           | –   | 5,89           | 0,5            | 11,1           | 4,4 | 3,8 |
| 85                         | 17   | 5,2                                                        | 0,5 | 9,3            | 4              | 2,8            | 2,6 | –                                           | –   | 5,9            | 0,5            | 11,1           | 4,4 | 3,8 |
| 90                         | 18   | 5,2                                                        | 0,5 | 9,3            | 4,2            | 3              | 2,6 | –                                           | –   | 6,85           | 0,5            | 13,4           | 5,2 | 4,3 |
| 95                         | 19   | 5,2                                                        | 0,5 | 9,3            | 4,2            | 3              | 2,6 | –                                           | –   | 6,41           | 0,5            | 13,4           | 5,2 | 4,3 |
| 100                        | 20   | 5,46                                                       | 0,5 | 10,9           | 4              | 3,3            | 2,3 | –                                           | –   | 6,46           | 0,5            | 13,4           | 5,2 | 4,3 |
| 105                        | 21   | 5,46                                                       | 0,5 | 10,9           | 3,9            | 3,2            | 2,3 | –                                           | –   | 6,92           | 0,5            | 14,1           | 6,2 | 5   |
| 110                        | 22   | 5,46                                                       | 0,5 | 10,9           | 4              | 3              | 2,3 | –                                           | –   | 7,41           | 0,5            | 15,1           | 6,2 | 5,4 |
| 120                        | 24   | 6,1                                                        | 0,5 | 11,9           | 4,2            | 2,9            | 2,6 | –                                           | –   | 7,41           | 0,5            | 15             | 6,2 | 5,4 |
| 130                        | 26   | 6,92                                                       | 0,5 | 13,3           | 5,6            | 2,9            | 2,6 | –                                           | –   | 8,9            | 0,5            | 17,9           | 6,6 | 5,6 |
| 140                        | 28   | 6,92                                                       | 0,5 | 13,3           | 5,4            | 2,9            | 2,6 | –                                           | –   | 8,9            | 0,5            | 17,9           | 6,6 | 5,6 |
| 150                        | 30   | 7,32                                                       | 0,6 | 15,6           | 6,6            | 5,6            | 2,6 | –                                           | –   | 9,3            | 0,6            | 19,2           | 7,1 | 5,6 |
| 160                        | 32   | 7,32                                                       | 0,6 | 15,6           | 6,6            | 5,6            | 2,6 | –                                           | –   | 10,3           | 0,6            | 21,2           | 7,1 | 6,6 |
| 170                        | 34   | 7,32                                                       | 0,6 | –              | –              | –              | –   | –                                           | –   | 11,8           | 0,6            | 23,8           | 7,1 | 7,1 |
| 180                        | 36   | 8,6                                                        | 0,6 | –              | –              | –              | –   | –                                           | –   | 13,4           | 0,6            | 26,1           | 7,5 | 7,5 |
| 190                        | 38   | 8,6                                                        | 0,6 | –              | –              | –              | –   | –                                           | –   | 13,4           | 0,6            | –              | –   | –   |
| 200                        | 40   | 10                                                         | 0,6 | –              | –              | –              | –   | –                                           | –   | 14             | 0,6            | –              | –   | –   |
| 220                        | 44   | –                                                          | –   | 20,9           | 7,1            | 5,45           | 3,5 | –                                           | –   | 15,5           | 0,6            | –              | –   | –   |
| 240                        | 48   | –                                                          | –   | 20,9           | 7,1            | 5,45           | 3,5 | –                                           | –   | 15,5           | 0,6            | –              | –   | –   |
| 260                        | 52   | –                                                          | –   | 24,9           | 7,1            | 6,7            | 4   | –                                           | –   | –              | –              | –              | –   | –   |

Table 3a

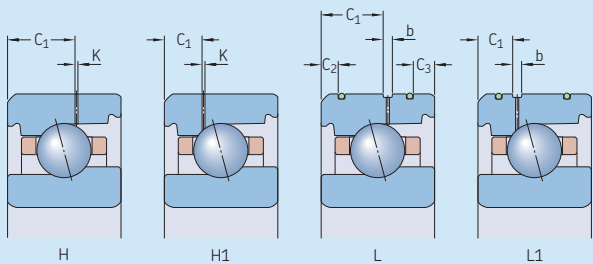
Dimensions for direct oil-air lubrication – 719 .. E series



| Bore diameter<br>d | Size | Dimensions          |     | Variants for bearings in the 719 .. E series |     | L<br>C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | b   |
|--------------------|------|---------------------|-----|----------------------------------------------|-----|---------------------|----------------|----------------|-----|
|                    |      | H<br>C <sub>1</sub> | K   | H1<br>C <sub>1</sub>                         | K   |                     |                |                |     |
| mm                 | –    | mm                  |     |                                              |     |                     |                |                |     |
| 8                  | 8    | 3,65                | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 9                  | 9    | 3,65                | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 10                 | 00   | 3,65                | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 12                 | 01   | 3,65                | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 15                 | 02   | 4,3                 | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 17                 | 03   | 4,35                | 0,5 | –                                            | –   | –                   | –              | –              | –   |
| 20                 | 04   | 5,45                | 0,5 | –                                            | –   | 4,6                 | 1,4            | 0,9            | 1,5 |
| 25                 | 05   | 5,45                | 0,5 | –                                            | –   | 4,6                 | 1,4            | 0,9            | 1,5 |
| 30                 | 06   | 5,45                | 0,5 | –                                            | –   | 4,6                 | 1,4            | 0,9            | 1,5 |
| 35                 | 07   | 6,15                | 0,5 | –                                            | –   | 5,1                 | 1,8            | 1,2            | 1,6 |
| 40                 | 08   | –                   | –   | 3,75                                         | 0,5 | 5,9                 | 1,8            | 1,8            | 2   |
| 45                 | 09   | –                   | –   | 3,75                                         | 0,5 | 5,9                 | 2,3            | 1,8            | 2   |
| 50                 | 10   | –                   | –   | 3,53                                         | 0,5 | 5,9                 | 2,3            | 1,8            | 2,2 |
| 55                 | 11   | –                   | –   | 3,83                                         | 0,5 | 6,5                 | 2,5            | 2              | 2,2 |
| 60                 | 12   | –                   | –   | 3,83                                         | 0,5 | 6,5                 | 2,5            | 2              | 2,2 |
| 65                 | 13   | –                   | –   | 3,83                                         | 0,5 | 6,5                 | 2,5            | 2              | 2,2 |
| 70                 | 14   | –                   | –   | 4,9                                          | 0,5 | 8,6                 | 2,8            | 2,8            | 2   |
| 75                 | 15   | –                   | –   | 4,9                                          | 0,5 | 8,6                 | 2,8            | 2,8            | 2   |
| 80                 | 16   | –                   | –   | 4,9                                          | 0,5 | 8,6                 | 2,8            | 2,8            | 2   |
| 85                 | 17   | –                   | –   | 5,48                                         | 0,5 | 9,3                 | 3              | 3              | 2,6 |
| 90                 | 18   | –                   | –   | 5,48                                         | 0,5 | 9,3                 | 3              | 3              | 2,6 |
| 95                 | 19   | –                   | –   | 5,48                                         | 0,5 | 9,3                 | 3              | 3              | 2,6 |
| 100                | 20   | –                   | –   | 6,05                                         | 0,5 | 10,9                | 3              | 3,3            | 2,3 |
| 110                | 22   | –                   | –   | 5,78                                         | 0,5 | 10,9                | 3,5            | 3              | 2,3 |
| 120                | 24   | –                   | –   | 6,31                                         | 0,5 | 11,9                | 4,2            | 3,6            | 2,6 |

Table 3b

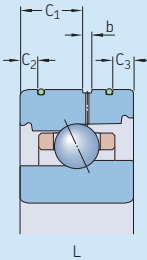
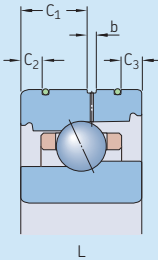
Dimensions for direct oil-air lubrication – 70 .. E series



| Bore diameter<br>d | Size | Dimensions          |     | Variants for bearings in the 70 .. E series |     |                     |                |                |     |                      |                |                |     |
|--------------------|------|---------------------|-----|---------------------------------------------|-----|---------------------|----------------|----------------|-----|----------------------|----------------|----------------|-----|
|                    |      | H<br>C <sub>1</sub> | K   | H1<br>C <sub>1</sub>                        | K   | L<br>C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | b   | L1<br>C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | b   |
| mm                 | –    | mm                  |     |                                             |     |                     |                |                |     |                      |                |                |     |
| 6                  | 6    | 3,65                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 7                  | 7    | 3,65                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 8                  | 8    | 4,25                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 9                  | 9    | 4,25                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 10                 | 00   | 4,75                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 12                 | 01   | 4,9                 | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 15                 | 02   | 5,35                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 17                 | 03   | 6,05                | 0,5 | –                                           | –   | –                   | –              | –              | –   | –                    | –              | –              | –   |
| 20                 | 04   | –                   | –   | 3,67                                        | 0,5 | 5,9                 | 1,8            | 1,9            | 1,9 | 3,2                  | 1,45           | 1,9            | 1,4 |
| 25                 | 05   | –                   | –   | 3,72                                        | 0,5 | 5,9                 | 1,8            | 1,9            | 2,1 | 3,2                  | 1,45           | 1,9            | 1,4 |
| 30                 | 06   | –                   | –   | 4,23                                        | 0,5 | 6,5                 | 2,3            | 2,6            | 1,8 | 3,7                  | 1,95           | 2,6            | 1,4 |
| 35                 | 07   | –                   | –   | 4,52                                        | 0,5 | 7,3                 | 2,2            | 2,8            | 1,7 | 4                    | 2,2            | 2,8            | 1,4 |
| 40                 | 08   | –                   | –   | 5,03                                        | 0,5 | 7,8                 | 2,5            | 3              | 1,7 | 4,5                  | 2,5            | 3              | 1,4 |
| 45                 | 09   | –                   | –   | 5,53                                        | 0,5 | 8,6                 | 3              | 3              | 1,7 | 5                    | 3              | 3              | 1,4 |
| 50                 | 10   | –                   | –   | 5,32                                        | 0,5 | 8,6                 | 2,7            | 3              | 1,7 | 4,7                  | 2,7            | 3              | 1,6 |
| 55                 | 11   | –                   | –   | 6,30                                        | 0,5 | 9                   | 3,4            | 3,4            | 2,4 | 5,65                 | 3,4            | 3,4            | 1,6 |
| 60                 | 12   | –                   | –   | 6,30                                        | 0,5 | 9                   | 3,4            | 3,4            | 2,4 | 5,65                 | 3,4            | 3,4            | 1,6 |
| 65                 | 13   | –                   | –   | 5,92                                        | 0,5 | 9,7                 | 3,3            | 3,3            | 1,9 | 5,3                  | 3,3            | 3,3            | 1,6 |
| 70                 | 14   | –                   | –   | 6,7                                         | 0,5 | 10,9                | 3,4            | 3,4            | 1,9 | 6,05                 | 3,4            | 3,4            | 1,6 |
| 75                 | 15   | –                   | –   | 6,73                                        | 0,5 | 10,9                | 3,4            | 3,4            | 1,8 | 6,1                  | 3,4            | 3,4            | 1,6 |
| 80                 | 16   | –                   | –   | 7,27                                        | 0,5 | 11,1                | 3,8            | 3,8            | 2,8 | 6,5                  | 3,8            | 3,8            | 1,8 |
| 85                 | 17   | –                   | –   | 7,27                                        | 0,5 | 11,1                | 3,8            | 3,8            | 2,8 | 6,5                  | 3,8            | 3,8            | 1,8 |
| 90                 | 18   | –                   | –   | 8,33                                        | 0,5 | 13,2                | 4,3            | 4,3            | 2,6 | 7,6                  | 4,3            | 4,3            | 1,8 |
| 95                 | 19   | –                   | –   | 7,81                                        | 0,5 | 13,4                | 4,3            | 4,3            | 2,2 | 7,1                  | 4,3            | 4,3            | 1,8 |
| 100                | 20   | –                   | –   | 7,82                                        | 0,5 | 13,4                | 4              | 4              | 2,2 | 7,1                  | 4              | 4              | 1,8 |
| 110                | 22   | –                   | –   | 9,84                                        | 0,5 | 15,1                | 5,4            | 5,4            | 2,6 | 9,05                 | 5,4            | 5,4            | 1,8 |
| 120                | 24   | –                   | –   | 9,38                                        | 0,5 | 15                  | 5,4            | 5,4            | 2,8 | 8,6                  | 5,4            | 5,4            | 1,8 |

Table 4

Dimensions for direct oil-air lubrication – 719 .. B and 70 .. B series



| Bore diameter<br>d | Size | Dimensions<br>Variant L for bearings in the 719 .. B series |                |                |     | Variant L for bearings in the 70 .. B series |                |                |     |
|--------------------|------|-------------------------------------------------------------|----------------|----------------|-----|----------------------------------------------|----------------|----------------|-----|
|                    |      | C <sub>1</sub>                                              | C <sub>2</sub> | C <sub>3</sub> | b   | C <sub>1</sub>                               | C <sub>2</sub> | C <sub>3</sub> | b   |
| mm                 | –    | mm                                                          |                |                |     |                                              |                |                |     |
| 30                 | 06   | –                                                           | –              | –              | –   | 6,5                                          | 3,4            | 2,4            | 1,7 |
| 35                 | 07   | –                                                           | –              | –              | –   | 7,3                                          | 3,4            | 2,4            | 1,4 |
| 40                 | 08   | 5,9                                                         | 2,8            | 1,7            | 2   | 7,8                                          | 3,6            | 2,6            | 1,5 |
| 45                 | 09   | 5,9                                                         | 2,8            | 1,7            | 2   | 8,6                                          | 3,6            | 2,6            | 1,5 |
| 50                 | 10   | 5,9                                                         | 2,8            | 1,7            | 2   | 8,6                                          | 3,6            | 2,6            | 1,5 |
| 55                 | 11   | 6,5                                                         | 3,8            | 1,7            | 2   | 9                                            | 4,3            | 2,8            | 2,2 |
| 60                 | 12   | 6,5                                                         | 3,8            | 1,7            | 2   | 9                                            | 4,3            | 2,8            | 2,2 |
| 65                 | 13   | 6,5                                                         | 3,8            | 1,7            | 2   | 9,7                                          | 4,3            | 2,8            | 1,5 |
| 70                 | 14   | 8,6                                                         | 3,8            | 1,7            | 1,5 | 10,9                                         | 4,4            | 2,9            | 1,5 |
| 75                 | 15   | 8,6                                                         | 3,8            | 2,7            | 1,5 | 10,9                                         | 4,4            | 2,9            | 1,5 |
| 80                 | 16   | 8,6                                                         | 3,8            | 2,7            | 2   | 11,1                                         | 4,7            | 3,2            | 2,5 |
| 85                 | 17   | 9,3                                                         | 4,5            | 2,9            | 2,2 | 11,1                                         | 4,7            | 3,2            | 2,5 |
| 90                 | 18   | 9,3                                                         | 4,5            | 2,9            | 2,2 | 13,4                                         | 5,2            | 4,2            | 2,2 |
| 95                 | 19   | 9,3                                                         | 4,5            | 2,9            | 2,2 | 13,4                                         | 5,2            | 4,2            | 2,2 |
| 100                | 20   | 10,9                                                        | 4,5            | 2,9            | 2,2 | 13,4                                         | 5,2            | 4,2            | 2,2 |
| 110                | 22   | 10,9                                                        | 4,5            | 2,9            | 2,2 | 15,1                                         | 6,2            | 4,2            | 2,2 |
| 120                | 24   | 11,9                                                        | 4,5            | 2,9            | 2,2 | 15,1                                         | 6,2            | 4,2            | 2,2 |

## Bearings made of NitroMax steel

The rings of conventional super-precision hybrid angular contact ball bearings are made of carbon chromium steel. Hybrid bearings can, however, be supplied with rings made of NitroMax steel (designation prefix V), a new generation high-nitrogen stainless steel. Bearing rings made of this material have superior corrosion resistance, high wear resistance and enhanced fatigue strength, a high modulus of elasticity and a high degree of hardness and impact toughness.

The combined properties of NitroMax steel rings and balls made of bearing grade silicon nitride greatly improve bearing performance, enabling the bearings to run up to three times longer than conventional hybrid bearings, depending on the lubrication conditions.

These bearings are particularly suitable for very demanding applications such as high-speed machining centres and milling machines, where speed, rigidity, and bearing service life are key operational parameters.

For additional information about carbon chromium steel, ceramics, and NitroMax steel, refer to *Materials for bearing rings and rolling elements* (→ page 141).

## Bearing arrangement design

Bearing arrangements using super-precision angular contact ball bearings can be specified as single bearings or as bearing sets.

An example of what options are available when ordering bearings for a three-bearing arrangement is provided in **table 5**.

### Single bearings and bearing sets

#### Single bearings

Single, super-precision angular contact ball bearings are available as standalone bearings or as universally matchable bearings. When ordering single bearings, indicate the number of individual bearings required.

#### Standalone bearings

Standalone bearings are intended for arrangements where only one bearing is used in each bearing position. Although the widths of the bearing rings are made to very tight tolerances, these bearings are not suitable for mounting immediately adjacent to each other.

Table 5

#### Example of the ordering possibilities for a three-bearing arrangement

| Design criteria                                                                                                                        | What to order                                 | Bearing series designation | Order example       |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------|---------------------|
| Bearings can be arranged immediately adjacent to each other in any order and in any orientation.                                       | Three single, universally matchable bearings  | 70 .. DG../P4A             | 3 x 7014 CDGA/P4A   |
| Bearings can be arranged immediately adjacent to each other in any order and in any orientation. Improved load sharing is desirable.   | A set of three universally matchable bearings | 70 .. D/P4ATG..            | 1 x 7014 CD/P4ATGA  |
| Bearings in a back-to-back and tandem arrangement. Improved load sharing is desirable.                                                 | Three bearings in a matched set               | 70 .. D/P4AT..             | 1 x 7014 CD/P4ATBTA |
| Bearings in a back-to-back and tandem arrangement. High speed capability with maximum rigidity and improved load sharing is desirable. | Three bearings in a matched set               | 70 .. E/P4AT..             | 1 x 7014 CE/P4ATBTA |
| Bearings in a back-to-back and tandem arrangement. Maximum speed capability with improved load sharing is desirable.                   | Three bearings in a matched set               | 70 .. E/P4AT..             | 1 x 7014 CE/P4ATBTL |

### Single, universally matchable bearings

Universally matchable bearings are specifically manufactured so that when mounted in random order, but immediately adjacent to each other, preload within a predetermined range and effective load sharing will result without the use of shims or similar devices.

Single, universally matchable bearings are available in different preload classes and are identified by the designation suffix G.

### Bearing sets

Sets of super-precision angular contact ball bearings are available as matched bearing sets or as sets of universally matchable bearings. When ordering bearing sets, indicate the number of bearing sets required (the number of individual bearings per set is specified in the designation).

### Matched bearing sets

Bearings can be supplied as a complete bearing set consisting of two, three or more bearings. The bearings are matched to each other during production so that when mounted immediately adjacent to each other, in the specified order, preload within a predetermined range and effective load sharing will result without the use of shims or similar devices.

The bore and outside diameters of these bearings are matched to within a maximum of one-third of the permitted diameter tolerance, to provide better load distribution than single universally matchable bearings.

Matched bearing sets are available in different preload classes.

### Sets of universally matchable bearings

Bearings in these sets can be mounted in random order for any desired bearing arrangement. The bore and outside diameters of a set of universally matchable bearings are matched to within a maximum of one-third of the permitted diameter tolerance, resulting in better load sharing, when mounted, than single universally matchable bearings.

Sets of universally matchable bearings are available in different preload classes.

Like single, universally matchable bearings, sets of universally matchable bearings are identified by the designation suffix G, but the position of the letter G in the designation is different.

## Bearing arrangements

### Back-to-back arrangement

In a back-to-back arrangement (→ **fig. 11**), the load lines diverge along the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in each direction.

Bearings mounted back-to-back provide a relatively rigid bearing arrangement. The wide span between bearing effective centres makes this arrangement particularly well suited to support moment loads.

### Face-to-face arrangement

In a face-to-face arrangement (→ **fig. 12**), the load lines converge along the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in each direction.

The short span between effective bearing centres makes face-to-face arrangements less suitable to support moment loads.

### Tandem arrangement

The use of a tandem arrangement provides increased axial and radial load carrying capacity compared to a single bearing. In a tandem arrangement (→ **fig. 13**), the load lines are parallel so that radial and axial loads are shared.

The bearing set can only accommodate axial loads acting in one direction. If axial loads act in both directions, or if combined loads are present, additional bearing(s) adjusted against the tandem arrangement must be added.



Fig. 11

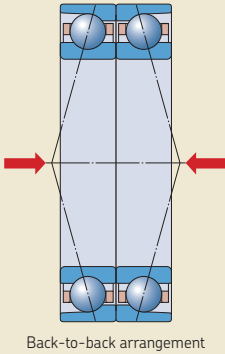


Fig. 12

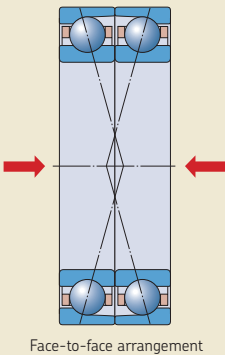
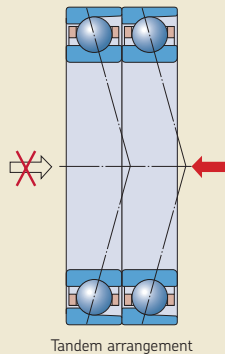


Fig. 13



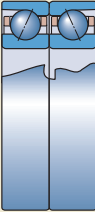
## Examples

Universally matchable bearings and matched bearing sets can be arranged in various ways depending on the stiffness and load requirements of the application. The possible arrangements are shown in **fig. 14** (→ **page 143**), including the designation suffixes applicable to matched bearing sets.

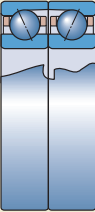
## Reducing inventories

To decrease inventories and improve parts availability, SKF recommends using universally matchable bearings whenever possible. With universally matchable bearings, a multitude of different bearing sets can be obtained.

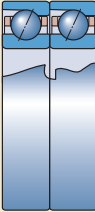
**Bearing sets with 2 bearings**



Back-to-back arrangement  
Designation suffix DB

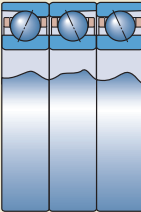


Face-to-face arrangement  
Designation suffix DF

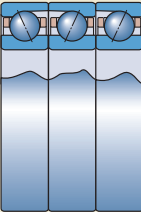


Tandem arrangement  
Designation suffix DT

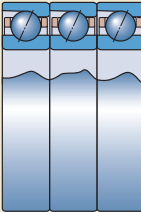
**Bearing sets with 3 bearings**



Back-to-back and tandem  
arrangement  
Designation suffix TBT

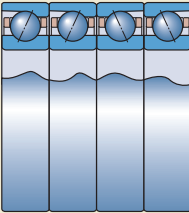


Face-to-face and tandem  
arrangement  
Designation suffix TFT

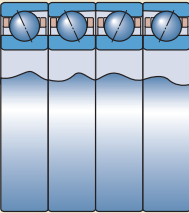


Tandem arrangement  
Designation suffix TT

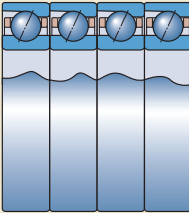
**Bearing sets with 4 bearings**



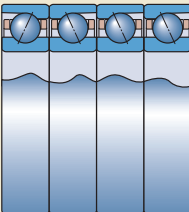
Tandem back-to-back  
arrangement  
Designation suffix QBC



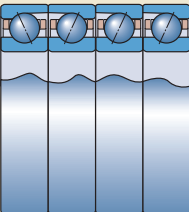
Tandem face-to-face  
arrangement  
Designation suffix QFC



Tandem arrangement  
Designation suffix QT



Back-to-back and tandem  
arrangement  
Designation suffix QBT



Face-to-face and tandem  
arrangement  
Designation suffix QFT

# Markings on bearings and bearing sets

Each super-precision angular contact ball bearing has various markings on the side faces of the rings (→ **fig. 15**):

- 1 SKF trademark
- 2 Complete designation of the bearing
- 3 Country of manufacture
- 4 Date of manufacture, coded
- 5 Deviation of the mean outside diameter  $\Delta_{Dm}$  [μm] and position of the maximum eccentricity of the outer ring
- 6 Deviation of the mean bore diameter  $\Delta_{dm}$  [μm] and position of the maximum eccentricity of the inner ring
- 7 Thrust face mark, punched
- 8 Serial number (bearing sets only)
- 9 "V-shaped" marking (matched bearing sets only)

Sealed bearings are marked in a similar way.

## "V-shaped" marking

A "V-shaped" marking on the outside surface of the outer rings of matched bearing sets indicates how the bearings should be mounted to obtain the proper preload in the set.

The marking also indicates how the bearing set should be mounted in relation to the axial load. The "V-shaped" marking should point in the direction that the axial load acts on the inner ring (→ **fig. 16**). In applications where there are axial loads in both directions, the "V-shaped" marking should point in the direction of the heavier of the two loads.

Fig. 16

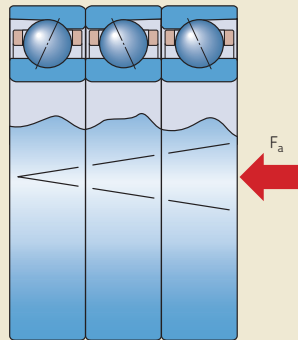
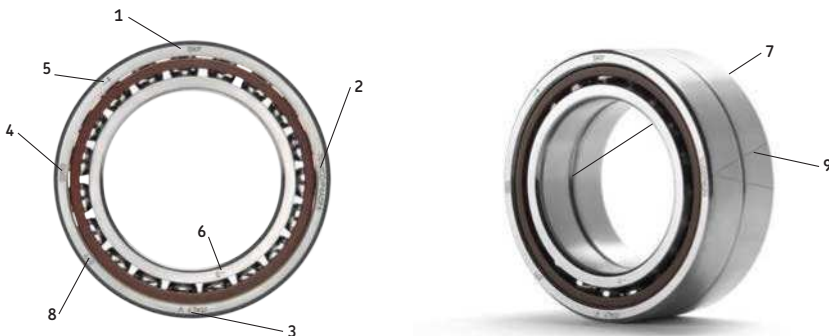


Fig. 15



## Bearing data

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Boundary dimensions                             | ISO 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Chamfer dimensions                              | <p>Minimum values for the chamfer dimensions in the radial direction (<math>r_1, r_3</math>) and axial direction (<math>r_2, r_4</math>) are listed in the product tables (→ <b>page 146</b>). The specifications differ according to the series.</p> <p><b>718 .. D series</b></p> <ul style="list-style-type: none"><li>• Values for the inner ring and thrust side of the outer ring: ISO 15</li><li>• Values for the non-thrust side of the outer ring are not standardized.</li></ul> <p><b>719 .. D, 70 .. D and 72 .. D series</b></p> <ul style="list-style-type: none"><li>• Values for the inner ring and thrust side of the outer ring: ISO 15</li><li>• Values for the non-thrust side of the outer ring: ISO 12044, where applicable</li></ul> <p><b>719 .. E series</b></p> <ul style="list-style-type: none"><li>• Values for the non-thrust side of the inner ring (<math>d \leq 30</math> mm), thrust side of the inner ring, and thrust side of the outer ring: ISO 15</li><li>• Values for the non-thrust side of the inner ring (<math>d &gt; 30</math> mm): smaller than those in accordance with ISO 15</li><li>• Values for the non-thrust side of the outer ring: ISO 12044</li></ul> <p><b>70 .. E series</b></p> <ul style="list-style-type: none"><li>• Values for the inner ring and thrust side of the outer ring: ISO 15</li><li>• Values for the non-thrust side of the outer ring: ISO 12044</li></ul> <p><b>719 .. B and 70 .. B series</b></p> <ul style="list-style-type: none"><li>• Values for the inner ring and thrust side of the outer ring: ISO 15</li><li>• Values for the non-thrust side of the outer ring: smaller than those in accordance with ISO 15</li></ul> <p>The appropriate maximum chamfer limits, which are important when dimensioning fillet radii on associated components, are in accordance with ISO 582 and are listed in the product tables.</p> |
| Tolerances                                      | <p>P4A or P4 class tolerances as standard. PA9A or P2 class tolerances available on request.</p> <p>The tolerance values are listed for:</p> <ul style="list-style-type: none"><li>• P4A class tolerances (→ <b>table 6</b>)</li><li>• P4 class tolerances (→ <b>table 7, page 146</b>)</li><li>• PA9A class tolerances (→ <b>table 8, page 146</b>)</li><li>• P2 class tolerances (→ <b>table 9, page 146</b>)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| For additional information (→ <b>page 146</b> ) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

Table 6

## Class P4A tolerances

| Inner ring |       | $\Delta_{dmp}^{(1)}$ |     | $\Delta_{ds}^{(2)}$ |     | $V_{dp}$       | $V_{dmp}$       | $\Delta_{Bs}$                                                                                         |      | $\Delta_{B1s}$ |          | $V_{Bs}$ | $K_{ia}$ | $S_d$   | $S_{ia}$ |
|------------|-------|----------------------|-----|---------------------|-----|----------------|-----------------|-------------------------------------------------------------------------------------------------------|------|----------------|----------|----------|----------|---------|----------|
| d          | incl. | high                 | low | high                | low | max.           | max.            | high                                                                                                  | low  | high           | low      | max.     | max.     | max.    | max.     |
| mm         |       | $\mu m$              |     | $\mu m$             |     | $\mu m$        | $\mu m$         | $\mu m$                                                                                               |      | $\mu m$        |          | $\mu m$  | $\mu m$  | $\mu m$ | $\mu m$  |
| 2,5        | 10    | 0                    | -4  | 0                   | -4  | 1,5            | 1               | 0                                                                                                     | -40  | 0              | -250     | 1,5      | 1,5      | 1,5     | 1,5      |
| 10         | 18    | 0                    | -4  | 0                   | -4  | 1,5            | 1               | 0                                                                                                     | -80  | 0              | -250     | 1,5      | 1,5      | 1,5     | 1,5      |
| 18         | 30    | 0                    | -5  | 0                   | -5  | 1,5            | 1               | 0                                                                                                     | -120 | 0              | -250     | 1,5      | 2,5      | 1,5     | 2,5      |
| 30         | 50    | 0                    | -6  | 0                   | -6  | 1,5            | 1               | 0                                                                                                     | -120 | 0              | -250     | 1,5      | 2,5      | 1,5     | 2,5      |
| 50         | 80    | 0                    | -7  | 0                   | -7  | 2              | 1,5             | 0                                                                                                     | -150 | 0              | -250     | 1,5      | 2,5      | 1,5     | 2,5      |
| 80         | 120   | 0                    | -8  | 0                   | -8  | 2,5            | 1,5             | 0                                                                                                     | -200 | 0              | -380     | 2,5      | 2,5      | 2,5     | 2,5      |
| 120        | 150   | 0                    | -10 | 0                   | -10 | 6              | 3               | 0                                                                                                     | -250 | 0              | -380     | 4        | 4        | 4       | 4        |
| 150        | 180   | 0                    | -10 | 0                   | -10 | 6              | 3               | 0                                                                                                     | -250 | 0              | -380     | 4        | 6        | 5       | 6        |
| 180        | 250   | 0                    | -12 | 0                   | -12 | 7              | 4               | 0                                                                                                     | -300 | 0              | -500     | 5        | 7        | 6       | 7        |
| 250        | 315   | 0                    | -13 | 0                   | -13 | 8              | 5               | 0                                                                                                     | -350 | 0              | -550     | 6        | 8        | 7       | 7        |
| 315        | 400   | 0                    | -16 | 0                   | -16 | 10             | 6               | 0                                                                                                     | -400 | 0              | -600     | 6        | 9        | 8       | 8        |
| Outer ring |       |                      |     |                     |     |                |                 |                                                                                                       |      |                |          |          |          |         |          |
| D          | incl. | $\Delta_{Dmp}^{(1)}$ |     | $\Delta_{Ds}^{(2)}$ |     | $V_{Dp}^{(3)}$ | $V_{Dmp}^{(3)}$ | $\Delta_{Cs}, \Delta_{C1s}$                                                                           |      | $V_{Cs}$       | $K_{ea}$ | $S_D$    | $S_{ea}$ |         |          |
| over       |       | high                 | low | high                | low | max.           | max.            |                                                                                                       |      | max.           | max.     | max.     | max.     |         |          |
| mm         |       | $\mu m$              |     | $\mu m$             |     | $\mu m$        | $\mu m$         |                                                                                                       |      | $\mu m$        | $\mu m$  | $\mu m$  | $\mu m$  |         |          |
| 10         | 18    | 0                    | -4  | 0                   | -4  | 1,5            | 1               | Values are identical to those for the inner ring of the same bearing ( $\Delta_{Bs}, \Delta_{B1s}$ ). |      | 1,5            | 1,5      | 1,5      | 1,5      |         |          |
| 18         | 30    | 0                    | -5  | 0                   | -5  | 2              | 1,5             |                                                                                                       |      | 1,5            | 1,5      | 1,5      |          |         |          |
| 30         | 50    | 0                    | -6  | 0                   | -6  | 2              | 1,5             |                                                                                                       |      | 1,5            | 2,5      | 1,5      | 2,5      |         |          |
| 50         | 80    | 0                    | -7  | 0                   | -7  | 2              | 1,5             |                                                                                                       |      | 1,5            | 4        | 1,5      | 4        |         |          |
| 80         | 120   | 0                    | -8  | 0                   | -8  | 2,5            | 1,5             |                                                                                                       |      | 2,5            | 5        | 2,5      | 5        |         |          |
| 120        | 150   | 0                    | -9  | 0                   | -9  | 4              | 1,5             |                                                                                                       |      | 2,5            | 5        | 2,5      | 5        |         |          |
| 150        | 180   | 0                    | -10 | 0                   | -10 | 6              | 3               |                                                                                                       |      | 4              | 6        | 4        | 6        |         |          |
| 180        | 250   | 0                    | -11 | 0                   | -11 | 6              | 4               |                                                                                                       |      | 5              | 8        | 5        | 8        |         |          |
| 250        | 315   | 0                    | -13 | 0                   | -13 | 8              | 5               |                                                                                                       |      | 5              | 9        | 6        | 8        |         |          |
| 315        | 400   | 0                    | -15 | 0                   | -15 | 9              | 6               |                                                                                                       |      | 7              | 10       | 8        | 10       |         |          |
| 400        | 500   | 0                    | -20 | 0                   | -20 | 12             | 8               |                                                                                                       |      | 8              | 13       | 10       | 13       |         |          |

Tolerance symbols and definitions → table 4, page 147

<sup>1)</sup> These deviations apply for bearings in the 8 and 9 diameter series only.<sup>2)</sup> These deviations apply for bearings in the 0 and 2 diameter series only.<sup>3)</sup> For sealed bearings, values refer to the ring before the seals are installed.

Table 7

Class P4 (ABEC 7) tolerances

| Inner ring |       | $\Delta_{dmp}^{(1)}$ |     | $\Delta_{ds}^{(2)}$ |     | $V_{dp}$       | $V_{dmp}$       | $\Delta_{Bs}$                                                                                         |      | $\Delta_{B1s}$ |      | $V_{Bs}$ | $K_{ia}$ | $S_d$   | $S_{ia}$ |
|------------|-------|----------------------|-----|---------------------|-----|----------------|-----------------|-------------------------------------------------------------------------------------------------------|------|----------------|------|----------|----------|---------|----------|
| d          | incl. | high                 | low | high                | low | max.           | max.            | high                                                                                                  | low  | high           | low  | max.     | max.     | max.    | max.     |
| mm         |       | $\mu m$              |     | $\mu m$             |     | $\mu m$        | $\mu m$         | $\mu m$                                                                                               |      | $\mu m$        |      | $\mu m$  | $\mu m$  | $\mu m$ | $\mu m$  |
| 2,5        | 10    | 0                    | -4  | 0                   | -4  | 4              | 2               | 0                                                                                                     | -60  | 0              | -250 | 2,5      | 2,5      | 3       | 3        |
| 10         | 18    | 0                    | -4  | 0                   | -4  | 4              | 2               | 0                                                                                                     | -80  | 0              | -250 | 2,5      | 2,5      | 3       | 3        |
| 18         | 30    | 0                    | -5  | 0                   | -5  | 5              | 2,5             | 0                                                                                                     | -120 | 0              | -250 | 2,5      | 3        | 4       | 4        |
| 30         | 50    | 0                    | -6  | 0                   | -6  | 6              | 3               | 0                                                                                                     | -120 | 0              | -250 | 3        | 4        | 4       | 4        |
| 50         | 80    | 0                    | -7  | 0                   | -7  | 7              | 3,5             | 0                                                                                                     | -150 | 0              | -250 | 4        | 4        | 5       | 5        |
| 80         | 120   | 0                    | -8  | 0                   | -8  | 8              | 4               | 0                                                                                                     | -200 | 0              | -380 | 4        | 5        | 5       | 5        |
| 120        | 150   | 0                    | -10 | 0                   | -10 | 10             | 5               | 0                                                                                                     | -250 | 0              | -380 | 5        | 6        | 6       | 7        |
| 150        | 180   | 0                    | -10 | 0                   | -10 | 10             | 5               | 0                                                                                                     | -250 | 0              | -380 | 5        | 6        | 6       | 7        |
| Outer ring |       | $\Delta_{Dmp}^{(1)}$ |     | $\Delta_{Ds}^{(2)}$ |     | $V_{Dp}^{(3)}$ | $V_{Dmp}^{(3)}$ | $\Delta_{Cs}, \Delta_{C1s}$                                                                           |      |                |      | $V_{Cs}$ | $K_{ea}$ | $S_D$   | $S_{ea}$ |
| D          | incl. | high                 | low | high                | low | max.           | max.            |                                                                                                       |      |                |      | max.     | max.     | max.    | max.     |
| mm         |       | $\mu m$              |     | $\mu m$             |     | $\mu m$        | $\mu m$         |                                                                                                       |      |                |      | $\mu m$  | $\mu m$  | $\mu m$ | $\mu m$  |
| 18         | 30    | 0                    | -5  | 0                   | -5  | 5              | 2,5             | Values are identical to those for the inner ring of the same bearing ( $\Delta_{Bs}, \Delta_{B1s}$ ). |      |                |      | 2,5      | 4        | 4       | 5        |
| 30         | 50    | 0                    | -6  | 0                   | -6  | 6              | 3               |                                                                                                       |      |                |      | 2,5      | 5        | 4       | 5        |
| 50         | 80    | 0                    | -7  | 0                   | -7  | 7              | 3,5             |                                                                                                       |      |                |      | 3        | 5        | 4       | 5        |
| 80         | 120   | 0                    | -8  | 0                   | -8  | 8              | 4               |                                                                                                       |      |                |      | 4        | 6        | 5       | 6        |
| 120        | 150   | 0                    | -9  | 0                   | -9  | 9              | 5               |                                                                                                       |      |                |      | 5        | 7        | 5       | 7        |
| 150        | 180   | 0                    | -10 | 0                   | -10 | 10             | 5               |                                                                                                       |      |                |      | 5        | 8        | 5       | 8        |
| 180        | 250   | 0                    | -11 | 0                   | -11 | 11             | 6               |                                                                                                       |      |                |      | 7        | 10       | 7       | 10       |

Tolerance symbols and definitions → table 4, page 148

1) These deviations apply for bearings in the 8 and 9 diameter series only.

2) These deviations apply for bearings in the 0 and 2 diameter series only.

3) For sealed bearings, values refer to the ring before the seals are installed.

Table 8

## Class PA9A tolerances

| Inner ring |       | $\Delta_{dmp}^{(1)}$ |      | $\Delta_{ds}^{(2)}$ |      | $V_{dp}$       | $V_{dmp}$       | $\Delta_{Bs}$                                                                                         |      | $\Delta_{B1s}$ |      | $V_{Bs}$ | $K_{ia}$ | $S_d$    | $S_{ia}$ |
|------------|-------|----------------------|------|---------------------|------|----------------|-----------------|-------------------------------------------------------------------------------------------------------|------|----------------|------|----------|----------|----------|----------|
| d over     | incl. | high                 | low  | high                | low  | max.           | max.            | high                                                                                                  | low  | high           | low  | max.     | max.     | max.     | max.     |
| mm         |       | $\mu m$              |      | $\mu m$             |      | $\mu m$        | $\mu m$         | $\mu m$                                                                                               |      | $\mu m$        |      | $\mu m$  | $\mu m$  | $\mu m$  | $\mu m$  |
| 2,5        | 10    | 0                    | -2,5 | 0                   | -2,5 | 1,5            | 1               | 0                                                                                                     | -40  | 0              | -250 | 1,5      | 1,5      | 1,5      | 1,5      |
| 10         | 18    | 0                    | -2,5 | 0                   | -2,5 | 1,5            | 1               | 0                                                                                                     | -80  | 0              | -250 | 1,5      | 1,5      | 1,5      | 1,5      |
| 18         | 30    | 0                    | -2,5 | 0                   | -2,5 | 1,5            | 1               | 0                                                                                                     | -120 | 0              | -250 | 1,5      | 2,5      | 1,5      | 2,5      |
| 30         | 50    | 0                    | -2,5 | 0                   | -2,5 | 1,5            | 1               | 0                                                                                                     | -120 | 0              | -250 | 1,5      | 2,5      | 1,5      | 2,5      |
| 50         | 80    | 0                    | -4   | 0                   | -4   | 2              | 1,5             | 0                                                                                                     | -150 | 0              | -250 | 1,5      | 2,5      | 1,5      | 2,5      |
| 80         | 120   | 0                    | -5   | 0                   | -5   | 2,5            | 1,5             | 0                                                                                                     | -200 | 0              | -380 | 2,5      | 2,5      | 2,5      | 2,5      |
| 120        | 150   | 0                    | -7   | 0                   | -7   | 4              | 3               | 0                                                                                                     | -250 | 0              | -380 | 2,5      | 2,5      | 2,5      | 2,5      |
| 150        | 180   | 0                    | -7   | 0                   | -7   | 4              | 3               | 0                                                                                                     | -250 | 0              | -380 | 4        | 5        | 4        | 5        |
| 180        | 250   | 0                    | -8   | 0                   | -8   | 5              | 4               | 0                                                                                                     | -300 | 0              | -500 | 5        | 5        | 5        | 5        |
|            |       |                      |      |                     |      |                |                 |                                                                                                       |      |                |      |          |          |          |          |
| Outer ring |       | $\Delta_{Dmp}^{(1)}$ |      | $\Delta_{Ds}^{(2)}$ |      | $V_{Dp}^{(3)}$ | $V_{Dmp}^{(3)}$ | $\Delta_{Cs}, \Delta_{C1s}$                                                                           |      | $V_{Cs}$       |      | $K_{ea}$ | $S_D$    | $S_{ea}$ |          |
| D over     | incl. | high                 | low  | high                | low  | max.           | max.            |                                                                                                       |      | max.           |      | max.     | max.     | max.     |          |
| mm         |       | $\mu m$              |      | $\mu m$             |      | $\mu m$        | $\mu m$         |                                                                                                       |      | $\mu m$        |      | $\mu m$  | $\mu m$  | $\mu m$  |          |
| 10         | 18    | 0                    | -2,5 | 0                   | -2,5 | 1,5            | 1               | Values are identical to those for the inner ring of the same bearing ( $\Delta_{Bs}, \Delta_{B1s}$ ). |      | 1,5            | 1,5  | 1,5      | 1,5      |          |          |
| 18         | 30    | 0                    | -4   | 0                   | -4   | 2              | 1,5             |                                                                                                       |      | 1,5            | 1,5  | 1,5      |          |          |          |
| 30         | 50    | 0                    | -4   | 0                   | -4   | 2              | 1,5             |                                                                                                       |      | 1,5            | 2,5  | 1,5      | 2,5      |          |          |
| 50         | 80    | 0                    | -4   | 0                   | -4   | 2              | 1,5             |                                                                                                       |      | 1,5            | 4    | 1,5      | 4        |          |          |
| 80         | 120   | 0                    | -5   | 0                   | -5   | 2,5            | 1,5             |                                                                                                       |      | 2,5            | 5    | 2,5      | 5        |          |          |
| 120        | 150   | 0                    | -5   | 0                   | -5   | 2,5            | 1,5             |                                                                                                       |      | 2,5            | 5    | 2,5      | 5        |          |          |
| 150        | 180   | 0                    | -7   | 0                   | -7   | 4              | 3               |                                                                                                       |      | 2,5            | 5    | 2,5      | 5        |          |          |
| 180        | 250   | 0                    | -8   | 0                   | -8   | 5              | 4               |                                                                                                       |      | 4              | 7    | 4        | 7        |          |          |
| 250        | 315   | 0                    | -8   | 0                   | -8   | 5              | 4               |                                                                                                       |      | 5              | 7    | 5        | 7        |          |          |
| 315        | 400   | 0                    | -10  | 0                   | -10  | 6              | 5               |                                                                                                       |      | 7              | 8    | 7        | 8        |          |          |

Tolerance symbols and definitions → table 4, page 149

1) These deviations apply for bearings in the 8 and 9 diameter series only.

2) These deviations apply for bearings in the 0 and 2 diameter series only.

3) For sealed bearings, values refer to the ring before the seals are installed.

Table 9

Class P2 (ABEC 9) tolerances

| Inner ring |       | $\Delta_{dmp}^{(1)}$ |      | $\Delta_{ds}^{(2)}$ |      | $V_{dp}$ | $V_{dmp}$ | $\Delta_{Bs}$                                                                                         |      | $\Delta_{B1s}$ |      | $V_{Bs}$ | $K_{ia}$ | $S_d$   | $S_{ia}$ |
|------------|-------|----------------------|------|---------------------|------|----------|-----------|-------------------------------------------------------------------------------------------------------|------|----------------|------|----------|----------|---------|----------|
| d over     | incl. | high                 | low  | high                | low  | max.     | max.      | high                                                                                                  | low  | high           | low  | max.     | max.     | max.    | max.     |
| mm         |       | $\mu m$              |      | $\mu m$             |      | $\mu m$  | $\mu m$   | $\mu m$                                                                                               |      | $\mu m$        |      | $\mu m$  | $\mu m$  | $\mu m$ | $\mu m$  |
| 2,5        | 10    | 0                    | -2,5 | 0                   | -2,5 | 2,5      | 1,5       | 0                                                                                                     | -40  | 0              | -250 | 1,5      | 1,5      | 1,5     | 1,5      |
| 10         | 18    | 0                    | -2,5 | 0                   | -2,5 | 2,5      | 1,5       | 0                                                                                                     | -80  | 0              | -250 | 1,5      | 1,5      | 1,5     | 1,5      |
| 18         | 30    | 0                    | -2,5 | 0                   | -2,5 | 2,5      | 1,5       | 0                                                                                                     | -120 | 0              | -250 | 1,5      | 2,5      | 1,5     | 2,5      |
| 30         | 50    | 0                    | -2,5 | 0                   | -2,5 | 2,5      | 1,5       | 0                                                                                                     | -120 | 0              | -250 | 1,5      | 2,5      | 1,5     | 2,5      |
| 50         | 80    | 0                    | -4   | 0                   | -4   | 4        | 2         | 0                                                                                                     | -150 | 0              | -250 | 1,5      | 2,5      | 1,5     | 2,5      |
| 80         | 120   | 0                    | -5   | 0                   | -5   | 5        | 2,5       | 0                                                                                                     | -200 | 0              | -380 | 2,5      | 2,5      | 2,5     | 2,5      |
| 120        | 150   | 0                    | -7   | 0                   | -7   | 7        | 3,5       | 0                                                                                                     | -250 | 0              | -380 | 2,5      | 2,5      | 2,5     | 2,5      |
| 150        | 180   | 0                    | -7   | 0                   | -7   | 7        | 3,5       | 0                                                                                                     | -250 | 0              | -380 | 4        | 5        | 4       | 5        |
|            |       |                      |      |                     |      |          |           |                                                                                                       |      |                |      |          |          |         |          |
| Outer ring |       | $\Delta_{Dmp}^{(1)}$ |      | $\Delta_{Ds}^{(2)}$ |      | $V_{Dp}$ | $V_{Dmp}$ | $\Delta_{Cs}, \Delta_{C1s}$                                                                           |      |                |      | $V_{Cs}$ | $K_{ea}$ | $S_D$   | $S_{ea}$ |
| D over     | incl. | high                 | low  | high                | low  | max.     | max.      |                                                                                                       |      |                |      | max.     | max.     | max.    | max.     |
| mm         |       | $\mu m$              |      | $\mu m$             |      | $\mu m$  | $\mu m$   |                                                                                                       |      |                |      | $\mu m$  | $\mu m$  | $\mu m$ | $\mu m$  |
| 18         | 30    | 0                    | -4   | 0                   | -4   | 4        | 2         | Values are identical to those for the inner ring of the same bearing ( $\Delta_{Bs}, \Delta_{B1s}$ ). |      |                |      | 1,5      | 2,5      | 1,5     | 2,5      |
| 30         | 50    | 0                    | -4   | 0                   | -4   | 4        | 2         |                                                                                                       |      |                |      | 1,5      | 2,5      | 1,5     | 2,5      |
| 50         | 80    | 0                    | -4   | 0                   | -4   | 4        | 2         |                                                                                                       |      |                |      | 1,5      | 4        | 1,5     | 4        |
| 80         | 120   | 0                    | -5   | 0                   | -5   | 5        | 2,5       |                                                                                                       |      |                |      | 2,5      | 5        | 2,5     | 5        |
| 120        | 150   | 0                    | -5   | 0                   | -5   | 5        | 2,5       |                                                                                                       |      |                |      | 2,5      | 5        | 2,5     | 5        |
| 150        | 180   | 0                    | -7   | 0                   | -7   | 7        | 3,5       |                                                                                                       |      |                |      | 2,5      | 5        | 2,5     | 5        |
|            |       |                      |      |                     |      |          |           |                                                                                                       |      |                |      |          |          |         |          |
| 180        | 250   | 0                    | -8   | 0                   | -8   | 8        | 4         |                                                                                                       |      |                |      | 4        | 7        | 4       | 7        |

Tolerance symbols and definitions → table 4, page 150

<sup>1)</sup> These deviations apply for bearings in the 8 and 9 diameter series only.

<sup>2)</sup> These deviations apply for bearings in the 0 and 2 diameter series only.



## Preload

A single super-precision angular contact ball bearing cannot be preloaded until a second bearing provides location in the opposite direction. Detailed information about preload is provided in the sections following.

### Bearings manufactured pre-set for preload

Universally matchable bearings and matched bearing sets are manufactured pre-set in different preload classes to meet varying requirements regarding rotational speed, rigidity, and operating temperature.

The amount of preload depends on the bearing series, the contact angle, the internal geometry, and the size of the bearing and applies to bearing sets in back-to-back or face-to-face arrangements. Preload values are not standardized and are listed in the following tables:

- **table 10 (→ page 151)** for bearings in the 718 .. D series
- **table 11 (→ page 151)** for bearings in the 719 .. D and 70 .. D series
- **table 12 (→ page 151)** for bearings in the 719 .. E and 70 .. E series
- **table 13 (→ page 151)** for bearings in the 719 .. B and 70 .. B series
- **table 14 (→ page 151)** for bearings in the 72 .. D series

Matched bearing sets with a special preload can be supplied on request. These bearing sets are identified by the designation suffix G followed by a number. The number is the mean preload value of the set expressed in daN. Special preload is not applicable for sets of universally matchable bearings consisting of three or more bearings. Matched bearing sets consisting of three or more bearings have a heavier preload than sets with two bearings. The preload for these bearing sets is obtained by multiplying the values for a single bearing by a factor listed in **table 15 (→ page 151)**.

### 719 .. D, 70 .. D and 72 .. D series

Bearings in the 719 .. D, 70 .. D and 72 .. D series are manufactured to four different preload classes:

- class A, extra light preload
- class B, light preload
- class C, moderate preload
- class D, heavy preload

### 718 .. D, 719 .. E and 70 .. E series

Bearings in the 718 .. D, 719 .. E and 70 .. E series are manufactured to three different preload classes:

- class A, light preload
- class B, moderate preload
- class C, heavy preload

These preload classes are valid for:

- single, universally matchable bearings
- sets of universally matchable bearings
- matched bearing sets

In applications where high speeds take precedence over the degree of rigidity, the following additional preload classes are available:

- class L, reduced light preload for asymmetrical bearing sets
- class M, reduced moderate preload for asymmetrical bearing sets
- class F, reduced heavy preload for asymmetrical bearing sets

As indicated, these preload classes are only available for matched bearing sets that are asymmetrical, e.g. TBT, TFT, QBT, and QFT. Bearing sets in the L, M or F preload class consisting of three or four bearings, have the same preload as sets with two bearings in the A, B or C preload class. Therefore, the preload for matched bearing sets that are asymmetrical, e.g. TBT, TFT, QBT, and QFT, can be obtained directly from the product tables.

An example of the preload possibilities for an arrangement with a matched set of 7014 CE bearings is presented in **table 16 (→ page 151)**.

## Angular contact ball bearings

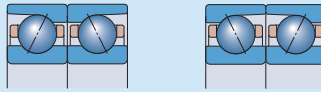
### 719 .. B and 70 .. B series

Bearings in the 719 .. B and 70 .. B series are manufactured to three different preload classes:

- class A, light preload
- class B, moderate preload
- class C, heavy preload

Table 10

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 718 .. D series

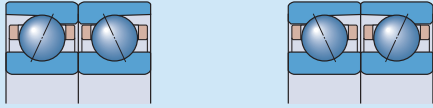


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>718 CD, 718 CD/HC<br>for preload class |     |       | 718 ACD, 718 ACD/HC<br>for preload class |       |       |
|--------------------|------|-------------------------------------------------------------------------------------------------|-----|-------|------------------------------------------|-------|-------|
|                    |      | A                                                                                               | B   | C     | A                                        | B     | C     |
| mm                 | –    | N                                                                                               |     |       |                                          |       |       |
| 10                 | 00   | 10                                                                                              | 30  | 60    | 16                                       | 48    | 100   |
| 12                 | 01   | 11                                                                                              | 33  | 66    | 17                                       | 53    | 105   |
| 15                 | 02   | 12                                                                                              | 36  | 72    | 19                                       | 58    | 115   |
| 17                 | 03   | 12                                                                                              | 37  | 75    | 20                                       | 60    | 120   |
| 20                 | 04   | 20                                                                                              | 60  | 120   | 32                                       | 100   | 200   |
| 25                 | 05   | 22                                                                                              | 66  | 132   | 35                                       | 105   | 210   |
| 30                 | 06   | 23                                                                                              | 70  | 140   | 37                                       | 110   | 220   |
| 35                 | 07   | 25                                                                                              | 75  | 150   | 39                                       | 115   | 230   |
| 40                 | 08   | 26                                                                                              | 78  | 155   | 40                                       | 120   | 240   |
| 45                 | 09   | 27                                                                                              | 80  | 160   | 41                                       | 125   | 250   |
| 50                 | 10   | 40                                                                                              | 120 | 240   | 60                                       | 180   | 360   |
| 55                 | 11   | 55                                                                                              | 165 | 330   | 87                                       | 260   | 520   |
| 60                 | 12   | 70                                                                                              | 210 | 420   | 114                                      | 340   | 680   |
| 65                 | 13   | 71                                                                                              | 215 | 430   | 115                                      | 345   | 690   |
| 70                 | 14   | 73                                                                                              | 220 | 440   | 117                                      | 350   | 700   |
| 75                 | 15   | 76                                                                                              | 225 | 450   | 120                                      | 360   | 720   |
| 80                 | 16   | 78                                                                                              | 235 | 470   | 123                                      | 370   | 740   |
| 85                 | 17   | 115                                                                                             | 345 | 690   | 183                                      | 550   | 1 100 |
| 90                 | 18   | 116                                                                                             | 350 | 700   | 184                                      | 555   | 1 110 |
| 95                 | 19   | 117                                                                                             | 355 | 710   | 186                                      | 560   | 1 120 |
| 100                | 20   | 120                                                                                             | 360 | 720   | 190                                      | 570   | 1 140 |
| 105                | 21   | 130                                                                                             | 390 | 780   | 200                                      | 600   | 1 200 |
| 110                | 22   | 160                                                                                             | 500 | 1 000 | 260                                      | 800   | 1 600 |
| 120                | 24   | 180                                                                                             | 550 | 1 100 | 280                                      | 850   | 1 700 |
| 130                | 26   | 210                                                                                             | 620 | 1 230 | 325                                      | 980   | 1 960 |
| 140                | 28   | 240                                                                                             | 720 | 1 440 | 380                                      | 1 140 | 2 280 |
| 150                | 30   | 270                                                                                             | 820 | 1 630 | 430                                      | 1 300 | 2 590 |
| 160                | 32   | 280                                                                                             | 850 | 1 700 | 450                                      | 1 350 | 2 690 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 153.

Table 11a

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 719 .. D series

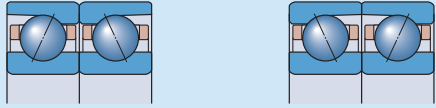


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>719 CD, 719 CD/HC<br>for preload class |       |       |        | 719 ACD, 719 ACD/HC<br>for preload class |       |       |        |
|--------------------|------|-------------------------------------------------------------------------------------------------|-------|-------|--------|------------------------------------------|-------|-------|--------|
|                    |      | A                                                                                               | B     | C     | D      | A                                        | B     | C     | D      |
| mm                 | –    | N                                                                                               |       |       |        |                                          |       |       |        |
| 10                 | 00   | 10                                                                                              | 20    | 40    | 80     | 15                                       | 30    | 60    | 120    |
| 12                 | 01   | 10                                                                                              | 20    | 40    | 80     | 15                                       | 30    | 60    | 120    |
| 15                 | 02   | 15                                                                                              | 30    | 60    | 120    | 25                                       | 50    | 100   | 200    |
| 17                 | 03   | 15                                                                                              | 30    | 60    | 120    | 25                                       | 50    | 100   | 200    |
| 20                 | 04   | 25                                                                                              | 50    | 100   | 200    | 35                                       | 70    | 140   | 280    |
| 25                 | 05   | 25                                                                                              | 50    | 100   | 200    | 40                                       | 80    | 160   | 320    |
| 30                 | 06   | 25                                                                                              | 50    | 100   | 200    | 40                                       | 80    | 160   | 320    |
| 35                 | 07   | 35                                                                                              | 70    | 140   | 280    | 60                                       | 120   | 240   | 480    |
| 40                 | 08   | 45                                                                                              | 90    | 180   | 360    | 70                                       | 140   | 280   | 560    |
| 45                 | 09   | 50                                                                                              | 100   | 200   | 400    | 80                                       | 160   | 320   | 640    |
| 50                 | 10   | 50                                                                                              | 100   | 200   | 400    | 80                                       | 160   | 320   | 640    |
| 55                 | 11   | 70                                                                                              | 140   | 280   | 560    | 120                                      | 240   | 480   | 960    |
| 60                 | 12   | 70                                                                                              | 140   | 280   | 560    | 120                                      | 240   | 480   | 960    |
| 65                 | 13   | 80                                                                                              | 160   | 320   | 640    | 120                                      | 240   | 480   | 960    |
| 70                 | 14   | 130                                                                                             | 260   | 520   | 1 040  | 200                                      | 400   | 800   | 1 600  |
| 75                 | 15   | 130                                                                                             | 260   | 520   | 1 040  | 210                                      | 420   | 840   | 1 680  |
| 80                 | 16   | 140                                                                                             | 280   | 560   | 1 120  | 220                                      | 440   | 880   | 1 760  |
| 85                 | 17   | 170                                                                                             | 340   | 680   | 1 360  | 270                                      | 540   | 1 080 | 2 160  |
| 90                 | 18   | 180                                                                                             | 360   | 720   | 1 440  | 280                                      | 560   | 1 120 | 2 240  |
| 95                 | 19   | 190                                                                                             | 380   | 760   | 1 520  | 290                                      | 580   | 1 160 | 2 320  |
| 100                | 20   | 230                                                                                             | 460   | 920   | 1 840  | 360                                      | 720   | 1 440 | 2 880  |
| 105                | 21   | 230                                                                                             | 460   | 920   | 1 840  | 360                                      | 720   | 1 440 | 2 880  |
| 110                | 22   | 230                                                                                             | 460   | 920   | 1 840  | 370                                      | 740   | 1 480 | 2 960  |
| 120                | 24   | 290                                                                                             | 580   | 1 160 | 2 320  | 450                                      | 900   | 1 800 | 3 600  |
| 130                | 26   | 350                                                                                             | 700   | 1 400 | 2 800  | 540                                      | 1 080 | 2 160 | 4 320  |
| 140                | 28   | 360                                                                                             | 720   | 1 440 | 2 880  | 560                                      | 1 120 | 2 240 | 4 480  |
| 150                | 30   | 470                                                                                             | 940   | 1 880 | 3 760  | 740                                      | 1 480 | 2 960 | 5 920  |
| 160                | 32   | 490                                                                                             | 980   | 1 960 | 3 920  | 800                                      | 1 600 | 3 200 | 6 400  |
| 170                | 34   | 500                                                                                             | 1 000 | 2 000 | 4 000  | 800                                      | 1 600 | 3 200 | 6 400  |
| 180                | 36   | 630                                                                                             | 1 260 | 2 520 | 5 040  | 1 000                                    | 2 000 | 4 000 | 8 000  |
| 190                | 38   | 640                                                                                             | 1 280 | 2 560 | 5 120  | 1 000                                    | 2 000 | 4 000 | 8 000  |
| 200                | 40   | 800                                                                                             | 1 600 | 3 200 | 6 400  | 1 250                                    | 2 500 | 5 000 | 10 000 |
| 220                | 44   | 850                                                                                             | 1 700 | 3 400 | 6 800  | 1 300                                    | 2 600 | 5 200 | 10 400 |
| 240                | 48   | 860                                                                                             | 1 720 | 3 440 | 6 880  | 1 350                                    | 2 700 | 5 400 | 10 800 |
| 260                | 52   | 1 050                                                                                           | 2 100 | 4 200 | 8 400  | 1 650                                    | 3 300 | 6 600 | 13 200 |
| 280                | 56   | 1 090                                                                                           | 2 180 | 4 360 | 8 720  | 1 700                                    | 3 400 | 6 800 | 13 600 |
| 300                | 60   | 1 400                                                                                           | 2 800 | 5 600 | 11 200 | 2 200                                    | 4 400 | 8 800 | 17 600 |
| 320                | 64   | 1 400                                                                                           | 2 800 | 5 600 | 11 200 | 2 200                                    | 4 400 | 8 800 | 17 600 |
| 340                | 68   | 1 460                                                                                           | 2 920 | 5 840 | 11 680 | 2 300                                    | 4 600 | 9 200 | 18 400 |
| 360                | 72   | 1 460                                                                                           | 2 920 | 5 840 | 11 680 | 2 300                                    | 4 600 | 9 200 | 18 400 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 154.

Table 11b

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 70 .. D series

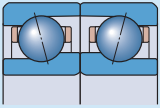
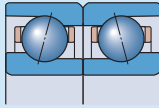


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>70 CD, 70 CD/HC<br>for preload class |       |       |        | 70 ACD, 70 ACD/HC<br>for preload class |       |       |        |
|--------------------|------|-----------------------------------------------------------------------------------------------|-------|-------|--------|----------------------------------------|-------|-------|--------|
|                    |      | A                                                                                             | B     | C     | D      | A                                      | B     | C     | D      |
| mm                 | –    | N                                                                                             |       |       |        |                                        |       |       |        |
| 6                  | 6    | 7                                                                                             | 13    | 25    | 50     | 12                                     | 25    | 50    | 100    |
| 7                  | 7    | 9                                                                                             | 18    | 35    | 70     | 15                                     | 30    | 60    | 120    |
| 8                  | 8    | 11                                                                                            | 22    | 45    | 90     | 20                                     | 40    | 80    | 160    |
| 9                  | 9    | 12                                                                                            | 25    | 50    | 100    | 22                                     | 45    | 90    | 180    |
| 10                 | 00   | 15                                                                                            | 30    | 60    | 120    | 25                                     | 50    | 100   | 200    |
| 12                 | 01   | 15                                                                                            | 30    | 60    | 120    | 25                                     | 50    | 100   | 200    |
| 15                 | 02   | 20                                                                                            | 40    | 80    | 160    | 30                                     | 60    | 120   | 240    |
| 17                 | 03   | 25                                                                                            | 50    | 100   | 200    | 40                                     | 80    | 160   | 320    |
| 20                 | 04   | 35                                                                                            | 70    | 140   | 280    | 50                                     | 100   | 200   | 400    |
| 25                 | 05   | 35                                                                                            | 70    | 140   | 280    | 60                                     | 120   | 240   | 480    |
| 30                 | 06   | 50                                                                                            | 100   | 200   | 400    | 90                                     | 180   | 360   | 720    |
| 35                 | 07   | 60                                                                                            | 120   | 240   | 480    | 90                                     | 180   | 360   | 720    |
| 40                 | 08   | 60                                                                                            | 120   | 240   | 480    | 100                                    | 200   | 400   | 800    |
| 45                 | 09   | 110                                                                                           | 220   | 440   | 880    | 170                                    | 340   | 680   | 1 360  |
| 50                 | 10   | 110                                                                                           | 220   | 440   | 880    | 180                                    | 360   | 720   | 1 440  |
| 55                 | 11   | 150                                                                                           | 300   | 600   | 1 200  | 230                                    | 460   | 920   | 1 840  |
| 60                 | 12   | 150                                                                                           | 300   | 600   | 1 200  | 240                                    | 480   | 960   | 1 920  |
| 65                 | 13   | 160                                                                                           | 320   | 640   | 1 280  | 240                                    | 480   | 960   | 1 920  |
| 70                 | 14   | 200                                                                                           | 400   | 800   | 1 600  | 300                                    | 600   | 1 200 | 2 400  |
| 75                 | 15   | 200                                                                                           | 400   | 800   | 1 600  | 310                                    | 620   | 1 240 | 2 480  |
| 80                 | 16   | 240                                                                                           | 480   | 960   | 1 920  | 390                                    | 780   | 1 560 | 3 120  |
| 85                 | 17   | 250                                                                                           | 500   | 1 000 | 2 000  | 400                                    | 800   | 1 600 | 3 200  |
| 90                 | 18   | 300                                                                                           | 600   | 1 200 | 2 400  | 460                                    | 920   | 1 840 | 3 680  |
| 95                 | 19   | 310                                                                                           | 620   | 1 240 | 2 480  | 480                                    | 960   | 1 920 | 3 840  |
| 100                | 20   | 310                                                                                           | 620   | 1 240 | 2 480  | 500                                    | 1 000 | 2 000 | 4 000  |
| 105                | 21   | 360                                                                                           | 720   | 1 440 | 2 880  | 560                                    | 1 120 | 2 240 | 4 480  |
| 110                | 22   | 420                                                                                           | 840   | 1 680 | 3 360  | 650                                    | 1 300 | 2 600 | 5 200  |
| 120                | 24   | 430                                                                                           | 860   | 1 720 | 3 440  | 690                                    | 1 380 | 2 760 | 5 520  |
| 130                | 26   | 560                                                                                           | 1 120 | 2 240 | 4 480  | 900                                    | 1 800 | 3 600 | 7 200  |
| 140                | 28   | 570                                                                                           | 1 140 | 2 280 | 4 560  | 900                                    | 1 800 | 3 600 | 7 200  |
| 150                | 30   | 650                                                                                           | 1 300 | 2 600 | 5 200  | 1 000                                  | 2 000 | 4 000 | 8 000  |
| 160                | 32   | 730                                                                                           | 1 460 | 2 920 | 5 840  | 1 150                                  | 2 300 | 4 600 | 9 200  |
| 170                | 34   | 800                                                                                           | 1 600 | 3 200 | 6 400  | 1 250                                  | 2 500 | 5 000 | 10 000 |
| 180                | 36   | 900                                                                                           | 1 800 | 3 600 | 7 200  | 1 450                                  | 2 900 | 5 800 | 11 600 |
| 190                | 38   | 950                                                                                           | 1 900 | 3 800 | 7 600  | 1 450                                  | 2 900 | 5 800 | 11 600 |
| 200                | 40   | 1 100                                                                                         | 2 200 | 4 400 | 8 800  | 1 750                                  | 3 500 | 7 000 | 14 000 |
| 220                | 44   | 1 250                                                                                         | 2 500 | 5 000 | 10 000 | 2 000                                  | 4 000 | 8 000 | 16 000 |
| 240                | 48   | 1 300                                                                                         | 2 600 | 5 200 | 10 400 | 2 050                                  | 4 100 | 8 200 | 16 400 |
| 260                | 52   | 1 550                                                                                         | 3 100 | 6 200 | 12 400 | 2 480                                  | 4 960 | 9 920 | 19 840 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 155.

Table 12a

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 719 .. E series

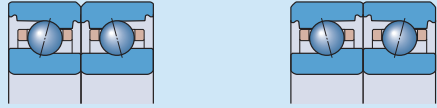


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup> |     |       |                                          |       |       |
|--------------------|------|-------------------------------------------------------|-----|-------|------------------------------------------|-------|-------|
|                    |      | 719 CE, 719 CE/HC<br>for preload class                |     |       | 719 ACE, 719 ACE/HC<br>for preload class |       |       |
|                    |      | A                                                     | B   | C     | A                                        | B     | C     |
| mm                 | –    | N                                                     |     |       |                                          |       |       |
| 8                  | 8    | 9                                                     | 27  | 55    | 15                                       | 46    | 91    |
| 9                  | 9    | 11                                                    | 32  | 64    | 17                                       | 50    | 100   |
| 10                 | 00   | 11                                                    | 32  | 65    | 17                                       | 50    | 100   |
| 12                 | 01   | 11                                                    | 34  | 68    | 18                                       | 55    | 110   |
| 15                 | 02   | 17                                                    | 51  | 102   | 28                                       | 84    | 170   |
| 17                 | 03   | 18                                                    | 54  | 108   | 29                                       | 87    | 175   |
| 20                 | 04   | 26                                                    | 79  | 157   | 42                                       | 130   | 250   |
| 25                 | 05   | 28                                                    | 85  | 170   | 45                                       | 140   | 270   |
| 30                 | 06   | 30                                                    | 90  | 180   | 48                                       | 145   | 290   |
| 35                 | 07   | 41                                                    | 125 | 250   | 66                                       | 200   | 400   |
| 40                 | 08   | 52                                                    | 157 | 315   | 84                                       | 250   | 505   |
| 45                 | 09   | 55                                                    | 166 | 331   | 88                                       | 265   | 529   |
| 50                 | 10   | 69                                                    | 210 | 410   | 110                                      | 330   | 660   |
| 55                 | 11   | 83                                                    | 250 | 500   | 133                                      | 400   | 800   |
| 60                 | 12   | 87                                                    | 262 | 523   | 139                                      | 418   | 836   |
| 65                 | 13   | 89                                                    | 266 | 532   | 142                                      | 425   | 850   |
| 70                 | 14   | 120                                                   | 360 | 710   | 190                                      | 570   | 1 130 |
| 75                 | 15   | 120                                                   | 361 | 722   | 192                                      | 577   | 1 150 |
| 80                 | 16   | 123                                                   | 370 | 740   | 195                                      | 590   | 1 170 |
| 85                 | 17   | 160                                                   | 479 | 957   | 255                                      | 765   | 1 529 |
| 90                 | 18   | 163                                                   | 488 | 977   | 260                                      | 780   | 1 560 |
| 95                 | 19   | 166                                                   | 500 | 995   | 265                                      | 795   | 1 590 |
| 100                | 20   | 208                                                   | 624 | 1 250 | 332                                      | 996   | 1 990 |
| 110                | 22   | 220                                                   | 650 | 1 300 | 340                                      | 1 030 | 2 070 |
| 120                | 24   | 250                                                   | 760 | 1 530 | 410                                      | 1 220 | 2 440 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 156.

Table 12b

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 70 .. E series

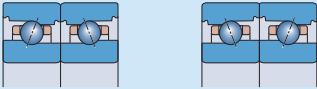


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>70 CE, 70 CE/HC<br>for preload class |     |       | 70 ACE, 70 ACE/HC<br>for preload class |       |       |
|--------------------|------|-----------------------------------------------------------------------------------------------|-----|-------|----------------------------------------|-------|-------|
|                    |      | A                                                                                             | B   | C     | A                                      | B     | C     |
| mm                 | –    | N                                                                                             |     |       |                                        |       |       |
| 6                  | 6    | 10                                                                                            | 25  | 50    | 14                                     | 41    | 82    |
| 7                  | 7    | 10                                                                                            | 30  | 60    | 17                                     | 50    | 100   |
| 8                  | 8    | 15                                                                                            | 35  | 75    | 20                                     | 60    | 120   |
| 9                  | 9    | 15                                                                                            | 40  | 80    | 23                                     | 65    | 130   |
| 10                 | 00   | 15                                                                                            | 48  | 95    | 26                                     | 80    | 160   |
| 12                 | 01   | 17                                                                                            | 53  | 110   | 28                                     | 85    | 170   |
| 15                 | 02   | 25                                                                                            | 70  | 140   | 38                                     | 115   | 230   |
| 17                 | 03   | 30                                                                                            | 90  | 185   | 50                                     | 150   | 300   |
| 20                 | 04   | 40                                                                                            | 120 | 235   | 64                                     | 193   | 390   |
| 25                 | 05   | 45                                                                                            | 130 | 260   | 70                                     | 210   | 430   |
| 30                 | 06   | 50                                                                                            | 150 | 300   | 80                                     | 240   | 480   |
| 35                 | 07   | 60                                                                                            | 180 | 370   | 100                                    | 300   | 590   |
| 40                 | 08   | 65                                                                                            | 200 | 390   | 105                                    | 310   | 630   |
| 45                 | 09   | 70                                                                                            | 210 | 410   | 110                                    | 330   | 660   |
| 50                 | 10   | 85                                                                                            | 250 | 500   | 130                                    | 400   | 800   |
| 55                 | 11   | 90                                                                                            | 270 | 540   | 140                                    | 430   | 860   |
| 60                 | 12   | 92                                                                                            | 275 | 550   | 150                                    | 440   | 870   |
| 65                 | 13   | 110                                                                                           | 330 | 650   | 170                                    | 520   | 1 040 |
| 70                 | 14   | 130                                                                                           | 380 | 760   | 200                                    | 610   | 1 220 |
| 75                 | 15   | 140                                                                                           | 420 | 840   | 220                                    | 670   | 1 340 |
| 80                 | 16   | 180                                                                                           | 550 | 1 090 | 280                                    | 850   | 1 700 |
| 85                 | 17   | 185                                                                                           | 560 | 1 110 | 290                                    | 890   | 1 780 |
| 90                 | 18   | 190                                                                                           | 580 | 1 150 | 300                                    | 920   | 1 840 |
| 95                 | 19   | 230                                                                                           | 700 | 1 400 | 380                                    | 1 130 | 2 270 |
| 100                | 20   | 240                                                                                           | 720 | 1 440 | 390                                    | 1 150 | 2 310 |
| 110                | 22   | 250                                                                                           | 760 | 1 520 | 400                                    | 1 210 | 2 420 |
| 120                | 24   | 310                                                                                           | 930 | 1 850 | 490                                    | 1 480 | 2 950 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 157.

Table 13a

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 719 .. B series



| Bore diameter<br><br>d | Size<br><br>– | Axial preload of bearings in the series <sup>1)</sup><br>719 CB, 719 CB/HC<br>for preload class |     |     | 719 ACB, 719 ACB/HC<br>for preload class |     |     |
|------------------------|---------------|-------------------------------------------------------------------------------------------------|-----|-----|------------------------------------------|-----|-----|
|                        |               | A                                                                                               | B   | C   | A                                        | B   | C   |
| mm                     | –             | N                                                                                               |     |     |                                          |     |     |
| 30                     | 06            | 16                                                                                              | 32  | 96  | 27                                       | 54  | 160 |
| 35                     | 07            | 17                                                                                              | 34  | 100 | 29                                       | 58  | 175 |
| 40                     | 08            | 18                                                                                              | 36  | 110 | 31                                       | 62  | 185 |
| 45                     | 09            | 24                                                                                              | 48  | 145 | 41                                       | 82  | 245 |
| 50                     | 10            | 26                                                                                              | 52  | 155 | 43                                       | 86  | 260 |
| 55                     | 11            | 33                                                                                              | 66  | 200 | 55                                       | 110 | 330 |
| 60                     | 12            | 34                                                                                              | 68  | 205 | 57                                       | 115 | 340 |
| 65                     | 13            | 35                                                                                              | 70  | 210 | 60                                       | 120 | 360 |
| 70                     | 14            | 45                                                                                              | 90  | 270 | 75                                       | 150 | 450 |
| 75                     | 15            | 46                                                                                              | 92  | 275 | 80                                       | 160 | 480 |
| 80                     | 16            | 52                                                                                              | 105 | 310 | 87                                       | 175 | 520 |
| 85                     | 17            | 54                                                                                              | 110 | 325 | 93                                       | 185 | 560 |
| 90                     | 18            | 59                                                                                              | 120 | 355 | 100                                      | 200 | 600 |
| 95                     | 19            | 60                                                                                              | 120 | 360 | 105                                      | 210 | 630 |
| 100                    | 20            | 72                                                                                              | 145 | 430 | 125                                      | 250 | 750 |
| 110                    | 22            | 86                                                                                              | 170 | 515 | 145                                      | 290 | 870 |
| 120                    | 24            | 90                                                                                              | 180 | 540 | 155                                      | 310 | 930 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 158.



Table 13b

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 70 .. B series

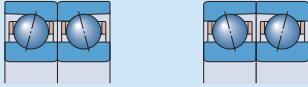


| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>70 CB, 70 CB /HC<br>for preload class |     |     | 70 ACB, 70 ACB/HC<br>for preload class |     |       |
|--------------------|------|------------------------------------------------------------------------------------------------|-----|-----|----------------------------------------|-----|-------|
|                    |      | A                                                                                              | B   | C   | A                                      | B   | C     |
| mm                 | –    | N                                                                                              |     |     |                                        |     |       |
| 30                 | 06   | 21                                                                                             | 42  | 125 | 36                                     | 72  | 215   |
| 35                 | 07   | 23                                                                                             | 46  | 140 | 38                                     | 76  | 230   |
| 40                 | 08   | 24                                                                                             | 48  | 145 | 41                                     | 82  | 245   |
| 45                 | 09   | 31                                                                                             | 62  | 185 | 54                                     | 110 | 330   |
| 50                 | 10   | 33                                                                                             | 66  | 200 | 56                                     | 110 | 330   |
| 55                 | 11   | 46                                                                                             | 92  | 275 | 78                                     | 155 | 470   |
| 60                 | 12   | 48                                                                                             | 96  | 290 | 80                                     | 160 | 480   |
| 65                 | 13   | 49                                                                                             | 98  | 295 | 85                                     | 170 | 510   |
| 70                 | 14   | 64                                                                                             | 130 | 390 | 110                                    | 220 | 660   |
| 75                 | 15   | 65                                                                                             | 130 | 390 | 115                                    | 230 | 690   |
| 80                 | 16   | 78                                                                                             | 155 | 470 | 150                                    | 300 | 900   |
| 85                 | 17   | 80                                                                                             | 160 | 480 | 150                                    | 300 | 900   |
| 90                 | 18   | 92                                                                                             | 185 | 550 | 160                                    | 320 | 960   |
| 95                 | 19   | 94                                                                                             | 190 | 570 | 165                                    | 330 | 990   |
| 100                | 20   | 96                                                                                             | 190 | 570 | 165                                    | 330 | 990   |
| 110                | 22   | 125                                                                                            | 250 | 750 | 210                                    | 420 | 1 260 |
| 120                | 24   | 130                                                                                            | 260 | 780 | 220                                    | 440 | 1 320 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 159.

Table 14

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face – 72 .. D series



| Bore diameter<br>d | Size | Axial preload of bearings in the series <sup>1)</sup><br>72 CD, 72 CD/HC<br>for preload class |       |       |       | 72 ACD, 72 ACD/HC<br>for preload class |       |       |        |
|--------------------|------|-----------------------------------------------------------------------------------------------|-------|-------|-------|----------------------------------------|-------|-------|--------|
|                    |      | A                                                                                             | B     | C     | D     | A                                      | B     | C     | D      |
| mm                 | –    | N                                                                                             |       |       |       |                                        |       |       |        |
| 7                  | 7    | 12                                                                                            | 24    | 48    | 96    | 18                                     | 36    | 72    | 144    |
| 8                  | 8    | 14                                                                                            | 28    | 56    | 112   | 22                                     | 44    | 88    | 176    |
| 9                  | 9    | 15                                                                                            | 30    | 60    | 120   | 25                                     | 50    | 100   | 200    |
| 10                 | 00   | 17                                                                                            | 34    | 68    | 136   | 27                                     | 54    | 108   | 216    |
| 12                 | 01   | 22                                                                                            | 44    | 88    | 176   | 35                                     | 70    | 140   | 280    |
| 15                 | 02   | 30                                                                                            | 60    | 120   | 240   | 45                                     | 90    | 180   | 360    |
| 17                 | 03   | 35                                                                                            | 70    | 140   | 280   | 60                                     | 120   | 240   | 480    |
| 20                 | 04   | 45                                                                                            | 90    | 180   | 360   | 70                                     | 140   | 280   | 560    |
| 25                 | 05   | 50                                                                                            | 100   | 200   | 400   | 80                                     | 160   | 320   | 640    |
| 30                 | 06   | 90                                                                                            | 180   | 360   | 720   | 150                                    | 300   | 600   | 1 200  |
| 35                 | 07   | 120                                                                                           | 240   | 480   | 960   | 190                                    | 380   | 760   | 1 520  |
| 40                 | 08   | 125                                                                                           | 250   | 500   | 1 000 | 200                                    | 400   | 800   | 1 600  |
| 45                 | 09   | 160                                                                                           | 320   | 640   | 1 280 | 260                                    | 520   | 1 040 | 2 080  |
| 50                 | 10   | 170                                                                                           | 340   | 680   | 1 360 | 265                                    | 530   | 1 060 | 2 120  |
| 55                 | 11   | 210                                                                                           | 420   | 840   | 1 680 | 330                                    | 660   | 1 320 | 2 640  |
| 60                 | 12   | 215                                                                                           | 430   | 860   | 1 720 | 350                                    | 700   | 1 400 | 2 800  |
| 65                 | 13   | 250                                                                                           | 500   | 1 000 | 2 000 | 400                                    | 800   | 1 600 | 3 200  |
| 70                 | 14   | 260                                                                                           | 520   | 1 040 | 2 080 | 420                                    | 840   | 1 680 | 3 360  |
| 75                 | 15   | 270                                                                                           | 540   | 1 080 | 2 160 | 430                                    | 860   | 1 720 | 3 440  |
| 80                 | 16   | 320                                                                                           | 640   | 1 280 | 2 560 | 520                                    | 1 040 | 2 080 | 4 160  |
| 85                 | 17   | 370                                                                                           | 740   | 1 480 | 2 960 | 600                                    | 1 200 | 2 400 | 4 800  |
| 90                 | 18   | 480                                                                                           | 960   | 1 920 | 3 840 | 750                                    | 1 500 | 3 000 | 6 000  |
| 95                 | 19   | 520                                                                                           | 1 040 | 2 080 | 4 160 | 850                                    | 1 700 | 3 400 | 6 800  |
| 100                | 20   | 590                                                                                           | 1 180 | 2 360 | 4 720 | 950                                    | 1 900 | 3 800 | 7 600  |
| 105                | 21   | 650                                                                                           | 1 300 | 2 600 | 5 200 | 1 000                                  | 2 000 | 4 000 | 8 000  |
| 110                | 22   | 670                                                                                           | 1 340 | 2 680 | 5 360 | 1 050                                  | 2 100 | 4 200 | 8 400  |
| 120                | 24   | 750                                                                                           | 1 500 | 3 000 | 6 000 | 1 200                                  | 2 400 | 4 800 | 9 600  |
| 130                | 26   | 810                                                                                           | 1 620 | 3 240 | 6 480 | 1 300                                  | 2 600 | 5 200 | 10 400 |
| 140                | 28   | 850                                                                                           | 1 700 | 3 400 | 6 800 | 1 350                                  | 2 700 | 5 400 | 10 800 |

<sup>1)</sup> The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 160.

Table 15

Factors for calculating the preload of a bearing set

| Number of bearings | Arrangement             | Designation suffix | Factor for preload class |            |
|--------------------|-------------------------|--------------------|--------------------------|------------|
|                    |                         |                    | A, B, C and D            | L, M and F |
| 3                  | Back-to-back and tandem | TBT                | 1,35                     | 1          |
|                    | Face-to-face and tandem | TFT                | 1,35                     | 1          |
| 4                  | Back-to-back and tandem | QBT                | 1,6                      | 1          |
|                    | Face-to-face and tandem | QFT                | 1,6                      | 1          |
|                    | Tandem back-to-back     | QBC                | 2                        | 2          |
|                    | Tandem face-to-face     | QFC                | 2                        | 2          |
| 5                  | Back-to-back and tandem | PBT                | 1,75                     | 1          |
|                    | Face-to-face and tandem | PFT                | 1,75                     | 1          |
|                    | Tandem back-to-back     | PBC                | 2,45                     | 2          |
|                    | Tandem face-to-face     | PFC                | 2,45                     | 2          |

2

Table 16

Example of the (light) preload possibilities for an arrangement with a matched set of 7014 CE bearings

| Number of bearings | Arrangement             | Preload of a matched set, prior to mounting for maximum rigidity |         | for maximum speed  |         |
|--------------------|-------------------------|------------------------------------------------------------------|---------|--------------------|---------|
|                    |                         | Designation suffix                                               | Preload | Designation suffix | Preload |
| –                  | –                       | –                                                                | N       | –                  | N       |
| 2                  | Back-to-back            | DBA                                                              | 130     | –                  | –       |
|                    | Face-to-face            | DFA                                                              | 130     | –                  | –       |
| 3                  | Back-to-back and tandem | TBTA                                                             | 175,5   | TBTL               | 130     |
|                    | Face-to-face and tandem | TFTA                                                             | 175,5   | TFTL               | 130     |
| 4                  | Tandem back-to-back     | QBCA                                                             | 260     | –                  | –       |
|                    | Tandem face-to-face     | QFCA                                                             | 260     | –                  | –       |
|                    | Back-to-back and tandem | QBTA                                                             | 208     | QBTL               | 130     |
|                    | Face-to-face and tandem | QFTA                                                             | 208     | QFTL               | 130     |

For symmetrical arrangements, preload class A = preload class L e.g. the designation suffix DBL does not exist.  
For bearing sets with five bearings, contact the SKF application engineering service.

### Preload in mounted bearing sets

After mounting, sets of universally matchable bearings and matched bearing sets can have a heavier preload than the pre-set preload, pre-determined during manufacture. The increase in preload depends mainly on the actual tolerances for the shaft and housing seats and whether these result in an interference fit with the bearing rings.

An increase in preload can also be caused by deviations from the geometrical form of associated components, such as cylindricity, perpendicularity or concentricity of the bearing seats.

During operation, an additional increase in preload can also be caused by:

- the centrifugal force caused by the rotational speed of the shaft, for constant position arrangements
- a temperature difference between the inner ring, outer ring, and balls
- different coefficient of thermal expansion for the shaft and housing materials compared to bearing steel

If the bearings are mounted with zero interference on a steel shaft and in a thick-walled steel or cast iron housing, preload can be determined with sufficient accuracy from

$$G_m = f f_1 f_2 f_{HC} G_{A,B,C,D}$$

where

$G_m$  = preload in the mounted bearing set [N]

$G_{A,B,C,D}$  = pre-set preload in the bearing set, prior to mounting [N] (→ **tables 10 to 14, pages 162 to 162**)

$f$  = bearing factor dependent on the bearing series and size (→ **table 17**)

$f_1$  = correction factor dependent on the contact angle (→ **table 18, page 162**)

$f_2$  = correction factor dependent on the preload class (→ **table 18**)

$f_{HC}$  = correction factor for hybrid bearings (→ **table 18**)

Considerably tighter fits may be necessary, for example, for very high speed spindles, where centrifugal forces can loosen the inner ring fit on its shaft seat. These bearing arrangements

must be carefully evaluated. In these cases, contact the SKF application engineering service.

#### Calculation example

What is the preload in a matched bearing set 71924 CD/P4ADBC after mounting?

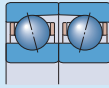
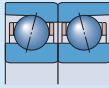
The pre-set preload for the set of two bearings in the 719 CD series, prior to mounting, preload class C, size 24 is  $G_C = 1\,160\text{ N}$  (→ **table 11, page 162**).

With the bearing factor  $f = 1,26$  (→ **table 17**) and correction factors  $f_1 = 1$  and  $f_2 = 1,09$  (→ **table 18, page 162**), the preload of the mounted bearing set is

$$\begin{aligned} G_m &= f f_1 f_2 G_C \\ &= 1,26 \times 1 \times 1,09 \times 1\,160 \\ &\approx 1\,590\text{ N} \end{aligned}$$

Table 17

Bearing factor  $f$  for calculating the preload in mounted bearing sets



| Bore diameter<br>$d$ | Size | Bearing factor of bearings in the series |          |          |          | 70 .. D | 70 .. E | 70 .. B | 72 .. D |
|----------------------|------|------------------------------------------|----------|----------|----------|---------|---------|---------|---------|
|                      |      | 718 .. D                                 | 719 .. D | 719 .. E | 719 .. B |         |         |         |         |
| mm                   | –    | –                                        | –        | –        | –        | –       | –       | –       | –       |
| 6                    | 6    | –                                        | –        | –        | –        | 1,01    | 1,02    | –       | –       |
| 7                    | 7    | –                                        | –        | –        | –        | 1,02    | 1,02    | –       | 1,02    |
| 8                    | 8    | –                                        | –        | 1,02     | –        | 1,02    | 1,02    | –       | 1,02    |
| 9                    | 9    | –                                        | –        | 1,03     | –        | 1,03    | 1,02    | –       | 1,02    |
| 10                   | 00   | 1,05                                     | 1,03     | 1,03     | –        | 1,03    | 1,03    | –       | 1,02    |
| 12                   | 01   | 1,06                                     | 1,04     | 1,04     | –        | 1,03    | 1,02    | –       | 1,02    |
| 15                   | 02   | 1,08                                     | 1,05     | 1,04     | –        | 1,03    | 1,03    | –       | 1,03    |
| 17                   | 03   | 1,1                                      | 1,05     | 1,05     | –        | 1,04    | 1,04    | –       | 1,03    |
| 20                   | 04   | 1,08                                     | 1,05     | 1,04     | –        | 1,03    | 1,04    | –       | 1,03    |
| 25                   | 05   | 1,11                                     | 1,07     | 1,06     | –        | 1,05    | 1,05    | –       | 1,03    |
| 30                   | 06   | 1,14                                     | 1,08     | 1,08     | 1,07     | 1,06    | 1,05    | 1,03    | 1,05    |
| 35                   | 07   | 1,18                                     | 1,1      | 1,05     | 1,06     | 1,06    | 1,06    | 1,04    | 1,05    |
| 40                   | 08   | 1,23                                     | 1,09     | 1,05     | 1,06     | 1,06    | 1,06    | 1,04    | 1,05    |
| 45                   | 09   | 1,24                                     | 1,11     | 1,09     | 1,08     | 1,09    | 1,06    | 1,05    | 1,07    |
| 50                   | 10   | 1,3                                      | 1,13     | 1,15     | 1,09     | 1,11    | 1,08    | 1,06    | 1,08    |
| 55                   | 11   | 1,27                                     | 1,15     | 1,16     | 1,09     | 1,1     | 1,07    | 1,06    | 1,08    |
| 60                   | 12   | 1,3                                      | 1,17     | 1,13     | 1,11     | 1,12    | 1,08    | 1,06    | 1,07    |
| 65                   | 13   | 1,28                                     | 1,2      | 1,19     | 1,13     | 1,13    | 1,09    | 1,07    | 1,07    |
| 70                   | 14   | 1,32                                     | 1,19     | 1,14     | 1,1      | 1,12    | 1,09    | 1,07    | 1,08    |
| 75                   | 15   | 1,36                                     | 1,21     | 1,16     | 1,11     | 1,14    | 1,1     | 1,08    | 1,08    |
| 80                   | 16   | 1,41                                     | 1,24     | 1,19     | 1,13     | 1,13    | 1,1     | 1,07    | 1,09    |
| 85                   | 17   | 1,31                                     | 1,2      | 1,16     | 1,11     | 1,15    | 1,11    | 1,08    | 1,08    |
| 90                   | 18   | 1,33                                     | 1,23     | 1,19     | 1,12     | 1,14    | 1,1     | 1,07    | 1,09    |
| 95                   | 19   | 1,36                                     | 1,26     | 1,18     | 1,13     | 1,15    | 1,11    | 1,07    | 1,09    |
| 100                  | 20   | 1,4                                      | 1,23     | 1,18     | 1,11     | 1,16    | 1,12    | 1,08    | 1,09    |
| 105                  | 21   | 1,44                                     | 1,25     | –        | –        | 1,15    | –       | –       | 1,08    |
| 110                  | 22   | 1,34                                     | 1,26     | 1,2      | 1,14     | 1,14    | 1,1     | 1,07    | 1,08    |
| 120                  | 24   | 1,41                                     | 1,26     | 1,18     | 1,13     | 1,17    | 1,12    | 1,08    | 1,08    |
| 130                  | 26   | 1,34                                     | 1,25     | –        | –        | 1,15    | –       | –       | 1,09    |
| 140                  | 28   | 1,43                                     | 1,29     | –        | –        | 1,16    | –       | –       | 1,09    |
| 150                  | 30   | 1,37                                     | 1,24     | –        | –        | 1,16    | –       | –       | –       |
| 160                  | 32   | 1,42                                     | 1,27     | –        | –        | 1,16    | –       | –       | –       |
| 170                  | 34   | –                                        | 1,3      | –        | –        | 1,14    | –       | –       | –       |
| 180                  | 36   | –                                        | 1,25     | –        | –        | 1,13    | –       | –       | –       |
| 190                  | 38   | –                                        | 1,27     | –        | –        | 1,14    | –       | –       | –       |
| 200                  | 40   | –                                        | 1,23     | –        | –        | 1,14    | –       | –       | –       |
| 220                  | 44   | –                                        | 1,28     | –        | –        | 1,13    | –       | –       | –       |
| 240                  | 48   | –                                        | 1,32     | –        | –        | 1,15    | –       | –       | –       |
| 260                  | 52   | –                                        | 1,24     | –        | –        | 1,13    | –       | –       | –       |
| 280                  | 56   | –                                        | 1,27     | –        | –        | –       | –       | –       | –       |
| 300                  | 60   | –                                        | 1,22     | –        | –        | –       | –       | –       | –       |
| 320                  | 64   | –                                        | 1,24     | –        | –        | –       | –       | –       | –       |
| 340                  | 68   | –                                        | 1,27     | –        | –        | –       | –       | –       | –       |
| 360                  | 72   | –                                        | 1,29     | –        | –        | –       | –       | –       | –       |

Table 18

## Correction factors for preload calculation in mounted bearing sets

| Bearing series | Correction factors |                                     |      |      |      | f <sub>HC</sub> |
|----------------|--------------------|-------------------------------------|------|------|------|-----------------|
|                | f <sub>1</sub>     | f <sub>2</sub><br>for preload class |      | C    | D    |                 |
|                |                    | A                                   | B    |      |      |                 |
| 718 CD         | 1                  | 1                                   | 1,09 | 1,16 | –    | 1               |
| 718 ACD        | 0,97               | 1                                   | 1,08 | 1,15 | –    | 1               |
| 718 CD/HC      | 1                  | 1                                   | 1,1  | 1,18 | –    | 1,02            |
| 718 ACD/HC     | 0,97               | 1                                   | 1,09 | 1,17 | –    | 1,02            |
| 719 CD         | 1                  | 1                                   | 1,04 | 1,09 | 1,15 | 1               |
| 719 ACD        | 0,98               | 1                                   | 1,04 | 1,08 | 1,14 | 1               |
| 719 CD/HC      | 1                  | 1                                   | 1,07 | 1,12 | 1,18 | 1,04            |
| 719 ACD/HC     | 0,98               | 1                                   | 1,07 | 1,12 | 1,17 | 1,04            |
| 719 CE         | 1                  | 1                                   | 1,04 | 1,08 | –    | 1               |
| 719 ACE        | 0,99               | 1                                   | 1,04 | 1,07 | –    | 1               |
| 719 CE/HC      | 1                  | 1                                   | 1,05 | 1,09 | –    | 1,01            |
| 719 ACE/HC     | 0,98               | 1                                   | 1,04 | 1,08 | –    | 1,01            |
| 719 CB         | 1                  | 1                                   | 1,02 | 1,07 | –    | 1               |
| 719 ACB        | 0,99               | 1                                   | 1,02 | 1,07 | –    | 1               |
| 719 CB/HC      | 1                  | 1                                   | 1,03 | 1,08 | –    | 1,01            |
| 719 ACB/HC     | 0,99               | 1                                   | 1,02 | 1,08 | –    | 1,01            |
| 70 CD          | 1                  | 1                                   | 1,02 | 1,05 | 1,09 | 1               |
| 70 ACD         | 0,99               | 1                                   | 1,02 | 1,05 | 1,08 | 1               |
| 70 CD/HC       | 1                  | 1                                   | 1,02 | 1,05 | 1,09 | 1,02            |
| 70 ACD/HC      | 0,99               | 1                                   | 1,02 | 1,05 | 1,08 | 1,02            |
| 70 CE          | 1                  | 1                                   | 1,03 | 1,05 | –    | 1               |
| 70 ACE         | 0,99               | 1                                   | 1,03 | 1,06 | –    | 1               |
| 70 CE/HC       | 1                  | 1                                   | 1,03 | 1,05 | –    | 1,01            |
| 70 ACE/HC      | 0,99               | 1                                   | 1,03 | 1,06 | –    | 1,01            |
| 70 CB          | 1                  | 1                                   | 1,02 | 1,05 | –    | 1               |
| 70 ACB         | 0,99               | 1                                   | 1,01 | 1,04 | –    | 1               |
| 70 CB/HC       | 1                  | 1                                   | 1,02 | 1,05 | –    | 1,01            |
| 70 ACB/HC      | 0,99               | 1                                   | 1,02 | 1,05 | –    | 1,01            |
| 72 CD          | 1                  | 1                                   | 1,01 | 1,03 | 1,05 | 1               |
| 72 ACD         | 0,99               | 1                                   | 1,01 | 1,02 | 1,05 | 1               |
| 72 CD/HC       | 1                  | 1                                   | 1,01 | 1,03 | 1,06 | 1,01            |
| 72 ACD/HC      | 0,99               | 1                                   | 1,01 | 1,03 | 1,06 | 1,01            |

The designation suffix HC denotes a hybrid bearing. For additional information, refer to *Hybrid bearings*, page 164.

## Preload with a constant force

In precision, high-speed applications, a constant, uniform preload is important. To maintain the proper preload, calibrated linear springs are typically used between the bearing outer ring and housing shoulder (→ **fig. 17**). With springs, the kinematic behaviour of the bearing does not influence preload under normal operating conditions. However, a spring-loaded bearing arrangement has a lower degree of stiffness than an arrangement using axial displacement to set the preload. The spring preload method is standard for spindles used on internal grinders.

Guideline values for the most common spring-loaded bearing arrangements are listed in **table 19**. The values apply to single CE and ACE design bearings. For bearings in tandem arrangements, the values should be multiplied by a factor equal to the number of bearings preloaded with the spring force. The specified spring preload forces are a compromise between minimal difference in operating contact angle at the inner and outer ring raceways, and axial rigidity at high rotational speeds. Heavier preloads lead to higher operating temperatures.

For additional information, contact the SKF application engineering service.

Fig. 17

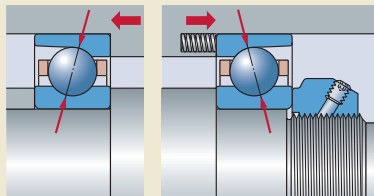


Table 19

Guideline values for spring preload forces for bearings in the 70 .. E series

| Bore diameter<br>d | Size | Preload <sup>1)</sup> |            |
|--------------------|------|-----------------------|------------|
|                    |      | CE design             | ACE design |
| mm                 | —    | N                     |            |
| 6                  | 6    | 50                    | 80         |
| 7                  | 7    | 60                    | 100        |
| 8                  | 8    | 70                    | 120        |
| 9                  | 9    | 80                    | 130        |
| 10                 | 00   | 90                    | 140        |
| 12                 | 01   | 90                    | 150        |
| 15                 | 02   | 120                   | 200        |
| 17                 | 03   | 160                   | 250        |
| 20                 | 04   | 200                   | 320        |
| 25                 | 05   | 220                   | 350        |
| 30                 | 06   | 240                   | 400        |
| 35                 | 07   | 300                   | 480        |
| 40                 | 08   | 320                   | 500        |
| 45                 | 09   | 340                   | 540        |
| 50                 | 10   | 400                   | 650        |
| 55                 | 11   | 420                   | 700        |
| 60                 | 12   | 450                   | 700        |
| 65                 | 13   | 520                   | 840        |
| 70                 | 14   | 600                   | 1 000      |
| 75                 | 15   | 700                   | 1 100      |
| 80                 | 16   | 900                   | 1 400      |
| 85                 | 17   | 900                   | 1 400      |
| 90                 | 18   | 900                   | 1 500      |
| 95                 | 19   | 1 200                 | 1 900      |
| 100                | 20   | 1 200                 | 1 900      |
| 110                | 22   | 1 200                 | 2 000      |
| 120                | 24   | 1 500                 | 2 400      |

<sup>1)</sup> For single bearings in the CE and ACE designs. For tandem bearing arrangements, the values should be multiplied by a factor equal to the number of bearings.

### Preload by axial displacement

For machining centres, milling machines, lathes, and drills, rigidity and precise axial guidance are critical parameters, especially when alternating axial loads occur. For these applications, the preload in the bearings is usually obtained by adjusting the bearing rings relative to each other in the axial direction.

This preload method offers significant advantages in terms of system rigidity. However, depending on the bearing internal design and ball material, preload increases considerably with rotational speed as a result of centrifugal forces.

Universally matchable bearings or matched bearing sets are manufactured so that when mounted properly, they attain their predetermined axial displacement and proper preload values (→ **fig. 18**). With single bearings, precision matched spacer rings must be used.

### Individual adjustment of preload

In cases where universally matchable bearings or matched bearing sets are used, preload is determined at the factory during production. In some cases, however, it may be necessary to optimize the preload to accommodate the particular operating conditions. In these cases, the bearings should not be modified, as this requires special tools and knowledge, and the bearings could be damaged irreparably. Bearing modification should be entrusted exclusively to SKF Spindle Service Centres (→ [skf.com](http://skf.com)).

It is possible, however, to increase or decrease preload by using spacer rings between two bearings arranged back-to-back or face-to-face, when used in sets of two or more bearings. There is no requirement to insert spacers between bearings arranged in tandem.

By grinding the side face of the inner or outer spacer, the preload in the bearing set can be changed.

**Table 20** provides information about which of the equal-width spacer ring side faces must be ground and what effect it has. The necessary dimensional deviation for the overall width of the spacer rings is listed in the following tables:

- **table 21** (→ **page 166**) for bearings in the 718 .. D series
- **table 22** (→ **page 166**) for bearings in the 719 .. D and 70 .. D series
- **table 23** (→ **page 166**) for bearings in the 719 .. E and 70 .. E series
- **table 24** (→ **page 166**) for bearings in the 719 .. B and 70 .. B series
- **table 25** (→ **page 166**) for bearings in the 72 .. D series

Fig. 18

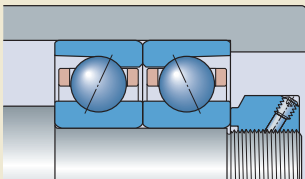




Table 20

Table 20

| Guidelines for spacer ring modification |                       |                                                 |              |
|-----------------------------------------|-----------------------|-------------------------------------------------|--------------|
| Preload change of a bearing set         | Width reduction Value | Requisite spacer ring between bearings arranged |              |
|                                         |                       | back-to-back                                    | face-to-face |
| Increasing the preload                  |                       |                                                 |              |
| from A to B                             | a                     | inner                                           | outer        |
| from B to C                             | b                     | inner                                           | outer        |
| from C to D                             | c                     | inner                                           | outer        |
| from A to C                             | a + b                 | inner                                           | outer        |
| from A to D                             | a + b + c             | inner                                           | outer        |
| Decreasing the preload                  |                       |                                                 |              |
| from B to A                             | a                     | outer                                           | inner        |
| from C to B                             | b                     | outer                                           | inner        |
| from D to C                             | c                     | outer                                           | inner        |
| from C to A                             | a + b                 | outer                                           | inner        |
| from D to A                             | a + b + c             | outer                                           | inner        |

Spacer rings

As a rule, using spacer rings with angular contact ball bearing sets is advantageous when:

- preload in the bearing set needs to be adjusted
- moment stiffness and moment load capacity should be increased
- nozzles for oil lubrication must be as close as possible to the bearing raceways
- sufficiently large space is needed for surplus grease, in order to reduce frictional heat in the bearing
- improved heat dissipation via the housing is required at very high operating speeds

To achieve optimum bearing performance, spacer rings must not deform under load, otherwise form deviations can influence the preload in the bearing set. As a result, the guideline values for the shaft and housing tolerances should always be used.

Spacer rings should be made of high-grade steel that can be hardened to between 45 and 60 HRC, depending on the application. Plane parallelism of the face surfaces is particularly important. The permissible deviation must not exceed 1 to 2 µm.

Unless preload is to be adjusted, the overall width of the inner and outer spacer rings should be identical. The most accurate way to do this is to process the width of the concentric inner and outer spacer rings in one operation.

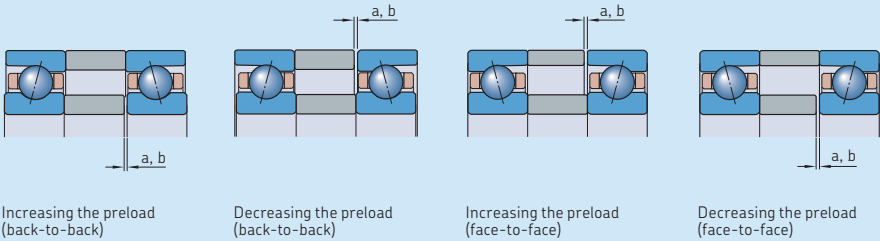
Effect of rotational speed on preload

Using strain gauges, SKF has determined that preload changes with rotational speed and that there is a marked increase in preload at very high rotational speeds. This is mainly attributable to the heavy centrifugal forces on the balls causing them to change their position in the raceways.

When compared to a bearing with steel balls, a hybrid bearing (bearing with ceramic balls) can attain much higher rotational speeds, without significantly increasing preload, as a result of the lower mass of the balls.

Table 21

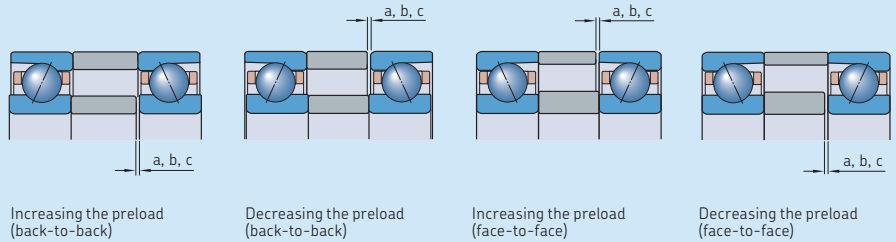
Guideline values for spacer ring width reduction – 718 .. D series



| Bore diameter<br>d | Size | Requisite spacer ring width reduction of bearings in the series |    |              |    |
|--------------------|------|-----------------------------------------------------------------|----|--------------|----|
|                    |      | 718 CD<br>a                                                     | b  | 718 ACD<br>a | b  |
| mm                 | –    | µm                                                              |    |              |    |
| 10                 | 00   | 5                                                               | 5  | 4            | 4  |
| 12                 | 01   | 5                                                               | 5  | 4            | 4  |
| 15                 | 02   | 5                                                               | 5  | 4            | 4  |
| 17                 | 03   | 5                                                               | 5  | 4            | 4  |
| 20                 | 04   | 6                                                               | 6  | 4            | 5  |
| 25                 | 05   | 6                                                               | 6  | 4            | 5  |
| 30                 | 06   | 6                                                               | 6  | 4            | 5  |
| 35                 | 07   | 6                                                               | 6  | 4            | 5  |
| 40                 | 08   | 6                                                               | 6  | 4            | 5  |
| 45                 | 09   | 6                                                               | 6  | 4            | 5  |
| 50                 | 10   | 8                                                               | 8  | 5            | 6  |
| 55                 | 11   | 9                                                               | 9  | 6            | 7  |
| 60                 | 12   | 10                                                              | 11 | 7            | 8  |
| 65                 | 13   | 10                                                              | 11 | 7            | 8  |
| 70                 | 14   | 10                                                              | 11 | 7            | 8  |
| 75                 | 15   | 10                                                              | 11 | 7            | 8  |
| 80                 | 16   | 10                                                              | 11 | 7            | 8  |
| 85                 | 17   | 13                                                              | 13 | 9            | 10 |
| 90                 | 18   | 13                                                              | 14 | 9            | 10 |
| 95                 | 19   | 13                                                              | 14 | 9            | 10 |
| 100                | 20   | 13                                                              | 14 | 9            | 10 |
| 105                | 21   | 14                                                              | 14 | 9            | 10 |
| 110                | 22   | 16                                                              | 16 | 10           | 12 |
| 120                | 24   | 16                                                              | 17 | 11           | 12 |
| 130                | 26   | 16                                                              | 17 | 11           | 12 |
| 140                | 28   | 18                                                              | 20 | 12           | 14 |
| 150                | 30   | 19                                                              | 20 | 13           | 14 |
| 160                | 32   | 19                                                              | 20 | 13           | 15 |

Table 22

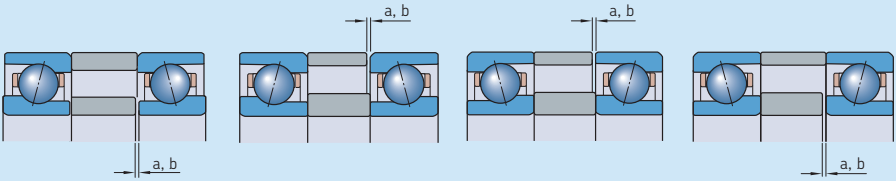
Guideline values for spacer ring width reduction – 719 .. D and 70 .. D series



| Bore diameter<br>d | Size | Requisite spacer ring width reduction of bearings in the series |    |    |         |    |    |       |    |    |        |    |    |
|--------------------|------|-----------------------------------------------------------------|----|----|---------|----|----|-------|----|----|--------|----|----|
|                    |      | 719 CD                                                          |    |    | 719 ACD |    |    | 70 CD |    |    | 70 ACD |    |    |
|                    |      | a                                                               | b  | c  | a       | b  | c  | a     | b  | c  | a      | b  | c  |
| mm                 | –    | μm                                                              |    |    |         |    |    |       |    |    |        |    |    |
| 6                  | 6    | –                                                               | –  | –  | –       | –  | –  | 3     | 4  | 7  | 2      | 4  | 5  |
| 7                  | 7    | –                                                               | –  | –  | –       | –  | –  | 4     | 5  | 8  | 2      | 4  | 6  |
| 8                  | 8    | –                                                               | –  | –  | –       | –  | –  | 4     | 6  | 8  | 3      | 4  | 6  |
| 9                  | 9    | –                                                               | –  | –  | –       | –  | –  | 4     | 6  | 8  | 3      | 4  | 6  |
| 10                 | 00   | 3                                                               | 4  | 6  | 2       | 3  | 5  | 4     | 6  | 9  | 3      | 4  | 7  |
| 12                 | 01   | 3                                                               | 4  | 6  | 2       | 3  | 5  | 4     | 6  | 9  | 3      | 4  | 7  |
| 15                 | 02   | 4                                                               | 5  | 8  | 2       | 4  | 6  | 4     | 6  | 9  | 3      | 4  | 7  |
| 17                 | 03   | 4                                                               | 5  | 8  | 2       | 4  | 6  | 5     | 7  | 10 | 3      | 5  | 7  |
| 20                 | 04   | 4                                                               | 6  | 9  | 3       | 4  | 6  | 6     | 8  | 12 | 3      | 5  | 8  |
| 25                 | 05   | 4                                                               | 6  | 9  | 3       | 4  | 6  | 6     | 8  | 12 | 3      | 5  | 8  |
| 30                 | 06   | 4                                                               | 6  | 9  | 3       | 4  | 6  | 6     | 9  | 14 | 4      | 7  | 10 |
| 35                 | 07   | 4                                                               | 7  | 10 | 3       | 5  | 7  | 6     | 10 | 14 | 4      | 7  | 10 |
|                    |      |                                                                 |    |    |         |    |    |       |    |    |        |    |    |
| 40                 | 08   | 5                                                               | 7  | 11 | 3       | 5  | 8  | 6     | 10 | 14 | 4      | 7  | 10 |
| 45                 | 09   | 5                                                               | 8  | 11 | 3       | 5  | 8  | 8     | 11 | 16 | 5      | 8  | 12 |
| 50                 | 10   | 5                                                               | 8  | 11 | 3       | 5  | 8  | 8     | 11 | 16 | 5      | 8  | 12 |
| 55                 | 11   | 6                                                               | 9  | 14 | 4       | 7  | 10 | 9     | 13 | 19 | 6      | 9  | 14 |
| 60                 | 12   | 6                                                               | 9  | 14 | 4       | 7  | 10 | 9     | 13 | 19 | 6      | 9  | 14 |
| 65                 | 13   | 6                                                               | 10 | 15 | 4       | 7  | 10 | 9     | 13 | 19 | 6      | 9  | 14 |
| 70                 | 14   | 7                                                               | 11 | 16 | 5       | 8  | 12 | 10    | 15 | 22 | 6      | 10 | 16 |
| 75                 | 15   | 7                                                               | 11 | 16 | 5       | 8  | 12 | 10    | 15 | 22 | 6      | 10 | 16 |
| 80                 | 16   | 7                                                               | 11 | 17 | 5       | 8  | 12 | 11    | 16 | 23 | 7      | 11 | 17 |
| 85                 | 17   | 8                                                               | 13 | 19 | 6       | 9  | 14 | 11    | 16 | 24 | 7      | 11 | 17 |
| 90                 | 18   | 9                                                               | 13 | 19 | 6       | 9  | 14 | 12    | 18 | 26 | 8      | 12 | 19 |
| 95                 | 19   | 9                                                               | 13 | 20 | 6       | 9  | 14 | 12    | 18 | 26 | 8      | 12 | 19 |
|                    |      |                                                                 |    |    |         |    |    |       |    |    |        |    |    |
| 100                | 20   | 10                                                              | 15 | 22 | 6       | 10 | 16 | 12    | 18 | 26 | 8      | 12 | 19 |
| 105                | 21   | 10                                                              | 15 | 22 | 6       | 10 | 16 | 13    | 19 | 29 | 8      | 13 | 21 |
| 110                | 22   | 10                                                              | 15 | 22 | 6       | 10 | 16 | 14    | 21 | 31 | 9      | 15 | 23 |
| 120                | 24   | 11                                                              | 16 | 24 | 7       | 11 | 18 | 14    | 21 | 31 | 9      | 15 | 23 |
| 130                | 26   | 12                                                              | 18 | 27 | 8       | 12 | 19 | 16    | 24 | 35 | 11     | 17 | 26 |
| 140                | 28   | 12                                                              | 18 | 27 | 8       | 12 | 20 | 16    | 24 | 36 | 11     | 17 | 26 |
| 150                | 30   | 14                                                              | 21 | 32 | 9       | 15 | 23 | 17    | 26 | 38 | 11     | 17 | 27 |
| 160                | 32   | 14                                                              | 22 | 32 | 9       | 15 | 24 | 18    | 27 | 40 | 12     | 19 | 29 |
| 170                | 34   | 14                                                              | 22 | 33 | 9       | 15 | 24 | 18    | 28 | 41 | 12     | 19 | 29 |
| 180                | 36   | 16                                                              | 24 | 36 | 10      | 17 | 27 | 20    | 30 | 44 | 13     | 20 | 32 |
| 190                | 38   | 16                                                              | 25 | 37 | 10      | 17 | 27 | 20    | 30 | 45 | 13     | 20 | 32 |
| 200                | 40   | 18                                                              | 28 | 41 | 12      | 19 | 30 | 22    | 33 | 49 | 14     | 22 | 35 |
|                    |      |                                                                 |    |    |         |    |    |       |    |    |        |    |    |
| 220                | 44   | 18                                                              | 28 | 42 | 12      | 19 | 30 | 23    | 35 | 52 | 15     | 24 | 37 |
| 240                | 48   | 18                                                              | 28 | 42 | 12      | 20 | 31 | 23    | 35 | 53 | 15     | 24 | 38 |
| 260                | 52   | 19                                                              | 30 | 45 | 13      | 21 | 33 | 25    | 39 | 58 | 16     | 26 | 41 |
| 280                | 56   | 19                                                              | 30 | 45 | 13      | 21 | 34 | –     | –  | –  | –      | –  | –  |
| 300                | 60   | 23                                                              | 36 | 54 | 15      | 24 | 38 | –     | –  | –  | –      | –  | –  |
| 320                | 64   | 23                                                              | 36 | 54 | 15      | 24 | 38 | –     | –  | –  | –      | –  | –  |
| 340                | 68   | 23                                                              | 36 | 54 | 15      | 24 | 39 | –     | –  | –  | –      | –  | –  |
| 360                | 72   | 23                                                              | 36 | 54 | 15      | 24 | 39 | –     | –  | –  | –      | –  | –  |

Table 23

Guideline values for spacer ring width reduction – 719 .. E and 70 .. E series



Increasing the preload  
(back-to-back)

Decreasing the preload  
(back-to-back)

Increasing the preload  
(face-to-face)

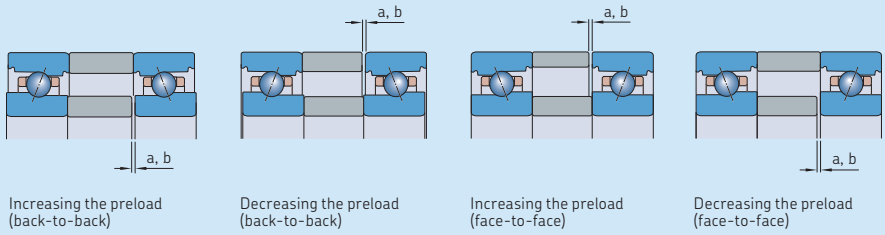
Decreasing the preload  
(face-to-face)

| Bore<br>diameter<br>d | Size | Requisite spacer ring width reduction of bearings in the series <sup>1)</sup> |    |         |    |       |    |        |    |
|-----------------------|------|-------------------------------------------------------------------------------|----|---------|----|-------|----|--------|----|
|                       |      | 719 CE                                                                        |    | 719 ACE |    | 70 CE |    | 70 ACE |    |
|                       |      | a                                                                             | b  | a       | b  | a     | b  | a      | b  |
| mm                    | –    | μm                                                                            |    |         |    |       |    |        |    |
| 6                     | 6    | –                                                                             | –  | –       | –  | 6     | 7  | 5      | 5  |
| 7                     | 7    | –                                                                             | –  | –       | –  | 8     | 8  | 5      | 6  |
| 8                     | 8    | 7                                                                             | 8  | 5       | 5  | 8     | 10 | 6      | 6  |
| 9                     | 9    | 7                                                                             | 8  | 5       | 5  | 8     | 10 | 6      | 6  |
| 10                    | 00   | 7                                                                             | 8  | 5       | 5  | 9     | 10 | 6      | 6  |
| 12                    | 01   | 7                                                                             | 8  | 5       | 5  | 9     | 10 | 6      | 6  |
| 15                    | 02   | 8                                                                             | 9  | 6       | 6  | 9     | 10 | 6      | 11 |
| 17                    | 03   | 9                                                                             | 9  | 6       | 6  | 11    | 12 | 7      | 11 |
| 20                    | 04   | 10                                                                            | 10 | 7       | 7  | 13    | 13 | 8      | 11 |
| 25                    | 05   | 10                                                                            | 10 | 7       | 7  | 13    | 13 | 8      | 11 |
| 30                    | 06   | 10                                                                            | 10 | 7       | 7  | 13    | 13 | 8      | 11 |
| 35                    | 07   | 11                                                                            | 11 | 7       | 8  | 13    | 15 | 9      | 11 |
| 40                    | 08   | 12                                                                            | 13 | 8       | 9  | 13    | 15 | 9      | 11 |
| 45                    | 09   | 12                                                                            | 13 | 8       | 9  | 13    | 15 | 9      | 11 |
| 50                    | 10   | 14                                                                            | 14 | 9       | 10 | 14    | 15 | 9      | 11 |
| 55                    | 11   | 15                                                                            | 16 | 9       | 11 | 14    | 15 | 9      | 11 |
| 60                    | 12   | 15                                                                            | 16 | 9       | 11 | 14    | 15 | 9      | 11 |
| 65                    | 13   | 15                                                                            | 16 | 9       | 11 | 15    | 16 | 10     | 11 |
| 70                    | 14   | 17                                                                            | 19 | 11      | 12 | 16    | 17 | 10     | 11 |
| 75                    | 15   | 17                                                                            | 19 | 11      | 13 | 16    | 17 | 10     | 11 |
| 80                    | 16   | 17                                                                            | 19 | 11      | 13 | 18    | 19 | 12     | 13 |
| 85                    | 17   | 20                                                                            | 22 | 13      | 14 | 18    | 19 | 12     | 13 |
| 90                    | 18   | 20                                                                            | 22 | 13      | 14 | 18    | 19 | 12     | 13 |
| 95                    | 19   | 20                                                                            | 22 | 13      | 15 | 20    | 22 | 13     | 15 |
| 100                   | 20   | 22                                                                            | 25 | 14      | 16 | 20    | 22 | 13     | 15 |
| 110                   | 22   | 22                                                                            | 25 | 14      | 16 | 20    | 22 | 13     | 15 |
| 120                   | 24   | 25                                                                            | 28 | 16      | 18 | 22    | 24 | 14     | 16 |

<sup>1)</sup> Data for bearings with an 18° contact angle is available on request.

Table 24

Guideline values for spacer ring width reduction – 719 .. B and 70 .. B series

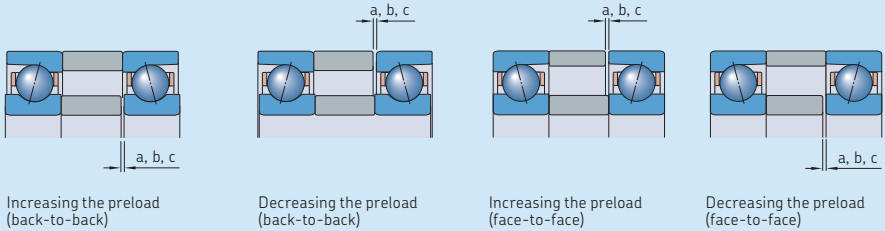


| Bore diameter<br>d | Size | Requisite spacer ring width reduction of bearings in the series <sup>1)</sup> |    |         |    |       |    |        |    |
|--------------------|------|-------------------------------------------------------------------------------|----|---------|----|-------|----|--------|----|
|                    |      | 719 CB                                                                        |    | 719 ACB |    | 70 CB |    | 70 ACB |    |
|                    |      | a                                                                             | b  | a       | b  | a     | b  | a      | b  |
| mm                 | –    | μm                                                                            |    |         |    |       |    |        |    |
| 30                 | 06   | 3                                                                             | 8  | 2       | 6  | 3     | 10 | 2      | 7  |
| 35                 | 07   | 3                                                                             | 8  | 2       | 6  | 3     | 10 | 2      | 7  |
| 40                 | 08   | 3                                                                             | 8  | 2       | 6  | 3     | 10 | 2      | 7  |
| 45                 | 09   | 3                                                                             | 9  | 2       | 6  | 4     | 10 | 3      | 7  |
| 50                 | 10   | 3                                                                             | 9  | 2       | 6  | 4     | 11 | 3      | 7  |
| 55                 | 11   | 4                                                                             | 11 | 2       | 7  | 4     | 12 | 3      | 9  |
| 60                 | 12   | 4                                                                             | 11 | 2       | 7  | 4     | 13 | 3      | 9  |
| 65                 | 13   | 4                                                                             | 11 | 2       | 7  | 5     | 13 | 3      | 9  |
| 70                 | 14   | 4                                                                             | 12 | 3       | 8  | 5     | 15 | 3      | 10 |
| 75                 | 15   | 4                                                                             | 12 | 3       | 8  | 5     | 15 | 3      | 10 |
| 80                 | 16   | 4                                                                             | 12 | 3       | 8  | 6     | 16 | 4      | 12 |
| 85                 | 17   | 4                                                                             | 12 | 3       | 8  | 6     | 16 | 4      | 12 |
| 90                 | 18   | 5                                                                             | 13 | 3       | 9  | 7     | 18 | 4      | 13 |
| 95                 | 19   | 5                                                                             | 13 | 3       | 9  | 7     | 18 | 4      | 13 |
| 100                | 20   | 5                                                                             | 14 | 3       | 9  | 7     | 18 | 4      | 13 |
| 110                | 22   | 5                                                                             | 16 | 4       | 10 | 7     | 19 | 4      | 13 |
| 120                | 24   | 5                                                                             | 16 | 4       | 10 | 7     | 19 | 4      | 13 |

<sup>1)</sup> Data for bearings with an 18° contact angle is available on request.

Table 25

Guideline values for spacer ring width reduction – 72 .. D series



| Bore diameter<br>d | Size | Requisite spacer ring width reduction of bearings in the series |    |    |        |    |    |
|--------------------|------|-----------------------------------------------------------------|----|----|--------|----|----|
|                    |      | 72 CD                                                           |    |    | 72 ACD |    |    |
|                    |      | a                                                               | b  | c  | a      | b  | c  |
| mm                 | –    | μm                                                              |    |    |        |    |    |
| 7                  | 7    | 4                                                               | 5  | 8  | 2      | 4  | 6  |
| 8                  | 8    | 4                                                               | 6  | 9  | 3      | 4  | 7  |
| 9                  | 9    | 4                                                               | 6  | 9  | 3      | 4  | 7  |
| 10                 | 00   | 4                                                               | 6  | 9  | 3      | 4  | 7  |
| 12                 | 01   | 5                                                               | 7  | 10 | 3      | 5  | 7  |
| 15                 | 02   | 6                                                               | 8  | 12 | 4      | 5  | 8  |
| 17                 | 03   | 6                                                               | 9  | 13 | 4      | 6  | 10 |
| 20                 | 04   | 6                                                               | 10 | 14 | 4      | 6  | 10 |
| 25                 | 05   | 6                                                               | 10 | 14 | 4      | 6  | 10 |
| 30                 | 06   | 8                                                               | 11 | 16 | 5      | 8  | 12 |
| 35                 | 07   | 9                                                               | 13 | 19 | 6      | 9  | 14 |
| 40                 | 08   | 9                                                               | 13 | 19 | 6      | 9  | 14 |
| 45                 | 09   | 10                                                              | 15 | 21 | 7      | 10 | 16 |
| 50                 | 10   | 10                                                              | 15 | 21 | 7      | 10 | 16 |
| 55                 | 11   | 11                                                              | 16 | 24 | 7      | 11 | 18 |
| 60                 | 12   | 11                                                              | 16 | 24 | 7      | 11 | 18 |
| 65                 | 13   | 12                                                              | 18 | 26 | 8      | 13 | 19 |
| 70                 | 14   | 12                                                              | 18 | 26 | 8      | 13 | 19 |
| 75                 | 15   | 12                                                              | 18 | 26 | 8      | 13 | 19 |
| 80                 | 16   | 13                                                              | 19 | 28 | 9      | 14 | 21 |
| 85                 | 17   | 14                                                              | 21 | 30 | 9      | 14 | 22 |
| 90                 | 18   | 16                                                              | 24 | 37 | 11     | 17 | 26 |
| 95                 | 19   | 17                                                              | 26 | 38 | 12     | 18 | 28 |
| 100                | 20   | 19                                                              | 28 | 40 | 12     | 19 | 30 |
| 105                | 21   | 19                                                              | 29 | 42 | 13     | 20 | 30 |
| 110                | 22   | 19                                                              | 29 | 42 | 13     | 20 | 30 |
| 120                | 24   | 21                                                              | 31 | 45 | 14     | 21 | 33 |
| 130                | 26   | 21                                                              | 31 | 45 | 14     | 21 | 33 |
| 140                | 28   | 21                                                              | 31 | 45 | 14     | 21 | 33 |

# Axial stiffness

Axial stiffness depends on the elastic deformation (deflection) of the bearing under load and can be expressed as a ratio of load to deflection. However, since the relationship between deflection and load is not linear, only guideline values can be provided. The values are listed in the following tables:

- **table 27 (→ page 173)** for bearings in the 718 .. D series
- **table 28 (→ page 173)** for bearings in the 719 .. D and 70 .. D series
- **table 29 (→ page 173)** for bearings in the 719 .. E and 70 .. E series
- **table 30 (→ page 173)** for bearings in the 719 .. B and 70 .. B series
- **table 31 (→ page 173)** for bearings in the 72 .. D series

These values apply to bearing pairs mounted with a near zero interference fit on a steel shaft, under static conditions and subjected to moderate loads.

More accurate values for axial stiffness can be calculated using advanced computer methods. For additional information, contact the SKF application engineering service.

Comparing same-size bearings, bearing sets comprising three or more bearings provide a higher degree of axial stiffness than sets with two bearings. The guideline values for axial stiffness for these sets can be calculated by

multiplying the values listed in **tables 27 to 31** by a factor provided in **table 26**.

For hybrid bearings, the guideline values for axial stiffness can be obtained in the same way as for bearings with steel balls. However, the calculated value should then be multiplied by a factor of 1,11 (for all arrangements and preload classes).

Table 26

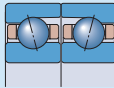
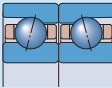
Factors for calculating the axial stiffness of a bearing set

| Number of bearings | Arrangement             | Designation suffix | Factor for preload class |            |
|--------------------|-------------------------|--------------------|--------------------------|------------|
|                    |                         |                    | A, B, C and D            | L, M and F |
| 3                  | Back-to-back and tandem | TBT                | 1,45                     | 1,25       |
|                    | Face-to-face and tandem | TFT                | 1,45                     | 1,25       |
| 4                  | Back-to-back and tandem | QBT                | 1,8                      | 1,45       |
|                    | Face-to-face and tandem | QFT                | 1,8                      | 1,45       |
|                    | Tandem back-to-back     | QBC                | 2                        | 2          |
|                    | Tandem face-to-face     | QFC                | 2                        | 2          |
|                    |                         |                    |                          |            |

For bearing sets with five bearings, contact the SKF application engineering service.

Table 27

Static axial stiffness for two bearings arranged back-to-back or face-to-face – 718 .. D series



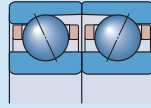
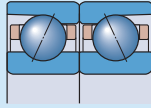
| Bore diameter | Size | Static axial stiffness of bearings in the series |     |     |                              |     |     |
|---------------|------|--------------------------------------------------|-----|-----|------------------------------|-----|-----|
|               |      | 718 CD<br>for preload class                      |     |     | 718 ACD<br>for preload class |     |     |
| d             |      | A                                                | B   | C   | A                            | B   | C   |
| mm            | –    | N/μm                                             |     |     |                              |     |     |
| 10            | 00   | 13                                               | 22  | 32  | 30                           | 47  | 65  |
| 12            | 01   | 15                                               | 25  | 37  | 34                           | 54  | 72  |
| 15            | 02   | 17                                               | 30  | 43  | 40                           | 63  | 85  |
| 17            | 03   | 18                                               | 31  | 45  | 43                           | 67  | 90  |
| 20            | 04   | 22                                               | 38  | 55  | 52                           | 83  | 112 |
| 25            | 05   | 26                                               | 44  | 64  | 60                           | 95  | 128 |
| 30            | 06   | 29                                               | 49  | 72  | 69                           | 106 | 144 |
| 35            | 07   | 32                                               | 56  | 82  | 76                           | 119 | 161 |
| 40            | 08   | 36                                               | 61  | 90  | 83                           | 130 | 178 |
| 45            | 09   | 38                                               | 65  | 95  | 87                           | 139 | 189 |
| 50            | 10   | 47                                               | 81  | 119 | 107                          | 168 | 231 |
| 55            | 11   | 53                                               | 91  | 135 | 124                          | 195 | 268 |
| 60            | 12   | 59                                               | 103 | 152 | 141                          | 222 | 306 |
| 65            | 13   | 61                                               | 105 | 155 | 144                          | 227 | 312 |
| 70            | 14   | 65                                               | 112 | 166 | 152                          | 241 | 332 |
| 75            | 15   | 69                                               | 119 | 177 | 162                          | 257 | 355 |
| 80            | 16   | 74                                               | 128 | 191 | 171                          | 274 | 379 |
| 85            | 17   | 79                                               | 137 | 202 | 189                          | 296 | 406 |
| 90            | 18   | 82                                               | 142 | 210 | 194                          | 307 | 420 |
| 95            | 19   | 85                                               | 147 | 218 | 200                          | 316 | 436 |
| 100           | 20   | 90                                               | 156 | 231 | 211                          | 335 | 462 |
| 105           | 21   | 96                                               | 167 | 250 | 220                          | 353 | 488 |
| 110           | 22   | 99                                               | 173 | 256 | 236                          | 377 | 518 |
| 120           | 24   | 112                                              | 196 | 291 | 262                          | 417 | 576 |
| 130           | 26   | 119                                              | 202 | 296 | 278                          | 439 | 603 |
| 140           | 28   | 130                                              | 226 | 336 | 306                          | 489 | 675 |
| 150           | 30   | 136                                              | 236 | 346 | 323                          | 512 | 702 |
| 160           | 32   | 147                                              | 256 | 379 | 352                          | 556 | 764 |





Table 28a

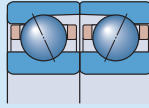
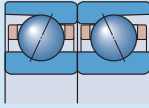
Static axial stiffness for two bearings arranged back-to-back or face-to-face – 719 .. D series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series<br>719 CD<br>for preload class |     |     |     | 719 ACD<br>for preload class |     |      |      |
|--------------------|------|---------------------------------------------------------------------------------|-----|-----|-----|------------------------------|-----|------|------|
|                    |      | A                                                                               | B   | C   | D   | A                            | B   | C    | D    |
| mm                 | –    | N/μm                                                                            |     |     |     |                              |     |      |      |
| 10                 | 00   | 12                                                                              | 16  | 22  | 32  | 29                           | 38  | 49   | 65   |
| 12                 | 01   | 13                                                                              | 17  | 23  | 33  | 31                           | 39  | 52   | 69   |
| 15                 | 02   | 16                                                                              | 21  | 29  | 41  | 40                           | 51  | 67   | 88   |
| 17                 | 03   | 16                                                                              | 22  | 30  | 43  | 42                           | 54  | 70   | 93   |
| 20                 | 04   | 22                                                                              | 29  | 40  | 56  | 51                           | 65  | 85   | 113  |
| 25                 | 05   | 24                                                                              | 32  | 44  | 62  | 60                           | 78  | 101  | 134  |
| 30                 | 06   | 26                                                                              | 35  | 47  | 67  | 65                           | 83  | 109  | 145  |
| 35                 | 07   | 32                                                                              | 42  | 58  | 82  | 81                           | 105 | 137  | 183  |
| 40                 | 08   | 36                                                                              | 48  | 66  | 93  | 89                           | 115 | 151  | 199  |
| 45                 | 09   | 40                                                                              | 53  | 73  | 103 | 100                          | 129 | 168  | 225  |
| 50                 | 10   | 43                                                                              | 57  | 78  | 110 | 105                          | 137 | 180  | 240  |
| 55                 | 11   | 49                                                                              | 65  | 89  | 126 | 124                          | 161 | 211  | 282  |
| 60                 | 12   | 50                                                                              | 67  | 92  | 130 | 128                          | 166 | 218  | 292  |
| 65                 | 13   | 56                                                                              | 75  | 104 | 148 | 136                          | 176 | 232  | 311  |
| 70                 | 14   | 76                                                                              | 104 | 147 | 215 | 180                          | 235 | 314  | 428  |
| 75                 | 15   | 80                                                                              | 110 | 156 | 228 | 194                          | 255 | 340  | 464  |
| 80                 | 16   | 85                                                                              | 117 | 167 | 246 | 204                          | 267 | 358  | 490  |
| 85                 | 17   | 89                                                                              | 122 | 172 | 251 | 214                          | 281 | 374  | 509  |
| 90                 | 18   | 94                                                                              | 129 | 183 | 268 | 224                          | 293 | 392  | 536  |
| 95                 | 19   | 101                                                                             | 139 | 198 | 291 | 240                          | 315 | 420  | 576  |
| 100                | 20   | 107                                                                             | 147 | 209 | 306 | 255                          | 336 | 449  | 613  |
| 105                | 21   | 110                                                                             | 151 | 215 | 316 | 263                          | 346 | 463  | 633  |
| 110                | 22   | 113                                                                             | 156 | 221 | 325 | 274                          | 359 | 482  | 661  |
| 120                | 24   | 127                                                                             | 174 | 246 | 361 | 302                          | 396 | 529  | 724  |
| 130                | 26   | 137                                                                             | 188 | 266 | 391 | 325                          | 427 | 570  | 780  |
| 140                | 28   | 146                                                                             | 201 | 286 | 420 | 348                          | 457 | 614  | 841  |
| 150                | 30   | 154                                                                             | 211 | 297 | 435 | 370                          | 485 | 648  | 882  |
| 160                | 32   | 166                                                                             | 227 | 321 | 471 | 402                          | 530 | 710  | 970  |
| 170                | 34   | 171                                                                             | 236 | 334 | 493 | 415                          | 546 | 731  | 1002 |
| 180                | 36   | 183                                                                             | 250 | 353 | 516 | 442                          | 581 | 774  | 1055 |
| 190                | 38   | 189                                                                             | 260 | 367 | 538 | 455                          | 599 | 798  | 1090 |
| 200                | 40   | 202                                                                             | 275 | 387 | 565 | 484                          | 635 | 845  | 1148 |
| 220                | 44   | 224                                                                             | 306 | 434 | 635 | 533                          | 699 | 934  | 1275 |
| 240                | 48   | 237                                                                             | 325 | 461 | 678 | 584                          | 767 | 1029 | 1412 |
| 260                | 52   | 249                                                                             | 339 | 475 | 688 | 616                          | 807 | 1071 | 1455 |
| 280                | 56   | 266                                                                             | 363 | 509 | 741 | 659                          | 867 | 1154 | 1572 |
| 300                | 60   | 272                                                                             | 369 | 514 | 741 | 663                          | 866 | 1146 | 1548 |
| 320                | 64   | 281                                                                             | 380 | 530 | 765 | 683                          | 892 | 1183 | 1599 |
| 340                | 68   | 300                                                                             | 408 | 571 | 827 | 739                          | 967 | 1284 | 1742 |
| 360                | 72   | 309                                                                             | 420 | 588 | 853 | 754                          | 987 | 1311 | 1779 |

Table 28b

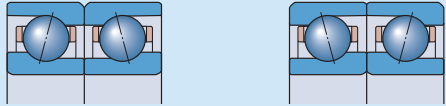
Static axial stiffness for two bearings arranged back-to-back or face-to-face – 70 .. D series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series<br>70 CD<br>for preload class |     |     |     | 70 ACD<br>for preload class |     |       |       |
|--------------------|------|--------------------------------------------------------------------------------|-----|-----|-----|-----------------------------|-----|-------|-------|
|                    |      | A                                                                              | B   | C   | D   | A                           | B   | C     | D     |
| mm                 | –    | N/μm                                                                           |     |     |     |                             |     |       |       |
| 6                  | 6    | 8                                                                              | 10  | 13  | 18  | 19                          | 26  | 33    | 44    |
| 7                  | 7    | 9                                                                              | 12  | 16  | 22  | 22                          | 28  | 37    | 49    |
| 8                  | 8    | 10                                                                             | 14  | 19  | 26  | 27                          | 35  | 45    | 60    |
| 9                  | 9    | 11                                                                             | 15  | 21  | 29  | 30                          | 39  | 51    | 67    |
| 10                 | 00   | 13                                                                             | 17  | 23  | 33  | 32                          | 41  | 54    | 71    |
| 12                 | 01   | 14                                                                             | 18  | 25  | 35  | 34                          | 44  | 57    | 76    |
| 15                 | 02   | 17                                                                             | 23  | 31  | 44  | 41                          | 53  | 69    | 92    |
| 17                 | 03   | 19                                                                             | 26  | 35  | 50  | 48                          | 62  | 81    | 107   |
| 20                 | 04   | 23                                                                             | 30  | 42  | 59  | 54                          | 69  | 90    | 120   |
| 25                 | 05   | 25                                                                             | 33  | 46  | 64  | 64                          | 83  | 108   | 143   |
| 30                 | 06   | 30                                                                             | 40  | 55  | 77  | 79                          | 102 | 133   | 176   |
| 35                 | 07   | 36                                                                             | 47  | 64  | 90  | 86                          | 110 | 144   | 190   |
| 40                 | 08   | 38                                                                             | 51  | 69  | 96  | 96                          | 124 | 162   | 214   |
| 45                 | 09   | 56                                                                             | 76  | 107 | 155 | 132                         | 173 | 229   | 309   |
| 50                 | 10   | 58                                                                             | 79  | 111 | 161 | 141                         | 184 | 244   | 331   |
| 55                 | 11   | 67                                                                             | 91  | 128 | 186 | 159                         | 207 | 275   | 372   |
| 60                 | 12   | 70                                                                             | 95  | 133 | 193 | 168                         | 219 | 291   | 393   |
| 65                 | 13   | 74                                                                             | 101 | 143 | 207 | 174                         | 227 | 302   | 409   |
| 70                 | 14   | 81                                                                             | 111 | 156 | 227 | 191                         | 249 | 330   | 447   |
| 75                 | 15   | 84                                                                             | 115 | 162 | 235 | 200                         | 262 | 347   | 471   |
| 80                 | 16   | 92                                                                             | 125 | 175 | 254 | 223                         | 291 | 386   | 523   |
| 85                 | 17   | 97                                                                             | 132 | 185 | 268 | 233                         | 304 | 405   | 549   |
| 90                 | 18   | 103                                                                            | 141 | 198 | 287 | 245                         | 321 | 425   | 575   |
| 95                 | 19   | 108                                                                            | 148 | 208 | 302 | 258                         | 337 | 448   | 607   |
| 100                | 20   | 112                                                                            | 153 | 215 | 312 | 270                         | 355 | 472   | 640   |
| 105                | 21   | 117                                                                            | 159 | 223 | 324 | 279                         | 365 | 484   | 655   |
| 110                | 22   | 122                                                                            | 166 | 232 | 337 | 290                         | 379 | 503   | 681   |
| 120                | 24   | 131                                                                            | 179 | 251 | 364 | 318                         | 416 | 552   | 749   |
| 130                | 26   | 145                                                                            | 198 | 277 | 400 | 353                         | 460 | 610   | 826   |
| 140                | 28   | 151                                                                            | 206 | 289 | 418 | 364                         | 477 | 633   | 856   |
| 150                | 30   | 163                                                                            | 221 | 310 | 449 | 388                         | 506 | 671   | 909   |
| 160                | 32   | 171                                                                            | 233 | 327 | 472 | 414                         | 540 | 717   | 968   |
| 170                | 34   | 179                                                                            | 243 | 339 | 488 | 433                         | 563 | 744   | 1 003 |
| 180                | 36   | 186                                                                            | 251 | 349 | 501 | 456                         | 593 | 782   | 1 052 |
| 190                | 38   | 196                                                                            | 266 | 370 | 532 | 471                         | 613 | 809   | 1 088 |
| 200                | 40   | 208                                                                            | 280 | 389 | 556 | 509                         | 660 | 871   | 1 170 |
| 220                | 44   | 222                                                                            | 300 | 415 | 592 | 546                         | 710 | 935   | 1 254 |
| 240                | 48   | 234                                                                            | 316 | 438 | 627 | 571                         | 743 | 979   | 1 315 |
| 260                | 52   | 250                                                                            | 336 | 464 | 660 | 617                         | 801 | 1 053 | 1 409 |

Table 29a

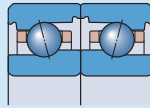
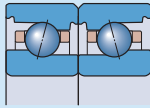
Static axial stiffness for two bearings arranged back-to-back or face-to-face – 719 .. E series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series |     |     |                              |     |     |
|--------------------|------|--------------------------------------------------|-----|-----|------------------------------|-----|-----|
|                    |      | 719 CE<br>for preload class                      |     |     | 719 ACE<br>for preload class |     |     |
|                    |      | A                                                | B   | C   | A                            | B   | C   |
| mm                 | –    | N/μm                                             |     |     |                              |     |     |
| 8                  | 8    | 8                                                | 13  | 18  | 21                           | 32  | 41  |
| 9                  | 9    | 10                                               | 16  | 21  | 25                           | 37  | 48  |
| 10                 | 00   | 10                                               | 16  | 22  | 25                           | 37  | 48  |
| 12                 | 01   | 11                                               | 17  | 23  | 27                           | 41  | 53  |
| 15                 | 02   | 13                                               | 21  | 29  | 34                           | 51  | 66  |
| 17                 | 03   | 14                                               | 23  | 31  | 35                           | 55  | 71  |
| 20                 | 04   | 18                                               | 28  | 39  | 47                           | 69  | 88  |
| 25                 | 05   | 20                                               | 32  | 44  | 51                           | 77  | 100 |
| 30                 | 06   | 23                                               | 35  | 49  | 55                           | 85  | 111 |
| 35                 | 07   | 28                                               | 43  | 59  | 69                           | 104 | 136 |
| 40                 | 08   | 32                                               | 49  | 67  | 78                           | 117 | 153 |
| 45                 | 09   | 34                                               | 53  | 73  | 85                           | 127 | 166 |
| 50                 | 10   | 38                                               | 61  | 83  | 96                           | 145 | 190 |
| 55                 | 11   | 42                                               | 67  | 92  | 105                          | 160 | 210 |
| 60                 | 12   | 47                                               | 73  | 100 | 115                          | 173 | 228 |
| 65                 | 13   | 47                                               | 76  | 105 | 120                          | 181 | 238 |
| 70                 | 14   | 52                                               | 83  | 113 | 131                          | 197 | 258 |
| 75                 | 15   | 54                                               | 86  | 118 | 137                          | 205 | 269 |
| 80                 | 16   | 56                                               | 89  | 123 | 141                          | 214 | 281 |
| 85                 | 17   | 63                                               | 99  | 136 | 157                          | 237 | 311 |
| 90                 | 18   | 65                                               | 102 | 141 | 164                          | 247 | 324 |
| 95                 | 19   | 68                                               | 107 | 147 | 170                          | 256 | 338 |
| 100                | 20   | 73                                               | 116 | 160 | 187                          | 280 | 367 |
| 110                | 22   | 80                                               | 126 | 174 | 199                          | 301 | 397 |
| 120                | 24   | 82                                               | 129 | 179 | 207                          | 312 | 411 |

Table 29b

Static axial stiffness for two bearings arranged back-to-back or face-to-face – 70 .. E series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series |     |     |                             |     |     |
|--------------------|------|--------------------------------------------------|-----|-----|-----------------------------|-----|-----|
|                    |      | 70 CE<br>for preload class                       |     |     | 70 ACE<br>for preload class |     |     |
|                    |      | A                                                | B   | C   | A                           | B   | C   |
| mm                 | –    | N/μm                                             |     |     |                             |     |     |
| 6                  | 6    | 8                                                | 12  | 16  | 19                          | 28  | 37  |
| 7                  | 7    | 8                                                | 13  | 18  | 21                          | 31  | 41  |
| 8                  | 8    | 10                                               | 14  | 20  | 23                          | 34  | 45  |
| 9                  | 9    | 11                                               | 16  | 22  | 26                          | 38  | 50  |
| 10                 | 00   | 12                                               | 19  | 26  | 31                          | 47  | 61  |
| 12                 | 01   | 13                                               | 21  | 30  | 34                          | 50  | 66  |
| 15                 | 02   | 16                                               | 25  | 34  | 40                          | 59  | 66  |
| 17                 | 03   | 18                                               | 28  | 39  | 46                          | 68  | 89  |
| 20                 | 04   | 21                                               | 32  | 44  | 52                          | 78  | 102 |
| 25                 | 05   | 24                                               | 37  | 50  | 59                          | 89  | 117 |
| 30                 | 06   | 28                                               | 44  | 60  | 71                          | 105 | 138 |
| 35                 | 07   | 31                                               | 49  | 67  | 79                          | 119 | 154 |
| 40                 | 08   | 34                                               | 54  | 73  | 87                          | 129 | 169 |
| 45                 | 09   | 38                                               | 59  | 79  | 94                          | 140 | 183 |
| 50                 | 10   | 42                                               | 65  | 88  | 104                         | 156 | 204 |
| 55                 | 11   | 46                                               | 72  | 98  | 116                         | 174 | 226 |
| 60                 | 12   | 48                                               | 75  | 101 | 122                         | 180 | 235 |
| 65                 | 13   | 53                                               | 83  | 112 | 132                         | 198 | 259 |
| 70                 | 14   | 57                                               | 88  | 120 | 143                         | 215 | 280 |
| 75                 | 15   | 65                                               | 102 | 140 | 161                         | 243 | 318 |
| 80                 | 16   | 72                                               | 114 | 157 | 178                         | 268 | 352 |
| 85                 | 17   | 75                                               | 118 | 163 | 186                         | 281 | 369 |
| 90                 | 18   | 79                                               | 125 | 171 | 196                         | 297 | 389 |
| 95                 | 19   | 84                                               | 133 | 184 | 212                         | 319 | 420 |
| 100                | 20   | 88                                               | 138 | 191 | 220                         | 330 | 435 |
| 110                | 22   | 94                                               | 149 | 204 | 237                         | 356 | 466 |
| 120                | 24   | 104                                              | 164 | 225 | 259                         | 391 | 512 |

Table 30a

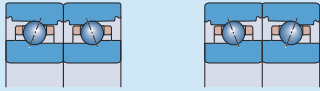
Static axial stiffness for two bearings arranged back-to-back or face-to-face – 719 .. B series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series |    |     |                              |     |     |
|--------------------|------|--------------------------------------------------|----|-----|------------------------------|-----|-----|
|                    |      | 719 CB<br>for preload class                      |    |     | 719 ACB<br>for preload class |     |     |
|                    |      | A                                                | B  | C   | A                            | B   | C   |
| mm                 | –    | N/μm                                             |    |     |                              |     |     |
| 30                 | 06   | 20                                               | 27 | 43  | 53                           | 68  | 102 |
| 35                 | 07   | 23                                               | 29 | 47  | 59                           | 75  | 114 |
| 40                 | 08   | 25                                               | 32 | 52  | 65                           | 83  | 124 |
| 45                 | 09   | 28                                               | 37 | 60  | 74                           | 95  | 143 |
| 50                 | 10   | 31                                               | 40 | 65  | 79                           | 102 | 155 |
| 55                 | 11   | 34                                               | 45 | 73  | 88                           | 114 | 172 |
| 60                 | 12   | 36                                               | 48 | 77  | 94                           | 122 | 182 |
| 65                 | 13   | 38                                               | 51 | 81  | 100                          | 129 | 195 |
| 70                 | 14   | 44                                               | 57 | 91  | 112                          | 144 | 218 |
| 75                 | 15   | 46                                               | 60 | 96  | 120                          | 155 | 234 |
| 80                 | 16   | 49                                               | 64 | 103 | 126                          | 163 | 246 |
| 85                 | 17   | 52                                               | 68 | 109 | 136                          | 174 | 264 |
| 90                 | 18   | 53                                               | 70 | 112 | 139                          | 178 | 270 |
| 95                 | 19   | 56                                               | 73 | 117 | 147                          | 188 | 286 |
| 100                | 20   | 60                                               | 79 | 125 | 157                          | 202 | 306 |
| 110                | 22   | 66                                               | 87 | 140 | 174                          | 221 | 338 |
| 120                | 24   | 71                                               | 94 | 150 | 188                          | 243 | 366 |

Table 30b

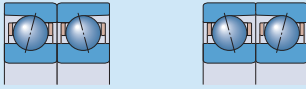
Static axial stiffness for two bearings arranged back-to-back or face-to-face – 70 .. B series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series |    |     |                             |     |     |
|--------------------|------|--------------------------------------------------|----|-----|-----------------------------|-----|-----|
|                    |      | 70 CB<br>for preload class                       |    |     | 70 ACB<br>for preload class |     |     |
|                    |      | A                                                | B  | C   | A                           | B   | C   |
| mm                 | –    | N/μm                                             |    |     |                             |     |     |
| 30                 | 06   | 22                                               | 29 | 46  | 58                          | 74  | 111 |
| 35                 | 07   | 25                                               | 33 | 52  | 64                          | 82  | 124 |
| 40                 | 08   | 28                                               | 36 | 57  | 71                          | 92  | 138 |
| 45                 | 09   | 31                                               | 40 | 64  | 79                          | 103 | 157 |
| 50                 | 10   | 33                                               | 43 | 69  | 87                          | 110 | 165 |
| 55                 | 11   | 38                                               | 50 | 80  | 100                         | 128 | 194 |
| 60                 | 12   | 41                                               | 54 | 86  | 107                         | 135 | 204 |
| 65                 | 13   | 41                                               | 54 | 85  | 107                         | 138 | 208 |
| 70                 | 14   | 47                                               | 63 | 99  | 123                         | 159 | 239 |
| 75                 | 15   | 50                                               | 65 | 104 | 133                         | 169 | 255 |
| 80                 | 16   | 52                                               | 68 | 109 | 144                         | 182 | 276 |
| 85                 | 17   | 54                                               | 71 | 112 | 148                         | 188 | 284 |
| 90                 | 18   | 54                                               | 71 | 112 | 142                         | 183 | 275 |
| 95                 | 19   | 56                                               | 74 | 117 | 147                         | 190 | 286 |
| 100                | 20   | 58                                               | 76 | 120 | 152                         | 194 | 294 |
| 110                | 22   | 71                                               | 93 | 147 | 184                         | 236 | 355 |
| 120                | 24   | 75                                               | 98 | 156 | 197                         | 252 | 379 |

Table 31

Static axial stiffness for two bearings arranged back-to-back or face-to-face – 72 .. D series



| Bore diameter<br>d | Size | Static axial stiffness of bearings in the series |     |     |     |                             |     |     |     |
|--------------------|------|--------------------------------------------------|-----|-----|-----|-----------------------------|-----|-----|-----|
|                    |      | 72 CD<br>for preload class                       |     |     |     | 72 ACD<br>for preload class |     |     |     |
|                    |      | A                                                | B   | C   | D   | A                           | B   | C   | D   |
| mm                 | –    | N/μm                                             |     |     |     |                             |     |     |     |
| 7                  | 7    | 11                                               | 15  | 21  | 30  | 27                          | 35  | 46  | 61  |
| 8                  | 8    | 12                                               | 15  | 21  | 30  | 28                          | 36  | 48  | 63  |
| 9                  | 9    | 13                                               | 17  | 23  | 33  | 32                          | 41  | 54  | 71  |
| 10                 | 00   | 14                                               | 19  | 26  | 37  | 35                          | 45  | 59  | 78  |
| 12                 | 01   | 16                                               | 22  | 30  | 42  | 41                          | 52  | 68  | 90  |
| 15                 | 02   | 19                                               | 26  | 35  | 49  | 46                          | 60  | 78  | 102 |
| 17                 | 03   | 21                                               | 28  | 38  | 53  | 53                          | 68  | 89  | 118 |
| 20                 | 04   | 25                                               | 33  | 45  | 63  | 61                          | 79  | 102 | 135 |
| 25                 | 05   | 29                                               | 38  | 52  | 72  | 71                          | 92  | 119 | 158 |
| 30                 | 06   | 43                                               | 59  | 82  | 118 | 105                         | 137 | 181 | 244 |
| 35                 | 07   | 50                                               | 67  | 94  | 136 | 119                         | 154 | 204 | 275 |
| 40                 | 08   | 53                                               | 71  | 100 | 143 | 127                         | 165 | 218 | 294 |
| 45                 | 09   | 61                                               | 82  | 115 | 166 | 146                         | 190 | 252 | 341 |
| 50                 | 10   | 65                                               | 88  | 124 | 178 | 154                         | 201 | 266 | 359 |
| 55                 | 11   | 72                                               | 98  | 137 | 197 | 172                         | 224 | 296 | 399 |
| 60                 | 12   | 75                                               | 102 | 142 | 205 | 182                         | 238 | 315 | 424 |
| 65                 | 13   | 78                                               | 106 | 148 | 212 | 189                         | 245 | 324 | 437 |
| 70                 | 14   | 83                                               | 112 | 156 | 225 | 201                         | 261 | 345 | 464 |
| 75                 | 15   | 87                                               | 118 | 165 | 237 | 211                         | 274 | 361 | 487 |
| 80                 | 16   | 96                                               | 130 | 181 | 260 | 257                         | 303 | 401 | 540 |
| 85                 | 17   | 102                                              | 139 | 193 | 278 | 250                         | 325 | 429 | 578 |
| 90                 | 18   | 114                                              | 154 | 215 | 314 | 273                         | 355 | 469 | 632 |
| 95                 | 19   | 115                                              | 156 | 217 | 313 | 280                         | 365 | 482 | 649 |
| 100                | 20   | 122                                              | 165 | 230 | 331 | 296                         | 388 | 509 | 685 |
| 105                | 21   | 129                                              | 174 | 243 | 349 | 308                         | 399 | 527 | 708 |
| 110                | 22   | 135                                              | 183 | 254 | 364 | 325                         | 423 | 557 | 748 |
| 120                | 24   | 139                                              | 188 | 261 | 373 | 338                         | 440 | 579 | 777 |
| 130                | 26   | 155                                              | 209 | 291 | 416 | 378                         | 491 | 530 | 869 |
| 140                | 28   | 163                                              | 220 | 305 | 437 | 397                         | 516 | 679 | 911 |



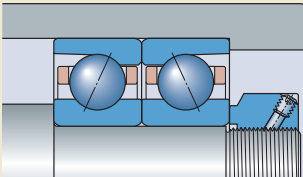
## Fitting and clamping bearing rings

Super-precision angular contact ball bearings are typically located axially on shafts or in housings with either precision lock nuts (→ **fig. 19**) or end plates. These components require high geometrical precision and good mechanical strength to provide adequate support and location.

The tightening torque  $M_t$ , for precision lock nuts or end plate bolts, must be sufficient to keep all components, including the bearings, in place without causing distortions or other damage.

For information about precision lock nuts, refer to *Precision lock nuts* (→ **page 183**).

Fig. 19



### Calculating the required tightening torque

Due to the number of variables (friction between mating components, degree of interference fit, increased preload due to interference fit etc.), it is not possible to accurately calculate the required tightening torque  $M_t$  for a precision lock nut or the bolts in an end plate. The following formulae can be used to estimate  $M_t$ , but the results should be verified during operation.

The required axial clamping force for a precision lock nut or the bolts in an end plate can be estimated from

$$P_a = F_s + (N_{cp} F_c) + G_{A,B,C,D}$$

The required tightening torque for a precision lock nut can be estimated from

$$M_t = K P_a$$

The required tightening torque for end plate bolts can be estimated from

$$M_t = K \frac{P_a}{N_b}$$

where

- $M_t$  = required tightening torque [Nmm]
- $P_a$  = required axial clamping force [N]
- $F_c$  = axial fitting force [N]
  - for bearings in the 718 .. D, 719 .. D, 70 .. D and 72 .. D series (→ **table 32, page 184**)
  - for bearings in the 719 .. E and 70 .. E series (→ **table 33, page 184**)
  - for bearings in the 719 .. B and 70 .. B series (→ **table 34, page 184**)
- $F_s$  = minimum axial clamping force [N]
  - for bearings in the 718 .. D, 719 .. D, 70 .. D and 72 .. D series (→ **table 32**)
  - for bearings in the 719 .. E and 70 .. E series (→ **table 33**)
  - for bearings in the 719 .. B and 70 .. B series (→ **table 34**)
- $G_{A,B,C,D}$  = pre-set bearing preload, prior to mounting [N] (→ **tables 10 to 14, pages 184 to 184**)
- $K$  = calculation factor dependent on the thread (→ **table 35, page 184**)
- $N_{cp}$  = number of bearings in the same orientation as the bearing that the precision lock nut or end plate is in direct contact with<sup>1)</sup>
- $N_b$  = number of end plate bolts

<sup>1)</sup> This is not the total number of bearings in the arrangement, only those that require to be moved to close gaps between rings to achieve pre-set preload. Refer also to *Locking procedure*.

### Locking procedure

When locating super-precision angular contact ball bearings axially using a precision lock nut or end plate, the following procedure should be applied to be sure that all of the bearings are fully seated and the clamping force is re-set to the estimated required level.

- 1 Tighten the lock nut / end plate bolts 2 to 3 times tighter than the value for  $M_t$ .
- 2 Loosen the lock nut / end plate bolts.
- 3 Retighten the lock nut / end plate bolts to the value of  $M_t$ .

Table 32

Minimum axial clamping force and axial fitting force for precision lock nuts and end plates for D design bearings

| Bore diameter<br>d | Size | Minimum axial clamping force<br>for bearings in the series |          |         |         | Axial fitting force<br>for bearings in the series |          |         |         |
|--------------------|------|------------------------------------------------------------|----------|---------|---------|---------------------------------------------------|----------|---------|---------|
|                    |      | 718 .. D<br>F <sub>s</sub>                                 | 719 .. D | 70 .. D | 72 .. D | 718 .. D<br>F <sub>c</sub>                        | 719 .. D | 70 .. D | 72 .. D |
| mm                 | –    | N                                                          |          |         |         | N                                                 |          |         |         |
| 6                  | 6    | –                                                          | –        | 260     | –       | –                                                 | –        | 430     | –       |
| 7                  | 7    | –                                                          | –        | 310     | 490     | –                                                 | –        | 410     | 550     |
| 8                  | 8    | –                                                          | –        | 450     | 490     | –                                                 | –        | 490     | 600     |
| 9                  | 9    | –                                                          | –        | 600     | 650     | –                                                 | –        | 490     | 600     |
| 10                 | 00   | 370                                                        | 500      | 600     | 850     | 240                                               | 280      | 500     | 700     |
| 12                 | 01   | 430                                                        | 600      | 700     | 1 000   | 210                                               | 280      | 470     | 700     |
| 15                 | 02   | 550                                                        | 650      | 1 000   | 950     | 180                                               | 280      | 490     | 600     |
| 17                 | 03   | 600                                                        | 750      | 1 000   | 1 300   | 160                                               | 280      | 490     | 700     |
| 20                 | 04   | 950                                                        | 1 300    | 1 600   | 2 300   | 250                                               | 400      | 650     | 850     |
| 25                 | 05   | 1 200                                                      | 1 600    | 2 000   | 2 400   | 210                                               | 340      | 550     | 750     |
| 30                 | 06   | 1 400                                                      | 1 900    | 2 500   | 3 400   | 180                                               | 300      | 550     | 700     |
| 35                 | 07   | 1 600                                                      | 2 600    | 3 300   | 5 500   | 210                                               | 440      | 750     | 1 200   |
| 40                 | 08   | 1 800                                                      | 3 100    | 4 100   | 6 000   | 180                                               | 500      | 750     | 1 200   |
| 45                 | 09   | 2 400                                                      | 3 800    | 4 500   | 7 000   | 190                                               | 480      | 750     | 1 200   |
| 50                 | 10   | 2 900                                                      | 3 100    | 5 000   | 6 000   | 180                                               | 380      | 650     | 1 000   |
| 55                 | 11   | 3 300                                                      | 4 100    | 6 000   | 7 500   | 230                                               | 430      | 800     | 1 100   |
| 60                 | 12   | 3 300                                                      | 4 500    | 6 500   | 11 000  | 240                                               | 400      | 750     | 1 300   |
| 65                 | 13   | 4 700                                                      | 4 800    | 7 000   | 13 000  | 260                                               | 370      | 700     | 1 300   |
| 70                 | 14   | 5 000                                                      | 6 500    | 8 500   | 14 000  | 240                                               | 500      | 800     | 1 300   |
| 75                 | 15   | 5 500                                                      | 6 500    | 9 000   | 15 000  | 230                                               | 480      | 750     | 1 300   |
| 80                 | 16   | 5 500                                                      | 7 000    | 11 000  | 17 000  | 300                                               | 650      | 1 200   | 1 900   |
| 85                 | 17   | 7 500                                                      | 9 000    | 11 000  | 19 000  | 550                                               | 900      | 1 400   | 2 500   |
| 90                 | 18   | 8 000                                                      | 9 500    | 14 000  | 19 000  | 500                                               | 850      | 1 700   | 2 500   |
| 95                 | 19   | 8 000                                                      | 10 000   | 14 000  | 27 000  | 480                                               | 850      | 1 500   | 3 000   |
| 100                | 20   | 8 500                                                      | 12 000   | 15 000  | 27 000  | 460                                               | 1 000    | 1 400   | 3 100   |
| 105                | 21   | 9 000                                                      | 12 500   | 17 000  | 31 000  | 450                                               | 900      | 1 600   | 3 300   |
| 110                | 22   | 11 000                                                     | 13 000   | 20 000  | 37 000  | 600                                               | 900      | 1 800   | 3 600   |
| 120                | 24   | 12 000                                                     | 16 000   | 22 000  | 45 000  | 600                                               | 1 200    | 1 900   | 4 300   |
| 130                | 26   | 17 000                                                     | 23 000   | 27 000  | 48 000  | 900                                               | 1 300    | 2 700   | 4 500   |
| 140                | 28   | 16 000                                                     | 24 000   | 29 000  | 59 000  | 800                                               | 1 300    | 2 500   | 5 000   |
| 150                | 30   | 21 000                                                     | 27 000   | 34 000  | –       | 1 000                                             | 1 800    | 2 700   | –       |
| 160                | 32   | 23 000                                                     | 28 000   | 38 000  | –       | 1 000                                             | 1 700    | 2 900   | –       |
| 170                | 34   | –                                                          | 30 000   | 51 000  | –       | –                                                 | 1 600    | 3 500   | –       |
| 180                | 36   | –                                                          | 37 000   | 59 000  | –       | –                                                 | 2 200    | 4 000   | –       |
| 190                | 38   | –                                                          | 39 000   | 62 000  | –       | –                                                 | 2 600    | 4 500   | –       |
| 200                | 40   | –                                                          | 48 000   | 66 000  | –       | –                                                 | 3 200    | 5 500   | –       |
| 220                | 44   | –                                                          | 52 000   | 79 000  | –       | –                                                 | 2 900    | 6 000   | –       |
| 240                | 48   | –                                                          | 57 000   | 86 000  | –       | –                                                 | 2 700    | 5 500   | –       |
| 260                | 52   | –                                                          | 77 000   | 109 000 | –       | –                                                 | 4 000    | 7 500   | –       |
| 280                | 56   | –                                                          | 83 000   | –       | –       | –                                                 | 4 000    | –       | –       |
| 300                | 60   | –                                                          | 107 000  | –       | –       | –                                                 | 5 300    | –       | –       |
| 320                | 64   | –                                                          | 114 000  | –       | –       | –                                                 | 5 700    | –       | –       |
| 340                | 68   | –                                                          | 120 000  | –       | –       | –                                                 | 6 000    | –       | –       |
| 360                | 72   | –                                                          | 127 000  | –       | –       | –                                                 | 6 200    | –       | –       |

Table 33

Minimum axial clamping force and axial fitting force for precision lock nuts and end plates for E design bearings

| Bore diameter<br>d | Size | Minimum axial clamping force<br>for bearings in the series |         | Axial fitting force<br>for bearings in the series |         |
|--------------------|------|------------------------------------------------------------|---------|---------------------------------------------------|---------|
|                    |      | 719 .. E<br>$F_s$                                          | 70 .. E | 719 .. E<br>$F_c$                                 | 70 .. E |
| mm                 | –    | N                                                          |         | N                                                 |         |
| 6                  | 6    | –                                                          | 260     | –                                                 | 430     |
| 7                  | 7    | –                                                          | 310     | –                                                 | 410     |
| 8                  | 8    | 330                                                        | 450     | 280                                               | 490     |
| 9                  | 9    | 400                                                        | 600     | 280                                               | 490     |
| 10                 | 00   | 500                                                        | 650     | 280                                               | 550     |
| 12                 | 01   | 600                                                        | 700     | 280                                               | 470     |
| 15                 | 02   | 650                                                        | 1 000   | 280                                               | 490     |
| 17                 | 03   | 750                                                        | 1 000   | 280                                               | 490     |
| 20                 | 04   | 1 300                                                      | 1 600   | 400                                               | 650     |
| 25                 | 05   | 1 600                                                      | 1 800   | 340                                               | 500     |
| 30                 | 06   | 1 900                                                      | 2 500   | 300                                               | 550     |
| 35                 | 07   | 2 600                                                      | 3 300   | 440                                               | 750     |
| 40                 | 08   | 3 100                                                      | 4 100   | 500                                               | 750     |
| 45                 | 09   | 3 800                                                      | 4 500   | 480                                               | 750     |
| 50                 | 10   | 3 100                                                      | 5 000   | 380                                               | 650     |
| 55                 | 11   | 4 100                                                      | 6 000   | 430                                               | 800     |
| 60                 | 12   | 4 500                                                      | 6 500   | 400                                               | 750     |
| 65                 | 13   | 4 800                                                      | 7 000   | 370                                               | 700     |
| 70                 | 14   | 6 500                                                      | 8 500   | 500                                               | 800     |
| 75                 | 15   | 6 500                                                      | 9 000   | 480                                               | 750     |
| 80                 | 16   | 7 000                                                      | 11 000  | 650                                               | 1 200   |
| 85                 | 17   | 9 000                                                      | 11 000  | 900                                               | 1 400   |
| 90                 | 18   | 9 500                                                      | 16 000  | 850                                               | 1 700   |
| 95                 | 19   | 10 000                                                     | 14 000  | 850                                               | 1 500   |
| 100                | 20   | 12 000                                                     | 15 000  | 1 000                                             | 1 400   |
| 110                | 22   | 13 000                                                     | 20 000  | 900                                               | 1 800   |
| 120                | 24   | 16 000                                                     | 22 000  | 1 200                                             | 1 900   |

Table 34

Minimum axial clamping force and axial fitting force for precision lock nuts and end plates for B design bearings

| Bore diameter<br>d | Size | Minimum axial clamping force<br>for bearings in the series |         | Axial fitting force<br>for bearings in the series |         |
|--------------------|------|------------------------------------------------------------|---------|---------------------------------------------------|---------|
|                    |      | 719 .. B<br>$F_s$                                          | 70 .. B | 719 .. B<br>$F_c$                                 | 70 .. B |
| mm                 | –    | N                                                          |         | N                                                 |         |
| 30                 | 06   | 1 900                                                      | 2 500   | 300                                               | 550     |
| 35                 | 07   | 2 600                                                      | 3 300   | 440                                               | 750     |
| 40                 | 08   | 3 100                                                      | 4 100   | 500                                               | 750     |
| 45                 | 09   | 3 800                                                      | 4 500   | 480                                               | 750     |
| 50                 | 10   | 3 100                                                      | 5 000   | 380                                               | 650     |
| 55                 | 11   | 4 100                                                      | 6 000   | 430                                               | 800     |
| 60                 | 12   | 4 500                                                      | 6 500   | 400                                               | 750     |
| 65                 | 13   | 4 800                                                      | 7 000   | 370                                               | 700     |
| 70                 | 14   | 6 500                                                      | 8 500   | 500                                               | 800     |
| 75                 | 15   | 6 500                                                      | 9 000   | 480                                               | 750     |
| 80                 | 16   | 7 000                                                      | 11 000  | 650                                               | 1 200   |
| 85                 | 17   | 9 000                                                      | 11 000  | 900                                               | 1 400   |
| 90                 | 18   | 9 500                                                      | 16 000  | 850                                               | 1 700   |
| 95                 | 19   | 10 000                                                     | 14 000  | 850                                               | 1 500   |
| 100                | 20   | 12 000                                                     | 15 000  | 1 000                                             | 1 400   |
| 110                | 22   | 13 000                                                     | 20 000  | 900                                               | 1 800   |
| 120                | 24   | 16 000                                                     | 22 000  | 1 200                                             | 1 900   |

Table 35

## Factor K for tightening torque calculation

| Nominal thread diameter <sup>1)</sup> | Factor K for<br>precision lock nuts | end plate bolts |
|---------------------------------------|-------------------------------------|-----------------|
| M 4                                   | –                                   | 0,8             |
| M 5                                   | –                                   | 1               |
| M 6                                   | –                                   | 1,2             |
| M 8                                   | –                                   | 1,6             |
| M 10                                  | 1,4                                 | 2               |
| M 12                                  | 1,6                                 | 2,4             |
| M 14                                  | 1,9                                 | 2,7             |
| M 15                                  | 2                                   | 2,9             |
| M 16                                  | 2,1                                 | 3,1             |
| M 17                                  | 2,2                                 | –               |
| M 20                                  | 2,6                                 | –               |
| M 25                                  | 3,2                                 | –               |
| M 30                                  | 3,9                                 | –               |
| M 35                                  | 4,5                                 | –               |
| M 40                                  | 5,1                                 | –               |
| M 45                                  | 5,8                                 | –               |
| M 50                                  | 6,4                                 | –               |
| M 55                                  | 7                                   | –               |
| M 60                                  | 7,6                                 | –               |
| M 65                                  | 8,1                                 | –               |
| M 70                                  | 9                                   | –               |
| M 75                                  | 9,6                                 | –               |
| M 80                                  | 10                                  | –               |
| M 85                                  | 11                                  | –               |
| M 90                                  | 11                                  | –               |
| M 95                                  | 12                                  | –               |
| M 100                                 | 12                                  | –               |
| M 105                                 | 13                                  | –               |
| M 110                                 | 14                                  | –               |
| M 120                                 | 15                                  | –               |
| M 130                                 | 16                                  | –               |
| M 140                                 | 17                                  | –               |
| M 150                                 | 18                                  | –               |
| M 160                                 | 19                                  | –               |
| M 170                                 | 21                                  | –               |
| M 180                                 | 22                                  | –               |
| M 190                                 | 23                                  | –               |
| M 200                                 | 24                                  | –               |
| M 220                                 | 26                                  | –               |
| M 240                                 | 27                                  | –               |
| M 260                                 | 29                                  | –               |
| M 280                                 | 32                                  | –               |
| M 300                                 | 34                                  | –               |
| M 320                                 | 36                                  | –               |
| M 340                                 | 38                                  | –               |
| M 360                                 | 40                                  | –               |

<sup>1)</sup> Applicable for fine threads only

## Load carrying capacity of bearing sets

The values for basic load ratings ( $C$ ,  $C_0$ ) and fatigue load limit ( $P_u$ ) listed in the product tables (→ **page 189**) apply to single bearings. For bearing sets, the corresponding values for single bearings should be multiplied by a factor, listed in **table 36**.

2

Table 36

## Calculation factors for bearing sets

| Number of bearings in a set | Calculation factor for        |                                |                          |
|-----------------------------|-------------------------------|--------------------------------|--------------------------|
|                             | Basic dynamic load rating $C$ | Basic static load rating $C_0$ | Fatigue load limit $P_u$ |
| 2                           | 1,62                          | 2                              | 2                        |
| 3                           | 2,16                          | 3                              | 3                        |
| 4                           | 2,64                          | 4                              | 4                        |
| 5                           | 3,09                          | 5                              | 5                        |

## Equivalent bearing loads

When determining the equivalent bearing load for preloaded angular contact ball bearings, preload must be taken into account. Depending on the operating conditions, the axial component of the bearing load  $F_a$  for a bearing pair, arranged back-to-back or face-to-face, can be determined approximately from the following equations.

For bearing pairs under radial load and mounted with an interference fit

$$F_a = G_m$$

For bearing pairs under radial load and preloaded by springs

$$F_a = G_{\text{springs}}$$

For bearing pairs under axial load and mounted with an interference fit

$$\begin{aligned} K_a \leq 3 G_m &\rightarrow F_a = G_m + 0,67 K_a \\ K_a > 3 G_m &\rightarrow F_a = K_a \end{aligned}$$

For bearing pairs under axial load and preloaded by springs

$$F_a = G_{\text{springs}} + K_a$$

where

$F_a$  = axial component of the bearing load [N]

$G_m$  = preload in the mounted bearing pair [N] ( $\rightarrow$  *Preload in mounted bearing sets*, **page 190**)

$G_{\text{springs}}$  = preload given by the springs [N] (for spindle applications, the bearing rings subjected to spring load must be free to move axially)

$K_a$  = external axial force acting on the bearing arrangement [N]

## Equivalent dynamic bearing load

The equivalent dynamic bearing load can be determined as follows:

For single bearings and bearings arranged in tandem

$$\begin{aligned} F_a/F_r \leq e &\rightarrow P = F_r \\ F_a/F_r > e &\rightarrow P = X_2 F_r + Y_2 F_a \end{aligned}$$

For bearing pairs, arranged back-to-back or face-to-face

$$\begin{aligned} F_a/F_r \leq e &\rightarrow P = F_r + Y_1 F_a \\ F_a/F_r > e &\rightarrow P = X_2 F_r + Y_2 F_a \end{aligned}$$

The values for the factors  $e$ ,  $X_2$ ,  $Y_1$  and  $Y_2$  depend on the bearing contact angle and are listed for:

- single bearings and bearings arranged in tandem ( $\rightarrow$  **table 37**)
- bearings paired back-to-back and face-to-face ( $\rightarrow$  **table 38**)

For bearings with a  $15^\circ$  contact angle, the factors  $e$ ,  $Y_1$  and  $Y_2$  depend on the relationship  $f_0 F_a/C_0$



where

$P$  = equivalent dynamic load on the bearing set [kN]

$F_r$  = radial load acting on the bearing set [kN]

$F_a$  = axial load acting on the bearing set [kN]

$f_0$  = calculation factor (→ **product tables**, **page 191**)

$C_0$  = basic static load rating [kN] (→ **product tables**)

### Equivalent static bearing load

The equivalent static bearing load can be determined as follows:

For single bearings and bearings arranged in tandem

$$P_0 = 0,5 F_r + Y_0 F_a$$

For bearing pairs, arranged back-to-back or face-to-face

$$P_0 = F_r + Y_0 F_a$$

where

$P_0$  = equivalent static load on the bearing set [kN]

$F_r$  = radial load acting on the bearing set [kN]

$F_a$  = axial load acting on the bearing set [kN]

If  $P_0 < F_r$ ,  $P_0 = F_r$  should be used.

The values for the factor  $Y_0$  depend on the bearing contact angle and are listed for:

- single bearings and bearings arranged in tandem (→ **table 37**)
- bearings paired back-to-back and face-to-face (→ **table 38**)

Table 37

Factors for single bearings and bearings arranged in tandem

| $f_0 F_a / C_0$                                                  | e    | $X_2$ | $Y_2$ | $Y_0$ |
|------------------------------------------------------------------|------|-------|-------|-------|
| <b>Contact angle 15°</b><br>(Designation suffix CD, CE or CB)    |      |       |       |       |
| $\leq 0,178$                                                     | 0,38 | 0,44  | 1,47  | 0,46  |
| <b>0,357</b>                                                     | 0,4  | 0,44  | 1,4   | 0,46  |
| <b>0,714</b>                                                     | 0,43 | 0,44  | 1,3   | 0,46  |
| <b>1,07</b>                                                      | 0,46 | 0,44  | 1,23  | 0,46  |
| <b>1,43</b>                                                      | 0,47 | 0,44  | 1,19  | 0,46  |
| <b>2,14</b>                                                      | 0,5  | 0,44  | 1,12  | 0,46  |
| <b>3,57</b>                                                      | 0,55 | 0,44  | 1,02  | 0,46  |
| $\geq 5,35$                                                      | 0,56 | 0,44  | 1     | 0,46  |
| <b>Contact angle 18°</b><br>(Designation suffix FE or FB)        |      |       |       |       |
| –                                                                | 0,57 | 0,43  | 1     | 0,42  |
| <b>Contact angle 25°</b><br>(Designation suffix ACD, ACE or ACB) |      |       |       |       |
| –                                                                | 0,68 | 0,41  | 0,87  | 0,38  |

Table 38

Factors for bearings paired back-to-back or face-to-face

| $2 f_0 F_a / C_0$                                                | e    | $X_2$ | $Y_1$ | $Y_2$ | $Y_0$ |
|------------------------------------------------------------------|------|-------|-------|-------|-------|
| <b>Contact angle 15°</b><br>(Designation suffix CD, CE or CB)    |      |       |       |       |       |
| $\leq 0,178$                                                     | 0,38 | 0,72  | 1,65  | 2,39  | 0,92  |
| <b>0,357</b>                                                     | 0,4  | 0,72  | 1,57  | 2,28  | 0,92  |
| <b>0,714</b>                                                     | 0,43 | 0,72  | 1,46  | 2,11  | 0,92  |
| <b>1,07</b>                                                      | 0,46 | 0,72  | 1,38  | 2     | 0,92  |
| <b>1,43</b>                                                      | 0,47 | 0,72  | 1,34  | 1,93  | 0,92  |
| <b>2,14</b>                                                      | 0,5  | 0,72  | 1,26  | 1,82  | 0,92  |
| <b>3,57</b>                                                      | 0,55 | 0,72  | 1,14  | 1,66  | 0,92  |
| $\geq 5,35$                                                      | 0,56 | 0,72  | 1,12  | 1,63  | 0,92  |
| <b>Contact angle 18°</b><br>(Designation suffix FE or FB)        |      |       |       |       |       |
| –                                                                | 0,57 | 0,7   | 1,09  | 1,63  | 0,84  |
| <b>Contact angle 25°</b><br>(Designation suffix ACD, ACE or ACB) |      |       |       |       |       |
| –                                                                | 0,68 | 0,67  | 0,92  | 1,41  | 0,76  |

## Attainable speeds

The attainable speeds listed in the product tables (→ **page 192**) are guideline values and are valid under certain conditions. For additional information, refer to *Attainable speeds* on **page 192**.

### Sealed bearings

As there is no friction generated at the seal lip, the attainable speed of a sealed bearing is equivalent to a same-sized open bearing.

### Effect of lubrication

The values listed for oil-air lubrication should be reduced if other oil lubrication methods are used.

The values listed for grease lubrication are maximum values that can be attained with sealed bearings or open bearings with an appropriate fill of a suitable, high-quality, soft consistency grease. For additional information, contact the SKF application engineering service.

### Adjusted bearings

If, in order to increase system rigidity, single bearings are adjusted so that a heavy preload results, the attainable speeds listed in the product tables should be reduced. For additional information, contact the SKF application engineering service.

### Bearing sets

If bearing sets with two or more bearings mounted immediately adjacent to each other are used, the attainable speeds listed in the product tables need to be reduced. Values for the maximum rotational speeds in these cases can be obtained by multiplying the guideline value listed in the product tables by a reduction factor (dependent on the bearing design, preload, and the bearing arrangement) listed in **table 39**.

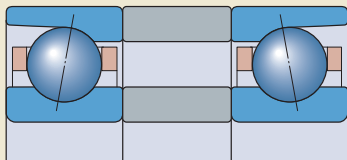
### Spacer rings

If the calculated attainable speed is not sufficient for the application, precision-matched spacer rings in the bearing set (→ **fig. 20**) can be used to increase the speed capability.

| Speed reduction factors for bearing sets |                         |                                        |                                                                                                              |      |      |      |      |      |
|------------------------------------------|-------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------|------|------|------|------|------|
| Number of bearings                       | Arrangement             | Designation suffix<br>for matched sets | Speed reduction factors<br>for bearings in the series<br>718 .. D, 719 .. E and 70 .. E<br>for preload class |      |      |      |      |      |
|                                          |                         |                                        | A                                                                                                            | L    | B    | M    | C    | F    |
| 2                                        | Back-to-back            | <b>DB</b>                              | 0,8                                                                                                          | –    | 0,65 | –    | 0,4  | –    |
|                                          | Face-to-face            | <b>DF</b>                              | 0,77                                                                                                         | –    | 0,61 | –    | 0,36 | –    |
| 3                                        | Back-to-back and tandem | <b>TBT</b>                             | 0,69                                                                                                         | 0,72 | 0,49 | 0,58 | 0,25 | 0,36 |
|                                          | Face-to-face and tandem | <b>TFT</b>                             | 0,63                                                                                                         | 0,66 | 0,42 | 0,49 | 0,17 | 0,24 |
| 4                                        | Tandem back-to-back     | <b>QBC</b>                             | 0,64                                                                                                         | –    | 0,53 | –    | 0,32 | –    |
|                                          | Tandem face-to-face     | <b>QFC</b>                             | 0,62                                                                                                         | –    | 0,48 | –    | 0,27 | –    |

For spring-loaded tandem sets, designation suffix DT, a speed reduction factor of 0,9 should be applied.

Fig. 20



2

Table 39

| 719 .. B and 70 .. B<br>for preload class |              |              | 719 .. D, 70 .. D and 72 .. D<br>for preload class |              |              |              |
|-------------------------------------------|--------------|--------------|----------------------------------------------------|--------------|--------------|--------------|
| A                                         | B            | C            | A                                                  | B            | C            | D            |
| 0,83<br>0,8                               | 0,78<br>0,74 | 0,58<br>0,54 | 0,81<br>0,77                                       | 0,75<br>0,72 | 0,65<br>0,61 | 0,4<br>0,36  |
| 0,72<br>0,64                              | 0,66<br>0,56 | 0,4<br>0,3   | 0,7<br>0,63                                        | 0,63<br>0,56 | 0,49<br>0,42 | 0,25<br>0,17 |
| 0,67<br>0,64                              | 0,64<br>0,6  | 0,48<br>0,41 | 0,64<br>0,62                                       | 0,6<br>0,58  | 0,53<br>0,48 | 0,32<br>0,27 |

## Mounting

### Pressing bearing sets together during hot mounting

Super-precision angular contact ball bearings are typically used in sets. When the bearings are heated, their bore diameter becomes larger and their width also expands. The larger bore diameter facilitates mounting.

When cooling, their bore diameter contracts to obtain the necessary (interference) fit. Their width also contracts and a small gap between the bearings can result. This gap can negatively impact the preload in the bearing set. To avoid this, the bearing inner rings should be pressed against each other while cooling (→ **fig. 21**) with an axial force that is slightly greater than the dismounting force. A force should never be applied directly or indirectly to the outer rings when pressing the bearings together.

### Package markings

SKF super-precision bearings are distributed in SKF illustrated boxes (→ **fig. 22**). An instruction sheet, with information about mounting, is supplied in each box.

When selecting universally matchable angular contact ball bearings to make a set from existing stock, the package provides helpful information such as the mean outside and the mean bore diameter deviations from the nominal diameters as well as the actual bearing contact angle (→ **fig. 23**). Bearings with similar deviations and contact angles should be used together in a set.

Fig. 21

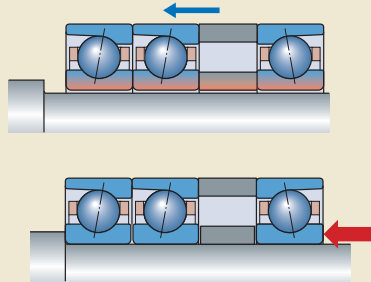


Fig. 22



Fig. 23





# Designation system

**Examples:** Single bearing – 71922 CDGBTNHA/PA9AL  
Matched bearing set – S7010 ACD/HCP4AQBCC

|   |     |    |     |    |      |   |  |
|---|-----|----|-----|----|------|---|--|
|   | 719 | 22 | CD  | GB | TNHA | / |  |
| S | 70  | 10 | ACD |    |      | / |  |

## Prefix

- Open bearing (no designation prefix)
- S Sealed bearing
- V Bearing with NitroMax steel rings and bearing grade silicon nitride Si<sub>3</sub>N<sub>4</sub> balls (hybrid bearing)

## Bearing series

- 718 Angular contact ball bearing in accordance with ISO dimension series 18
- 719 Angular contact ball bearing in accordance with ISO dimension series 19
- 70 Angular contact ball bearing in accordance with ISO dimension series 10
- 72 Angular contact ball bearing in accordance with ISO dimension series 02

## Bearing size

- 6 6 mm bore diameter
- 7 7 mm bore diameter
- 8 8 mm bore diameter
- 9 9 mm bore diameter
- 00 10 mm bore diameter
- 01 12 mm bore diameter
- 02 15 mm bore diameter
- 03 17 mm bore diameter
- 04 (x5) 20 mm bore diameter
- to
- 72 (x5) 360 mm bore diameter

## Internal design

- CD 15° contact angle, high-capacity design
- ACD 25° contact angle, high-capacity design
- CE 15° contact angle, high-speed E design
- FE 18° contact angle, high-speed E design
- ACE 25° contact angle, high-speed E design
- CB 15° contact angle, high-speed B design
- FB 18° contact angle, high-speed B design
- ACB 25° contact angle, high-speed B design

## Single bearing – execution and preload

- Single standalone bearing (no designation suffix) (718 .. D, 719 .. D, 70 .. D, 72 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)
- GA Single, universally matchable, extra light preload (719 .. D, 70 .. D and 72 .. D series)
- GA Single, universally matchable, light preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)
- GB Single, universally matchable, light preload (719 .. D, 70 .. D and 72 .. D series)
- GB Single, universally matchable, moderate preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)
- GC Single, universally matchable, moderate preload (719 .. D, 70 .. D and 72 .. D series)
- GC Single, universally matchable, heavy preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)
- GD Single, universally matchable, heavy preload (719 .. D, 70 .. D and 72 .. D series)

## Cage

- Cotton fabric reinforced phenolic resin or carbon fibre reinforced PEEK, outer ring centred (no designation suffix)
- MA Machined brass, outer ring centred
- TNHA Glass fibre reinforced PEEK, outer ring centred

|    |      |   |     |   |
|----|------|---|-----|---|
|    | PA9A | L |     |   |
| HC | P4A  |   | QBC | C |

**Bearing set – preload**

|      |                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------|
| A    | Extra light preload (719 .. D, 70 .. D and 72 .. D series)                                                                         |
| A    | Light preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)                                                           |
| L    | Light preload – only for matched bearings sets in TBT, TFT, QBT and QFT arrangements (718 .. D, 719 .. E and 70 .. E series)       |
| B    | Light preload (719 .. D, 70 .. D and 72 .. D series)                                                                               |
| B    | Moderate preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)                                                        |
| M    | Moderate preload – only for matched bearings sets in TBT, TFT, QBT and QFT arrangements (718 .. D, 719 .. E and 70 .. E series)    |
| C    | Moderate preload (719 .. D, 70 .. D and 72 .. D series)                                                                            |
| C    | Heavy preload (718 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series)                                                           |
| F    | Heavy preload – only for matched bearings sets in TBT, TFT, QBT and QFT arrangements (718 .. D, 719 .. E and 70 .. E series)       |
| D    | Heavy preload (719 .. D, 70 .. D and 72 .. D series)                                                                               |
| G... | Special preload, expressed in daN e.g. G240 (718 .. D, 719 .. D, 70 .. D, 72 .. D, 719 .. E, 70 .. E, 719 .. B and 70 .. B series) |

**Bearing set arrangement**

|     |                                                             |
|-----|-------------------------------------------------------------|
| DB  | Set of two bearings arranged back-to-back <>                |
| DF  | Set of two bearings arranged face-to-face ><                |
| DT  | Set of two bearings arranged in tandem <<                   |
| DG  | Set of two bearings for universal matching                  |
| TBT | Set of three bearings arranged back-to-back and tandem <>>  |
| TFT | Set of three bearings arranged face-to-face and tandem ><<  |
| TT  | Set of three bearings arranged in tandem <<<                |
| TG  | Set of three bearings for universal matching                |
| QBC | Set of four bearings arranged tandem back-to-back <>>>      |
| QFC | Set of four bearings arranged tandem face-to-face ><<<      |
| QBT | Set of four bearings arranged back-to-back and tandem <>>>  |
| QFT | Set of four bearings arranged face-to-face and tandem ><<<  |
| QT  | Set of four bearings arranged in tandem <<<<                |
| QG  | Set of four bearings for universal matching                 |
| PBC | Set of five bearings arranged tandem back-to-back <>>>>     |
| PFC | Set of five bearings arranged tandem face-to-face ><<<<     |
| PBT | Set of five bearings arranged back-to-back and tandem <>>>> |
| PFT | Set of five bearings arranged face-to-face and tandem ><<<< |
| PT  | Set of five bearings arranged in tandem <<<<<               |
| PG  | Set of five bearings for universal matching                 |

**Lubrication features**

|    |                                                                                                                                                  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| H  | Two lubrication holes on the non-thrust side of the outer ring                                                                                   |
| H1 | Two lubrication holes on the thrust side of the outer ring                                                                                       |
| L  | Annular groove with two lubrication holes on the non-thrust side of the outer ring and two annular grooves fitted with O-rings in the outer ring |
| L1 | Annular groove with two lubrication holes on the thrust side of the outer ring and two annular grooves fitted with O-rings in the outer ring     |

**Accuracy**

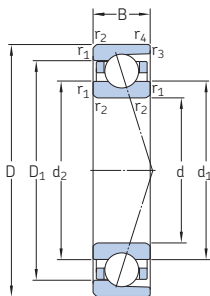
|      |                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------|
| P4   | Dimensional and running accuracy in accordance with ISO tolerance class 4                                         |
| P4A  | Dimensional accuracy in accordance with ISO tolerance class 4, running accuracy better than ISO tolerance class 4 |
| P2   | Dimensional and running accuracy in accordance with ISO tolerance class 2                                         |
| PA9A | Dimensional and running accuracy in accordance with ISO tolerance class 2                                         |

**Ball material**

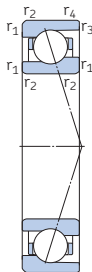
|    |                                                                                             |
|----|---------------------------------------------------------------------------------------------|
| –  | Carbon chromium steel (no designation suffix)                                               |
| HC | Balls made of bearing grade silicon nitride Si <sub>3</sub> N <sub>4</sub> (hybrid bearing) |

## 2.1 Angular contact ball bearings

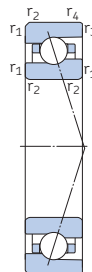
### d 6 – 8 mm



ACD, CD



719 .. ACE,  
719 .. CE

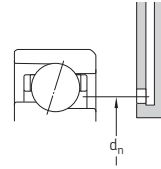
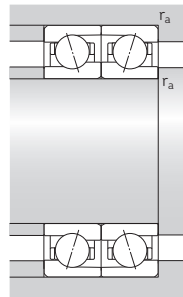
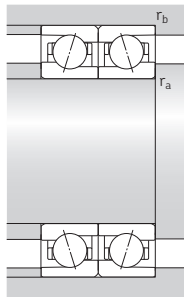
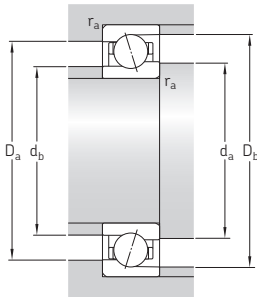


70 .. ACE,  
70 .. CE

| Principal dimensions |    |   | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass  | Designation     | Available variants |                                                   |
|----------------------|----|---|--------------------|-----------------------|--------------------|--------------------|---------------------|-------|-----------------|--------------------|---------------------------------------------------|
| d                    | D  | B | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |       |                 | Sealing            | Direct oil-air solution lubrication <sup>1)</sup> |
| mm                   |    |   | kN                 |                       | kN                 | r/min              |                     | kg    | –               | –                  |                                                   |
| 6                    | 17 | 6 | 1,51               | 0,49                  | 0,02               | 127 000            | 195 000             | 0,006 | 706 ACE/P4A     | –                  | H                                                 |
|                      | 17 | 6 | 1,51               | 0,49                  | 0,02               | 150 000            | 230 000             | 0,005 | 706 ACE/HCP4A   | –                  | H                                                 |
|                      | 17 | 6 | 1,56               | 0,5                   | 0,022              | 140 000            | 220 000             | 0,006 | 706 CE/P4A      | –                  | H                                                 |
|                      | 17 | 6 | 1,56               | 0,5                   | 0,022              | 170 000            | 260 000             | 0,005 | 706 CE/HCP4A    | –                  | H                                                 |
|                      | 17 | 6 | 1,95               | 0,75                  | 0,032              | 110 000            | 160 000             | 0,006 | 706 ACD/P4A     | –                  | H                                                 |
|                      | 17 | 6 | 1,95               | 0,75                  | 0,032              | 130 000            | 190 000             | 0,005 | 706 ACD/HCP4A   | –                  | H                                                 |
|                      | 17 | 6 | 2,03               | 0,765                 | 0,032              | 120 000            | 180 000             | 0,006 | 706 CD/P4A      | –                  | H                                                 |
|                      | 17 | 6 | 2,03               | 0,765                 | 0,032              | 140 000            | 220 000             | 0,005 | 706 CD/HCP4A    | –                  | H                                                 |
|                      | 19 | 6 | 1,86               | 0,62                  | 0,026              | 112 000            | 175 000             | 0,007 | 707 ACE/P4A     | –                  | H                                                 |
|                      | 19 | 6 | 1,86               | 0,62                  | 0,026              | 133 000            | 205 000             | 0,006 | 707 ACE/HCP4A   | –                  | H                                                 |
|                      | 19 | 6 | 1,95               | 0,64                  | 0,027              | 127 000            | 190 000             | 0,007 | 707 CE/P4A      | –                  | H                                                 |
|                      | 19 | 6 | 1,95               | 0,64                  | 0,027              | 150 000            | 230 000             | 0,006 | 707 CE/HCP4A    | –                  | H                                                 |
| 7                    | 19 | 6 | 2,42               | 0,95                  | 0,04               | 95 000             | 140 000             | 0,008 | 707 ACD/P4A     | –                  | H                                                 |
|                      | 19 | 6 | 2,42               | 0,95                  | 0,04               | 110 000            | 170 000             | 0,007 | 707 ACD/HCP4A   | –                  | H                                                 |
|                      | 19 | 6 | 2,51               | 0,98                  | 0,04               | 100 000            | 160 000             | 0,008 | 707 CD/P4A      | –                  | H                                                 |
|                      | 19 | 6 | 2,51               | 0,98                  | 0,04               | 120 000            | 190 000             | 0,007 | 707 CD/HCP4A    | –                  | H                                                 |
|                      | 22 | 7 | 2,91               | 1,12                  | 0,048              | 70 000             | 110 000             | 0,013 | 727 ACD/P4A     | –                  | –                                                 |
|                      | 22 | 7 | 2,91               | 1,12                  | 0,048              | 85 000             | 130 000             | 0,012 | 727 ACD/HCP4A   | –                  | –                                                 |
|                      | 22 | 7 | 2,96               | 1,16                  | 0,049              | 80 000             | 120 000             | 0,013 | 727 CD/P4A      | –                  | –                                                 |
|                      | 22 | 7 | 2,96               | 1,16                  | 0,049              | 95 000             | 150 000             | 0,012 | 727 CD/HCP4A    | –                  | –                                                 |
|                      | 19 | 6 | 1,68               | 0,6                   | 0,026              | 109 000            | 165 000             | 0,007 | 719/8 ACE/P4A   | –                  | H                                                 |
|                      | 19 | 6 | 1,68               | 0,6                   | 0,026              | 130 000            | 200 000             | 0,006 | 719/8 ACE/HCP4A | –                  | H                                                 |
|                      | 19 | 6 | 1,74               | 0,63                  | 0,027              | 120 000            | 185 000             | 0,007 | 719/8 CE/P4A    | –                  | H                                                 |
|                      | 19 | 6 | 1,74               | 0,63                  | 0,027              | 145 000            | 220 000             | 0,006 | 719/8 CE/HCP4A  | –                  | H                                                 |
|                      | 22 | 7 | 2,29               | 0,765                 | 0,032              | 98 000             | 150 000             | 0,012 | 708 ACE/P4A     | –                  | H                                                 |
|                      | 22 | 7 | 2,29               | 0,765                 | 0,032              | 115 000            | 180 000             | 0,011 | 708 ACE/HCP4A   | –                  | H                                                 |
|                      | 22 | 7 | 2,34               | 0,8                   | 0,034              | 109 000            | 165 000             | 0,012 | 708 CE/P4A      | –                  | H                                                 |
|                      | 22 | 7 | 2,34               | 0,8                   | 0,034              | 130 000            | 200 000             | 0,011 | 708 CE/HCP4A    | –                  | H                                                 |
|                      | 22 | 7 | 3,19               | 1,34                  | 0,056              | 80 000             | 120 000             | 0,012 | 708 ACD/P4A     | –                  | H                                                 |
|                      | 22 | 7 | 3,19               | 1,34                  | 0,056              | 95 000             | 150 000             | 0,011 | 708 ACD/HCP4A   | –                  | H                                                 |
|                      | 22 | 7 | 3,25               | 1,37                  | 0,057              | 90 000             | 130 000             | 0,012 | 708 CD/P4A      | –                  | H                                                 |
|                      | 22 | 7 | 3,25               | 1,37                  | 0,057              | 110 000            | 160 000             | 0,011 | 708 CD/HCP4A    | –                  | H                                                 |

<sup>1)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 198).

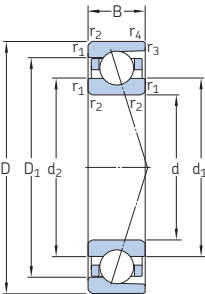




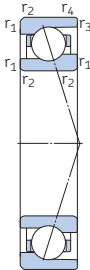
| Dimensions |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |      | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------|------------------------------------------------------|-----------------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |      |                                                      |                             |
| mm         |                |                |                |                |                                |                          | mm                     |                        |                        |                        |                        |                        |                |      | cm <sup>3</sup>                                      | –                           |
| 6          | 9,2            | 8,7            | 13,9           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 15,6                   | 0,3                    | 0,15                   | 10,1           | 0,09 | –                                                    | –                           |
|            | 9,2            | 8,7            | 13,9           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 15,6                   | 0,3                    | 0,15                   | 10,1           | 0,09 | –                                                    | –                           |
|            | 9,2            | 8,7            | 13,9           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 15,6                   | 0,3                    | 0,15                   | 10,1           | 0,09 | 6,4                                                  | 6,4                         |
|            | 9,2            | 8,7            | 13,9           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 15,6                   | 0,3                    | 0,15                   | 10,1           | 0,09 | 6,4                                                  | 6,4                         |
|            | 9,5            | 9,5            | 13,5           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 16,2                   | 0,3                    | 0,15                   | 10,3           | 0,09 | –                                                    | –                           |
|            | 9,5            | 9,5            | 13,5           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 16,2                   | 0,3                    | 0,15                   | 10,3           | 0,09 | –                                                    | –                           |
|            | 9,5            | 9,5            | 13,5           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 16,2                   | 0,3                    | 0,15                   | 10,3           | 0,09 | 8,3                                                  | 8,3                         |
|            | 9,5            | 9,5            | 13,5           | –              | 0,3                            | 0,15                     | 8                      | 8                      | 15                     | 16,2                   | 0,3                    | 0,15                   | 10,3           | 0,09 | 8,3                                                  | 8,3                         |
|            | 10,4           | 9,9            | 15,7           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 17,6                   | 0,3                    | 0,15                   | 11,4           | 0,11 | –                                                    | –                           |
|            | 10,4           | 9,9            | 15,7           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 17,6                   | 0,3                    | 0,15                   | 11,4           | 0,11 | –                                                    | –                           |
|            | 10,4           | 9,9            | 15,7           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 17,6                   | 0,3                    | 0,15                   | 11,4           | 0,11 | 6,5                                                  | 6,5                         |
|            | 10,4           | 9,9            | 15,7           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 17,6                   | 0,3                    | 0,15                   | 11,4           | 0,11 | 6,5                                                  | 6,5                         |
| 7          | 10,8           | 10,8           | 15,2           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 18,2                   | 0,3                    | 0,15                   | 11,7           | 0,12 | –                                                    | –                           |
|            | 10,8           | 10,8           | 15,2           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 18,2                   | 0,3                    | 0,15                   | 11,7           | 0,12 | –                                                    | –                           |
|            | 10,8           | 10,8           | 15,2           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 18,2                   | 0,3                    | 0,15                   | 11,7           | 0,12 | 8,1                                                  | 8,1                         |
|            | 10,8           | 10,8           | 15,2           | –              | 0,3                            | 0,15                     | 9                      | 9                      | 17                     | 18,2                   | 0,3                    | 0,15                   | 11,7           | 0,12 | 8,1                                                  | 8,1                         |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 9,4                    | 9,4                    | 19,6                   | 20,2                   | 0,3                    | 0,2                    | 13,6           | 0,16 | –                                                    | –                           |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 9,4                    | 9,4                    | 19,6                   | 20,2                   | 0,3                    | 0,2                    | 13,6           | 0,16 | –                                                    | –                           |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 9,4                    | 9,4                    | 19,6                   | 20,2                   | 0,3                    | 0,2                    | 13,6           | 0,16 | 8,4                                                  | 8,4                         |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 9,4                    | 9,4                    | 19,6                   | 20,2                   | 0,3                    | 0,2                    | 13,6           | 0,16 | 8,4                                                  | 8,4                         |
|            | 11,3           | 10,8           | 15,7           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 12,2           | 0,09 | –                                                    | –                           |
|            | 11,3           | 10,8           | 15,7           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 12,2           | 0,09 | –                                                    | –                           |
|            | 11,3           | 10,8           | 15,7           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 12,2           | 0,09 | 7,2                                                  | 7,2                         |
|            | 11,3           | 10,8           | 15,7           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 12,2           | 0,09 | 7,2                                                  | 7,2                         |
|            | 12,1           | 11,5           | 17,9           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,15                   | 13,3           | 0,17 | –                                                    | –                           |
| 8          | 12,1           | 11,5           | 17,9           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,15                   | 13,3           | 0,17 | –                                                    | –                           |
|            | 12,1           | 11,5           | 17,9           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,15                   | 13,3           | 0,17 | –                                                    | –                           |
|            | 12,1           | 11,5           | 17,9           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,15                   | 13,3           | 0,17 | 6,6                                                  | 6,6                         |
|            | 12,1           | 11,5           | 17,9           | –              | 0,3                            | 0,15                     | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,15                   | 13,3           | 0,17 | 6,6                                                  | 6,6                         |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,2                    | 13,6           | 0,15 | –                                                    | –                           |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,2                    | 13,6           | 0,15 | –                                                    | –                           |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,2                    | 13,6           | 0,15 | 8,4                                                  | 8,4                         |
|            | 12,6           | 12,6           | 17,4           | –              | 0,3                            | 0,2                      | 10                     | 10                     | 20                     | 20,6                   | 0,3                    | 0,2                    | 13,6           | 0,15 | 8,4                                                  | 8,4                         |

<sup>1)</sup> For calculating the initial grease fill → page 199

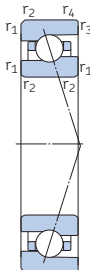
2.1 Angular contact ball bearings
d 8 – 10 mm



ACD, CD



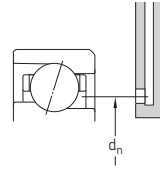
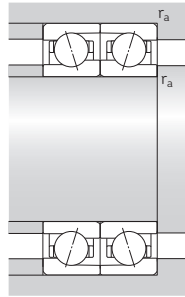
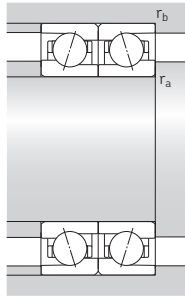
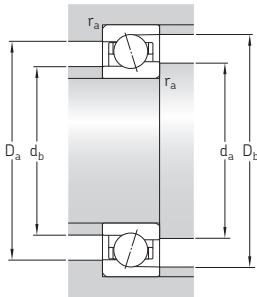
719 .. ACE,
719 .. CE



70 .. ACE,
70 .. CE

| Principal dimensions |    |   | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass  | Designation     | Available variants |                                          |
|----------------------|----|---|--------------------|-----------------------|--------------------|--------------------|---------------------|-------|-----------------|--------------------|------------------------------------------|
| d                    | D  | B | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |       |                 | Sealing solution   | Direct oil-air lubrication <sup>1)</sup> |
| mm                   |    |   | kN                 |                       | kN                 | r/min              |                     | kg    | –               |                    | –                                        |
| 8 cont.              | 24 | 8 | 3,58               | 1,34                  | 0,057              | 67 000             | 100 000             | 0,017 | 728 ACD/P4A     | –                  | –                                        |
|                      | 24 | 8 | 3,58               | 1,34                  | 0,057              | 75 000             | 120 000             | 0,015 | 728 ACD/HCP4A   | –                  | –                                        |
|                      | 24 | 8 | 3,71               | 1,37                  | 0,057              | 70 000             | 110 000             | 0,017 | 728 CD/P4A      | –                  | –                                        |
|                      | 24 | 8 | 3,71               | 1,37                  | 0,057              | 85 000             | 130 000             | 0,015 | 728 CD/HCP4A    | –                  | –                                        |
| 9                    | 20 | 6 | 1,95               | 0,765                 | 0,032              | 100 000            | 150 000             | 0,008 | 719/9 ACE/P4A   | –                  | H                                        |
|                      | 20 | 6 | 1,95               | 0,765                 | 0,032              | 120 000            | 180 000             | 0,007 | 719/9 ACE/HCP4A | –                  | H                                        |
|                      | 20 | 6 | 2,03               | 0,8                   | 0,034              | 109 000            | 165 000             | 0,008 | 719/9 CE/P4A    | –                  | H                                        |
|                      | 20 | 6 | 2,03               | 0,8                   | 0,034              | 133 000            | 200 000             | 0,007 | 719/9 CE/HCP4A  | –                  | H                                        |
|                      | 24 | 7 | 2,51               | 0,9                   | 0,038              | 90 000             | 137 000             | 0,014 | 709 ACE/P4A     | –                  | H                                        |
|                      | 24 | 7 | 2,51               | 0,9                   | 0,038              | 106 000            | 165 000             | 0,013 | 709 ACE/HCP4A   | –                  | H                                        |
|                      | 24 | 7 | 2,6                | 0,93                  | 0,04               | 98 000             | 150 000             | 0,014 | 709 CE/P4A      | –                  | H                                        |
|                      | 24 | 7 | 2,6                | 0,93                  | 0,04               | 120 000            | 180 000             | 0,013 | 709 CE/HCP4A    | –                  | H                                        |
|                      | 24 | 7 | 3,45               | 1,53                  | 0,064              | 75 000             | 110 000             | 0,015 | 709 ACD/P4A     | –                  | H                                        |
|                      | 24 | 7 | 3,45               | 1,53                  | 0,064              | 85 000             | 130 000             | 0,013 | 709 ACD/HCP4A   | –                  | H                                        |
|                      | 24 | 7 | 3,58               | 1,6                   | 0,068              | 80 000             | 120 000             | 0,015 | 709 CD/P4A      | –                  | H                                        |
|                      | 24 | 7 | 3,58               | 1,6                   | 0,068              | 95 000             | 150 000             | 0,013 | 709 CD/HCP4A    | –                  | H                                        |
|                      | 26 | 8 | 3,97               | 1,6                   | 0,067              | 60 000             | 90 000              | 0,02  | 729 ACD/P4A     | –                  | –                                        |
|                      | 26 | 8 | 3,97               | 1,6                   | 0,067              | 70 000             | 110 000             | 0,018 | 729 ACD/HCP4A   | –                  | –                                        |
|                      | 26 | 8 | 4,1                | 1,66                  | 0,071              | 67 000             | 100 000             | 0,02  | 729 CD/P4A      | –                  | –                                        |
|                      | 26 | 8 | 4,1                | 1,66                  | 0,071              | 80 000             | 120 000             | 0,018 | 729 CD/HCP4A    | –                  | –                                        |
| 10                   | 19 | 5 | 1,78               | 0,93                  | 0,04               | 70 000             | 110 000             | 0,005 | 71800 ACD/P4    | –                  | –                                        |
|                      | 19 | 5 | 1,78               | 0,93                  | 0,04               | 85 000             | 130 000             | 0,005 | 71800 ACD/HCP4  | –                  | –                                        |
|                      | 19 | 5 | 1,9                | 0,98                  | 0,043              | 80 000             | 120 000             | 0,005 | 71800 CD/P4     | –                  | –                                        |
|                      | 19 | 5 | 1,9                | 0,98                  | 0,043              | 95 000             | 150 000             | 0,005 | 71800 CD/HCP4   | –                  | –                                        |
|                      | 22 | 6 | 1,95               | 0,78                  | 0,032              | 93 000             | 140 000             | 0,009 | 71900 ACE/P4A   | –                  | H                                        |
|                      | 22 | 6 | 1,95               | 0,78                  | 0,032              | 109 000            | 165 000             | 0,008 | 71900 ACE/HCP4A | –                  | H                                        |
|                      | 22 | 6 | 2,03               | 0,815                 | 0,034              | 100 000            | 155 000             | 0,009 | 71900 CE/P4A    | –                  | H                                        |
|                      | 22 | 6 | 2,03               | 0,815                 | 0,034              | 123 000            | 185 000             | 0,008 | 71900 CE/HCP4A  | –                  | H                                        |

1) Designation suffix H, H1, L or L1. For details, refer to Direct oil-air lubrication (→ page 200).

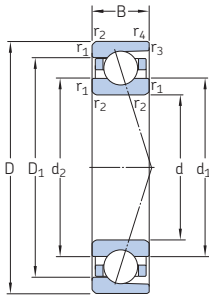


| Dimensions        |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |      | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|-------------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------|------------------------------------------------------|-----------------------------|
| d                 | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |      | cm <sup>3</sup>                                      | –                           |
| mm                |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |      |                                                      |                             |
| <b>8</b><br>cont. | 13,1           | 13,1           | 18,9           | –              | 0,3                            | 0,2                      | 10,4                   | 10,4                   | 21,6                   | 22,2                   | 0,3                    | 0,2                    | 14,3           | 0,23 | –                                                    | –                           |
|                   | 13,1           | 13,1           | 18,9           | –              | 0,3                            | 0,2                      | 10,4                   | 10,4                   | 21,6                   | 22,2                   | 0,3                    | 0,2                    | 14,3           | 0,23 | –                                                    | –                           |
|                   | 13,1           | 13,1           | 18,9           | –              | 0,3                            | 0,2                      | 10,4                   | 10,4                   | 21,6                   | 22,2                   | 0,3                    | 0,2                    | 14,3           | 0,23 | 7,9                                                  | 7,9                         |
|                   | 13,1           | 13,1           | 18,9           | –              | 0,3                            | 0,2                      | 10,4                   | 10,4                   | 21,6                   | 22,2                   | 0,3                    | 0,2                    | 14,3           | 0,23 | –                                                    | –                           |
| <b>9</b>          | 12,5           | 11,8           | 16,5           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 18                     | 19,2                   | 0,3                    | 0,15                   | 13,3           | 0,09 | –                                                    | –                           |
|                   | 12,5           | 11,8           | 16,5           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 18                     | 19,2                   | 0,3                    | 0,15                   | 13,3           | 0,09 | –                                                    | –                           |
|                   | 12,5           | 11,8           | 16,5           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 18                     | 19,2                   | 0,3                    | 0,15                   | 13,3           | 0,09 | 7,4                                                  | 7,4                         |
|                   | 12,5           | 11,8           | 16,5           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 18                     | 19,2                   | 0,3                    | 0,15                   | 13,3           | 0,09 | –                                                    | –                           |
|                   | 13,6           | 13             | 19,4           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,15                   | 14,8           | 0,19 | –                                                    | –                           |
|                   | 13,6           | 13             | 19,4           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,15                   | 14,8           | 0,19 | –                                                    | –                           |
|                   | 13,6           | 13             | 19,4           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,15                   | 14,8           | 0,19 | 6,8                                                  | 6,8                         |
|                   | 13,6           | 13             | 19,4           | –              | 0,3                            | 0,15                     | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,15                   | 14,8           | 0,19 | –                                                    | –                           |
|                   | 14,1           | 14,1           | 18,9           | –              | 0,3                            | 0,2                      | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,2                    | 15,1           | 0,18 | –                                                    | –                           |
|                   | 14,1           | 14,1           | 18,9           | –              | 0,3                            | 0,2                      | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,2                    | 15,1           | 0,18 | –                                                    | –                           |
|                   | 14,1           | 14,1           | 18,9           | –              | 0,3                            | 0,2                      | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,2                    | 15,1           | 0,18 | 8,8                                                  | 8,8                         |
|                   | 14,1           | 14,1           | 18,9           | –              | 0,3                            | 0,2                      | 11                     | 11                     | 22                     | 22,6                   | 0,3                    | 0,2                    | 15,1           | 0,18 | –                                                    | –                           |
|                   | 15,1           | 15,1           | 20,9           | –              | 0,3                            | 0,2                      | 11,4                   | 11,4                   | 23,6                   | 24,2                   | 0,3                    | 0,2                    | 16,3           | 0,26 | –                                                    | –                           |
|                   | 15,1           | 15,1           | 20,9           | –              | 0,3                            | 0,2                      | 11,4                   | 11,4                   | 23,6                   | 24,2                   | 0,3                    | 0,2                    | 16,3           | 0,26 | –                                                    | –                           |
|                   | 15,1           | 15,1           | 20,9           | –              | 0,3                            | 0,2                      | 11,4                   | 11,4                   | 23,6                   | 24,2                   | 0,3                    | 0,2                    | 16,3           | 0,26 | 8,3                                                  | 8,3                         |
|                   | 15,1           | 15,1           | 20,9           | –              | 0,3                            | 0,2                      | 11,4                   | 11,4                   | 23,6                   | 24,2                   | 0,3                    | 0,2                    | 16,3           | 0,26 | –                                                    | –                           |
| <b>10</b>         | 13,1           | 13,1           | 16,1           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 13,4           | 0,06 | –                                                    | –                           |
|                   | 13,1           | 13,1           | 16,1           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 13,4           | 0,06 | –                                                    | –                           |
|                   | 13,1           | 13,1           | 16,1           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 13,4           | 0,06 | 15                                                   | 15                          |
|                   | 13,1           | 13,1           | 16,1           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 17                     | 18,2                   | 0,3                    | 0,15                   | 13,4           | 0,06 | –                                                    | –                           |
|                   | 14             | 13,3           | 17,9           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 20                     | 21,2                   | 0,3                    | 0,15                   | 14,8           | 0,1  | –                                                    | –                           |
|                   | 14             | 13,3           | 17,9           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 20                     | 21,2                   | 0,3                    | 0,15                   | 14,8           | 0,1  | –                                                    | –                           |
|                   | 14             | 13,3           | 17,9           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 20                     | 21,2                   | 0,3                    | 0,15                   | 14,8           | 0,1  | 7,6                                                  | 7,6                         |
|                   | 14             | 13,3           | 17,9           | –              | 0,3                            | 0,15                     | 12                     | 12                     | 20                     | 21,2                   | 0,3                    | 0,15                   | 14,8           | 0,1  | –                                                    | –                           |

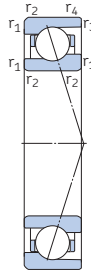
<sup>1)</sup> For calculating the initial grease fill → page 201

## 2.1 Angular contact ball bearings

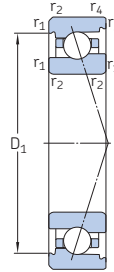
### d 10 – 12 mm



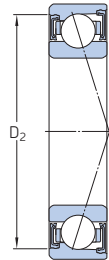
ACD, CD



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



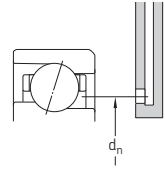
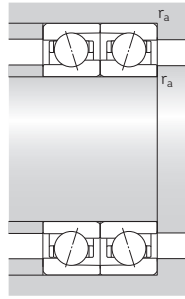
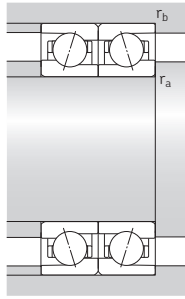
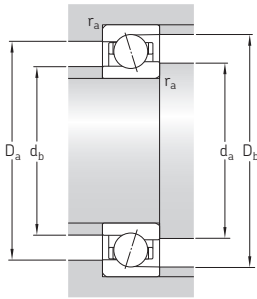
S... <sup>1)</sup>

| Principal dimensions |    |   | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|---|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |   | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 10<br>cont.          | 22 | 6 | 2,42               | 1,06                  | 0,045              | 63 000             | 95 000                            | 0,009              | 71900 ACD/P4A   | S                              | –                                        |
|                      | 22 | 6 | 2,42               | 1,06                  | 0,045              | 70 000             | 110 000                           | 0,009              | 71900 ACD/HCP4A | S                              | –                                        |
|                      | 22 | 6 | 2,51               | 1,1                   | 0,048              | 70 000             | 110 000                           | 0,009              | 71900 CD/P4A    | S                              | –                                        |
|                      | 22 | 6 | 2,51               | 1,1                   | 0,048              | 80 000             | 120 000                           | 0,009              | 71900 CD/HCP4A  | S                              | –                                        |
|                      | 26 | 8 | 2,86               | 1,14                  | 0,048              | 83 000             | 127 000                           | 0,019              | 7000 ACE/P4A    | S                              | H                                        |
|                      | 26 | 8 | 2,86               | 1,14                  | 0,048              | 98 000             | 150 000                           | 0,017              | 7000 ACE/HCP4A  | S                              | H                                        |
|                      | 26 | 8 | 3,02               | 1,18                  | 0,05               | 90 000             | 140 000                           | 0,019              | 7000 CE/P4A     | S                              | H                                        |
|                      | 26 | 8 | 3,02               | 1,18                  | 0,05               | 109 000            | 165 000                           | 0,017              | 7000 CE/HCP4A   | S                              | H                                        |
|                      | 26 | 8 | 3,97               | 1,6                   | 0,067              | 67 000             | 100 000                           | 0,019              | 7000 ACD/P4A    | S                              | H                                        |
|                      | 26 | 8 | 3,97               | 1,6                   | 0,067              | 80 000             | 120 000                           | 0,017              | 7000 ACD/HCP4A  | S                              | H                                        |
|                      | 26 | 8 | 4,1                | 1,66                  | 0,071              | 75 000             | 110 000                           | 0,019              | 7000 CD/P4A     | S                              | H                                        |
|                      | 26 | 8 | 4,1                | 1,66                  | 0,071              | 90 000             | 140 000                           | 0,017              | 7000 CD/HCP4A   | S                              | H                                        |
|                      | 30 | 9 | 4,36               | 1,86                  | 0,078              | 53 000             | 80 000                            | 0,032              | 7200 ACD/P4A    | S                              | –                                        |
|                      | 30 | 9 | 4,36               | 1,86                  | 0,078              | 63 000             | 95 000                            | 0,029              | 7200 ACD/HCP4A  | S                              | –                                        |
|                      | 30 | 9 | 4,49               | 1,93                  | 0,08               | 60 000             | 90 000                            | 0,032              | 7200 CD/P4A     | S                              | –                                        |
|                      | 30 | 9 | 4,49               | 1,93                  | 0,08               | 70 000             | 100 000                           | 0,029              | 7200 CD/HCP4A   | S                              | –                                        |
| 12                   | 21 | 5 | 1,95               | 1,12                  | 0,048              | 63 000             | 95 000                            | 0,006              | 71801 ACD/P4    | –                              | –                                        |
|                      | 21 | 5 | 1,95               | 1,12                  | 0,048              | 75 000             | 110 000                           | 0,006              | 71801 ACD/HCP4  | –                              | –                                        |
|                      | 21 | 5 | 2,08               | 1,18                  | 0,05               | 70 000             | 110 000                           | 0,006              | 71801 CD/P4     | –                              | –                                        |
|                      | 21 | 5 | 2,08               | 1,18                  | 0,05               | 85 000             | 130 000                           | 0,006              | 71801 CD/HCP4   | –                              | –                                        |
|                      | 24 | 6 | 2,03               | 0,865                 | 0,036              | 83 000             | 123 000                           | 0,01               | 71901 ACE/P4A   | –                              | H                                        |
|                      | 24 | 6 | 2,03               | 0,865                 | 0,036              | 98 000             | 150 000                           | 0,009              | 71901 ACE/HCP4A | –                              | H                                        |
|                      | 24 | 6 | 2,12               | 0,915                 | 0,039              | 90 000             | 137 000                           | 0,01               | 71901 CE/P4A    | –                              | H                                        |
|                      | 24 | 6 | 2,12               | 0,915                 | 0,039              | 109 000            | 165 000                           | 0,009              | 71901 CE/HCP4A  | –                              | H                                        |
|                      | 24 | 6 | 2,55               | 1,18                  | 0,05               | 56 000             | 85 000                            | 0,01               | 71901 ACD/P4A   | S                              | –                                        |
|                      | 24 | 6 | 2,55               | 1,18                  | 0,05               | 67 000             | 100 000                           | 0,01               | 71901 ACD/HCP4A | S                              | –                                        |
|                      | 24 | 6 | 2,65               | 1,25                  | 0,053              | 63 000             | 95 000                            | 0,01               | 71901 CD/P4A    | S                              | –                                        |
|                      | 24 | 6 | 2,65               | 1,25                  | 0,053              | 75 000             | 110 000                           | 0,01               | 71901 CD/HCP4A  | S                              | –                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 202).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 202).

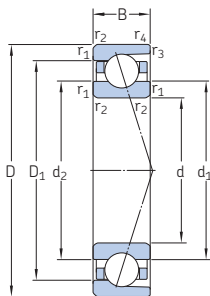


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 10<br>cont. | 14             | 14             | 18             | 19,8           | 0,3                   | 0,2                   | 12                             | 12                  | 20                  | 20,6                | 0,3                 | 0,2                 | 14,8           | 0,12                                    | –                  |                 |   |
|             | 14             | 14             | 18             | 19,8           | 0,3                   | 0,2                   | 12                             | 12                  | 20                  | 20,6                | 0,3                 | 0,2                 | 14,8           | 0,12                                    | –                  |                 |   |
|             | 14             | 14             | 18             | 19,8           | 0,3                   | 0,2                   | 12                             | 12                  | 20                  | 20,6                | 0,3                 | 0,2                 | 14,8           | 0,12                                    | 9,5                |                 |   |
|             | 14             | 14             | 18             | 19,8           | 0,3                   | 0,2                   | 12                             | 12                  | 20                  | 20,6                | 0,3                 | 0,2                 | 14,8           | 0,12                                    | 9,5                |                 |   |
|             | 15,6           | 14,5           | 22,4           | 22,4           | 0,3                   | 0,3                   | 12                             | 12                  | 24                  | 23,6                | 0,3                 | 0,3                 | 16,5           | 0,28                                    | –                  |                 |   |
|             | 15,6           | 14,5           | 22,4           | 22,4           | 0,3                   | 0,3                   | 12                             | 12                  | 24                  | 23,6                | 0,3                 | 0,3                 | 16,5           | 0,28                                    | –                  |                 |   |
|             | 15,6           | 14,5           | 22,4           | 22,4           | 0,3                   | 0,3                   | 12                             | 12                  | 24                  | 23,6                | 0,3                 | 0,3                 | 16,5           | 0,28                                    | 7,1                |                 |   |
|             | 15,6           | 14,5           | 22,4           | 22,4           | 0,3                   | 0,3                   | 12                             | 12                  | 24                  | 23,6                | 0,3                 | 0,3                 | 16,5           | 0,28                                    | 7,1                |                 |   |
|             | 15,1           | 15,1           | 20,9           | 23,5           | 0,3                   | 0,2                   | 12                             | 12                  | 24                  | 24,6                | 0,3                 | 0,2                 | 16             | 0,24                                    | –                  |                 |   |
|             | 15,1           | 15,1           | 20,9           | 23,5           | 0,3                   | 0,2                   | 12                             | 12                  | 24                  | 24,6                | 0,3                 | 0,2                 | 16             | 0,24                                    | –                  |                 |   |
|             | 15,1           | 15,1           | 20,9           | 23,5           | 0,3                   | 0,2                   | 12                             | 12                  | 24                  | 24,6                | 0,3                 | 0,2                 | 16             | 0,24                                    | 8,3                |                 |   |
|             | 15,1           | 15,1           | 20,9           | 23,5           | 0,3                   | 0,2                   | 12                             | 12                  | 24                  | 24,6                | 0,3                 | 0,2                 | 16             | 0,24                                    | 8,3                |                 |   |
|             | 17,3           | 17,3           | 23,1           | 24,3           | 0,6                   | 0,3                   | 14,2                           | 14,2                | 25,8                | 27,6                | 0,6                 | 0,3                 | 18,3           | 0,36                                    | –                  |                 |   |
|             | 17,3           | 17,3           | 23,1           | 24,3           | 0,6                   | 0,3                   | 14,2                           | 14,2                | 25,8                | 27,6                | 0,6                 | 0,3                 | 18,3           | 0,36                                    | –                  |                 |   |
|             | 17,3           | 17,3           | 23,1           | 24,3           | 0,6                   | 0,3                   | 14,2                           | 14,2                | 25,8                | 27,6                | 0,6                 | 0,3                 | 18,3           | 0,36                                    | 8,8                |                 |   |
|             | 17,3           | 17,3           | 23,1           | 24,3           | 0,6                   | 0,3                   | 14,2                           | 14,2                | 25,8                | 27,6                | 0,6                 | 0,3                 | 18,3           | 0,36                                    | 8,8                |                 |   |
| 12          | 15,1           | 15,1           | 18,1           | –              | 0,3                   | 0,15                  | 14                             | 14                  | 19                  | 20,2                | 0,3                 | 0,15                | 15,4           | 0,07                                    | –                  |                 |   |
|             | 15,1           | 15,1           | 18,1           | –              | 0,3                   | 0,15                  | 14                             | 14                  | 19                  | 20,2                | 0,3                 | 0,15                | 15,4           | 0,07                                    | –                  |                 |   |
|             | 15,1           | 15,1           | 18,1           | –              | 0,3                   | 0,15                  | 14                             | 14                  | 19                  | 20,2                | 0,3                 | 0,15                | 15,4           | 0,07                                    | 15,4               |                 |   |
|             | 15,1           | 15,1           | 18,1           | –              | 0,3                   | 0,15                  | 14                             | 14                  | 19                  | 20,2                | 0,3                 | 0,15                | 15,4           | 0,07                                    | 15,4               |                 |   |
|             | 16             | 15,3           | 20             | –              | 0,3                   | 0,15                  | 14                             | 14                  | 22                  | 23,2                | 0,3                 | 0,15                | 16,8           | 0,1                                     | –                  |                 |   |
|             | 16             | 15,3           | 20             | –              | 0,3                   | 0,15                  | 14                             | 14                  | 22                  | 23,2                | 0,3                 | 0,15                | 16,8           | 0,1                                     | –                  |                 |   |
|             | 16             | 15,3           | 20             | –              | 0,3                   | 0,15                  | 14                             | 14                  | 22                  | 23,2                | 0,3                 | 0,15                | 16,8           | 0,1                                     | 7,8                |                 |   |
|             | 16             | 15,3           | 20             | –              | 0,3                   | 0,15                  | 14                             | 14                  | 22                  | 23,2                | 0,3                 | 0,15                | 16,8           | 0,1                                     | 7,8                |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | –                  |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | –                  |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | 9,8                |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | 9,8                |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | –                  |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | –                  |                 |   |
|             | 16             | 16             | 20             | 21,8           | 0,3                   | 0,2                   | 14                             | 14                  | 22                  | 22,6                | 0,3                 | 0,2                 | 16,8           | 0,12                                    | 9,8                |                 |   |

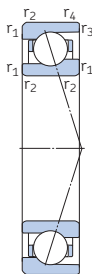
<sup>1)</sup> For calculating the initial grease fill → page 203

## 2.1 Angular contact ball bearings

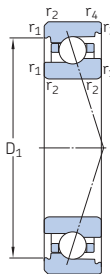
### d 12 – 15 mm



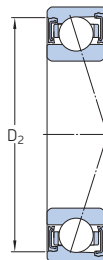
ACD, CD



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



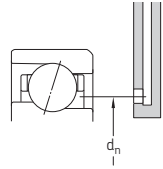
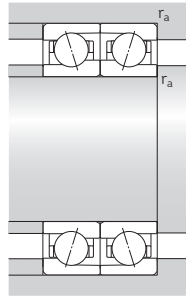
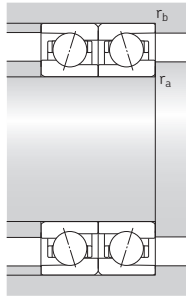
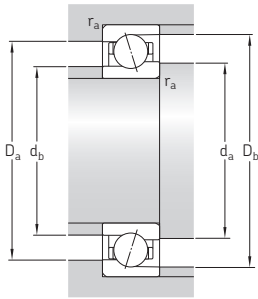
S... <sup>1)</sup>

| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 12<br>cont.          | 28 | 8  | 3,07               | 1,27                  | 0,054              | 73 000             | 112 000                           | 0,021              | 7001 ACE/P4A    | S                              | H                                        |
|                      | 28 | 8  | 3,07               | 1,27                  | 0,054              | 88 000             | 133 000                           | 0,019              | 7001 ACE/HCP4A  | S                              | H                                        |
|                      | 28 | 8  | 3,19               | 1,34                  | 0,057              | 80 000             | 127 000                           | 0,021              | 7001 CE/P4A     | S                              | H                                        |
|                      | 28 | 8  | 3,19               | 1,34                  | 0,057              | 98 000             | 150 000                           | 0,019              | 7001 CE/HCP4A   | S                              | H                                        |
|                      | 28 | 8  | 4,36               | 1,83                  | 0,078              | 60 000             | 90 000                            | 0,021              | 7001 ACD/P4A    | S                              | H                                        |
|                      | 28 | 8  | 4,36               | 1,83                  | 0,078              | 70 000             | 110 000                           | 0,018              | 7001 ACD/HCP4A  | S                              | H                                        |
|                      | 28 | 8  | 4,49               | 1,9                   | 0,08               | 67 000             | 100 000                           | 0,021              | 7001 CD/P4A     | S                              | H                                        |
|                      | 28 | 8  | 4,49               | 1,9                   | 0,08               | 80 000             | 120 000                           | 0,018              | 7001 CD/HCP4A   | S                              | H                                        |
|                      | 32 | 10 | 5,72               | 2,45                  | 0,104              | 48 000             | 70 000                            | 0,037              | 7201 ACD/P4A    | S                              | –                                        |
|                      | 32 | 10 | 5,72               | 2,45                  | 0,104              | 56 000             | 85 000                            | 0,033              | 7201 ACD/HCP4A  | S                              | –                                        |
|                      | 32 | 10 | 5,85               | 2,55                  | 0,108              | 53 000             | 80 000                            | 0,037              | 7201 CD/P4A     | S                              | –                                        |
|                      | 32 | 10 | 5,85               | 2,55                  | 0,108              | 67 000             | 95 000                            | 0,033              | 7201 CD/HCP4A   | S                              | –                                        |
| 15                   | 24 | 5  | 2,16               | 1,4                   | 0,06               | 53 000             | 80 000                            | 0,007              | 71802 ACD/P4    | –                              | –                                        |
|                      | 24 | 5  | 2,16               | 1,4                   | 0,06               | 63 000             | 100 000                           | 0,006              | 71802 ACD/HCP4  | –                              | –                                        |
|                      | 24 | 5  | 2,29               | 1,5                   | 0,063              | 60 000             | 90 000                            | 0,007              | 71802 CD/P4     | –                              | –                                        |
|                      | 24 | 5  | 2,29               | 1,5                   | 0,063              | 70 000             | 110 000                           | 0,006              | 71802 CD/HCP4   | –                              | –                                        |
|                      | 28 | 7  | 3,02               | 1,34                  | 0,057              | 68 000             | 106 000                           | 0,015              | 71902 ACE/P4A   | –                              | H                                        |
|                      | 28 | 7  | 3,02               | 1,34                  | 0,057              | 83 000             | 127 000                           | 0,013              | 71902 ACE/HCP4A | –                              | H                                        |
|                      | 28 | 7  | 3,19               | 1,4                   | 0,06               | 75 000             | 115 000                           | 0,015              | 71902 CE/P4A    | –                              | H                                        |
|                      | 28 | 7  | 3,19               | 1,4                   | 0,06               | 90 000             | 140 000                           | 0,013              | 71902 CE/HCP4A  | –                              | H                                        |
|                      | 28 | 7  | 3,77               | 1,8                   | 0,078              | 50 000             | 75 000                            | 0,015              | 71902 ACD/P4A   | S                              | –                                        |
|                      | 28 | 7  | 3,77               | 1,8                   | 0,078              | 60 000             | 90 000                            | 0,014              | 71902 ACD/HCP4A | S                              | –                                        |
|                      | 28 | 7  | 3,97               | 1,9                   | 0,08               | 56 000             | 85 000                            | 0,015              | 71902 CD/P4A    | S                              | –                                        |
|                      | 28 | 7  | 3,97               | 1,9                   | 0,08               | 70 000             | 100 000                           | 0,014              | 71902 CD/HCP4A  | S                              | –                                        |
|                      | 32 | 9  | 4,23               | 1,83                  | 0,078              | 63 000             | 95 000                            | 0,028              | 7002 ACE/P4A    | S                              | H                                        |
|                      | 32 | 9  | 4,23               | 1,83                  | 0,078              | 75 000             | 115 000                           | 0,025              | 7002 ACE/HCP4A  | S                              | H                                        |
|                      | 32 | 9  | 4,42               | 1,93                  | 0,08               | 68 000             | 106 000                           | 0,028              | 7002 CE/P4A     | S                              | H                                        |
|                      | 32 | 9  | 4,42               | 1,93                  | 0,08               | 83 000             | 127 000                           | 0,025              | 7002 CE/HCP4A   | S                              | H                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 204).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 204).

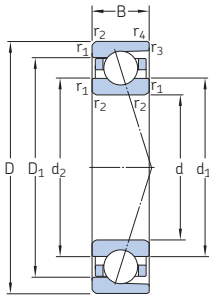


| Dimensions  |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |      | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|-------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------|------------------------------------------------------|-----------------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |      |                                                      |                             |
| mm          |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |      |                                                      |                             |
|             |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |      | cm <sup>3</sup>                                      | –                           |
| 12<br>cont. | 17,5           | 16,5           | 24,4           | 24,4           | 0,3                            | 0,15                     | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,15                   | 18,5           | 0,31 | –                                                    | –                           |
|             | 17,5           | 16,5           | 24,4           | 24,4           | 0,3                            | 0,15                     | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,15                   | 18,5           | 0,31 | –                                                    | –                           |
|             | 17,5           | 16,5           | 24,4           | 24,4           | 0,3                            | 0,15                     | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,15                   | 18,5           | 0,31 | 7,3                                                  | 7,3                         |
|             | 17,5           | 16,5           | 24,4           | 24,4           | 0,3                            | 0,15                     | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,15                   | 18,5           | 0,31 | 7,3                                                  | 7,3                         |
|             | 17,1           | 17,1           | 22,9           | 25,5           | 0,3                            | 0,2                      | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 18             | 0,27 | –                                                    | –                           |
|             | 17,1           | 17,1           | 22,9           | 25,5           | 0,3                            | 0,2                      | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 18             | 0,27 | –                                                    | –                           |
|             | 17,1           | 17,1           | 22,9           | 25,5           | 0,3                            | 0,2                      | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 18             | 0,27 | 8,7                                                  | 8,7                         |
|             | 17,1           | 17,1           | 22,9           | 25,5           | 0,3                            | 0,2                      | 14                     | 14                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 18             | 0,27 | 8,7                                                  | 8,7                         |
|             | 18,6           | 18,6           | 25,4           | 26,6           | 0,6                            | 0,3                      | 16,2                   | 16,2                   | 27,8                   | 29,6                   | 0,6                    | 0,3                    | 20             | 0,51 | –                                                    | –                           |
|             | 18,6           | 18,6           | 25,4           | 26,6           | 0,6                            | 0,3                      | 16,2                   | 16,2                   | 27,8                   | 29,6                   | 0,6                    | 0,3                    | 20             | 0,51 | –                                                    | –                           |
|             | 18,6           | 18,6           | 25,4           | 26,6           | 0,6                            | 0,3                      | 16,2                   | 16,2                   | 27,8                   | 29,6                   | 0,6                    | 0,3                    | 20             | 0,51 | 8,5                                                  | 8,5                         |
|             | 18,6           | 18,6           | 25,4           | 26,6           | 0,6                            | 0,3                      | 16,2                   | 16,2                   | 27,8                   | 29,6                   | 0,6                    | 0,3                    | 20             | 0,51 | 8,5                                                  | 8,5                         |
| 15          | 18,1           | 18,1           | 21,1           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 22                     | 23,2                   | 0,3                    | 0,15                   | 18,4           | 0,08 | –                                                    | –                           |
|             | 18,1           | 18,1           | 21,1           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 22                     | 23,2                   | 0,3                    | 0,15                   | 18,4           | 0,08 | –                                                    | –                           |
|             | 18,1           | 18,1           | 21,1           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 22                     | 23,2                   | 0,3                    | 0,15                   | 18,4           | 0,08 | 16                                                   | 16                          |
|             | 18,1           | 18,1           | 21,1           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 22                     | 23,2                   | 0,3                    | 0,15                   | 18,4           | 0,08 | 16                                                   | 16                          |
|             | 19,1           | 18,1           | 23,9           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 26                     | 27,2                   | 0,3                    | 0,15                   | 20             | 0,2  | –                                                    | –                           |
|             | 19,1           | 18,1           | 23,9           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 26                     | 27,2                   | 0,3                    | 0,15                   | 20             | 0,2  | –                                                    | –                           |
|             | 19,1           | 18,1           | 23,9           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 26                     | 27,2                   | 0,3                    | 0,15                   | 20             | 0,2  | 7,7                                                  | 7,7                         |
|             | 19,1           | 18,1           | 23,9           | –              | 0,3                            | 0,15                     | 17                     | 17                     | 26                     | 27,2                   | 0,3                    | 0,15                   | 20             | 0,2  | 7,7                                                  | 7,7                         |
|             | 19,1           | 19,1           | 23,7           | 25,8           | 0,3                            | 0,2                      | 17                     | 17                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 20,1           | 0,21 | –                                                    | –                           |
|             | 19,1           | 19,1           | 23,7           | 25,8           | 0,3                            | 0,2                      | 17                     | 17                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 20,1           | 0,21 | –                                                    | –                           |
|             | 19,1           | 19,1           | 23,7           | 25,8           | 0,3                            | 0,2                      | 17                     | 17                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 20,1           | 0,21 | 9,6                                                  | 9,6                         |
|             | 19,1           | 19,1           | 23,7           | 25,8           | 0,3                            | 0,2                      | 17                     | 17                     | 26                     | 26,6                   | 0,3                    | 0,2                    | 20,1           | 0,21 | 9,6                                                  | 9,6                         |
|             | 20,7           | 19,5           | 28,8           | 28,8           | 0,3                            | 0,15                     | 17                     | 17                     | 30                     | 30,6                   | 0,3                    | 0,15                   | 21,9           | 0,5  | –                                                    | –                           |
|             | 20,7           | 19,5           | 28,8           | 28,8           | 0,3                            | 0,15                     | 17                     | 17                     | 30                     | 30,6                   | 0,3                    | 0,15                   | 21,9           | 0,5  | –                                                    | –                           |
|             | 20,7           | 19,5           | 28,8           | 28,8           | 0,3                            | 0,15                     | 17                     | 17                     | 30                     | 30,6                   | 0,3                    | 0,15                   | 21,9           | 0,5  | 7,3                                                  | 7,3                         |
|             | 20,7           | 19,5           | 28,8           | 28,8           | 0,3                            | 0,15                     | 17                     | 17                     | 30                     | 30,6                   | 0,3                    | 0,15                   | 21,9           | 0,5  | 7,3                                                  | 7,3                         |

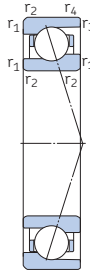
<sup>1)</sup> For calculating the initial grease fill → page 205

## 2.1 Angular contact ball bearings

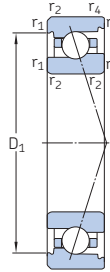
d 15 – 17 mm



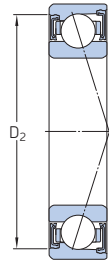
ACD, CD



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



S... <sup>1)</sup>

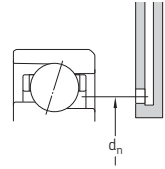
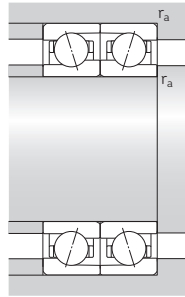
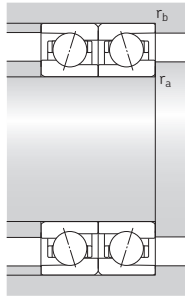
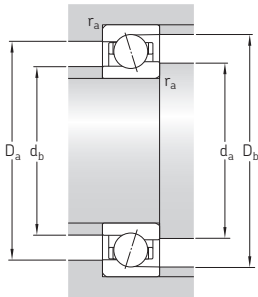
| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 15<br>cont.          | 32 | 9  | 4,94               | 2,32                  | 0,098              | 50 000             | 75 000                            | 0,03               | 7002 ACD/P4A    | S                              | H                                        |
|                      | 32 | 9  | 4,94               | 2,32                  | 0,098              | 60 000             | 95 000                            | 0,027              | 7002 ACD/HCP4A  | S                              | H                                        |
|                      | 32 | 9  | 5,2                | 2,45                  | 0,104              | 56 000             | 85 000                            | 0,03               | 7002 CD/P4A     | S                              | H                                        |
|                      | 32 | 9  | 5,2                | 2,45                  | 0,104              | 67 000             | 100 000                           | 0,027              | 7002 CD/HCP4A   | S                              | H                                        |
|                      | 35 | 11 | 7,15               | 3,2                   | 0,134              | 43 000             | 63 000                            | 0,043              | 7202 ACD/P4A    | S                              | –                                        |
|                      | 35 | 11 | 7,15               | 3,2                   | 0,134              | 50 000             | 75 000                            | 0,037              | 7202 ACD/HCP4A  | S                              | –                                        |
|                      | 35 | 11 | 7,41               | 3,35                  | 0,14               | 48 000             | 70 000                            | 0,043              | 7202 CD/P4A     | S                              | –                                        |
|                      | 35 | 11 | 7,41               | 3,35                  | 0,14               | 60 000             | 85 000                            | 0,037              | 7202 CD/HCP4A   | S                              | –                                        |
|                      | 26 | 5  | 2,21               | 1,53                  | 0,064              | 48 000             | 75 000                            | 0,01               | 71803 ACD/P4    | –                              | –                                        |
|                      | 26 | 5  | 2,21               | 1,53                  | 0,064              | 60 000             | 90 000                            | 0,009              | 71803 ACD/HCP4  | –                              | –                                        |
|                      | 26 | 5  | 2,34               | 1,6                   | 0,068              | 53 000             | 85 000                            | 0,01               | 71803 CD/P4     | –                              | –                                        |
|                      | 26 | 5  | 2,34               | 1,6                   | 0,068              | 63 000             | 100 000                           | 0,009              | 71803 CD/HCP4   | –                              | –                                        |
| 17                   | 30 | 7  | 3,19               | 1,46                  | 0,063              | 63 000             | 95 000                            | 0,016              | 71903 ACE/P4A   | –                              | H                                        |
|                      | 30 | 7  | 3,19               | 1,46                  | 0,063              | 75 000             | 115 000                           | 0,014              | 71903 ACE/HCP4A | –                              | H                                        |
|                      | 30 | 7  | 3,32               | 1,56                  | 0,067              | 70 000             | 106 000                           | 0,016              | 71903 CE/P4A    | –                              | H                                        |
|                      | 30 | 7  | 3,32               | 1,56                  | 0,067              | 83 000             | 127 000                           | 0,014              | 71903 CE/HCP4A  | –                              | H                                        |
|                      | 30 | 7  | 3,97               | 2                     | 0,085              | 45 000             | 67 000                            | 0,017              | 71903 ACD/P4A   | S                              | –                                        |
|                      | 30 | 7  | 3,97               | 2                     | 0,085              | 53 000             | 80 000                            | 0,015              | 71903 ACD/HCP4A | S                              | –                                        |
|                      | 30 | 7  | 4,16               | 2,08                  | 0,088              | 50 000             | 75 000                            | 0,017              | 71903 CD/P4A    | S                              | –                                        |
|                      | 30 | 7  | 4,16               | 2,08                  | 0,088              | 63 000             | 90 000                            | 0,015              | 71903 CD/HCP4A  | S                              | –                                        |
|                      | 35 | 10 | 5,59               | 2,45                  | 0,104              | 56 000             | 88 000                            | 0,035              | 7003 ACE/P4A    | S                              | H                                        |
|                      | 35 | 10 | 5,59               | 2,45                  | 0,104              | 68 000             | 103 000                           | 0,03               | 7003 ACE/HCP4A  | S                              | H                                        |
|                      | 35 | 10 | 5,85               | 2,55                  | 0,108              | 63 000             | 95 000                            | 0,035              | 7003 CE/P4A     | S                              | H                                        |
|                      | 35 | 10 | 5,85               | 2,55                  | 0,108              | 75 000             | 115 000                           | 0,03               | 7003 CE/HCP4A   | S                              | H                                        |
|                      | 35 | 10 | 6,5                | 3,1                   | 0,132              | 45 000             | 70 000                            | 0,038              | 7003 ACD/P4A    | S                              | H                                        |
|                      | 35 | 10 | 6,5                | 3,1                   | 0,132              | 56 000             | 85 000                            | 0,033              | 7003 ACD/HCP4A  | S                              | H                                        |
|                      | 35 | 10 | 6,76               | 3,25                  | 0,137              | 50 000             | 75 000                            | 0,038              | 7003 CD/P4A     | S                              | H                                        |
|                      | 35 | 10 | 6,76               | 3,25                  | 0,137              | 60 000             | 95 000                            | 0,033              | 7003 CD/HCP4A   | S                              | H                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 206).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 206).



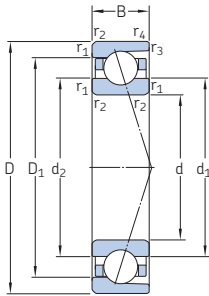


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |
| mm          |                |                |                |                |                       |                       | mm                             |                     |                     |                     |                     |                     |                | cm <sup>3</sup>  |                                         | –                  |
| 15<br>cont. | 20,6           | 20,6           | 26,4           | 29,2           | 0,3                   | 0,2                   | 17                             | 17                  | 30                  | 30,6                | 0,3                 | 0,2                 | 21,5           | 0,39             | –                                       |                    |
|             | 20,6           | 20,6           | 26,4           | 29,2           | 0,3                   | 0,2                   | 17                             | 17                  | 30                  | 30,6                | 0,3                 | 0,2                 | 21,5           | 0,39             | –                                       |                    |
|             | 20,6           | 20,6           | 26,4           | 29,2           | 0,3                   | 0,2                   | 17                             | 17                  | 30                  | 30,6                | 0,3                 | 0,2                 | 21,5           | 0,39             | 9,3                                     |                    |
|             | 20,6           | 20,6           | 26,4           | 29,2           | 0,3                   | 0,2                   | 17                             | 17                  | 30                  | 30,6                | 0,3                 | 0,2                 | 21,5           | 0,39             | 9,3                                     |                    |
|             | 21,4           | 21,4           | 29,1           | 30,7           | 0,6                   | 0,3                   | 19,2                           | 19,2                | 30,8                | 32,6                | 0,6                 | 0,3                 | 23             | 0,73             | –                                       |                    |
|             | 21,4           | 21,4           | 29,1           | 30,7           | 0,6                   | 0,3                   | 19,2                           | 19,2                | 30,8                | 32,6                | 0,6                 | 0,3                 | 23             | 0,73             | –                                       |                    |
|             | 21,4           | 21,4           | 29,1           | 30,7           | 0,6                   | 0,3                   | 19,2                           | 19,2                | 30,8                | 32,6                | 0,6                 | 0,3                 | 23             | 0,73             | 8,5                                     |                    |
|             | 21,4           | 21,4           | 29,1           | 30,7           | 0,6                   | 0,3                   | 19,2                           | 19,2                | 30,8                | 32,6                | 0,6                 | 0,3                 | 23             | 0,73             | 8,5                                     |                    |
| 17          | 20,1           | 20,1           | 23             | –              | 0,3                   | 0,15                  | 19                             | 19                  | 24                  | 25,2                | 0,3                 | 0,15                | 20,4           | 0,09             | –                                       |                    |
|             | 20,1           | 20,1           | 23             | –              | 0,3                   | 0,15                  | 19                             | 19                  | 24                  | 25,2                | 0,3                 | 0,15                | 20,4           | 0,09             | –                                       |                    |
|             | 20,1           | 20,1           | 23             | –              | 0,3                   | 0,15                  | 19                             | 19                  | 24                  | 25,2                | 0,3                 | 0,15                | 20,4           | 0,09             | 16,2                                    |                    |
|             | 20,1           | 20,1           | 23             | –              | 0,3                   | 0,15                  | 19                             | 19                  | 24                  | 25,2                | 0,3                 | 0,15                | 20,4           | 0,09             | 16,2                                    |                    |
|             | 21,1           | 20,1           | 25,9           | –              | 0,3                   | 0,15                  | 19                             | 19                  | 28                  | 29,2                | 0,3                 | 0,15                | 22             | 0,2              | –                                       |                    |
|             | 21,1           | 20,1           | 25,9           | –              | 0,3                   | 0,15                  | 19                             | 19                  | 28                  | 29,2                | 0,3                 | 0,15                | 22             | 0,2              | –                                       |                    |
|             | 21,1           | 20,1           | 25,9           | –              | 0,3                   | 0,15                  | 19                             | 19                  | 28                  | 29,2                | 0,3                 | 0,15                | 22             | 0,2              | 7,9                                     |                    |
|             | 21,1           | 20,1           | 25,9           | –              | 0,3                   | 0,15                  | 19                             | 19                  | 28                  | 29,2                | 0,3                 | 0,15                | 22             | 0,2              | 7,9                                     |                    |
|             | 20,9           | 20,9           | 25,7           | 27,8           | 0,3                   | 0,2                   | 19                             | 19                  | 28                  | 28,6                | 0,3                 | 0,2                 | 22,1           | 0,24             | –                                       |                    |
|             | 20,9           | 20,9           | 25,7           | 27,8           | 0,3                   | 0,2                   | 19                             | 19                  | 28                  | 28,6                | 0,3                 | 0,2                 | 22,1           | 0,24             | –                                       |                    |
|             | 20,9           | 20,9           | 25,7           | 27,8           | 0,3                   | 0,2                   | 19                             | 19                  | 28                  | 28,6                | 0,3                 | 0,2                 | 22,1           | 0,24             | 9,8                                     |                    |
|             | 20,9           | 20,9           | 25,7           | 27,8           | 0,3                   | 0,2                   | 19                             | 19                  | 28                  | 28,6                | 0,3                 | 0,2                 | 22,1           | 0,24             | 9,8                                     |                    |
|             | 22,7           | 21,1           | 31,2           | 31,2           | 0,3                   | 0,15                  | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,15                | 24,1           | 0,68             | –                                       |                    |
|             | 22,7           | 21,1           | 31,2           | 31,2           | 0,3                   | 0,15                  | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,15                | 24,1           | 0,68             | –                                       |                    |
|             | 22,7           | 21,1           | 31,2           | 31,2           | 0,3                   | 0,15                  | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,15                | 24,1           | 0,68             | 7,2                                     |                    |
|             | 22,7           | 21,1           | 31,2           | 31,2           | 0,3                   | 0,15                  | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,15                | 24,1           | 0,68             | 7,2                                     |                    |
|             | 22,6           | 22,6           | 29,3           | 32,4           | 0,3                   | 0,2                   | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,2                 | 23,7           | 0,54             | –                                       |                    |
|             | 22,6           | 22,6           | 29,3           | 32,4           | 0,3                   | 0,2                   | 19                             | 19                  | 33                  | 33,6                | 0,3                 | 0,2                 | 23,7           | 0,54             | –                                       |                    |
| 22,6        | 22,6           | 29,3           | 32,4           | 0,3            | 0,2                   | 19                    | 19                             | 33                  | 33,6                | 0,3                 | 0,2                 | 23,7                | 0,54           | 9,1              |                                         |                    |
| 22,6        | 22,6           | 29,3           | 32,4           | 0,3            | 0,2                   | 19                    | 19                             | 33                  | 33,6                | 0,3                 | 0,2                 | 23,7                | 0,54           | 9,1              |                                         |                    |

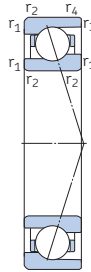
<sup>1)</sup> For calculating the initial grease fill → page 207

## 2.1 Angular contact ball bearings

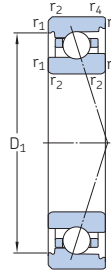
### d 17 – 20 mm



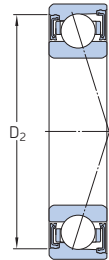
ACD, CD



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



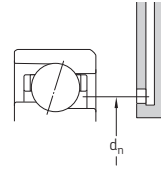
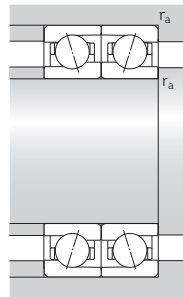
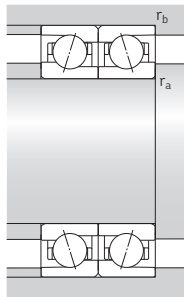
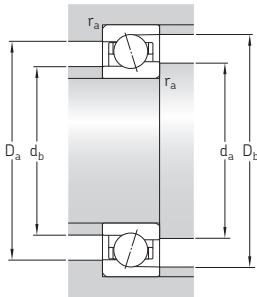
S... <sup>1)</sup>

| Principal dimensions |    |    | Basic load ratings |                 | Fatigue load limit<br>$P_u$ | Attainable speeds     |                                      | Mass <sup>2)</sup> | Designation     | Available variants                |                                             |
|----------------------|----|----|--------------------|-----------------|-----------------------------|-----------------------|--------------------------------------|--------------------|-----------------|-----------------------------------|---------------------------------------------|
| d                    | D  | B  | dynamic<br>C       | static<br>$C_0$ |                             | Grease<br>lubrication | Oil-air<br>lubrication <sup>2)</sup> |                    |                 | Sealing<br>solution <sup>1)</sup> | Direct oil-air<br>lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                 | kN                          | r/min                 |                                      | kg                 | –               | –                                 |                                             |
| <b>17</b><br>cont.   | 40 | 12 | 8,84               | 4               | 0,17                        | 38 000                | 56 000                               | 0,063              | 7203 ACD/P4A    | S                                 | –                                           |
|                      | 40 | 12 | 8,84               | 4               | 0,17                        | 45 000                | 67 000                               | 0,054              | 7203 ACD/HCP4A  | S                                 | –                                           |
|                      | 40 | 12 | 9,23               | 4,15            | 0,176                       | 43 000                | 63 000                               | 0,063              | 7203 CD/P4A     | S                                 | –                                           |
|                      | 40 | 12 | 9,23               | 4,15            | 0,176                       | 53 000                | 75 000                               | 0,054              | 7203 CD/HCP4A   | S                                 | –                                           |
| <b>20</b>            | 32 | 7  | 3,64               | 2,5             | 0,106                       | 40 000                | 63 000                               | 0,018              | 71804 ACD/P4    | –                                 | –                                           |
|                      | 32 | 7  | 3,64               | 2,5             | 0,106                       | 48 000                | 75 000                               | 0,017              | 71804 ACD/HCP4  | –                                 | –                                           |
|                      | 32 | 7  | 3,9                | 2,65            | 0,112                       | 45 000                | 70 000                               | 0,018              | 71804 CD/P4     | –                                 | –                                           |
|                      | 32 | 7  | 3,9                | 2,65            | 0,112                       | 53 000                | 80 000                               | 0,017              | 71804 CD/HCP4   | –                                 | –                                           |
|                      | 37 | 9  | 4,68               | 2,28            | 0,098                       | 52 000                | 78 000                               | 0,036              | 71904 ACE/P4A   | S                                 | H, L                                        |
|                      | 37 | 9  | 4,68               | 2,28            | 0,098                       | 60 000                | 95 000                               | 0,032              | 71904 ACE/HCP4A | S                                 | H, L                                        |
|                      | 37 | 9  | 4,88               | 2,4             | 0,102                       | 56 000                | 88 000                               | 0,036              | 71904 CE/P4A    | S                                 | H, L                                        |
|                      | 37 | 9  | 4,88               | 2,4             | 0,102                       | 68 000                | 106 000                              | 0,032              | 71904 CE/HCP4A  | S                                 | H, L                                        |
|                      | 37 | 9  | 5,72               | 3,05            | 0,129                       | 38 000                | 56 000                               | 0,035              | 71904 ACD/P4A   | S                                 | –                                           |
|                      | 37 | 9  | 5,72               | 3,05            | 0,129                       | 45 000                | 67 000                               | 0,033              | 71904 ACD/HCP4A | S                                 | –                                           |
|                      | 37 | 9  | 6,05               | 3,2             | 0,137                       | 43 000                | 63 000                               | 0,035              | 71904 CD/P4A    | S                                 | –                                           |
|                      | 37 | 9  | 6,05               | 3,2             | 0,137                       | 53 000                | 75 000                               | 0,033              | 71904 CD/HCP4A  | S                                 | –                                           |
|                      | 42 | 12 | 7,15               | 3,25            | 0,137                       | 48 000                | 75 000                               | 0,064              | 7004 ACE/P4A    | S                                 | H1, L, L1                                   |
|                      | 42 | 12 | 7,15               | 3,25            | 0,137                       | 58 000                | 88 000                               | 0,056              | 7004 ACE/HCP4A  | S                                 | H1, L, L1                                   |
|                      | 42 | 12 | 7,41               | 3,35            | 0,143                       | 54 000                | 83 000                               | 0,064              | 7004 CE/P4A     | S                                 | H1, L, L1                                   |
|                      | 42 | 12 | 7,41               | 3,35            | 0,143                       | 65 000                | 100 000                              | 0,056              | 7004 CE/HCP4A   | S                                 | H1, L, L1                                   |
|                      | 42 | 12 | 8,32               | 4,15            | 0,173                       | 38 000                | 60 000                               | 0,068              | 7004 ACD/P4A    | S                                 | H                                           |
|                      | 42 | 12 | 8,32               | 4,15            | 0,173                       | 45 000                | 70 000                               | 0,06               | 7004 ACD/HCP4A  | S                                 | H                                           |
|                      | 42 | 12 | 8,71               | 4,3             | 0,18                        | 43 000                | 63 000                               | 0,068              | 7004 CD/P4A     | S                                 | H                                           |
|                      | 42 | 12 | 8,71               | 4,3             | 0,18                        | 50 000                | 80 000                               | 0,06               | 7004 CD/HCP4A   | S                                 | H                                           |
|                      | 47 | 14 | 11,4               | 5,6             | 0,236                       | 32 000                | 48 000                               | 0,1                | 7204 ACD/P4A    | S                                 | –                                           |
|                      | 47 | 14 | 11,4               | 5,6             | 0,236                       | 38 000                | 56 000                               | 0,09               | 7204 ACD/HCP4A  | S                                 | –                                           |
|                      | 47 | 14 | 11,9               | 5,85            | 0,245                       | 36 000                | 53 000                               | 0,1                | 7204 CD/P4A     | S                                 | –                                           |
|                      | 47 | 14 | 11,9               | 5,85            | 0,245                       | 43 000                | 60 000                               | 0,09               | 7204 CD/HCP4A   | S                                 | –                                           |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 208).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 208).

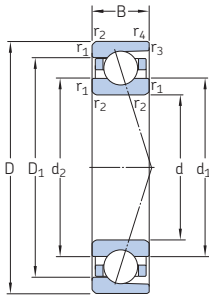


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                  |                                         | cm <sup>3</sup>    | – |
| 17<br>cont. | 24,1           | 24,1           | 32,8           | 34,4           | 0,6                   | 0,3                   | 21,2                           | 21,2                | 35,8                | 37,6                | 0,6                 | 0,3                 | 25,9           | 1                | –                                       |                    |   |
|             | 24,1           | 24,1           | 32,8           | 34,4           | 0,6                   | 0,3                   | 21,2                           | 21,2                | 35,8                | 37,6                | 0,6                 | 0,3                 | 25,9           | 1                | –                                       |                    |   |
|             | 24,1           | 24,1           | 32,8           | 34,4           | 0,6                   | 0,3                   | 21,2                           | 21,2                | 35,8                | 37,6                | 0,6                 | 0,3                 | 25,9           | 1                | 8,5                                     |                    |   |
|             | 24,1           | 24,1           | 32,8           | 34,4           | 0,6                   | 0,3                   | 21,2                           | 21,2                | 35,8                | 37,6                | 0,6                 | 0,3                 | 25,9           | 1                | 8,5                                     |                    |   |
| 20          | 24,1           | 24,1           | 28,1           | –              | 0,3                   | 0,15                  | 22                             | 22                  | 30                  | 31,2                | 0,3                 | 0,15                | 24,5           | 0,18             | –                                       |                    |   |
|             | 24,1           | 24,1           | 28,1           | –              | 0,3                   | 0,15                  | 22                             | 22                  | 30                  | 31,2                | 0,3                 | 0,15                | 24,5           | 0,18             | –                                       |                    |   |
|             | 24,1           | 24,1           | 28,1           | –              | 0,3                   | 0,15                  | 22                             | 22                  | 30                  | 31,2                | 0,3                 | 0,15                | 24,5           | 0,18             | 16                                      |                    |   |
|             | 24,1           | 24,1           | 28,1           | –              | 0,3                   | 0,15                  | 22                             | 22                  | 30                  | 31,2                | 0,3                 | 0,15                | 24,5           | 0,18             | 16                                      |                    |   |
|             | 25,7           | 24,4           | 31,5           | 33,5           | 0,3                   | 0,15                  | 22                             | 22                  | 35                  | 36,2                | 0,3                 | 0,15                | 26,7           | 0,5              | –                                       |                    |   |
|             | 25,7           | 24,4           | 31,5           | 33,5           | 0,3                   | 0,15                  | 22                             | 22                  | 35                  | 36,2                | 0,3                 | 0,15                | 26,7           | 0,5              | –                                       |                    |   |
|             | 25,7           | 24,4           | 31,5           | 33,5           | 0,3                   | 0,15                  | 22                             | 22                  | 35                  | 36,2                | 0,3                 | 0,15                | 26,7           | 0,5              | 7,8                                     |                    |   |
|             | 25,7           | 24,4           | 31,5           | 33,5           | 0,3                   | 0,15                  | 22                             | 22                  | 35                  | 36,2                | 0,3                 | 0,15                | 26,7           | 0,5              | 7,8                                     |                    |   |
|             | 25,6           | 25,6           | 31,4           | 34             | 0,3                   | 0,2                   | 22                             | 22                  | 35                  | 35,6                | 0,3                 | 0,2                 | 26,8           | 0,45             | –                                       |                    |   |
|             | 25,6           | 25,6           | 31,4           | 34             | 0,3                   | 0,2                   | 22                             | 22                  | 35                  | 35,6                | 0,3                 | 0,2                 | 26,8           | 0,45             | –                                       |                    |   |
|             | 25,6           | 25,6           | 31,4           | 34             | 0,3                   | 0,2                   | 22                             | 22                  | 35                  | 35,6                | 0,3                 | 0,2                 | 26,8           | 0,45             | 9,8                                     |                    |   |
|             | 25,6           | 25,6           | 31,4           | 34             | 0,3                   | 0,2                   | 22                             | 22                  | 35                  | 35,6                | 0,3                 | 0,2                 | 26,8           | 0,45             | 9,8                                     |                    |   |
|             | 26,6           | 24,8           | 36,5           | 36,5           | 0,6                   | 0,3                   | 22                             | 22                  | 40                  | 39,6                | 0,6                 | 0,3                 | 28,1           | 1,1              | –                                       |                    |   |
|             | 26,6           | 24,8           | 36,5           | 36,5           | 0,6                   | 0,3                   | 22                             | 22                  | 40                  | 39,6                | 0,6                 | 0,3                 | 28,1           | 1,1              | –                                       |                    |   |
|             | 26,6           | 24,8           | 36,5           | 36,5           | 0,6                   | 0,3                   | 22                             | 22                  | 40                  | 39,6                | 0,6                 | 0,3                 | 28,1           | 1,1              | 7,2                                     |                    |   |
|             | 26,6           | 24,8           | 36,5           | 36,5           | 0,6                   | 0,3                   | 22                             | 22                  | 40                  | 39,6                | 0,6                 | 0,3                 | 28,1           | 1,1              | 7,2                                     |                    |   |
| 27,1        | 27,1           | 34,8           | 37,1           | 0,6            | 0,3                   | 23,2                  | 23,2                           | 38,8                | 40                  | 0,6                 | 0,3                 | 28,4                | 0,9            | –                |                                         |                    |   |
| 27,1        | 27,1           | 34,8           | 37,1           | 0,6            | 0,3                   | 23,2                  | 23,2                           | 38,8                | 40                  | 0,6                 | 0,3                 | 28,4                | 0,9            | –                |                                         |                    |   |
| 27,1        | 27,1           | 34,8           | 37,1           | 0,6            | 0,3                   | 23,2                  | 23,2                           | 38,8                | 40                  | 0,6                 | 0,3                 | 28,4                | 0,9            | 9,2              |                                         |                    |   |
| 27,1        | 27,1           | 34,8           | 37,1           | 0,6            | 0,3                   | 23,2                  | 23,2                           | 38,8                | 40                  | 0,6                 | 0,3                 | 28,4                | 0,9            | 9,2              |                                         |                    |   |
| 29,1        | 29,1           | 38,7           | 40,9           | 1              | 0,3                   | 25,6                  | 25,6                           | 41,4                | 44,6                | 1                   | 0,3                 | 31,1                | 1,5            | –                |                                         |                    |   |
| 29,1        | 29,1           | 38,7           | 40,9           | 1              | 0,3                   | 25,6                  | 25,6                           | 41,4                | 44,6                | 1                   | 0,3                 | 31,1                | 1,5            | –                |                                         |                    |   |
| 29,1        | 29,1           | 38,7           | 40,9           | 1              | 0,3                   | 25,6                  | 25,6                           | 41,4                | 44,6                | 1                   | 0,3                 | 31,1                | 1,5            | 8,7              |                                         |                    |   |
| 29,1        | 29,1           | 38,7           | 40,9           | 1              | 0,3                   | 25,6                  | 25,6                           | 41,4                | 44,6                | 1                   | 0,3                 | 31,1                | 1,5            | 8,7              |                                         |                    |   |

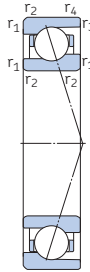
<sup>1)</sup> For calculating the initial grease fill → page 209

## 2.1 Angular contact ball bearings

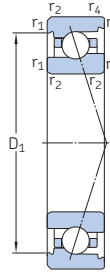
### d 25 – 30 mm



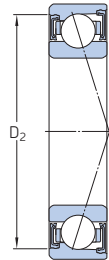
ACD, CD



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



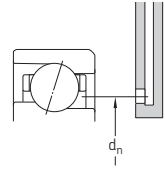
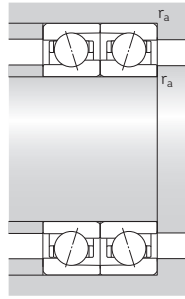
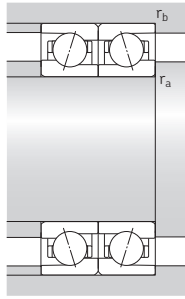
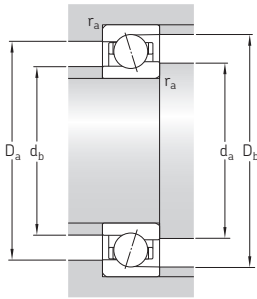
S... <sup>1)</sup>

| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 25                   | 37 | 7  | 3,9                | 3,05                  | 0,129              | 34 000             | 53 000                            | 0,021              | 71805 ACD/P4    | –                              | –                                        |
|                      | 37 | 7  | 3,9                | 3,05                  | 0,129              | 40 000             | 63 000                            | 0,019              | 71805 ACD/HCP4  | –                              | –                                        |
|                      | 37 | 7  | 4,16               | 3,2                   | 0,137              | 38 000             | 56 000                            | 0,021              | 71805 CD/P4     | –                              | –                                        |
|                      | 37 | 7  | 4,16               | 3,2                   | 0,137              | 45 000             | 70 000                            | 0,019              | 71805 CD/HCP4   | –                              | –                                        |
|                      | 42 | 9  | 4,94               | 2,7                   | 0,114              | 44 000             | 68 000                            | 0,04               | 71905 ACE/P4A   | S                              | H, L                                     |
|                      | 42 | 9  | 4,94               | 2,7                   | 0,114              | 52 000             | 83 000                            | 0,036              | 71905 ACE/HCP4A | S                              | H, L                                     |
|                      | 42 | 9  | 5,27               | 2,85                  | 0,12               | 49 000             | 75 000                            | 0,04               | 71905 CE/P4A    | S                              | H, L                                     |
|                      | 42 | 9  | 5,27               | 2,85                  | 0,12               | 58 000             | 90 000                            | 0,036              | 71905 CE/HCP4A  | S                              | H, L                                     |
|                      | 42 | 9  | 6,37               | 3,8                   | 0,16               | 32 000             | 48 000                            | 0,042              | 71905 ACD/P4A   | S                              | –                                        |
|                      | 42 | 9  | 6,37               | 3,8                   | 0,16               | 38 000             | 56 000                            | 0,039              | 71905 ACD/HCP4A | S                              | –                                        |
|                      | 42 | 9  | 6,76               | 4                     | 0,17               | 36 000             | 53 000                            | 0,042              | 71905 CD/P4A    | S                              | –                                        |
|                      | 42 | 9  | 6,76               | 4                     | 0,17               | 45 000             | 63 000                            | 0,039              | 71905 CD/HCP4A  | S                              | –                                        |
|                      | 47 | 12 | 7,93               | 3,9                   | 0,166              | 42 000             | 63 000                            | 0,074              | 7005 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 47 | 12 | 7,93               | 3,9                   | 0,166              | 50 000             | 75 000                            | 0,065              | 7005 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 47 | 12 | 8,32               | 4,15                  | 0,173              | 46 000             | 70 000                            | 0,074              | 7005 CE/P4A     | S                              | H1, L, L1                                |
|                      | 47 | 12 | 8,32               | 4,15                  | 0,173              | 56 000             | 85 000                            | 0,065              | 7005 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 47 | 12 | 9,23               | 5                     | 0,212              | 34 000             | 50 000                            | 0,079              | 7005 ACD/P4A    | S                              | H                                        |
|                      | 47 | 12 | 9,23               | 5                     | 0,212              | 40 000             | 60 000                            | 0,07               | 7005 ACD/HCP4A  | S                              | H                                        |
|                      | 47 | 12 | 9,56               | 5,2                   | 0,22               | 36 000             | 56 000                            | 0,079              | 7005 CD/P4A     | S                              | H                                        |
|                      | 47 | 12 | 9,56               | 5,2                   | 0,22               | 43 000             | 67 000                            | 0,07               | 7005 CD/HCP4A   | S                              | H                                        |
|                      | 52 | 15 | 13                 | 6,95                  | 0,29               | 26 000             | 40 000                            | 0,13               | 7205 ACD/P4A    | S                              | –                                        |
|                      | 52 | 15 | 13                 | 6,95                  | 0,29               | 32 000             | 48 000                            | 0,11               | 7205 ACD/HCP4A  | S                              | –                                        |
|                      | 52 | 15 | 13,5               | 7,2                   | 0,305              | 30 000             | 45 000                            | 0,13               | 7205 CD/P4A     | S                              | –                                        |
|                      | 52 | 15 | 13,5               | 7,2                   | 0,305              | 38 000             | 53 000                            | 0,11               | 7205 CD/HCP4A   | S                              | –                                        |
| 30                   | 42 | 7  | 4,16               | 3,55                  | 0,15               | 28 000             | 45 000                            | 0,026              | 71806 ACD/P4    | –                              | –                                        |
|                      | 42 | 7  | 4,16               | 3,55                  | 0,15               | 34 000             | 53 000                            | 0,024              | 71806 ACD/HCP4  | –                              | –                                        |
|                      | 42 | 7  | 4,42               | 3,75                  | 0,16               | 32 000             | 50 000                            | 0,026              | 71806 CD/P4     | –                              | –                                        |
|                      | 42 | 7  | 4,42               | 3,75                  | 0,16               | 38 000             | 60 000                            | 0,024              | 71806 CD/HCP4   | –                              | –                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 210).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 210).

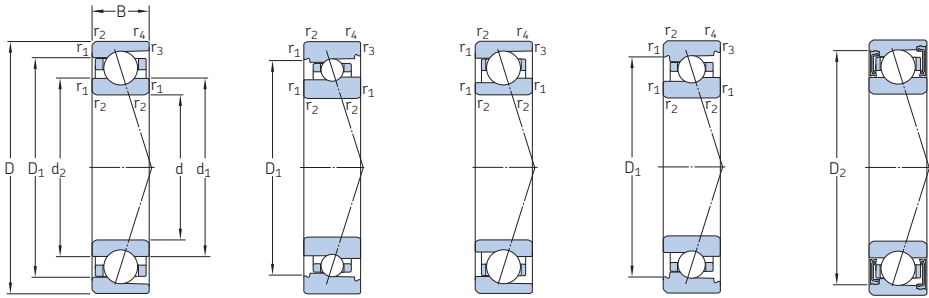


| Dimensions |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |      | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------|------------------------------------------------------|-----------------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |      |                                                      |                             |
| mm         |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |      |                                                      |                             |
|            |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |      | cm <sup>3</sup>                                      | –                           |
| 25         | 29,1           | 29,1           | 33,1           | –              | 0,3                            | 0,15                     | 27                     | 27                     | 35                     | 36,2                   | 0,3                    | 0,15                   | 29,5           | 0,21 | –                                                    | –                           |
|            | 29,1           | 29,1           | 33,1           | –              | 0,3                            | 0,15                     | 27                     | 27                     | 35                     | 36,2                   | 0,3                    | 0,15                   | 29,5           | 0,21 | –                                                    | –                           |
|            | 29,1           | 29,1           | 33,1           | –              | 0,3                            | 0,15                     | 27                     | 27                     | 35                     | 36,2                   | 0,3                    | 0,15                   | 29,5           | 0,21 | 16,4                                                 | 16,4                        |
|            | 29,1           | 29,1           | 33,1           | –              | 0,3                            | 0,15                     | 27                     | 27                     | 35                     | 36,2                   | 0,3                    | 0,15                   | 29,5           | 0,21 | –                                                    | –                           |
|            | 30,7           | 29,4           | 36,4           | 38,4           | 0,3                            | 0,15                     | 27                     | 27                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 31,8           | 0,6  | –                                                    | –                           |
|            | 30,7           | 29,4           | 36,4           | 38,4           | 0,3                            | 0,15                     | 27                     | 27                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 31,8           | 0,6  | –                                                    | –                           |
|            | 30,7           | 29,4           | 36,4           | 38,4           | 0,3                            | 0,15                     | 27                     | 27                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 31,8           | 0,6  | 8,1                                                  | 8,1                         |
|            | 30,7           | 29,4           | 36,4           | 38,4           | 0,3                            | 0,15                     | 27                     | 27                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 31,8           | 0,6  | –                                                    | –                           |
|            | 30,6           | 30,6           | 36,4           | 39             | 0,3                            | 0,2                      | 27                     | 27                     | 40                     | 40,6                   | 0,3                    | 0,2                    | 31,8           | 0,54 | –                                                    | –                           |
|            | 30,6           | 30,6           | 36,4           | 39             | 0,3                            | 0,2                      | 27                     | 27                     | 40                     | 40,6                   | 0,3                    | 0,2                    | 31,8           | 0,54 | –                                                    | –                           |
|            | 30,6           | 30,6           | 36,4           | 39             | 0,3                            | 0,2                      | 27                     | 27                     | 40                     | 40,6                   | 0,3                    | 0,2                    | 31,8           | 0,54 | 10,2                                                 | 10,2                        |
|            | 30,6           | 30,6           | 36,4           | 39             | 0,3                            | 0,2                      | 27                     | 27                     | 40                     | 40,6                   | 0,3                    | 0,2                    | 31,8           | 0,54 | –                                                    | –                           |
|            | 31,6           | 29,8           | 41,5           | 41,5           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 44,6                   | 0,6                    | 0,3                    | 33,1           | 1,3  | –                                                    | –                           |
|            | 31,6           | 29,8           | 41,5           | 41,5           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 44,6                   | 0,6                    | 0,3                    | 33,1           | 1,3  | –                                                    | –                           |
|            | 31,6           | 29,8           | 41,5           | 41,5           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 44,6                   | 0,6                    | 0,3                    | 33,1           | 1,3  | 7,5                                                  | 7,5                         |
|            | 31,6           | 29,8           | 41,5           | 41,5           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 44,6                   | 0,6                    | 0,3                    | 33,1           | 1,3  | –                                                    | –                           |
|            | 32,1           | 32,1           | 39,9           | 42,2           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 45                     | 0,6                    | 0,3                    | 33,4           | 1    | –                                                    | –                           |
|            | 32,1           | 32,1           | 39,9           | 42,2           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 45                     | 0,6                    | 0,3                    | 33,4           | 1    | –                                                    | –                           |
|            | 32,1           | 32,1           | 39,9           | 42,2           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 45                     | 0,6                    | 0,3                    | 33,4           | 1    | 9,6                                                  | 9,6                         |
|            | 32,1           | 32,1           | 39,9           | 42,2           | 0,6                            | 0,3                      | 28,2                   | 28,2                   | 43,8                   | 45                     | 0,6                    | 0,3                    | 33,4           | 1    | –                                                    | –                           |
|            | 34,1           | 34,1           | 43,7           | 45,9           | 1                              | 0,3                      | 30,6                   | 30,6                   | 46,4                   | 49,6                   | 1                      | 0,3                    | 36,1           | 1,9  | –                                                    | –                           |
|            | 34,1           | 34,1           | 43,7           | 45,9           | 1                              | 0,3                      | 30,6                   | 30,6                   | 46,4                   | 49,6                   | 1                      | 0,3                    | 36,1           | 1,9  | –                                                    | –                           |
|            | 34,1           | 34,1           | 43,7           | 45,9           | 1                              | 0,3                      | 30,6                   | 30,6                   | 46,4                   | 49,6                   | 1                      | 0,3                    | 36,1           | 1,9  | 9,1                                                  | 9,1                         |
|            | 34,1           | 34,1           | 43,7           | 45,9           | 1                              | 0,3                      | 30,6                   | 30,6                   | 46,4                   | 49,6                   | 1                      | 0,3                    | 36,1           | 1,9  | –                                                    | –                           |
| 30         | 34,1           | 34,1           | 38,1           | –              | 0,3                            | 0,15                     | 32                     | 32                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 34,5           | 0,24 | –                                                    | –                           |
|            | 34,1           | 34,1           | 38,1           | –              | 0,3                            | 0,15                     | 32                     | 32                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 34,5           | 0,24 | –                                                    | –                           |
|            | 34,1           | 34,1           | 38,1           | –              | 0,3                            | 0,15                     | 32                     | 32                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 34,5           | 0,24 | 16,8                                                 | 16,8                        |
|            | 34,1           | 34,1           | 38,1           | –              | 0,3                            | 0,15                     | 32                     | 32                     | 40                     | 41,2                   | 0,3                    | 0,15                   | 34,5           | 0,24 | –                                                    | –                           |

<sup>1)</sup> For calculating the initial grease fill → page 211

## 2.1 Angular contact ball bearings

d 30 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

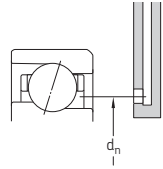
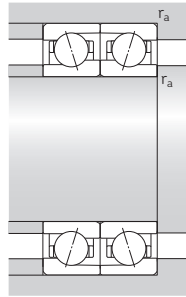
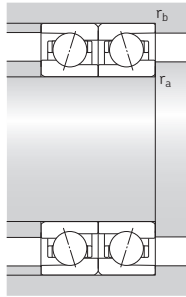
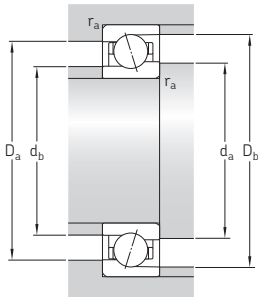
S... 1)

| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 30<br>cont.          | 47 | 9  | 4,62               | 3                     | 0,127              | 36 000             | 56 000                            | 0,047              | 71906 ACB/P4A   | S                              | –                                        |
|                      | 47 | 9  | 4,62               | 3                     | 0,127              | 43 000             | 67 000                            | 0,044              | 71906 ACB/HCP4A | S                              | –                                        |
|                      | 47 | 9  | 4,88               | 3,15                  | 0,134              | 40 000             | 60 000                            | 0,047              | 71906 CB/P4A    | S                              | –                                        |
|                      | 47 | 9  | 4,88               | 3,15                  | 0,134              | 48 000             | 75 000                            | 0,044              | 71906 CB/HCP4A  | S                              | –                                        |
|                      | 47 | 9  | 5,27               | 3,1                   | 0,132              | 37 000             | 58 000                            | 0,05               | 71906 ACE/P4A   | S                              | H, L                                     |
|                      | 47 | 9  | 5,27               | 3,1                   | 0,132              | 44 000             | 70 000                            | 0,045              | 71906 ACE/HCP4A | S                              | H, L                                     |
|                      | 47 | 9  | 5,59               | 3,25                  | 0,14               | 41 000             | 63 000                            | 0,05               | 71906 CE/P4A    | S                              | H, L                                     |
|                      | 47 | 9  | 5,59               | 3,25                  | 0,14               | 49 000             | 75 000                            | 0,045              | 71906 CE/HCP4A  | S                              | H, L                                     |
|                      | 47 | 9  | 6,76               | 4,3                   | 0,183              | 26 000             | 40 000                            | 0,048              | 71906 ACD/P4A   | S                              | –                                        |
|                      | 47 | 9  | 6,76               | 4,3                   | 0,183              | 32 000             | 48 000                            | 0,045              | 71906 ACD/HCP4A | S                              | –                                        |
|                      | 47 | 9  | 7,15               | 4,55                  | 0,193              | 30 000             | 45 000                            | 0,048              | 71906 CD/P4A    | S                              | –                                        |
|                      | 47 | 9  | 7,15               | 4,55                  | 0,193              | 38 000             | 53 000                            | 0,045              | 71906 CD/HCP4A  | S                              | –                                        |
|                      | 55 | 13 | 6,18               | 3,9                   | 0,166              | 34 000             | 50 000                            | 0,13               | 7006 ACB/P4A    | S                              | –                                        |
|                      | 55 | 13 | 6,18               | 3,9                   | 0,166              | 40 000             | 60 000                            | 0,13               | 7006 ACB/HCP4A  | S                              | –                                        |
|                      | 55 | 13 | 6,5                | 4,15                  | 0,176              | 36 000             | 56 000                            | 0,13               | 7006 CB/P4A     | S                              | –                                        |
|                      | 55 | 13 | 6,5                | 4,15                  | 0,176              | 43 000             | 67 000                            | 0,13               | 7006 CB/HCP4A   | S                              | –                                        |
|                      | 55 | 13 | 8,84               | 5                     | 0,212              | 35 000             | 54 000                            | 0,11               | 7006 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 55 | 13 | 8,84               | 5                     | 0,212              | 42 000             | 65 000                            | 0,1                | 7006 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 55 | 13 | 9,36               | 5,2                   | 0,22               | 39 000             | 60 000                            | 0,11               | 7006 CE/P4A     | S                              | H1, L, L1                                |
|                      | 55 | 13 | 9,36               | 5,2                   | 0,22               | 47 000             | 73 000                            | 0,1                | 7006 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 55 | 13 | 13,8               | 7,65                  | 0,325              | 28 000             | 43 000                            | 0,11               | 7006 ACD/P4A    | S                              | H                                        |
|                      | 55 | 13 | 13,8               | 7,65                  | 0,325              | 34 000             | 53 000                            | 0,095              | 7006 ACD/HCP4A  | S                              | H                                        |
|                      | 55 | 13 | 14,3               | 8                     | 0,34               | 32 000             | 48 000                            | 0,11               | 7006 CD/P4A     | S                              | H                                        |
|                      | 55 | 13 | 14,3               | 8                     | 0,34               | 38 000             | 56 000                            | 0,095              | 7006 CD/HCP4A   | S                              | H                                        |
|                      | 62 | 16 | 23,4               | 15,3                  | 0,64               | 20 000             | 34 000                            | 0,2                | 7206 ACD/P4A    | S                              | –                                        |
|                      | 62 | 16 | 23,4               | 15,3                  | 0,64               | 26 000             | 40 000                            | 0,17               | 7206 ACD/HCP4A  | S                              | –                                        |
|                      | 62 | 16 | 24,2               | 16                    | 0,67               | 24 000             | 38 000                            | 0,2                | 7206 CD/P4A     | S                              | –                                        |
|                      | 62 | 16 | 24,2               | 16                    | 0,67               | 32 000             | 45 000                            | 0,17               | 7206 CD/HCP4A   | S                              | –                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 212).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 212).

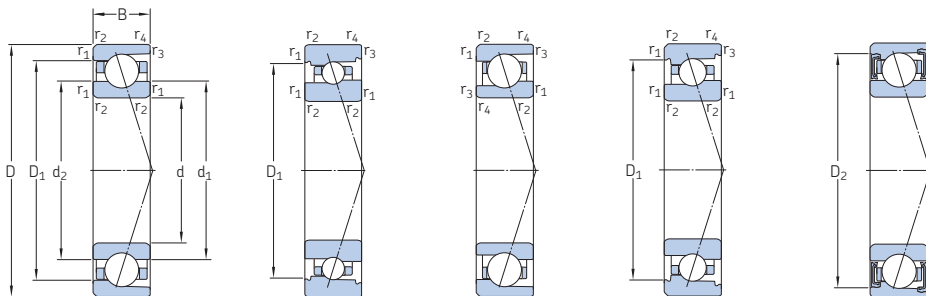


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |
| mm          |                |                |                |                |                       |                       | mm                             |                     |                     |                     |                     |                     |                | cm <sup>3</sup>  | –                                       |                    |
| 30<br>cont. | 36             | 35,1           | 43             | 43             | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,6           | 0,72             | –                                       |                    |
|             | 36             | 35,1           | 43             | 43             | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,6           | 0,72             | –                                       |                    |
|             | 36             | 35,1           | 43             | 43             | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,6           | 0,72             | 9,5                                     |                    |
|             | 36             | 35,1           | 43             | 43             | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,6           | 0,72             | 9,5                                     |                    |
|             | 35,8           | 34,4           | 41,4           | 43,4           | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,8           | 0,6              | –                                       |                    |
|             | 35,8           | 34,4           | 41,4           | 43,4           | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,8           | 0,6              | –                                       |                    |
|             | 35,8           | 34,4           | 41,4           | 43,4           | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,8           | 0,6              | 8,3                                     |                    |
|             | 35,8           | 34,4           | 41,4           | 43,4           | 0,3                   | 0,15                  | 32                             | 32                  | 45                  | 46,2                | 0,3                 | 0,15                | 36,8           | 0,6              | 8,3                                     |                    |
|             | 35,6           | 35,6           | 41,4           | 44             | 0,3                   | 0,2                   | 32                             | 32                  | 45                  | 45,6                | 0,3                 | 0,2                 | 36,8           | 0,63             | –                                       |                    |
|             | 35,6           | 35,6           | 41,4           | 44             | 0,3                   | 0,2                   | 32                             | 32                  | 45                  | 45,6                | 0,3                 | 0,2                 | 36,8           | 0,63             | –                                       |                    |
|             | 35,6           | 35,6           | 41,4           | 44             | 0,3                   | 0,2                   | 32                             | 32                  | 45                  | 45,6                | 0,3                 | 0,2                 | 36,8           | 0,63             | 10,4                                    |                    |
|             | 35,6           | 35,6           | 41,4           | 44             | 0,3                   | 0,2                   | 32                             | 32                  | 45                  | 45,6                | 0,3                 | 0,2                 | 36,8           | 0,63             | 10,4                                    |                    |
|             | 39,5           | 38,3           | 47,3           | 47,3           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 51,8                | 1                   | 0,6                 | 40             | 1,4              | –                                       |                    |
|             | 39,5           | 38,3           | 47,3           | 47,3           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 51,8                | 1                   | 0,6                 | 40             | 1,4              | –                                       |                    |
|             | 39,5           | 38,3           | 47,3           | 47,3           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 51,8                | 1                   | 0,6                 | 40             | 1,4              | 9,4                                     |                    |
|             | 39,5           | 38,3           | 47,3           | 47,3           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 51,8                | 1                   | 0,6                 | 40             | 1,4              | 9,4                                     |                    |
|             | 38,2           | 36,4           | 48,1           | 48,1           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 50,8                | 1                   | 0,6                 | 39,9           | 1,7              | –                                       |                    |
|             | 38,2           | 36,4           | 48,1           | 48,1           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 50,8                | 1                   | 0,6                 | 39,9           | 1,7              | –                                       |                    |
|             | 38,2           | 36,4           | 48,1           | 48,1           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 50,8                | 1                   | 0,6                 | 39,9           | 1,7              | 7,9                                     |                    |
|             | 38,2           | 36,4           | 48,1           | 48,1           | 1                     | 0,6                   | 34,6                           | 34,6                | 50,4                | 50,8                | 1                   | 0,6                 | 39,9           | 1,7              | 7,9                                     |                    |
|             | 37,7           | 37,7           | 47,3           | 49,6           | 1                     | 0,3                   | 34,6                           | 34,6                | 50,4                | 53                  | 1                   | 0,3                 | 39,3           | 1,6              | –                                       |                    |
|             | 37,7           | 37,7           | 47,3           | 49,6           | 1                     | 0,3                   | 34,6                           | 34,6                | 50,4                | 53                  | 1                   | 0,3                 | 39,3           | 1,6              | –                                       |                    |
|             | 37,7           | 37,7           | 47,3           | 49,6           | 1                     | 0,3                   | 34,6                           | 34,6                | 50,4                | 53                  | 1                   | 0,3                 | 39,3           | 1,6              | 9,4                                     |                    |
|             | 37,7           | 37,7           | 47,3           | 49,6           | 1                     | 0,3                   | 34,6                           | 34,6                | 50,4                | 53                  | 1                   | 0,3                 | 39,3           | 1,6              | 9,4                                     |                    |
|             | 40,2           | 40,2           | 51,8           | 54             | 1                     | 0,3                   | 35,6                           | 35,6                | 56,4                | 59,6                | 1                   | 0,3                 | 42,7           | 2,8              | –                                       |                    |
|             | 40,2           | 40,2           | 51,8           | 54             | 1                     | 0,3                   | 35,6                           | 35,6                | 56,4                | 59,6                | 1                   | 0,3                 | 42,7           | 2,8              | –                                       |                    |
|             | 40,2           | 40,2           | 51,8           | 54             | 1                     | 0,3                   | 35,6                           | 35,6                | 56,4                | 59,6                | 1                   | 0,3                 | 42,7           | 2,8              | 14                                      |                    |
|             | 40,2           | 40,2           | 51,8           | 54             | 1                     | 0,3                   | 35,6                           | 35,6                | 56,4                | 59,6                | 1                   | 0,3                 | 42,7           | 2,8              | 14                                      |                    |

<sup>1)</sup> For calculating the initial grease fill → page 213

## 2.1 Angular contact ball bearings

d 35 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

S... <sup>1)</sup>

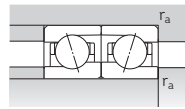
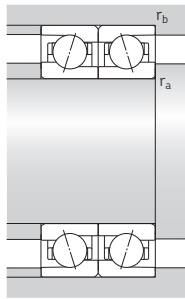
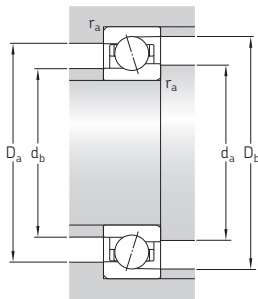
| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 35                   | 47 | 7  | 4,36               | 4,05                  | 0,173              | 26 000             | 40 000                            | 0,028              | 71807 ACD/P4    | –                              | –                                        |
|                      | 47 | 7  | 4,36               | 4,05                  | 0,173              | 30 000             | 48 000                            | 0,026              | 71807 ACD/HCP4  | –                              | –                                        |
|                      | 47 | 7  | 4,62               | 4,3                   | 0,183              | 28 000             | 43 000                            | 0,028              | 71807 CD/P4     | –                              | –                                        |
|                      | 47 | 7  | 4,62               | 4,3                   | 0,183              | 34 000             | 53 000                            | 0,026              | 71807 CD/HCP4   | –                              | –                                        |
|                      | 55 | 10 | 4,88               | 3,45                  | 0,146              | 30 000             | 48 000                            | 0,078              | 71907 ACB/P4A   | S                              | –                                        |
|                      | 55 | 10 | 4,88               | 3,45                  | 0,146              | 36 000             | 56 000                            | 0,074              | 71907 ACB/HCP4A | S                              | –                                        |
|                      | 55 | 10 | 5,2                | 3,65                  | 0,156              | 34 000             | 53 000                            | 0,078              | 71907 CB/P4A    | S                              | –                                        |
|                      | 55 | 10 | 5,2                | 3,65                  | 0,156              | 40 000             | 63 000                            | 0,074              | 71907 CB/HCP4A  | S                              | –                                        |
|                      | 55 | 10 | 7,28               | 4,5                   | 0,19               | 32 000             | 50 000                            | 0,075              | 71907 ACE/P4A   | S                              | H, L                                     |
|                      | 55 | 10 | 7,28               | 4,5                   | 0,19               | 38 000             | 60 000                            | 0,067              | 71907 ACE/HCP4A | S                              | H, L                                     |
|                      | 55 | 10 | 7,61               | 4,75                  | 0,2                | 36 000             | 54 000                            | 0,075              | 71907 CE/P4A    | S                              | H, L                                     |
|                      | 55 | 10 | 7,61               | 4,75                  | 0,2                | 43 000             | 65 000                            | 0,067              | 71907 CE/HCP4A  | S                              | H, L                                     |
|                      | 55 | 10 | 9,23               | 6,2                   | 0,26               | 22 000             | 36 000                            | 0,074              | 71907 ACD/P4A   | S                              | –                                        |
|                      | 55 | 10 | 9,23               | 6,2                   | 0,26               | 28 000             | 43 000                            | 0,068              | 71907 ACD/HCP4A | S                              | –                                        |
|                      | 55 | 10 | 9,75               | 6,55                  | 0,275              | 26 000             | 40 000                            | 0,074              | 71907 CD/P4A    | S                              | –                                        |
|                      | 55 | 10 | 9,75               | 6,55                  | 0,275              | 32 000             | 45 000                            | 0,068              | 71907 CD/HCP4A  | S                              | –                                        |
|                      | 62 | 14 | 6,5                | 4,55                  | 0,193              | 28 000             | 43 000                            | 0,17               | 7007 ACB/P4A    | S                              | –                                        |
|                      | 62 | 14 | 6,5                | 4,55                  | 0,193              | 34 000             | 53 000                            | 0,16               | 7007 ACB/HCP4A  | S                              | –                                        |
|                      | 62 | 14 | 6,89               | 4,8                   | 0,204              | 32 000             | 48 000                            | 0,17               | 7007 CB/P4A     | S                              | –                                        |
|                      | 62 | 14 | 6,89               | 4,8                   | 0,204              | 38 000             | 60 000                            | 0,16               | 7007 CB/HCP4A   | S                              | –                                        |
|                      | 62 | 14 | 11,1               | 6,3                   | 0,265              | 31 000             | 46 000                            | 0,15               | 7007 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 62 | 14 | 11,1               | 6,3                   | 0,265              | 36 000             | 56 000                            | 0,13               | 7007 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 62 | 14 | 11,4               | 6,55                  | 0,28               | 34 000             | 50 000                            | 0,15               | 7007 CE/P4A     | S                              | H1, L, L1                                |
|                      | 62 | 14 | 11,4               | 6,55                  | 0,28               | 40 000             | 63 000                            | 0,13               | 7007 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 62 | 14 | 14,8               | 9                     | 0,38               | 20 000             | 32 000                            | 0,15               | 7007 ACD/P4A    | S                              | H                                        |
|                      | 62 | 14 | 14,8               | 9                     | 0,38               | 24 000             | 38 000                            | 0,13               | 7007 ACD/HCP4A  | S                              | H                                        |
|                      | 62 | 14 | 15,6               | 9,5                   | 0,4                | 24 000             | 36 000                            | 0,15               | 7007 CD/P4A     | S                              | H                                        |
|                      | 62 | 14 | 15,6               | 9,5                   | 0,4                | 28 000             | 43 000                            | 0,13               | 7007 CD/HCP4A   | S                              | H                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 214).

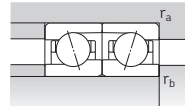
<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 214).

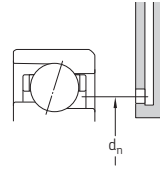




ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

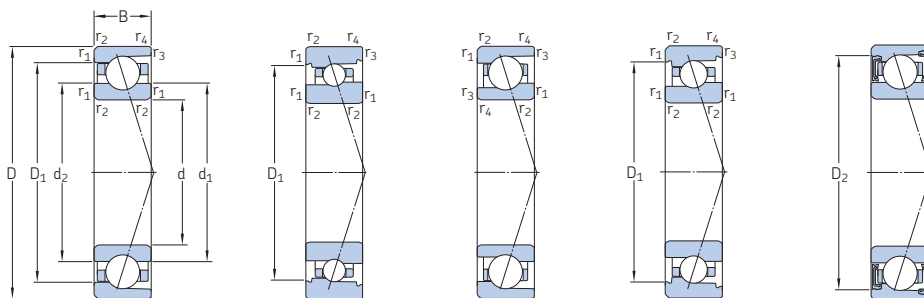


| Dimensions |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|---|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |   |
| mm         |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         | cm <sup>3</sup>    | – |
| 35         | 39,1           | 39,1           | 43,1           | –              | 0,3                   | 0,15                  | 37                             | 37                  | 45                  | 46,2                | 0,3                 | 0,15                | 39,5           | 0,28                                    | –                  |   |
|            | 39,1           | 39,1           | 43,1           | –              | 0,3                   | 0,15                  | 37                             | 37                  | 45                  | 46,2                | 0,3                 | 0,15                | 39,5           | 0,28                                    | –                  |   |
|            | 39,1           | 39,1           | 43,1           | –              | 0,3                   | 0,15                  | 37                             | 37                  | 45                  | 46,2                | 0,3                 | 0,15                | 39,5           | 0,28                                    | 17                 |   |
|            | 39,1           | 39,1           | 43,1           | –              | 0,3                   | 0,15                  | 37                             | 37                  | 45                  | 46,2                | 0,3                 | 0,15                | 39,5           | 0,28                                    | 17                 |   |
|            | 42,5           | 41,6           | 49,5           | 49,5           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,96                                    | –                  |   |
|            | 42,5           | 41,6           | 49,5           | 49,5           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,96                                    | –                  |   |
|            | 42,5           | 41,6           | 49,5           | 49,5           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,96                                    | 9,7                |   |
|            | 42,5           | 41,6           | 49,5           | 49,5           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,96                                    | 9,7                |   |
|            | 41,7           | 40,2           | 48,3           | 50,3           | 0,6                   | 0,3                   | 38,2                           | 37                  | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,8                                     | –                  |   |
|            | 41,7           | 40,2           | 48,3           | 50,3           | 0,6                   | 0,3                   | 38,2                           | 37                  | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,8                                     | –                  |   |
|            | 41,7           | 40,2           | 48,3           | 50,3           | 0,6                   | 0,3                   | 38,2                           | 37                  | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,8                                     | 8,3                |   |
|            | 41,7           | 40,2           | 48,3           | 50,3           | 0,6                   | 0,3                   | 38,2                           | 37                  | 51,8                | 53                  | 0,6                 | 0,3                 | 43             | 0,8                                     | 8,3                |   |
|            | 41,6           | 41,6           | 48,4           | 50,1           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53,6                | 0,6                 | 0,3                 | 43             | 0,93                                    | –                  |   |
|            | 41,6           | 41,6           | 48,4           | 50,1           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53,6                | 0,6                 | 0,3                 | 43             | 0,93                                    | –                  |   |
|            | 41,6           | 41,6           | 48,4           | 50,1           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53,6                | 0,6                 | 0,3                 | 43             | 0,93                                    | 10,4               |   |
|            | 41,6           | 41,6           | 48,4           | 50,1           | 0,6                   | 0,3                   | 38,2                           | 38,2                | 51,8                | 53,6                | 0,6                 | 0,3                 | 43             | 0,93                                    | 10,4               |   |
|            | 45,5           | 44,3           | 53,4           | 53,4           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 58,8                | 1                   | 0,6                 | 46,1           | 1,8                                     | –                  |   |
|            | 45,5           | 44,3           | 53,4           | 53,4           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 58,8                | 1                   | 0,6                 | 46,1           | 1,8                                     | –                  |   |
|            | 45,5           | 44,3           | 53,4           | 53,4           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 58,8                | 1                   | 0,6                 | 46,1           | 1,8                                     | 9,6                |   |
|            | 45,5           | 44,3           | 53,4           | 53,4           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 58,8                | 1                   | 0,6                 | 46,1           | 1,8                                     | 9,6                |   |
|            | 43,7           | 41,6           | 54,9           | 54,9           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 57,8                | 1                   | 0,6                 | 45,6           | 2,4                                     | –                  |   |
|            | 43,7           | 41,6           | 54,9           | 54,9           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 57,8                | 1                   | 0,6                 | 45,6           | 2,4                                     | –                  |   |
|            | 43,7           | 41,6           | 54,9           | 54,9           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 57,8                | 1                   | 0,6                 | 45,6           | 2,4                                     | 7,9                |   |
|            | 43,7           | 41,6           | 54,9           | 54,9           | 1                     | 0,6                   | 39,6                           | 39,6                | 57,4                | 57,8                | 1                   | 0,6                 | 45,6           | 2,4                                     | 7,9                |   |
|            | 43,7           | 43,7           | 53,3           | 55,6           | 1                     | 0,3                   | 39,6                           | 39,6                | 57,4                | 60                  | 1                   | 0,3                 | 45,3           | 2                                       | –                  |   |
|            | 43,7           | 43,7           | 53,3           | 55,6           | 1                     | 0,3                   | 39,6                           | 39,6                | 57,4                | 60                  | 1                   | 0,3                 | 45,3           | 2                                       | –                  |   |
|            | 43,7           | 43,7           | 53,3           | 55,6           | 1                     | 0,3                   | 39,6                           | 39,6                | 57,4                | 60                  | 1                   | 0,3                 | 45,3           | 2                                       | 9,7                |   |
|            | 43,7           | 43,7           | 53,3           | 55,6           | 1                     | 0,3                   | 39,6                           | 39,6                | 57,4                | 60                  | 1                   | 0,3                 | 45,3           | 2                                       | 9,7                |   |

<sup>1)</sup> For calculating the initial grease fill → page 215

## 2.1 Angular contact ball bearings

### d 35 – 40 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

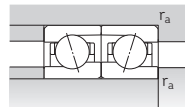
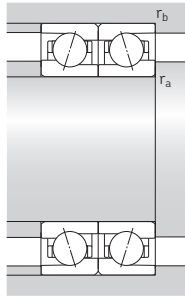
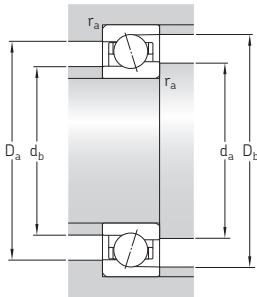
S... 1)

| Principal dimensions |    |      | Basic load ratings |                       | Fatigue load limit | Attainable speeds  | Mass <sup>2)</sup>                | Designation    | Available variants             |                                          |       |
|----------------------|----|------|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|----------------|--------------------------------|------------------------------------------|-------|
| d                    | D  | B    | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |       |
| mm                   |    |      | kN                 |                       | kN                 | r/min              |                                   | kg             | –                              | –                                        |       |
| 35<br>cont.          | 72 | 17   | 30,7               | 20,8                  | 0,88               | 18 000             | 30 000                            | 0,29           | 7207 ACD/P4A                   | S                                        | –     |
|                      | 72 | 17   | 30,7               | 20,8                  | 0,88               | 20 000             | 34 000                            | 0,24           | 7207 ACD/HCP4A                 | S                                        | –     |
|                      | 72 | 17   | 31,9               | 21,6                  | 0,915              | 20 000             | 34 000                            | 0,29           | 7207 CD/P4A                    | S                                        | –     |
|                      | 72 | 17   | 31,9               | 21,6                  | 0,915              | 26 000             | 38 000                            | 0,24           | 7207 CD/HCP4A                  | S                                        | –     |
| 40                   | 52 | 7    | 4,49               | 4,55                  | 0,196              | 22 000             | 34 000                            | 0,031          | 71808 ACD/P4                   | –                                        | –     |
|                      | 52 | 7    | 4,49               | 4,55                  | 0,196              | 28 000             | 43 000                            | 0,029          | 71808 ACD/HCP4                 | –                                        | –     |
|                      | 52 | 7    | 4,88               | 4,9                   | 0,208              | 26 000             | 38 000                            | 0,031          | 71808 CD/P4                    | –                                        | –     |
|                      | 52 | 7    | 4,88               | 4,9                   | 0,208              | 30 000             | 45 000                            | 0,029          | 71808 CD/HCP4                  | –                                        | –     |
|                      | 62 | 12   | 5,07               | 4                     | 0,166              | 28 000             | 43 000                            | 0,12           | 71908 ACB/P4A                  | S                                        | L     |
|                      | 62 | 12   | 5,07               | 4                     | 0,166              | 32 000             | 50 000                            | 0,11           | 71908 ACB/HCP4A                | S                                        | L     |
|                      | 62 | 12   | 5,4                | 4,15                  | 0,176              | 30 000             | 45 000                            | 0,12           | 71908 CB/P4A                   | S                                        | L     |
|                      | 62 | 12   | 5,4                | 4,15                  | 0,176              | 36 000             | 56 000                            | 0,11           | 71908 CB/HCP4A                 | S                                        | L     |
|                      | 62 | 12   | 9,23               | 5,85                  | 0,245              | 28 000             | 44 000                            | 0,1            | 71908 ACE/P4A                  | S                                        | H1, L |
|                      | 62 | 12   | 9,23               | 5,85                  | 0,245              | 34 000             | 52 000                            | 0,088          | 71908 ACE/HCP4A                | S                                        | H1, L |
|                      | 62 | 12   | 9,75               | 6,1                   | 0,26               | 32 000             | 49 000                            | 0,1            | 71908 CE/P4A                   | S                                        | H1, L |
|                      | 62 | 12   | 9,75               | 6,1                   | 0,26               | 38 000             | 58 000                            | 0,088          | 71908 CE/HCP4A                 | S                                        | H1, L |
|                      | 62 | 12   | 11,7               | 8                     | 0,34               | 18 000             | 30 000                            | 0,11           | 71908 ACD/P4A                  | S                                        | –     |
|                      | 62 | 12   | 11,7               | 8                     | 0,34               | 22 000             | 36 000                            | 0,1            | 71908 ACD/HCP4A                | S                                        | –     |
|                      | 62 | 12   | 12,4               | 8,5                   | 0,36               | 20 000             | 34 000                            | 0,11           | 71908 CD/P4A                   | S                                        | –     |
|                      | 62 | 12   | 12,4               | 8,5                   | 0,36               | 28 000             | 40 000                            | 0,1            | 71908 CD/HCP4A                 | S                                        | –     |
| 68                   | 15 | 6,89 | 5,3                | 0,224                 | 26 000             | 40 000             | 0,21                              | 7008 ACB/P4A   | S                              | L                                        |       |
|                      | 15 | 6,89 | 5,3                | 0,224                 | 32 000             | 48 000             | 0,2                               | 7008 ACB/HCP4A | S                              | L                                        |       |
|                      | 15 | 7,41 | 5,6                | 0,236                 | 28 000             | 43 000             | 0,21                              | 7008 CB/P4A    | S                              | L                                        |       |
|                      | 15 | 7,41 | 5,6                | 0,236                 | 34 000             | 53 000             | 0,2                               | 7008 CB/HCP4A  | S                              | L                                        |       |
| 68                   | 15 | 11,7 | 7,2                | 0,305                 | 27 000             | 41 000             | 0,19                              | 7008 ACE/P4A   | S                              | H1, L, L1                                |       |
|                      | 15 | 11,7 | 7,2                | 0,305                 | 32 000             | 50 000             | 0,17                              | 7008 ACE/HCP4A | S                              | H1, L, L1                                |       |
|                      | 15 | 12,4 | 7,65               | 0,32                  | 30 000             | 45 000             | 0,19                              | 7008 CE/P4A    | S                              | H1, L, L1                                |       |
|                      | 15 | 12,4 | 7,65               | 0,32                  | 36 000             | 56 000             | 0,17                              | 7008 CE/HCP4A  | S                              | H1, L, L1                                |       |

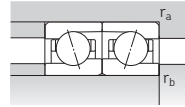
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 216).

<sup>2)</sup> Applicable to open bearings only.

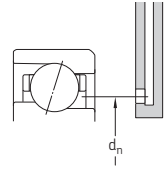
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 216).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

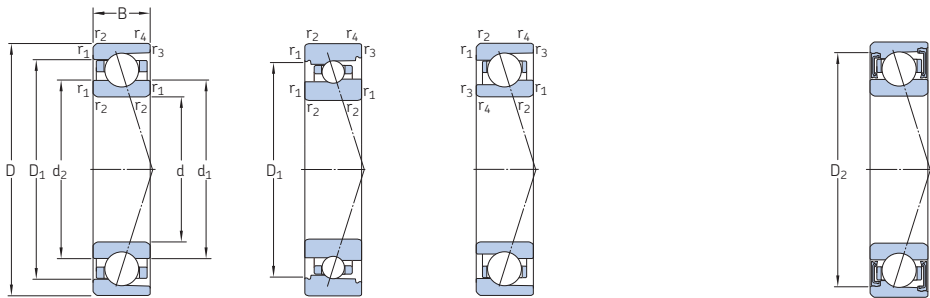


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 35<br>cont. | 46,8           | 46,8           | 60,2           | 63,2           | 1,1                   | 0,3                   | 42                             | 42                  | 65                  | 69,6                | 1                   | 0,3                 | 49,7           | 3,9                                     | –                  |                 |   |
|             | 46,8           | 46,8           | 60,2           | 63,2           | 1,1                   | 0,3                   | 42                             | 42                  | 65                  | 69,6                | 1                   | 0,3                 | 49,7           | 3,9                                     | –                  |                 |   |
|             | 46,8           | 46,8           | 60,2           | 63,2           | 1,1                   | 0,3                   | 42                             | 42                  | 65                  | 69,6                | 1                   | 0,3                 | 49,7           | 3,9                                     | 13,9               |                 |   |
|             | 46,8           | 46,8           | 60,2           | 63,2           | 1,1                   | 0,3                   | 42                             | 42                  | 65                  | 69,6                | 1                   | 0,3                 | 49,7           | 3,9                                     | 13,9               |                 |   |
| 40          | 44,1           | 44,1           | 48,1           | –              | 0,3                   | 0,15                  | 42                             | 42                  | 50                  | 51,2                | 0,3                 | 0,15                | 44,5           | 0,31                                    | –                  |                 |   |
|             | 44,1           | 44,1           | 48,1           | –              | 0,3                   | 0,15                  | 42                             | 42                  | 50                  | 51,2                | 0,3                 | 0,15                | 44,5           | 0,31                                    | –                  |                 |   |
|             | 44,1           | 44,1           | 48,1           | –              | 0,3                   | 0,15                  | 42                             | 42                  | 50                  | 51,2                | 0,3                 | 0,15                | 44,5           | 0,31                                    | 17,2               |                 |   |
|             | 44,1           | 44,1           | 48,1           | –              | 0,3                   | 0,15                  | 42                             | 42                  | 50                  | 51,2                | 0,3                 | 0,15                | 44,5           | 0,31                                    | 17,2               |                 |   |
|             | 48,5           | 47,6           | 55,6           | 55,6           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60                  | 0,6                 | 0,3                 | 49,1           | 1,4                                     | –                  |                 |   |
|             | 48,5           | 47,6           | 55,6           | 55,6           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60                  | 0,6                 | 0,3                 | 49,1           | 1,4                                     | –                  |                 |   |
|             | 48,5           | 47,6           | 55,6           | 55,6           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60                  | 0,6                 | 0,3                 | 49,1           | 1,4                                     | 9,8                |                 |   |
|             | 48,5           | 47,6           | 55,6           | 55,6           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60                  | 0,6                 | 0,3                 | 49,1           | 1,4                                     | 9,8                |                 |   |
|             | 46,5           | 44,8           | 54,2           | 56,5           | 0,6                   | 0,3                   | 43,2                           | 42                  | 58,8                | 60                  | 0,6                 | 0,3                 | 48             | 1,4                                     | –                  |                 |   |
|             | 46,5           | 44,8           | 54,2           | 56,5           | 0,6                   | 0,3                   | 43,2                           | 42                  | 58,8                | 60                  | 0,6                 | 0,3                 | 48             | 1,4                                     | –                  |                 |   |
|             | 46,5           | 44,8           | 54,2           | 56,5           | 0,6                   | 0,3                   | 43,2                           | 42                  | 58,8                | 60                  | 0,6                 | 0,3                 | 48             | 1,4                                     | 8,3                |                 |   |
|             | 46,5           | 44,8           | 54,2           | 56,5           | 0,6                   | 0,3                   | 43,2                           | 42                  | 58,8                | 60                  | 0,6                 | 0,3                 | 48             | 1,4                                     | 8,3                |                 |   |
|             | 47,1           | 47,1           | 54,9           | 57,1           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60,6                | 0,6                 | 0,3                 | 48,7           | 1,4                                     | –                  |                 |   |
|             | 47,1           | 47,1           | 54,9           | 57,1           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60,6                | 0,6                 | 0,3                 | 48,7           | 1,4                                     | –                  |                 |   |
|             | 47,1           | 47,1           | 54,9           | 57,1           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60,6                | 0,6                 | 0,3                 | 48,7           | 1,4                                     | 10,4               |                 |   |
|             | 47,1           | 47,1           | 54,9           | 57,1           | 0,6                   | 0,3                   | 43,2                           | 43,2                | 58,8                | 60,6                | 0,6                 | 0,3                 | 48,7           | 1,4                                     | 10,4               |                 |   |
| 51          | 49,9           | 58,9           | 58,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 64,8                | 1                   | 0,6                 | 51,6                | 2,2            | –                                       |                    |                 |   |
| 51          | 49,9           | 58,9           | 58,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 64,8                | 1                   | 0,6                 | 51,6                | 2,2            | –                                       |                    |                 |   |
| 51          | 49,9           | 58,9           | 58,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 64,8                | 1                   | 0,6                 | 51,6                | 2,2            | 9,8                                     |                    |                 |   |
| 51          | 49,9           | 58,9           | 58,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 64,8                | 1                   | 0,6                 | 51,6                | 2,2            | 9,8                                     |                    |                 |   |
| 49,7        | 47,6           | 60,9           | 60,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 63,8                | 1                   | 0,6                 | 51,6                | 2,8            | –                                       |                    |                 |   |
| 49,7        | 47,6           | 60,9           | 60,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 63,8                | 1                   | 0,6                 | 51,6                | 2,8            | –                                       |                    |                 |   |
| 49,7        | 47,6           | 60,9           | 60,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 63,8                | 1                   | 0,6                 | 51,6                | 2,8            | 8,1                                     |                    |                 |   |
| 49,7        | 47,6           | 60,9           | 60,9           | 1              | 0,6                   | 44,6                  | 44,6                           | 63,4                | 63,8                | 1                   | 0,6                 | 51,6                | 2,8            | 8,1                                     |                    |                 |   |

<sup>1)</sup> For calculating the initial grease fill → page 217

## 2.1 Angular contact ball bearings

### d 40 – 45 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

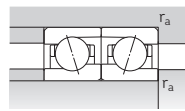
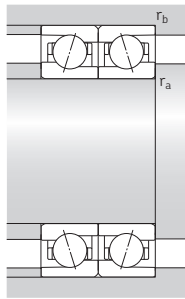
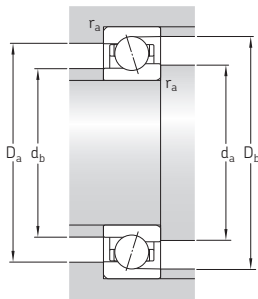
S... 1)

| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 40<br>cont.          | 68 | 15 | 15,9               | 10,4                  | 0,44               | 19 000             | 30 000                            | 0,19               | 7008 ACD/P4A    | S                              | H                                        |
|                      | 68 | 15 | 15,9               | 10,4                  | 0,44               | 22 000             | 34 000                            | 0,17               | 7008 ACD/HCP4A  | S                              | H                                        |
|                      | 68 | 15 | 16,8               | 11                    | 0,465              | 20 000             | 32 000                            | 0,19               | 7008 CD/P4A     | S                              | H                                        |
|                      | 68 | 15 | 16,8               | 11                    | 0,465              | 24 000             | 38 000                            | 0,17               | 7008 CD/HCP4A   | S                              | H                                        |
|                      | 80 | 18 | 31,9               | 22,8                  | 0,98               | 16 000             | 26 000                            | 0,37               | 7208 ACD/P4A    | S                              | –                                        |
|                      | 80 | 18 | 31,9               | 22,8                  | 0,98               | 19 000             | 32 000                            | 0,33               | 7208 ACD/HCP4A  | S                              | –                                        |
|                      | 80 | 18 | 33,8               | 24                    | 1,02               | 18 000             | 30 000                            | 0,37               | 7208 CD/P4A     | S                              | –                                        |
|                      | 80 | 18 | 33,8               | 24                    | 1,02               | 22 000             | 34 000                            | 0,33               | 7208 CD/HCP4A   | S                              | –                                        |
|                      | 58 | 7  | 4,62               | 5                     | 0,212              | 20 000             | 30 000                            | 0,039              | 71809 ACD/P4    | –                              | –                                        |
|                      | 58 | 7  | 4,62               | 5                     | 0,212              | 24 000             | 38 000                            | 0,037              | 71809 ACD/HCP4  | –                              | –                                        |
| 45                   | 58 | 7  | 4,88               | 5,3                   | 0,224              | 22 000             | 34 000                            | 0,039              | 71809 CD/P4     | –                              | –                                        |
|                      | 58 | 7  | 4,88               | 5,3                   | 0,224              | 26 000             | 40 000                            | 0,037              | 71809 CD/HCP4   | –                              | –                                        |
|                      | 68 | 12 | 7,02               | 5,4                   | 0,232              | 24 000             | 38 000                            | 0,13               | 71909 ACB/P4A   | S                              | L                                        |
|                      | 68 | 12 | 7,02               | 5,4                   | 0,232              | 30 000             | 45 000                            | 0,13               | 71909 ACB/HCP4A | S                              | L                                        |
|                      | 68 | 12 | 7,41               | 5,7                   | 0,245              | 28 000             | 43 000                            | 0,13               | 71909 CB/P4A    | S                              | L                                        |
|                      | 68 | 12 | 7,41               | 5,7                   | 0,245              | 32 000             | 50 000                            | 0,13               | 71909 CB/HCP4A  | S                              | L                                        |
|                      | 68 | 12 | 9,75               | 6,55                  | 0,275              | 25 000             | 39 000                            | 0,13               | 71909 ACE/P4A   | S                              | H1, L                                    |
|                      | 68 | 12 | 9,75               | 6,55                  | 0,275              | 30 000             | 47 000                            | 0,12               | 71909 ACE/HCP4A | S                              | H1, L                                    |
|                      | 68 | 12 | 10,1               | 6,95                  | 0,29               | 29 000             | 44 000                            | 0,13               | 71909 CE/P4A    | S                              | H1, L                                    |
|                      | 68 | 12 | 10,1               | 6,95                  | 0,29               | 34 000             | 52 000                            | 0,12               | 71909 CE/HCP4A  | S                              | H1, L                                    |
|                      | 68 | 12 | 12,4               | 9                     | 0,38               | 17 000             | 28 000                            | 0,13               | 71909 ACD/P4A   | S                              | –                                        |
|                      | 68 | 12 | 12,4               | 9                     | 0,38               | 20 000             | 34 000                            | 0,12               | 71909 ACD/HCP4A | S                              | –                                        |
|                      | 68 | 12 | 13                 | 9,5                   | 0,4                | 19 000             | 32 000                            | 0,13               | 71909 CD/P4A    | S                              | –                                        |
|                      | 68 | 12 | 13                 | 9,5                   | 0,4                | 24 000             | 36 000                            | 0,12               | 71909 CD/HCP4A  | S                              | –                                        |
|                      | 75 | 16 | 9,04               | 6,8                   | 0,285              | 24 000             | 36 000                            | 0,26               | 7009 ACB/P4A    | S                              | L                                        |
|                      | 75 | 16 | 9,04               | 6,8                   | 0,285              | 28 000             | 43 000                            | 0,25               | 7009 ACB/HCP4A  | S                              | L                                        |
|                      | 75 | 16 | 9,56               | 7,2                   | 0,305              | 26 000             | 40 000                            | 0,26               | 7009 CB/P4A     | S                              | L                                        |
|                      | 75 | 16 | 9,56               | 7,2                   | 0,305              | 30 000             | 48 000                            | 0,25               | 7009 CB/HCP4A   | S                              | L                                        |

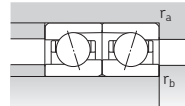
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 218).

<sup>2)</sup> Applicable to open bearings only.

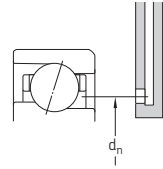
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 218).



ACD, CD, ACB, CB



719 .. ACE, 719 .. CE

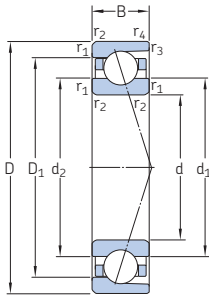


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                  |                                         | cm <sup>3</sup>    | – |
| 40<br>cont. | 49,2           | 49,2           | 58,8           | 61             | 1                     | 0,3                   | 44,6                           | 44,6                | 63,4                | 66                  | 1                   | 0,3                 | 50,8           | 2,4              | –                                       |                    |   |
|             | 49,2           | 49,2           | 58,8           | 61             | 1                     | 0,3                   | 44,6                           | 44,6                | 63,4                | 66                  | 1                   | 0,3                 | 50,8           | 2,4              | –                                       |                    |   |
|             | 49,2           | 49,2           | 58,8           | 61             | 1                     | 0,3                   | 44,6                           | 44,6                | 63,4                | 66                  | 1                   | 0,3                 | 50,8           | 2,4              | 10                                      |                    |   |
|             | 49,2           | 49,2           | 58,8           | 61             | 1                     | 0,3                   | 44,6                           | 44,6                | 63,4                | 66                  | 1                   | 0,3                 | 50,8           | 2,4              | 10                                      |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | –                                       |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | –                                       |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | 14,4                                    |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | 14,4                                    |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | 14,4                                    |                    |   |
|             | 53,3           | 53,3           | 66,7           | 69,7           | 1,1                   | 0,6                   | 47                             | 47                  | 73                  | 75,8                | 1                   | 0,6                 | 56,2           | 4,7              | 14,4                                    |                    |   |
| 45          | 49,6           | 49,6           | 53,6           | –              | 0,3                   | 0,15                  | 47                             | 47                  | 56                  | 57,2                | 0,3                 | 0,15                | 50             | 0,36             | –                                       |                    |   |
|             | 49,6           | 49,6           | 53,6           | –              | 0,3                   | 0,15                  | 47                             | 47                  | 56                  | 57,2                | 0,3                 | 0,15                | 50             | 0,36             | –                                       |                    |   |
|             | 49,6           | 49,6           | 53,6           | –              | 0,3                   | 0,15                  | 47                             | 47                  | 56                  | 57,2                | 0,3                 | 0,15                | 50             | 0,36             | 17,4                                    |                    |   |
|             | 49,6           | 49,6           | 53,6           | –              | 0,3                   | 0,15                  | 47                             | 47                  | 56                  | 57,2                | 0,3                 | 0,15                | 50             | 0,36             | 17,4                                    |                    |   |
|             | 53,5           | 52,4           | 61,8           | 61,8           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,8              | –                                       |                    |   |
|             | 53,5           | 52,4           | 61,8           | 61,8           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,8              | –                                       |                    |   |
|             | 53,5           | 52,4           | 61,8           | 61,8           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,8              | 9,7                                     |                    |   |
|             | 53,5           | 52,4           | 61,8           | 61,8           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,8              | 9,7                                     |                    |   |
|             | 52,7           | 51             | 60,3           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 47                  | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,5              | –                                       |                    |   |
|             | 52,7           | 51             | 60,3           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 47                  | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,5              | –                                       |                    |   |
|             | 52,7           | 51             | 60,3           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 47                  | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,5              | 8,4                                     |                    |   |
|             | 52,7           | 51             | 60,3           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 47                  | 64,8                | 66                  | 0,6                 | 0,3                 | 54,2           | 1,5              | 8,4                                     |                    |   |
|             | 52,6           | 52,6           | 60,4           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66,6                | 0,6                 | 0,3                 | 54,2           | 1,6              | –                                       |                    |   |
|             | 52,6           | 52,6           | 60,4           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66,6                | 0,6                 | 0,3                 | 54,2           | 1,6              | –                                       |                    |   |
|             | 52,6           | 52,6           | 60,4           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66,6                | 0,6                 | 0,3                 | 54,2           | 1,6              | 10,5                                    |                    |   |
|             | 52,6           | 52,6           | 60,4           | 62,6           | 0,6                   | 0,3                   | 48,2                           | 48,2                | 64,8                | 66,6                | 0,6                 | 0,3                 | 54,2           | 1,6              | 10,5                                    |                    |   |
|             | 56,4           | 55,2           | 65,6           | 65,6           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 71,8                | 1                   | 0,6                 | 57,2           | 2,9              | –                                       |                    |   |
|             | 56,4           | 55,2           | 65,6           | 65,6           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 71,8                | 1                   | 0,6                 | 57,2           | 2,9              | –                                       |                    |   |
|             | 56,4           | 55,2           | 65,6           | 65,6           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 71,8                | 1                   | 0,6                 | 57,2           | 2,9              | 9,6                                     |                    |   |
|             | 56,4           | 55,2           | 65,6           | 65,6           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 71,8                | 1                   | 0,6                 | 57,2           | 2,9              | 9,6                                     |                    |   |

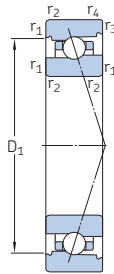
<sup>1)</sup> For calculating the initial grease fill → page 219

## 2.1 Angular contact ball bearings

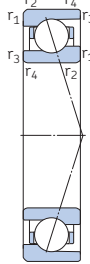
d 45 – 50 mm



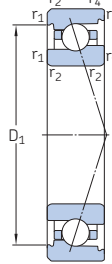
ACD, CD



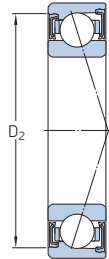
ACB, CB



719 .. ACE,  
719 .. CE



70 .. ACE,  
70 .. CE



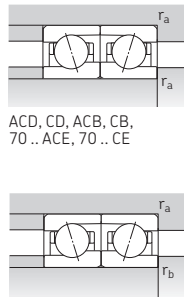
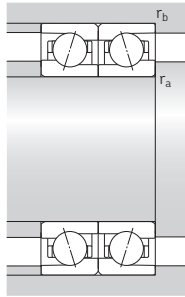
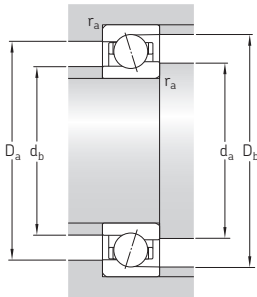
S... 1)

| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 45<br>cont.          | 75 | 16 | 12,1               | 8,15                  | 0,345              | 24 000             | 37 000                            | 0,24               | 7009 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 75 | 16 | 12,1               | 8,15                  | 0,345              | 29 000             | 45 000                            | 0,22               | 7009 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 75 | 16 | 13                 | 8,5                   | 0,36               | 27 000             | 41 000                            | 0,24               | 7009 CE/P4A     | S                              | H1, L, L1                                |
|                      | 75 | 16 | 13                 | 8,5                   | 0,36               | 32 000             | 50 000                            | 0,22               | 7009 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 75 | 16 | 27,6               | 21,6                  | 0,9                | 17 000             | 26 000                            | 0,24               | 7009 ACD/P4A    | S                              | H                                        |
|                      | 75 | 16 | 27,6               | 21,6                  | 0,9                | 20 000             | 32 000                            | 0,2                | 7009 ACD/HCP4A  | S                              | H                                        |
|                      | 75 | 16 | 28,6               | 22,4                  | 0,95               | 19 000             | 30 000                            | 0,24               | 7009 CD/P4A     | S                              | H                                        |
|                      | 75 | 16 | 28,6               | 22,4                  | 0,95               | 22 000             | 34 000                            | 0,2                | 7009 CD/HCP4A   | S                              | H                                        |
|                      | 85 | 19 | 41                 | 30                    | 1,25               | 15 000             | 24 000                            | 0,41               | 7209 ACD/P4A    | S                              | –                                        |
|                      | 85 | 19 | 41                 | 30                    | 1,25               | 17 000             | 28 000                            | 0,34               | 7209 ACD/HCP4A  | S                              | –                                        |
|                      | 85 | 19 | 42,3               | 31                    | 1,32               | 17 000             | 28 000                            | 0,41               | 7209 CD/P4A     | S                              | –                                        |
|                      | 85 | 19 | 42,3               | 31                    | 1,32               | 20 000             | 32 000                            | 0,34               | 7209 CD/HCP4A   | S                              | –                                        |
| 50                   | 65 | 7  | 6,89               | 7,35                  | 0,315              | 18 000             | 28 000                            | 0,051              | 71810 ACD/P4    | –                              | –                                        |
|                      | 65 | 7  | 6,89               | 7,35                  | 0,315              | 22 000             | 34 000                            | 0,046              | 71810 ACD/HCP4  | –                              | –                                        |
|                      | 65 | 7  | 7,41               | 7,8                   | 0,335              | 20 000             | 30 000                            | 0,051              | 71810 CD/P4     | –                              | –                                        |
|                      | 65 | 7  | 7,41               | 7,8                   | 0,335              | 24 000             | 36 000                            | 0,046              | 71810 CD/HCP4   | –                              | –                                        |
|                      | 72 | 12 | 7,28               | 5,85                  | 0,25               | 22 000             | 36 000                            | 0,13               | 71910 ACB/P4A   | S                              | L                                        |
|                      | 72 | 12 | 7,28               | 5,85                  | 0,25               | 28 000             | 43 000                            | 0,13               | 71910 ACB/HCP4A | S                              | L                                        |
|                      | 72 | 12 | 7,61               | 6,2                   | 0,265              | 26 000             | 38 000                            | 0,13               | 71910 CB/P4A    | S                              | L                                        |
|                      | 72 | 12 | 7,61               | 6,2                   | 0,265              | 30 000             | 45 000                            | 0,13               | 71910 CB/HCP4A  | S                              | L                                        |
|                      | 72 | 12 | 12,1               | 8,15                  | 0,345              | 23 000             | 36 000                            | 0,13               | 71910 ACE/P4A   | S                              | H1, L                                    |
|                      | 72 | 12 | 12,1               | 8,15                  | 0,345              | 28 000             | 43 000                            | 0,11               | 71910 ACE/HCP4A | S                              | H1, L                                    |
|                      | 72 | 12 | 12,7               | 8,65                  | 0,365              | 26 000             | 40 000                            | 0,13               | 71910 CE/P4A    | S                              | H1, L                                    |
|                      | 72 | 12 | 12,7               | 8,65                  | 0,365              | 32 000             | 48 000                            | 0,11               | 71910 CE/HCP4A  | S                              | H1, L                                    |
|                      | 72 | 12 | 12,7               | 9,8                   | 0,415              | 16 000             | 26 000                            | 0,13               | 71910 ACD/P4A   | S                              | –                                        |
|                      | 72 | 12 | 12,7               | 9,8                   | 0,415              | 19 000             | 30 000                            | 0,12               | 71910 ACD/HCP4A | S                              | –                                        |
|                      | 72 | 12 | 13,5               | 10,4                  | 0,44               | 17 000             | 28 000                            | 0,13               | 71910 CD/P4A    | S                              | –                                        |
|                      | 72 | 12 | 13,5               | 10,4                  | 0,44               | 22 000             | 34 000                            | 0,12               | 71910 CD/HCP4A  | S                              | –                                        |

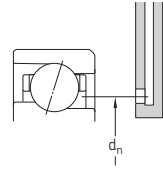
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 220).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 220).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



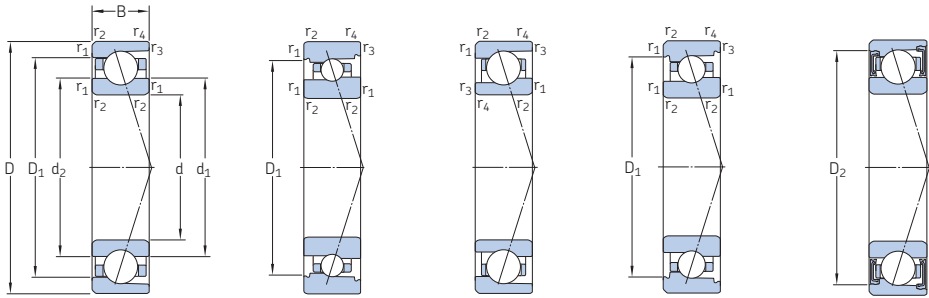
719 .. ACE, 719 .. CE

| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                  |                                         | cm <sup>3</sup>    | – |
| 45<br>cont. | 55,7           | 53,6           | 66,9           | 66,9           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 70,8                | 1                   | 0,6                 | 57,6           | 3,4              | –                                       |                    |   |
|             | 55,7           | 53,6           | 66,9           | 66,9           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 70,8                | 1                   | 0,6                 | 57,6           | 3,4              | –                                       |                    |   |
|             | 55,7           | 53,6           | 66,9           | 66,9           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 70,8                | 1                   | 0,6                 | 57,6           | 3,4              | 8,2                                     |                    |   |
|             | 55,7           | 53,6           | 66,9           | 66,9           | 1                     | 0,6                   | 49,6                           | 49,6                | 70,4                | 70,8                | 1                   | 0,6                 | 57,6           | 3,4              | 8,2                                     |                    |   |
|             | 54,2           | 54,2           | 65,8           | 68,3           | 1                     | 0,3                   | 49,6                           | 49,6                | 70,4                | 73                  | 1                   | 0,3                 | 56,2           | 3,3              | –                                       |                    |   |
|             | 54,2           | 54,2           | 65,8           | 68,3           | 1                     | 0,3                   | 49,6                           | 49,6                | 70,4                | 73                  | 1                   | 0,3                 | 56,2           | 3,3              | –                                       |                    |   |
|             | 54,2           | 54,2           | 65,8           | 68,3           | 1                     | 0,3                   | 49,6                           | 49,6                | 70,4                | 73                  | 1                   | 0,3                 | 56,2           | 3,3              | 15,1                                    |                    |   |
|             | 54,2           | 54,2           | 65,8           | 68,3           | 1                     | 0,3                   | 49,6                           | 49,6                | 70,4                | 73                  | 1                   | 0,3                 | 56,2           | 3,3              | 15,1                                    |                    |   |
|             | 57,3           | 57,3           | 72,7           | 75,7           | 1,1                   | 0,6                   | 52                             | 52                  | 78                  | 80,8                | 1                   | 0,6                 | 60,6           | 5,9              | –                                       |                    |   |
|             | 57,3           | 57,3           | 72,7           | 75,7           | 1,1                   | 0,6                   | 52                             | 52                  | 78                  | 80,8                | 1                   | 0,6                 | 60,6           | 5,9              | –                                       |                    |   |
|             | 57,3           | 57,3           | 72,7           | 75,7           | 1,1                   | 0,6                   | 52                             | 52                  | 78                  | 80,8                | 1                   | 0,6                 | 60,6           | 5,9              | 14,2                                    |                    |   |
|             | 57,3           | 57,3           | 72,7           | 75,7           | 1,1                   | 0,6                   | 52                             | 52                  | 78                  | 80,8                | 1                   | 0,6                 | 60,6           | 5,9              | 14,2                                    |                    |   |
| 50          | 55,1           | 55,1           | 60             | –              | 0,3                   | 0,15                  | 52                             | 52                  | 63                  | 64,2                | 0,3                 | 0,15                | 55,6           | 0,5              | –                                       |                    |   |
|             | 55,1           | 55,1           | 60             | –              | 0,3                   | 0,15                  | 52                             | 52                  | 63                  | 64,2                | 0,3                 | 0,15                | 55,6           | 0,5              | –                                       |                    |   |
|             | 55,1           | 55,1           | 60             | –              | 0,3                   | 0,15                  | 52                             | 52                  | 63                  | 64,2                | 0,3                 | 0,15                | 55,6           | 0,5              | 17,2                                    |                    |   |
|             | 55,1           | 55,1           | 60             | –              | 0,3                   | 0,15                  | 52                             | 52                  | 63                  | 64,2                | 0,3                 | 0,15                | 55,6           | 0,5              | 17,2                                    |                    |   |
|             | 58             | 56,9           | 66             | 66             | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70                  | 0,6                 | 0,3                 | 58,7           | 1,9              | –                                       |                    |   |
|             | 58             | 56,9           | 66             | 66             | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70                  | 0,6                 | 0,3                 | 58,7           | 1,9              | –                                       |                    |   |
|             | 58             | 56,9           | 66             | 66             | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70                  | 0,6                 | 0,3                 | 58,7           | 1,9              | 9,8                                     |                    |   |
|             | 58             | 56,9           | 66             | 66             | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70                  | 0,6                 | 0,3                 | 58,7           | 1,9              | 9,8                                     |                    |   |
|             | 56,7           | 54,9           | 65,3           | 67,7           | 0,6                   | 0,3                   | 53,2                           | 52                  | 68,8                | 70                  | 0,6                 | 0,3                 | 58,4           | 1,7              | –                                       |                    |   |
|             | 56,7           | 54,9           | 65,3           | 67,7           | 0,6                   | 0,3                   | 53,2                           | 52                  | 68,8                | 70                  | 0,6                 | 0,3                 | 58,4           | 1,7              | –                                       |                    |   |
|             | 56,7           | 54,9           | 65,3           | 67,7           | 0,6                   | 0,3                   | 53,2                           | 52                  | 68,8                | 70                  | 0,6                 | 0,3                 | 58,4           | 1,7              | 8,4                                     |                    |   |
|             | 56,7           | 54,9           | 65,3           | 67,7           | 0,6                   | 0,3                   | 53,2                           | 52                  | 68,8                | 70                  | 0,6                 | 0,3                 | 58,4           | 1,7              | 8,4                                     |                    |   |
|             | 57,1           | 57,1           | 64,9           | 67,1           | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70,6                | 0,6                 | 0,3                 | 58,7           | 1,7              | –                                       |                    |   |
|             | 57,1           | 57,1           | 64,9           | 67,1           | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70,6                | 0,6                 | 0,3                 | 58,7           | 1,7              | –                                       |                    |   |
|             | 57,1           | 57,1           | 64,9           | 67,1           | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70,6                | 0,6                 | 0,3                 | 58,7           | 1,7              | 10,7                                    |                    |   |
|             | 57,1           | 57,1           | 64,9           | 67,1           | 0,6                   | 0,3                   | 53,2                           | 53,2                | 68,8                | 70,6                | 0,6                 | 0,3                 | 58,7           | 1,7              | 10,7                                    |                    |   |

<sup>1)</sup> For calculating the initial grease fill → page 221

## 2.1 Angular contact ball bearings

d 50 – 55 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

S... 1)

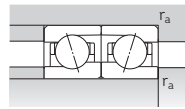
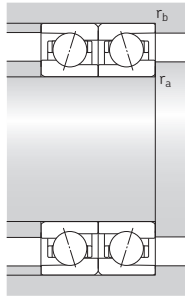
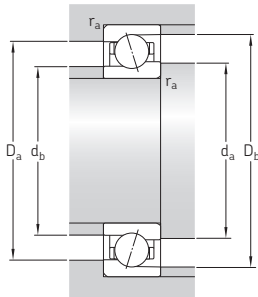
| Principal dimensions |    |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D  | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |    |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 50<br>cont.          | 80 | 16 | 9,36               | 7,35                  | 0,31               | 22 000             | 32 000                            | 0,29               | 7010 ACB/P4A    | S                              | L                                        |
|                      | 80 | 16 | 9,36               | 7,35                  | 0,31               | 26 000             | 40 000                            | 0,28               | 7010 ACB/HCP4A  | S                              | L                                        |
|                      | 80 | 16 | 9,95               | 7,8                   | 0,335              | 24 000             | 36 000                            | 0,29               | 7010 CB/P4A     | S                              | L                                        |
|                      | 80 | 16 | 9,95               | 7,8                   | 0,335              | 28 000             | 45 000                            | 0,28               | 7010 CB/HCP4A   | S                              | L                                        |
|                      | 80 | 16 | 14,8               | 10                    | 0,425              | 23 000             | 34 000                            | 0,25               | 7010 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 80 | 16 | 14,8               | 10                    | 0,425              | 27 000             | 41 000                            | 0,23               | 7010 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 80 | 16 | 15,6               | 10,6                  | 0,45               | 25 000             | 38 000                            | 0,25               | 7010 CE/P4A     | S                              | H1, L, L1                                |
|                      | 80 | 16 | 15,6               | 10,6                  | 0,45               | 30 000             | 46 000                            | 0,23               | 7010 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 80 | 16 | 28,1               | 23,2                  | 0,98               | 15 000             | 24 000                            | 0,25               | 7010 ACD/P4A    | S                              | H, L                                     |
|                      | 80 | 16 | 28,1               | 23,2                  | 0,98               | 18 000             | 28 000                            | 0,22               | 7010 ACD/HCP4A  | S                              | H, L                                     |
|                      | 80 | 16 | 29,6               | 24                    | 1,02               | 17 000             | 28 000                            | 0,25               | 7010 CD/P4A     | S                              | H, L                                     |
|                      | 80 | 16 | 29,6               | 24                    | 1,02               | 20 000             | 32 000                            | 0,22               | 7010 CD/HCP4A   | S                              | H, L                                     |
|                      | 90 | 20 | 42,3               | 32,5                  | 1,37               | 14 000             | 22 000                            | 0,46               | 7210 ACD/P4A    | S                              | –                                        |
|                      | 90 | 20 | 42,3               | 32,5                  | 1,37               | 16 000             | 26 000                            | 0,39               | 7210 ACD/HCP4A  | S                              | –                                        |
|                      | 90 | 20 | 44,9               | 34                    | 1,43               | 16 000             | 26 000                            | 0,46               | 7210 CD/P4A     | S                              | –                                        |
|                      | 90 | 20 | 44,9               | 34                    | 1,43               | 19 000             | 30 000                            | 0,39               | 7210 CD/HCP4A   | S                              | –                                        |
| 55                   | 72 | 9  | 9,56               | 10,2                  | 0,43               | 16 000             | 24 000                            | 0,081              | 71811 ACD/P4    | –                              | –                                        |
|                      | 72 | 9  | 9,56               | 10,2                  | 0,43               | 19 000             | 30 000                            | 0,073              | 71811 ACD/HCP4  | –                              | –                                        |
|                      | 72 | 9  | 10,1               | 10,8                  | 0,455              | 18 000             | 28 000                            | 0,081              | 71811 CD/P4     | –                              | –                                        |
|                      | 72 | 9  | 10,1               | 10,8                  | 0,455              | 22 000             | 32 000                            | 0,073              | 71811 CD/HCP4   | –                              | –                                        |
|                      | 80 | 13 | 9,36               | 7,65                  | 0,325              | 20 000             | 32 000                            | 0,18               | 71911 ACB/P4A   | S                              | L                                        |
|                      | 80 | 13 | 9,36               | 7,65                  | 0,325              | 24 000             | 38 000                            | 0,17               | 71911 ACB/HCP4A | S                              | L                                        |
|                      | 80 | 13 | 9,95               | 8,15                  | 0,345              | 22 000             | 34 000                            | 0,18               | 71911 CB/P4A    | S                              | L                                        |
|                      | 80 | 13 | 9,95               | 8,15                  | 0,345              | 28 000             | 43 000                            | 0,17               | 71911 CB/HCP4A  | S                              | L                                        |
|                      | 80 | 13 | 14,6               | 10,2                  | 0,43               | 21 000             | 32 000                            | 0,17               | 71911 ACE/P4A   | S                              | H1, L                                    |
|                      | 80 | 13 | 14,6               | 10,2                  | 0,43               | 25 000             | 39 000                            | 0,14               | 71911 ACE/HCP4A | S                              | H1, L                                    |
|                      | 80 | 13 | 15,3               | 10,6                  | 0,455              | 24 000             | 36 000                            | 0,17               | 71911 CE/P4A    | S                              | H1, L                                    |
|                      | 80 | 13 | 15,3               | 10,6                  | 0,455              | 28 000             | 43 000                            | 0,14               | 71911 CE/HCP4A  | S                              | H1, L                                    |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 222).

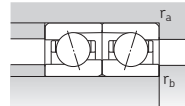
<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 222).

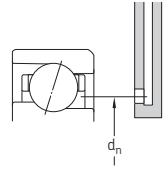




ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

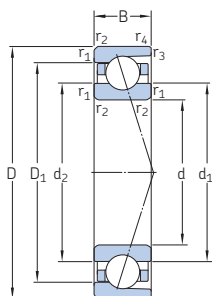


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    |
| 50<br>cont. | 61,4           | 59,7           | 70,7           | 70,7           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 76,8                | 1                   | 0,6                 | 61,8           | 3,1                                     | –                  |
|             | 61,4           | 59,7           | 70,7           | 70,7           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 76,8                | 1                   | 0,6                 | 61,8           | 3,1                                     | –                  |
|             | 61,4           | 59,7           | 70,7           | 70,7           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 76,8                | 1                   | 0,6                 | 61,8           | 3,1                                     | 9,7                |
|             | 61,4           | 59,7           | 70,7           | 70,7           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 76,8                | 1                   | 0,6                 | 61,8           | 3,1                                     | 9,7                |
|             | 60,3           | 57,9           | 72,9           | 72,9           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 75,8                | 1                   | 0,6                 | 62,3           | 4,1                                     | –                  |
|             | 60,3           | 57,9           | 72,9           | 72,9           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 75,8                | 1                   | 0,6                 | 62,3           | 4,1                                     | –                  |
|             | 60,3           | 57,9           | 72,9           | 72,9           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 75,8                | 1                   | 0,6                 | 62,3           | 4,1                                     | 8,2                |
|             | 60,3           | 57,9           | 72,9           | 72,9           | 1                     | 0,6                   | 54,6                           | 54,6                | 75,4                | 75,8                | 1                   | 0,6                 | 62,3           | 4,1                                     | 8,2                |
|             | 59,2           | 59,2           | 70,8           | 73,3           | 1                     | 0,3                   | 54,6                           | 54,6                | 75,4                | 78                  | 1                   | 0,3                 | 61,2           | 3,6                                     | –                  |
|             | 59,2           | 59,2           | 70,8           | 73,3           | 1                     | 0,3                   | 54,6                           | 54,6                | 75,4                | 78                  | 1                   | 0,3                 | 61,2           | 3,6                                     | –                  |
|             | 59,2           | 59,2           | 70,8           | 73,3           | 1                     | 0,3                   | 54,6                           | 54,6                | 75,4                | 78                  | 1                   | 0,3                 | 61,2           | 3,6                                     | 15,4               |
|             | 59,2           | 59,2           | 70,8           | 73,3           | 1                     | 0,3                   | 54,6                           | 54,6                | 75,4                | 78                  | 1                   | 0,3                 | 61,2           | 3,6                                     | 15,4               |
| 55          | 62,3           | 62,3           | 77,7           | 80,7           | 1,1                   | 0,6                   | 57                             | 57                  | 83                  | 85,8                | 1                   | 0,6                 | 65,6           | 6,7                                     | –                  |
|             | 62,3           | 62,3           | 77,7           | 80,7           | 1,1                   | 0,6                   | 57                             | 57                  | 83                  | 85,8                | 1                   | 0,6                 | 65,6           | 6,7                                     | –                  |
|             | 62,3           | 62,3           | 77,7           | 80,7           | 1,1                   | 0,6                   | 57                             | 57                  | 83                  | 85,8                | 1                   | 0,6                 | 65,6           | 6,7                                     | 14,5               |
|             | 62,3           | 62,3           | 77,7           | 80,7           | 1,1                   | 0,6                   | 57                             | 57                  | 83                  | 85,8                | 1                   | 0,6                 | 65,6           | 6,7                                     | 14,5               |
|             | 60,7           | 60,7           | 66,5           | –              | 0,3                   | 0,15                  | 57                             | 57                  | 70                  | 71,2                | 0,3                 | 0,15                | 61,3           | 0,88                                    | –                  |
|             | 60,7           | 60,7           | 66,5           | –              | 0,3                   | 0,15                  | 57                             | 57                  | 70                  | 71,2                | 0,3                 | 0,15                | 61,3           | 0,88                                    | –                  |
|             | 60,7           | 60,7           | 66,5           | –              | 0,3                   | 0,15                  | 57                             | 57                  | 70                  | 71,2                | 0,3                 | 0,15                | 61,3           | 0,88                                    | 17,1               |
|             | 60,7           | 60,7           | 66,5           | –              | 0,3                   | 0,15                  | 57                             | 57                  | 70                  | 71,2                | 0,3                 | 0,15                | 61,3           | 0,88                                    | 17,1               |
|             | 63,9           | 62,7           | 73,2           | 73,2           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,8           | 2,6                                     | –                  |
|             | 63,9           | 62,7           | 73,2           | 73,2           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,8           | 2,6                                     | –                  |
|             | 63,9           | 62,7           | 73,2           | 73,2           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,8           | 2,6                                     | 9,8                |
|             | 63,9           | 62,7           | 73,2           | 73,2           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,8           | 2,6                                     | 9,8                |
|             | 62,8           | 60,7           | 72,3           | 74,7           | 1                     | 0,3                   | 59,6                           | 57                  | 75,4                | 78                  | 1                   | 0,3                 | 64,6           | 2,3                                     | –                  |
|             | 62,8           | 60,7           | 72,3           | 74,7           | 1                     | 0,3                   | 59,6                           | 57                  | 75,4                | 78                  | 1                   | 0,3                 | 64,6           | 2,3                                     | –                  |
|             | 62,8           | 60,7           | 72,3           | 74,7           | 1                     | 0,3                   | 59,6                           | 57                  | 75,4                | 78                  | 1                   | 0,3                 | 64,6           | 2,3                                     | 8,4                |
|             | 62,8           | 60,7           | 72,3           | 74,7           | 1                     | 0,3                   | 59,6                           | 57                  | 75,4                | 78                  | 1                   | 0,3                 | 64,6           | 2,3                                     | 8,4                |

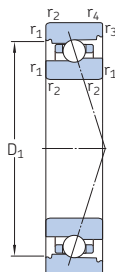
<sup>1)</sup> For calculating the initial grease fill → page 223

## 2.1 Angular contact ball bearings

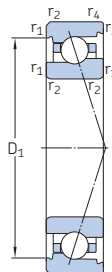
### d 55 – 60 mm



ACD, CD



ACB, CB



70 .. ACE,  
70 .. CE



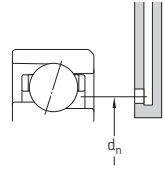
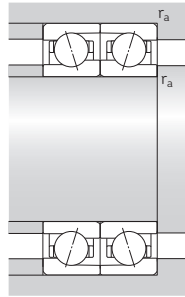
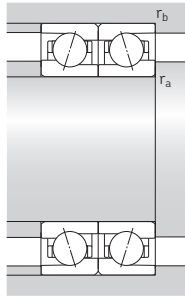
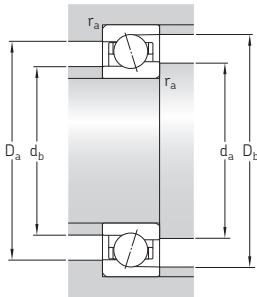
S... <sup>1)</sup>

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 55<br>cont.          | 80  | 13 | 18,2               | 13,7                  | 0,585              | 15 000             | 24 000                            | 0,18               | 71911 ACD/P4A   | S                              | L                                        |
|                      | 80  | 13 | 18,2               | 13,7                  | 0,585              | 17 000             | 28 000                            | 0,15               | 71911 ACD/HCP4A | S                              | L                                        |
|                      | 80  | 13 | 19,5               | 14,6                  | 0,62               | 16 000             | 26 000                            | 0,18               | 71911 CD/P4A    | S                              | L                                        |
|                      | 80  | 13 | 19,5               | 14,6                  | 0,62               | 19 000             | 30 000                            | 0,15               | 71911 CD/HCP4A  | S                              | L                                        |
|                      | 90  | 18 | 13,3               | 10,4                  | 0,44               | 19 000             | 30 000                            | 0,42               | 7011 ACB/P4A    | S                              | L                                        |
|                      | 90  | 18 | 13,3               | 10,4                  | 0,44               | 24 000             | 36 000                            | 0,4                | 7011 ACB/HCP4A  | S                              | L                                        |
|                      | 90  | 18 | 14                 | 11                    | 0,465              | 22 000             | 32 000                            | 0,42               | 7011 CB/P4A     | S                              | L                                        |
|                      | 90  | 18 | 14                 | 11                    | 0,465              | 26 000             | 40 000                            | 0,4                | 7011 CB/HCP4A   | S                              | L                                        |
|                      | 90  | 18 | 15,9               | 11,6                  | 0,49               | 19 000             | 30 000                            | 0,39               | 7011 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 90  | 18 | 15,9               | 11,6                  | 0,49               | 23 000             | 35 000                            | 0,36               | 7011 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 90  | 18 | 16,8               | 12,2                  | 0,52               | 22 000             | 34 000                            | 0,39               | 7011 CE/P4A     | S                              | H1, L, L1                                |
|                      | 90  | 18 | 16,8               | 12,2                  | 0,52               | 25 000             | 39 000                            | 0,36               | 7011 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 90  | 18 | 37,1               | 31                    | 1,32               | 14 000             | 22 000                            | 0,38               | 7011 ACD/P4A    | S                              | H1, L                                    |
|                      | 90  | 18 | 37,1               | 31                    | 1,32               | 17 000             | 26 000                            | 0,32               | 7011 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 90  | 18 | 39,7               | 32,5                  | 1,37               | 15 000             | 24 000                            | 0,38               | 7011 CD/P4A     | S                              | H1, L                                    |
|                      | 90  | 18 | 39,7               | 32,5                  | 1,37               | 18 000             | 28 000                            | 0,32               | 7011 CD/HCP4A   | S                              | H1, L                                    |
|                      | 100 | 21 | 52,7               | 40,5                  | 1,73               | 13 000             | 20 000                            | 0,61               | 7211 ACD/P4A    | S                              | –                                        |
|                      | 100 | 21 | 52,7               | 40,5                  | 1,73               | 15 000             | 24 000                            | 0,51               | 7211 ACD/HCP4A  | S                              | –                                        |
|                      | 100 | 21 | 55,3               | 43                    | 1,8                | 14 000             | 22 000                            | 0,61               | 7211 CD/P4A     | S                              | –                                        |
|                      | 100 | 21 | 55,3               | 43                    | 1,8                | 17 000             | 26 000                            | 0,51               | 7211 CD/HCP4A   | S                              | –                                        |
| 60                   | 78  | 10 | 12,7               | 13,4                  | 0,57               | 15 000             | 22 000                            | 0,1                | 71812 ACD/P4    | –                              | –                                        |
|                      | 78  | 10 | 12,7               | 13,4                  | 0,57               | 18 000             | 26 000                            | 0,088              | 71812 ACD/HCP4  | –                              | –                                        |
|                      | 78  | 10 | 13,5               | 14,3                  | 0,6                | 16 000             | 24 000                            | 0,1                | 71812 CD/P4     | –                              | –                                        |
|                      | 78  | 10 | 13,5               | 14,3                  | 0,6                | 19 000             | 30 000                            | 0,088              | 71812 CD/HCP4   | –                              | –                                        |
|                      | 85  | 13 | 9,75               | 8,3                   | 0,355              | 19 000             | 30 000                            | 0,2                | 71912 ACB/P4A   | S                              | L                                        |
|                      | 85  | 13 | 9,75               | 8,3                   | 0,355              | 22 000             | 36 000                            | 0,18               | 71912 ACB/HCP4A | S                              | L                                        |
|                      | 85  | 13 | 10,4               | 8,8                   | 0,375              | 22 000             | 32 000                            | 0,2                | 71912 CB/P4A    | S                              | L                                        |
|                      | 85  | 13 | 10,4               | 8,8                   | 0,375              | 26 000             | 40 000                            | 0,18               | 71912 CB/HCP4A  | S                              | L                                        |
|                      |     |    |                    |                       |                    |                    |                                   |                    |                 |                                |                                          |
|                      |     |    |                    |                       |                    |                    |                                   |                    |                 |                                |                                          |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 224).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 224).

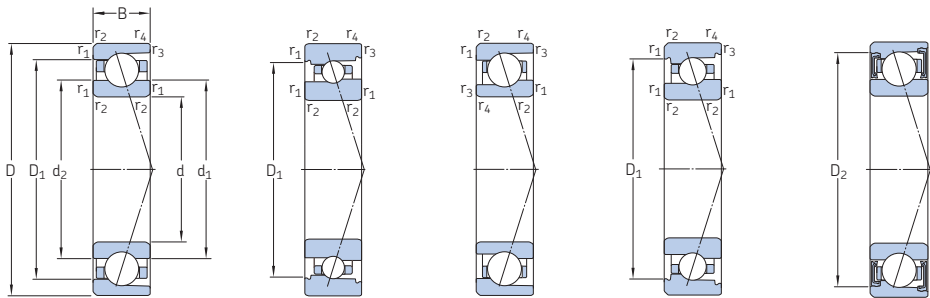


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 55<br>cont. | 62,7           | 62,7           | 72,3           | 74,6           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,7           | 2,5                                     | –                  |                 |   |
|             | 62,7           | 62,7           | 72,3           | 74,6           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,7           | 2,5                                     | –                  |                 |   |
|             | 62,7           | 62,7           | 72,3           | 74,6           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,7           | 2,5                                     | 10,4               |                 |   |
|             | 62,7           | 62,7           | 72,3           | 74,6           | 1                     | 0,3                   | 59,6                           | 59,6                | 75,4                | 78                  | 1                   | 0,3                 | 64,7           | 2,5                                     | 10,4               |                 |   |
|             | 68,2           | 66,7           | 79,4           | 79,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 69,2           | 4,7                                     | –                  |                 |   |
|             | 68,2           | 66,7           | 79,4           | 79,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 69,2           | 4,7                                     | –                  |                 |   |
|             | 68,2           | 66,7           | 79,4           | 79,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 69,2           | 4,7                                     | 9,7                |                 |   |
|             | 68,2           | 66,7           | 79,4           | 79,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 69,2           | 4,7                                     | 9,7                |                 |   |
|             | 67,7           | 65,6           | 80,4           | 80,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 85,8                | 1                   | 0,6                 | 69,6           | 5                                       | –                  |                 |   |
|             | 67,7           | 65,6           | 80,4           | 80,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 85,8                | 1                   | 0,6                 | 69,6           | 5                                       | –                  |                 |   |
|             | 67,7           | 65,6           | 80,4           | 80,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 85,8                | 1                   | 0,6                 | 69,6           | 5                                       | 8,4                |                 |   |
|             | 67,7           | 65,6           | 80,4           | 80,4           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 85,8                | 1                   | 0,6                 | 69,6           | 5                                       | 8,4                |                 |   |
| 60          | 65,8           | 65,8           | 79,2           | 81,8           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 68,1           | 5,1                                     | –                  |                 |   |
|             | 65,8           | 65,8           | 79,2           | 81,8           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 68,1           | 5,1                                     | –                  |                 |   |
|             | 65,8           | 65,8           | 79,2           | 81,8           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 68,1           | 5,1                                     | 15,1               |                 |   |
|             | 65,8           | 65,8           | 79,2           | 81,8           | 1,1                   | 0,6                   | 61                             | 61                  | 84                  | 86,8                | 1                   | 0,6                 | 68,1           | 5,1                                     | 15,1               |                 |   |
|             | 68,9           | 68,9           | 86,1           | 89,1           | 1,5                   | 0,6                   | 64                             | 64                  | 91                  | 95,8                | 1,5                 | 0,6                 | 72,6           | 8,6                                     | –                  |                 |   |
|             | 68,9           | 68,9           | 86,1           | 89,1           | 1,5                   | 0,6                   | 64                             | 64                  | 91                  | 95,8                | 1,5                 | 0,6                 | 72,6           | 8,6                                     | –                  |                 |   |
|             | 68,9           | 68,9           | 86,1           | 89,1           | 1,5                   | 0,6                   | 64                             | 64                  | 91                  | 95,8                | 1,5                 | 0,6                 | 72,6           | 8,6                                     | 14,5               |                 |   |
|             | 68,9           | 68,9           | 86,1           | 89,1           | 1,5                   | 0,6                   | 64                             | 64                  | 91                  | 95,8                | 1,5                 | 0,6                 | 72,6           | 8,6                                     | 14,5               |                 |   |
|             | 65,7           | 65,7           | 72,5           | –              | 0,3                   | 0,15                  | 62                             | 62                  | 76                  | 77,2                | 0,3                 | 0,15                | 66,4           | 1,2                                     | –                  |                 |   |
|             | 65,7           | 65,7           | 72,5           | –              | 0,3                   | 0,15                  | 62                             | 62                  | 76                  | 77,2                | 0,3                 | 0,15                | 66,4           | 1,2                                     | –                  |                 |   |
|             | 65,7           | 65,7           | 72,5           | –              | 0,3                   | 0,15                  | 62                             | 62                  | 76                  | 77,2                | 0,3                 | 0,15                | 66,4           | 1,2                                     | 17                 |                 |   |
|             | 65,7           | 65,7           | 72,5           | –              | 0,3                   | 0,15                  | 62                             | 62                  | 76                  | 77,2                | 0,3                 | 0,15                | 66,4           | 1,2                                     | 17                 |                 |   |
| 60          | 68,9           | 67,7           | 78,4           | 78,4           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,8           | 2,8                                     | –                  |                 |   |
|             | 68,9           | 67,7           | 78,4           | 78,4           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,8           | 2,8                                     | –                  |                 |   |
|             | 68,9           | 67,7           | 78,4           | 78,4           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,8           | 2,8                                     | 9,8                |                 |   |
|             | 68,9           | 67,7           | 78,4           | 78,4           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,8           | 2,8                                     | 9,8                |                 |   |
|             | 68,9           | 67,7           | 78,4           | 78,4           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,8           | 2,8                                     | 9,8                |                 |   |

<sup>1)</sup> For calculating the initial grease fill → page 225

## 2.1 Angular contact ball bearings

d 60 – 65 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

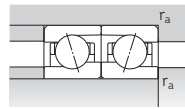
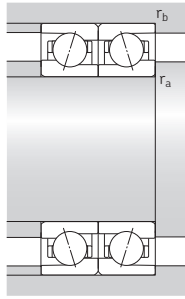
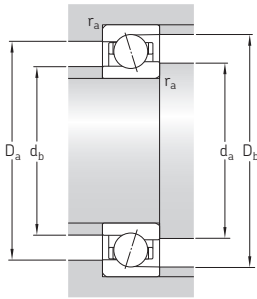
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 60<br>cont.          | 85  | 13 | 15,3               | 11,2                  | 0,475              | 19 500             | 30 000                            | 0,19               | 71912 ACE/P4A   | S                              | H1, L                                    |
|                      | 85  | 13 | 15,3               | 11,2                  | 0,475              | 23 000             | 36 000                            | 0,16               | 71912 ACE/HCP4A | S                              | H1, L                                    |
|                      | 85  | 13 | 16,3               | 11,8                  | 0,5                | 22 000             | 34 000                            | 0,19               | 71912 CE/P4A    | S                              | H1, L                                    |
|                      | 85  | 13 | 16,3               | 11,8                  | 0,5                | 26 000             | 40 000                            | 0,16               | 71912 CE/HCP4A  | S                              | H1, L                                    |
|                      | 85  | 13 | 18,6               | 14,6                  | 0,62               | 14 000             | 22 000                            | 0,19               | 71912 ACD/P4A   | S                              | L                                        |
|                      | 85  | 13 | 18,6               | 14,6                  | 0,62               | 16 000             | 26 000                            | 0,16               | 71912 ACD/HCP4A | S                              | L                                        |
|                      | 85  | 13 | 19,9               | 15,3                  | 0,655              | 15 000             | 24 000                            | 0,19               | 71912 CD/P4A    | S                              | L                                        |
|                      | 85  | 13 | 19,9               | 15,3                  | 0,655              | 18 000             | 28 000                            | 0,16               | 71912 CD/HCP4A  | S                              | L                                        |
|                      | 95  | 18 | 13,5               | 11,4                  | 0,48               | 17 000             | 26 000                            | 0,45               | 7012 ACB/P4A    | S                              | L                                        |
|                      | 95  | 18 | 13,5               | 11,4                  | 0,48               | 22 000             | 32 000                            | 0,43               | 7012 ACB/HCP4A  | S                              | L                                        |
|                      | 95  | 18 | 14,6               | 12                    | 0,51               | 19 000             | 30 000                            | 0,45               | 7012 CB/P4A     | S                              | L                                        |
|                      | 95  | 18 | 14,6               | 12                    | 0,51               | 24 000             | 36 000                            | 0,43               | 7012 CB/HCP4A   | S                              | L                                        |
|                      | 95  | 18 | 16,3               | 12,2                  | 0,52               | 18 000             | 28 000                            | 0,42               | 7012 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 95  | 18 | 16,3               | 12,2                  | 0,52               | 22 000             | 33 000                            | 0,39               | 7012 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 95  | 18 | 17,2               | 12,9                  | 0,54               | 20 000             | 31 000                            | 0,42               | 7012 CE/P4A     | S                              | H1, L, L1                                |
|                      | 95  | 18 | 17,2               | 12,9                  | 0,54               | 24 000             | 37 000                            | 0,39               | 7012 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 95  | 18 | 39                 | 33,5                  | 1,4                | 13 000             | 20 000                            | 0,4                | 7012 ACD/P4A    | S                              | H1, L                                    |
|                      | 95  | 18 | 39                 | 33,5                  | 1,4                | 15 000             | 24 000                            | 0,34               | 7012 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 95  | 18 | 40,3               | 34,5                  | 1,5                | 14 000             | 22 000                            | 0,4                | 7012 CD/P4A     | S                              | H1, L                                    |
|                      | 95  | 18 | 40,3               | 34,5                  | 1,5                | 17 000             | 26 000                            | 0,34               | 7012 CD/HCP4A   | S                              | H1, L                                    |
| 65                   | 110 | 22 | 55,3               | 45                    | 1,9                | 11 000             | 18 000                            | 0,81               | 7212 ACD/P4A    | S                              | –                                        |
|                      | 110 | 22 | 55,3               | 45                    | 1,9                | 14 000             | 22 000                            | 0,69               | 7212 ACD/HCP4A  | S                              | –                                        |
|                      | 110 | 22 | 57,2               | 46,5                  | 2                  | 13 000             | 20 000                            | 0,81               | 7212 CD/P4A     | S                              | –                                        |
|                      | 110 | 22 | 57,2               | 46,5                  | 2                  | 16 000             | 24 000                            | 0,69               | 7212 CD/HCP4A   | S                              | –                                        |
|                      | 85  | 10 | 12,7               | 14                    | 0,585              | 13 000             | 20 000                            | 0,13               | 71813 ACD/P4    | –                              | –                                        |
|                      | 85  | 10 | 12,7               | 14                    | 0,585              | 16 000             | 24 000                            | 0,11               | 71813 ACD/HCP4  | –                              | –                                        |
|                      | 85  | 10 | 13,5               | 14,6                  | 0,63               | 15 000             | 22 000                            | 0,13               | 71813 CD/P4     | –                              | –                                        |
|                      | 85  | 10 | 13,5               | 14,6                  | 0,63               | 18 000             | 28 000                            | 0,11               | 71813 CD/HCP4   | –                              | –                                        |

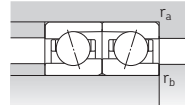
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 226).

<sup>2)</sup> Applicable to open bearings only.

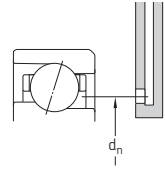
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 226).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

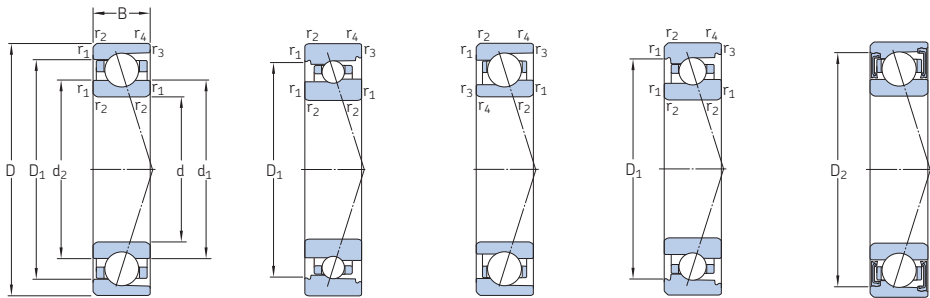


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 60<br>cont. | 67,8           | 65,7           | 77,3           | 79,7           | 1                     | 0,3                   | 64,6                           | 62                  | 80,4                | 83                  | 1                   | 0,3                 | 69,6           | 2,5                                     | –                  |                 |   |
|             | 67,8           | 65,7           | 77,3           | 79,7           | 1                     | 0,3                   | 64,6                           | 62                  | 80,4                | 83                  | 1                   | 0,3                 | 69,6           | 2,5                                     | –                  |                 |   |
|             | 67,8           | 65,7           | 77,3           | 79,7           | 1                     | 0,3                   | 64,6                           | 62                  | 80,4                | 83                  | 1                   | 0,3                 | 69,6           | 2,5                                     | 8,5                |                 |   |
|             | 67,8           | 65,7           | 77,3           | 79,7           | 1                     | 0,3                   | 64,6                           | 62                  | 80,4                | 83                  | 1                   | 0,3                 | 69,6           | 2,5                                     | 8,5                |                 |   |
|             | 67,7           | 67,7           | 77,3           | 79,6           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,7           | 2,7                                     | –                  |                 |   |
|             | 67,7           | 67,7           | 77,3           | 79,6           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,7           | 2,7                                     | –                  |                 |   |
|             | 67,7           | 67,7           | 77,3           | 79,6           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,7           | 2,7                                     | 10,5               |                 |   |
|             | 67,7           | 67,7           | 77,3           | 79,6           | 1                     | 0,3                   | 64,6                           | 64,6                | 80,4                | 83                  | 1                   | 0,3                 | 69,7           | 2,7                                     | 10,5               |                 |   |
|             | 73,2           | 71,7           | 84,4           | 84,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 74,2           | 5                                       | –                  |                 |   |
|             | 73,2           | 71,7           | 84,4           | 84,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 74,2           | 5                                       | –                  |                 |   |
|             | 73,2           | 71,7           | 84,4           | 84,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 74,2           | 5                                       | 9,7                |                 |   |
|             | 73,2           | 71,7           | 84,4           | 84,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 74,2           | 5                                       | 9,7                |                 |   |
|             | 72,7           | 70,6           | 85,4           | 85,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 90,8                | 1                   | 0,6                 | 74,6           | 5,3                                     | –                  |                 |   |
|             | 72,7           | 70,6           | 85,4           | 85,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 90,8                | 1                   | 0,6                 | 74,6           | 5,3                                     | –                  |                 |   |
|             | 72,7           | 70,6           | 85,4           | 85,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 90,8                | 1                   | 0,6                 | 74,6           | 5,3                                     | 8,5                |                 |   |
|             | 72,7           | 70,6           | 85,4           | 85,4           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 90,8                | 1                   | 0,6                 | 74,6           | 5,3                                     | 8,5                |                 |   |
| 65          | 70,8           | 70,8           | 84,2           | 86,7           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 73,1           | 5,4                                     | –                  |                 |   |
|             | 70,8           | 70,8           | 84,2           | 86,7           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 73,1           | 5,4                                     | –                  |                 |   |
|             | 70,8           | 70,8           | 84,2           | 86,7           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 73,1           | 5,4                                     | 15,4               |                 |   |
|             | 70,8           | 70,8           | 84,2           | 86,7           | 1,1                   | 0,6                   | 66                             | 66                  | 89                  | 91,8                | 1                   | 0,6                 | 73,1           | 5,4                                     | 15,4               |                 |   |
|             | 76,4           | 76,4           | 93,6           | 96,8           | 1,5                   | 0,6                   | 69                             | 69                  | 101                 | 105,8               | 1,5                 | 0,6                 | 80,1           | 10                                      | –                  |                 |   |
|             | 76,4           | 76,4           | 93,6           | 96,8           | 1,5                   | 0,6                   | 69                             | 69                  | 101                 | 105,8               | 1,5                 | 0,6                 | 80,1           | 10                                      | –                  |                 |   |
|             | 76,4           | 76,4           | 93,6           | 96,8           | 1,5                   | 0,6                   | 69                             | 69                  | 101                 | 105,8               | 1,5                 | 0,6                 | 80,1           | 10                                      | 14,9               |                 |   |
|             | 76,4           | 76,4           | 93,6           | 96,8           | 1,5                   | 0,6                   | 69                             | 69                  | 101                 | 105,8               | 1,5                 | 0,6                 | 80,1           | 10                                      | 14,9               |                 |   |
|             | 71,7           | 71,7           | 78,5           | –              | 0,6                   | 0,3                   | 68,2                           | 68,2                | 81,8                | 83                  | 0,6                 | 0,3                 | 72,4           | 1,3                                     | –                  |                 |   |
|             | 71,7           | 71,7           | 78,5           | –              | 0,6                   | 0,3                   | 68,2                           | 68,2                | 81,8                | 83                  | 0,6                 | 0,3                 | 72,4           | 1,3                                     | –                  |                 |   |
|             | 71,7           | 71,7           | 78,5           | –              | 0,6                   | 0,3                   | 68,2                           | 68,2                | 81,8                | 83                  | 0,6                 | 0,3                 | 72,4           | 1,3                                     | 17,1               |                 |   |
|             | 71,7           | 71,7           | 78,5           | –              | 0,6                   | 0,3                   | 68,2                           | 68,2                | 81,8                | 83                  | 0,6                 | 0,3                 | 72,4           | 1,3                                     | 17,1               |                 |   |

<sup>1)</sup> For calculating the initial grease fill → page 227

## 2.1 Angular contact ball bearings

d 65 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

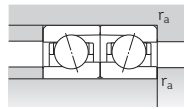
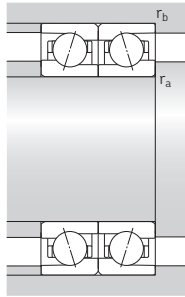
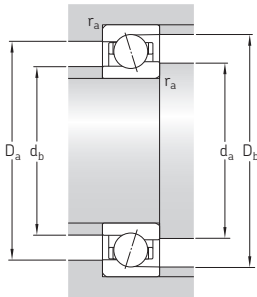
S... 1)

| Principal dimensions |     |    | Basic load ratings |                 | Fatigue load limit<br>$P_u$ | Attainable speeds     |                                      | Mass <sup>2)</sup> | Designation     | Available variants                |                                             |
|----------------------|-----|----|--------------------|-----------------|-----------------------------|-----------------------|--------------------------------------|--------------------|-----------------|-----------------------------------|---------------------------------------------|
| d                    | D   | B  | dynamic<br>C       | static<br>$C_0$ |                             | Grease<br>lubrication | Oil-air<br>lubrication <sup>2)</sup> |                    |                 | Sealing<br>solution <sup>1)</sup> | Direct oil-air<br>lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                 | kN                          | r/min                 |                                      | kg                 | –               | –                                 |                                             |
| 65<br>cont.          | 90  | 13 | 9,95               | 9               | 0,38                        | 18 000                | 28 000                               | 0,21               | 71913 ACB/P4A   | S                                 | L                                           |
|                      | 90  | 13 | 9,95               | 9               | 0,38                        | 22 000                | 34 000                               | 0,19               | 71913 ACB/HCP4A | S                                 | L                                           |
|                      | 90  | 13 | 10,6               | 9,5             | 0,4                         | 20 000                | 30 000                               | 0,21               | 71913 CB/P4A    | S                                 | L                                           |
|                      | 90  | 13 | 10,6               | 9,5             | 0,4                         | 24 000                | 36 000                               | 0,19               | 71913 CB/HCP4A  | S                                 | L                                           |
|                      | 90  | 13 | 15,6               | 11,8            | 0,5                         | 18 000                | 28 000                               | 0,2                | 71913 ACE/P4A   | S                                 | H1, L                                       |
|                      | 90  | 13 | 15,6               | 11,8            | 0,5                         | 22 000                | 34 000                               | 0,17               | 71913 ACE/HCP4A | S                                 | H1, L                                       |
|                      | 90  | 13 | 16,5               | 12,5            | 0,53                        | 20 000                | 31 000                               | 0,2                | 71913 CE/P4A    | S                                 | H1, L                                       |
|                      | 90  | 13 | 16,5               | 12,5            | 0,53                        | 24 000                | 38 000                               | 0,17               | 71913 CE/HCP4A  | S                                 | H1, L                                       |
|                      | 90  | 13 | 19,5               | 16              | 0,68                        | 13 000                | 20 000                               | 0,21               | 71913 ACD/P4A   | S                                 | L                                           |
|                      | 90  | 13 | 19,5               | 16              | 0,68                        | 15 000                | 24 000                               | 0,17               | 71913 ACD/HCP4A | S                                 | L                                           |
|                      | 90  | 13 | 20,8               | 17              | 0,71                        | 14 000                | 22 000                               | 0,21               | 71913 CD/P4A    | S                                 | L                                           |
|                      | 90  | 13 | 20,8               | 17              | 0,71                        | 17 000                | 26 000                               | 0,17               | 71913 CD/HCP4A  | S                                 | L                                           |
|                      | 100 | 18 | 14,6               | 12,2            | 0,52                        | 16 000                | 26 000                               | 0,47               | 7013 ACB/P4A    | S                                 | L                                           |
|                      | 100 | 18 | 14,6               | 12,2            | 0,52                        | 19 000                | 30 000                               | 0,45               | 7013 ACB/HCP4A  | S                                 | L                                           |
|                      | 100 | 18 | 15,6               | 12,9            | 0,55                        | 18 000                | 28 000                               | 0,47               | 7013 CB/P4A     | S                                 | L                                           |
|                      | 100 | 18 | 15,6               | 12,9            | 0,55                        | 22 000                | 34 000                               | 0,45               | 7013 CB/HCP4A   | S                                 | L                                           |
|                      | 100 | 18 | 19,5               | 14,6            | 0,62                        | 17 000                | 26 000                               | 0,43               | 7013 ACE/P4A    | S                                 | H1, L, L1                                   |
|                      | 100 | 18 | 19,5               | 14,6            | 0,62                        | 20 000                | 31 000                               | 0,39               | 7013 ACE/HCP4A  | S                                 | H1, L, L1                                   |
|                      | 100 | 18 | 20,3               | 15,6            | 0,655                       | 19 000                | 30 000                               | 0,43               | 7013 CE/P4A     | S                                 | H1, L, L1                                   |
|                      | 100 | 18 | 20,3               | 15,6            | 0,655                       | 22 000                | 34 000                               | 0,39               | 7013 CE/HCP4A   | S                                 | H1, L, L1                                   |
|                      | 100 | 18 | 39                 | 35,5            | 1,5                         | 12 000                | 19 000                               | 0,43               | 7013 ACD/P4A    | S                                 | H1, L                                       |
|                      | 100 | 18 | 39                 | 35,5            | 1,5                         | 15 000                | 22 000                               | 0,36               | 7013 ACD/HCP4A  | S                                 | H1, L                                       |
|                      | 100 | 18 | 41,6               | 37,5            | 1,6                         | 14 000                | 22 000                               | 0,43               | 7013 CD/P4A     | S                                 | H1, L                                       |
|                      | 100 | 18 | 41,6               | 37,5            | 1,6                         | 16 000                | 24 000                               | 0,36               | 7013 CD/HCP4A   | S                                 | H1, L                                       |
|                      | 120 | 23 | 63,7               | 51              | 2,2                         | 10 000                | 17 000                               | 1,05               | 7213 ACD/P4A    | S                                 | –                                           |
|                      | 120 | 23 | 63,7               | 51              | 2,2                         | 13 000                | 20 000                               | 0,88               | 7213 ACD/HCP4A  | S                                 | –                                           |
|                      | 120 | 23 | 66,3               | 53              | 2,28                        | 12 000                | 19 000                               | 1,05               | 7213 CD/P4A     | S                                 | –                                           |
|                      | 120 | 23 | 66,3               | 53              | 2,28                        | 15 000                | 22 000                               | 0,88               | 7213 CD/HCP4A   | S                                 | –                                           |

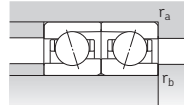
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 228).

<sup>2)</sup> Applicable to open bearings only.

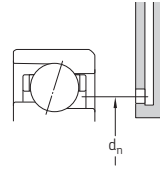
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 228).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

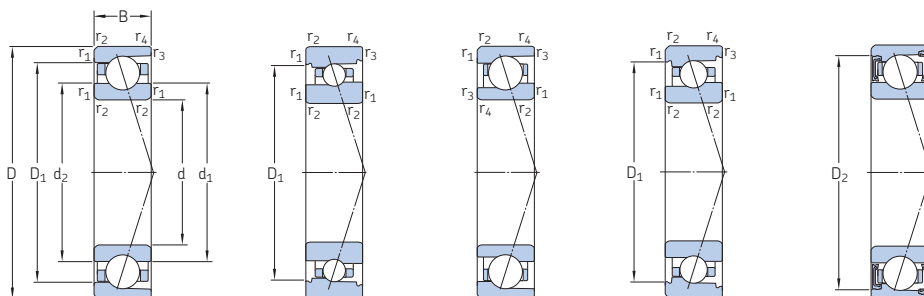


| Dimensions          |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> | Calculation factor<br>f <sub>0</sub> |
|---------------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|-------------------------------------------------------------|--------------------------------------|
| d                   | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     |                                                             |                                      |
| mm                  |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     |                                                             |                                      |
|                     |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     | cm <sup>3</sup>                                             | –                                    |
| 65<br>cont.         | 73,9           | 72,7           | 83,5           | 83,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,8           | 3   | –                                                           | –                                    |
|                     | 73,9           | 72,7           | 83,5           | 83,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,8           | 3   | –                                                           | –                                    |
|                     | 73,9           | 72,7           | 83,5           | 83,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,8           | 3   | 9,9                                                         | 9,9                                  |
|                     | 73,9           | 72,7           | 83,5           | 83,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,8           | 3   | 9,9                                                         | 9,9                                  |
|                     | 72,8           | 70,7           | 82,3           | 84,7           | 1                              | 0,3                      | 69,6                   | 67                     | 85,4                   | 88                     | 1                      | 0,3                    | 74,5           | 2,6 | –                                                           | –                                    |
|                     | 72,8           | 70,7           | 82,3           | 84,7           | 1                              | 0,3                      | 69,6                   | 67                     | 85,4                   | 88                     | 1                      | 0,3                    | 74,5           | 2,6 | –                                                           | –                                    |
|                     | 72,8           | 70,7           | 82,3           | 84,7           | 1                              | 0,3                      | 69,6                   | 67                     | 85,4                   | 88                     | 1                      | 0,3                    | 74,5           | 2,6 | 8,5                                                         | 8,5                                  |
|                     | 72,8           | 70,7           | 82,3           | 84,7           | 1                              | 0,3                      | 69,6                   | 67                     | 85,4                   | 88                     | 1                      | 0,3                    | 74,5           | 2,6 | 8,5                                                         | 8,5                                  |
|                     | 72,7           | 72,7           | 82,3           | 84,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,7           | 2,9 | –                                                           | –                                    |
|                     | 72,7           | 72,7           | 82,3           | 84,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,7           | 2,9 | –                                                           | –                                    |
|                     | 72,7           | 72,7           | 82,3           | 84,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,7           | 2,9 | 10,7                                                        | 10,7                                 |
|                     | 72,7           | 72,7           | 82,3           | 84,5           | 1                              | 0,3                      | 69,6                   | 69,6                   | 85,4                   | 88                     | 1                      | 0,3                    | 74,7           | 2,9 | 10,7                                                        | 10,7                                 |
|                     | 78             | 76,4           | 89,7           | 89,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 79             | 5,5 | –                                                           | –                                    |
|                     | 78             | 76,4           | 89,7           | 89,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 79             | 5,5 | –                                                           | –                                    |
|                     | 78             | 76,4           | 89,7           | 89,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 79             | 5,5 | 9,7                                                         | 9,7                                  |
|                     | 78             | 76,4           | 89,7           | 89,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 79             | 5,5 | 9,7                                                         | 9,7                                  |
| 70 .. ACE, 70 .. CE | 77,3           | 74,9           | 91,1           | 91,1           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 95,8                   | 1                      | 0,6                    | 79,3           | 6,2 | –                                                           | –                                    |
|                     | 77,3           | 74,9           | 91,1           | 91,1           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 95,8                   | 1                      | 0,6                    | 79,3           | 6,2 | –                                                           | –                                    |
|                     | 77,3           | 74,9           | 91,1           | 91,1           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 95,8                   | 1                      | 0,6                    | 79,3           | 6,2 | 8,4                                                         | 8,4                                  |
|                     | 77,3           | 74,9           | 91,1           | 91,1           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 95,8                   | 1                      | 0,6                    | 79,3           | 6,2 | 8,4                                                         | 8,4                                  |
|                     | 75,8           | 75,8           | 89,2           | 91,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 78,1           | 5,7 | –                                                           | –                                    |
|                     | 75,8           | 75,8           | 89,2           | 91,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 78,1           | 5,7 | –                                                           | –                                    |
|                     | 75,8           | 75,8           | 89,2           | 91,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 78,1           | 5,7 | 15,6                                                        | 15,6                                 |
|                     | 75,8           | 75,8           | 89,2           | 91,7           | 1,1                            | 0,6                      | 71                     | 71                     | 94                     | 96,8                   | 1                      | 0,6                    | 78,1           | 5,7 | 15,6                                                        | 15,6                                 |
|                     | 82,9           | 82,9           | 102,1          | 105,3          | 1,5                            | 0,6                      | 74                     | 74                     | 111                    | 115,8                  | 1,5                    | 0,6                    | 86,6           | 12  | –                                                           | –                                    |
|                     | 82,9           | 82,9           | 102,1          | 105,3          | 1,5                            | 0,6                      | 74                     | 74                     | 111                    | 115,8                  | 1,5                    | 0,6                    | 86,6           | 12  | –                                                           | –                                    |
|                     | 82,9           | 82,9           | 102,1          | 105,3          | 1,5                            | 0,6                      | 74                     | 74                     | 111                    | 115,8                  | 1,5                    | 0,6                    | 86,6           | 12  | 14,6                                                        | 14,6                                 |
|                     | 82,9           | 82,9           | 102,1          | 105,3          | 1,5                            | 0,6                      | 74                     | 74                     | 111                    | 115,8                  | 1,5                    | 0,6                    | 86,6           | 12  | 14,6                                                        | 14,6                                 |

<sup>1)</sup> For calculating the initial grease fill → page 229

## 2.1 Angular contact ball bearings

d 70 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

S... 1)

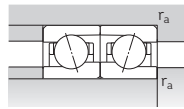
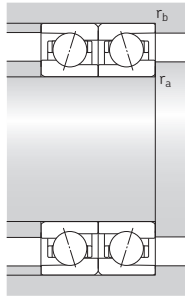
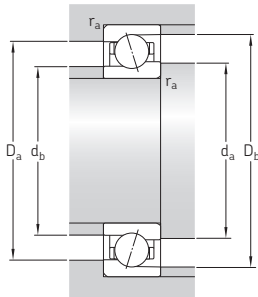
| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 70                   | 90  | 10 | 13                 | 15                    | 0,64               | 13 000             | 19 000                            | 0,13               | 71814 ACD/P4    | –                              | –                                        |
|                      | 90  | 10 | 13                 | 15                    | 0,64               | 15 000             | 24 000                            | 0,12               | 71814 ACD/HCP4  | –                              | –                                        |
|                      | 90  | 10 | 13,8               | 16                    | 0,67               | 14 000             | 22 000                            | 0,13               | 71814 CD/P4     | –                              | –                                        |
|                      | 90  | 10 | 13,8               | 16                    | 0,67               | 17 000             | 26 000                            | 0,12               | 71814 CD/HCP4   | –                              | –                                        |
|                      | 100 | 16 | 12,7               | 11,6                  | 0,49               | 16 000             | 24 000                            | 0,35               | 71914 ACB/P4A   | S                              | L                                        |
|                      | 100 | 16 | 12,7               | 11,6                  | 0,49               | 19 000             | 30 000                            | 0,33               | 71914 ACB/HCP4A | S                              | L                                        |
|                      | 100 | 16 | 13,5               | 12,2                  | 0,52               | 18 000             | 28 000                            | 0,35               | 71914 CB/P4A    | S                              | L                                        |
|                      | 100 | 16 | 13,5               | 12,2                  | 0,52               | 22 000             | 32 000                            | 0,33               | 71914 CB/HCP4A  | S                              | L                                        |
|                      | 100 | 16 | 20,8               | 15,3                  | 0,655              | 16 500             | 26 000                            | 0,32               | 71914 ACE/P4A   | S                              | H1, L                                    |
|                      | 100 | 16 | 20,8               | 15,3                  | 0,655              | 20 000             | 31 000                            | 0,27               | 71914 ACE/HCP4A | S                              | H1, L                                    |
|                      | 100 | 16 | 22,1               | 16,3                  | 0,68               | 18 500             | 28 000                            | 0,32               | 71914 CE/P4A    | S                              | H1, L                                    |
|                      | 100 | 16 | 22,1               | 16,3                  | 0,68               | 22 000             | 34 000                            | 0,27               | 71914 CE/HCP4A  | S                              | H1, L                                    |
|                      | 100 | 16 | 32,5               | 32,5                  | 1,37               | 11 000             | 18 000                            | 0,33               | 71914 ACD/P4A   | S                              | H1, L                                    |
|                      | 100 | 16 | 32,5               | 32,5                  | 1,37               | 14 000             | 22 000                            | 0,28               | 71914 ACD/HCP4A | S                              | H1, L                                    |
|                      | 100 | 16 | 34,5               | 34                    | 1,43               | 13 000             | 20 000                            | 0,33               | 71914 CD/P4A    | S                              | H1, L                                    |
|                      | 100 | 16 | 34,5               | 34                    | 1,43               | 16 000             | 24 000                            | 0,28               | 71914 CD/HCP4A  | S                              | H1, L                                    |
|                      | 110 | 20 | 18,2               | 15,6                  | 0,655              | 15 000             | 24 000                            | 0,66               | 7014 ACB/P4A    | S                              | L                                        |
|                      | 110 | 20 | 18,2               | 15,6                  | 0,655              | 18 000             | 28 000                            | 0,63               | 7014 ACB/HCP4A  | S                              | L                                        |
|                      | 110 | 20 | 19                 | 16,3                  | 0,695              | 17 000             | 26 000                            | 0,66               | 7014 CB/P4A     | S                              | L                                        |
|                      | 110 | 20 | 19                 | 16,3                  | 0,695              | 19 000             | 30 000                            | 0,63               | 7014 CB/HCP4A   | S                              | L                                        |
|                      | 110 | 20 | 22,5               | 17,3                  | 0,735              | 15 500             | 24 000                            | 0,61               | 7014 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 110 | 20 | 22,5               | 17,3                  | 0,735              | 18 500             | 29 000                            | 0,56               | 7014 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 110 | 20 | 23,8               | 18,3                  | 0,78               | 17 000             | 27 000                            | 0,61               | 7014 CE/P4A     | S                              | H1, L, L1                                |
|                      | 110 | 20 | 23,8               | 18,3                  | 0,78               | 20 500             | 32 000                            | 0,56               | 7014 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 110 | 20 | 48,8               | 44                    | 1,86               | 11 000             | 17 000                            | 0,6                | 7014 ACD/P4A    | S                              | H1, L                                    |
|                      | 110 | 20 | 48,8               | 44                    | 1,86               | 13 000             | 20 000                            | 0,5                | 7014 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 110 | 20 | 52                 | 45,5                  | 1,93               | 12 000             | 19 000                            | 0,6                | 7014 CD/P4A     | S                              | H1, L                                    |
|                      | 110 | 20 | 52                 | 45,5                  | 1,93               | 15 000             | 22 000                            | 0,5                | 7014 CD/HCP4A   | S                              | H1, L                                    |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 230).

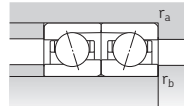
<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 230).

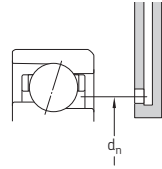




ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

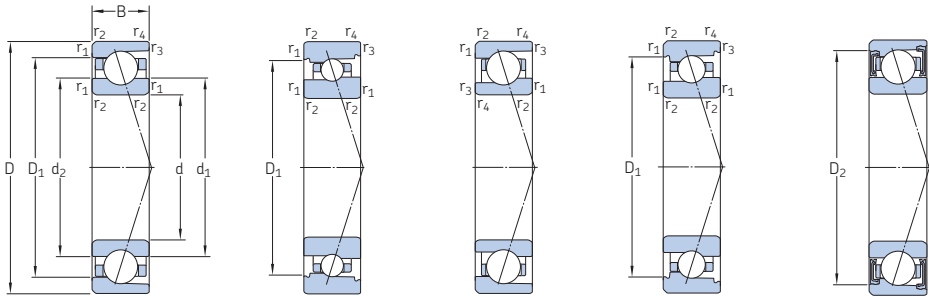


| Dimensions |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|---|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |   |
| mm         |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         | cm <sup>3</sup>    | – |
| 70         | 76,7           | 76,7           | 83,5           | –              | 0,6                   | 0,3                   | 73,2                           | 73,2                | 86,8                | 88                  | 0,6                 | 0,3                 | 77,4           | 1,4                                     | –                  |   |
|            | 76,7           | 76,7           | 83,5           | –              | 0,6                   | 0,3                   | 73,2                           | 73,2                | 86,8                | 88                  | 0,6                 | 0,3                 | 77,4           | 1,4                                     | –                  |   |
|            | 76,7           | 76,7           | 83,5           | –              | 0,6                   | 0,3                   | 73,2                           | 73,2                | 86,8                | 88                  | 0,6                 | 0,3                 | 77,4           | 1,4                                     | 17,2               |   |
|            | 76,7           | 76,7           | 83,5           | –              | 0,6                   | 0,3                   | 73,2                           | 73,2                | 86,8                | 88                  | 0,6                 | 0,3                 | 77,4           | 1,4                                     | 17,2               |   |
|            | 80,9           | 79,6           | 91,7           | 91,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,9           | 4,5                                     | –                  |   |
|            | 80,9           | 79,6           | 91,7           | 91,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,9           | 4,5                                     | –                  |   |
|            | 80,9           | 79,6           | 91,7           | 91,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,9           | 4,5                                     | 9,9                |   |
|            | 80,9           | 79,6           | 91,7           | 91,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,9           | 4,5                                     | 9,9                |   |
|            | 79,3           | 76,8           | 90,5           | 93,6           | 1                     | 0,3                   | 74,6                           | 72                  | 95,4                | 98                  | 1                   | 0,3                 | 81,5           | 4,3                                     | –                  |   |
|            | 79,3           | 76,8           | 90,5           | 93,6           | 1                     | 0,3                   | 74,6                           | 72                  | 95,4                | 98                  | 1                   | 0,3                 | 81,5           | 4,3                                     | –                  |   |
|            | 79,3           | 76,8           | 90,5           | 93,6           | 1                     | 0,3                   | 74,6                           | 72                  | 95,4                | 98                  | 1                   | 0,3                 | 81,5           | 4,3                                     | 8,4                |   |
|            | 79,3           | 76,8           | 90,5           | 93,6           | 1                     | 0,3                   | 74,6                           | 72                  | 95,4                | 98                  | 1                   | 0,3                 | 81,5           | 4,3                                     | 8,4                |   |
|            | 79,2           | 79,2           | 90,8           | 93,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,7           | 4,5                                     | –                  |   |
|            | 79,2           | 79,2           | 90,8           | 93,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,7           | 4,5                                     | –                  |   |
|            | 79,2           | 79,2           | 90,8           | 93,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,7           | 4,5                                     | 16,2               |   |
|            | 79,2           | 79,2           | 90,8           | 93,7           | 1                     | 0,3                   | 74,6                           | 74,6                | 95,4                | 98                  | 1                   | 0,3                 | 81,7           | 4,5                                     | 16,2               |   |
|            | 85             | 83,2           | 97,8           | 97,8           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106,8               | 1                   | 0,6                 | 86,1           | 7,3                                     | –                  |   |
|            | 85             | 83,2           | 97,8           | 97,8           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106,8               | 1                   | 0,6                 | 86,1           | 7,3                                     | –                  |   |
|            | 85             | 83,2           | 97,8           | 97,8           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106,8               | 1                   | 0,6                 | 86,1           | 7,3                                     | 9,6                |   |
|            | 85             | 83,2           | 97,8           | 97,8           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106,8               | 1                   | 0,6                 | 86,1           | 7,3                                     | 9,6                |   |
|            | 84,3           | 81,6           | 98,6           | 98,6           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 105,8               | 1                   | 0,6                 | 86,5           | 8,2                                     | –                  |   |
|            | 84,3           | 81,6           | 98,6           | 98,6           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 105,8               | 1                   | 0,6                 | 86,5           | 8,2                                     | –                  |   |
|            | 84,3           | 81,6           | 98,6           | 98,6           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 105,8               | 1                   | 0,6                 | 86,5           | 8,2                                     | 8,4                |   |
|            | 84,3           | 81,6           | 98,6           | 98,6           | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 105,8               | 1                   | 0,6                 | 86,5           | 8,2                                     | 8,4                |   |
|            | 82,3           | 82,3           | 97,7           | 100,6          | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106                 | 1                   | 0,6                 | 85             | 8,1                                     | –                  |   |
|            | 82,3           | 82,3           | 97,7           | 100,6          | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106                 | 1                   | 0,6                 | 85             | 8,1                                     | –                  |   |
|            | 82,3           | 82,3           | 97,7           | 100,6          | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106                 | 1                   | 0,6                 | 85             | 8,1                                     | 15,5               |   |
|            | 82,3           | 82,3           | 97,7           | 100,6          | 1,1                   | 0,6                   | 76                             | 76                  | 104                 | 106                 | 1                   | 0,6                 | 85             | 8,1                                     | 15,5               |   |

<sup>1)</sup> For calculating the initial grease fill → page 231

## 2.1 Angular contact ball bearings

d 70 – 75 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

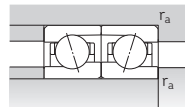
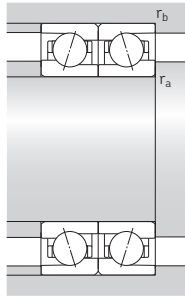
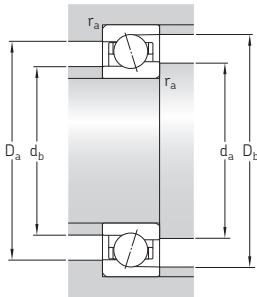
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 70<br>cont.          | 125 | 24 | 66,3               | 55                    | 2,36               | 9 500              | 16 000                            | 1,1                | 7214 ACD/P4A    | S                              | –                                        |
|                      | 125 | 24 | 66,3               | 55                    | 2,36               | 12 000             | 19 000                            | 0,95               | 7214 ACD/HCP4A  | S                              | –                                        |
|                      | 125 | 24 | 68,9               | 58,5                  | 2,45               | 11 000             | 18 000                            | 1,1                | 7214 CD/P4A     | S                              | –                                        |
|                      | 125 | 24 | 68,9               | 58,5                  | 2,45               | 14 000             | 20 000                            | 0,95               | 7214 CD/HCP4A   | S                              | –                                        |
| 75                   | 95  | 10 | 13,3               | 16                    | 0,68               | 12 000             | 18 000                            | 0,14               | 71815 ACD/P4    | –                              | –                                        |
|                      | 95  | 10 | 13,3               | 16                    | 0,68               | 14 000             | 22 000                            | 0,13               | 71815 ACD/HCP4  | –                              | –                                        |
|                      | 95  | 10 | 14,3               | 17                    | 0,72               | 13 000             | 20 000                            | 0,14               | 71815 CD/P4     | –                              | –                                        |
|                      | 95  | 10 | 14,3               | 17                    | 0,72               | 16 000             | 24 000                            | 0,13               | 71815 CD/HCP4   | –                              | –                                        |
|                      | 105 | 16 | 13,3               | 12,5                  | 0,52               | 15 000             | 24 000                            | 0,37               | 71915 ACB/P4A   | S                              | L                                        |
|                      | 105 | 16 | 13,3               | 12,5                  | 0,52               | 18 000             | 28 000                            | 0,34               | 71915 ACB/HCP4A | S                              | L                                        |
|                      | 105 | 16 | 14                 | 13,2                  | 0,56               | 17 000             | 26 000                            | 0,37               | 71915 CB/P4A    | S                              | L                                        |
|                      | 105 | 16 | 14                 | 13,2                  | 0,56               | 20 000             | 30 000                            | 0,34               | 71915 CB/HCP4A  | S                              | L                                        |
|                      | 105 | 16 | 21,2               | 16,3                  | 0,68               | 15 500             | 24 000                            | 0,34               | 71915 ACE/P4A   | S                              | H1, L                                    |
|                      | 105 | 16 | 21,2               | 16,3                  | 0,68               | 18 500             | 29 000                            | 0,29               | 71915 ACE/HCP4A | S                              | H1, L                                    |
|                      | 105 | 16 | 22,5               | 17                    | 0,72               | 17 500             | 27 000                            | 0,34               | 71915 CE/P4A    | S                              | H1, L                                    |
|                      | 105 | 16 | 22,5               | 17                    | 0,72               | 20 500             | 32 000                            | 0,29               | 71915 CE/HCP4A  | S                              | H1, L                                    |
|                      | 105 | 16 | 33,8               | 35,5                  | 1,5                | 10 000             | 17 000                            | 0,35               | 71915 ACD/P4A   | S                              | H1, L                                    |
|                      | 105 | 16 | 33,8               | 35,5                  | 1,5                | 13 000             | 20 000                            | 0,3                | 71915 ACD/HCP4A | S                              | H1, L                                    |
|                      | 105 | 16 | 35,8               | 37,5                  | 1,56               | 12 000             | 19 000                            | 0,35               | 71915 CD/P4A    | S                              | H1, L                                    |
|                      | 105 | 16 | 35,8               | 37,5                  | 1,56               | 15 000             | 22 000                            | 0,3                | 71915 CD/HCP4A  | S                              | H1, L                                    |
|                      | 115 | 20 | 19                 | 16,6                  | 0,71               | 14 000             | 22 000                            | 0,7                | 7015 ACB/P4A    | S                              | L                                        |
|                      | 115 | 20 | 19                 | 16,6                  | 0,71               | 17 000             | 26 000                            | 0,66               | 7015 ACB/HCP4A  | S                              | L                                        |
|                      | 115 | 20 | 19,9               | 17,6                  | 0,75               | 16 000             | 24 000                            | 0,7                | 7015 CB/P4A     | S                              | L                                        |
|                      | 115 | 20 | 19,9               | 17,6                  | 0,75               | 18 000             | 28 000                            | 0,66               | 7015 CB/HCP4A   | S                              | L                                        |
|                      | 115 | 20 | 24,7               | 20,4                  | 0,865              | 14 500             | 23 000                            | 0,65               | 7015 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 115 | 20 | 24,7               | 20,4                  | 0,865              | 17 000             | 27 000                            | 0,59               | 7015 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 115 | 20 | 26                 | 21,6                  | 0,915              | 16 000             | 26 000                            | 0,65               | 7015 CE/P4A     | S                              | H1, L, L1                                |
|                      | 115 | 20 | 26                 | 21,6                  | 0,915              | 19 000             | 29 000                            | 0,59               | 7015 CE/HCP4A   | S                              | H1, L, L1                                |

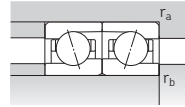
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 232).

<sup>2)</sup> Applicable to open bearings only.

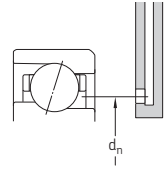
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 232).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

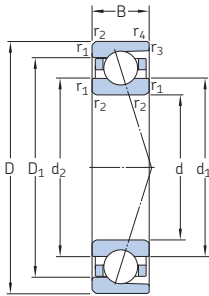


| Dimensions         |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> | Calculation factor<br>f <sub>0</sub> |
|--------------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|-------------------------------------------------------------|--------------------------------------|
| d                  | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     |                                                             |                                      |
| mm                 |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     |                                                             |                                      |
|                    |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     | cm <sup>3</sup>                                             | –                                    |
| <b>70</b><br>cont. | 87,9           | 87,9           | 107,1          | 110,3          | 1,5                            | 0,6                      | 79                     | 79                     | 116                    | 120,8                  | 1,5                    | 0,6                    | 91,6           | 14  | –                                                           |                                      |
|                    | 87,9           | 87,9           | 107,1          | 110,3          | 1,5                            | 0,6                      | 79                     | 79                     | 116                    | 120,8                  | 1,5                    | 0,6                    | 91,6           | 14  | –                                                           |                                      |
|                    | 87,9           | 87,9           | 107,1          | 110,3          | 1,5                            | 0,6                      | 79                     | 79                     | 116                    | 120,8                  | 1,5                    | 0,6                    | 91,6           | 14  | 14,8                                                        |                                      |
|                    | 87,9           | 87,9           | 107,1          | 110,3          | 1,5                            | 0,6                      | 79                     | 79                     | 116                    | 120,8                  | 1,5                    | 0,6                    | 91,6           | 14  | 14,8                                                        |                                      |
| <b>75</b>          | 81,7           | 81,7           | 88,5           | –              | 0,6                            | 0,3                      | 78,2                   | 78,2                   | 91,8                   | 93                     | 0,6                    | 0,3                    | 82,4           | 1,5 | –                                                           |                                      |
|                    | 81,7           | 81,7           | 88,5           | –              | 0,6                            | 0,3                      | 78,2                   | 78,2                   | 91,8                   | 93                     | 0,6                    | 0,3                    | 82,4           | 1,5 | –                                                           |                                      |
|                    | 81,7           | 81,7           | 88,5           | –              | 0,6                            | 0,3                      | 78,2                   | 78,2                   | 91,8                   | 93                     | 0,6                    | 0,3                    | 82,4           | 1,5 | 17,3                                                        |                                      |
|                    | 81,7           | 81,7           | 88,5           | –              | 0,6                            | 0,3                      | 78,2                   | 78,2                   | 91,8                   | 93                     | 0,6                    | 0,3                    | 82,4           | 1,5 | 17,3                                                        |                                      |
|                    | 85,9           | 84,6           | 97,5           | 97,5           | 1                              | 0,6                      | 79,6                   | 79,6                   | 100                    | 101,8                  | 1                      | 0,6                    | 86,9           | 4,8 | –                                                           |                                      |
|                    | 85,9           | 84,6           | 97,5           | 97,5           | 1                              | 0,6                      | 79,6                   | 79,6                   | 100                    | 101,8                  | 1                      | 0,6                    | 86,9           | 4,8 | –                                                           |                                      |
|                    | 85,9           | 84,6           | 97,5           | 97,5           | 1                              | 0,6                      | 79,6                   | 79,6                   | 100                    | 101,8                  | 1                      | 0,6                    | 86,9           | 4,8 | 9,9                                                         |                                      |
|                    | 85,9           | 84,6           | 97,5           | 97,5           | 1                              | 0,6                      | 79,6                   | 79,6                   | 100                    | 101,8                  | 1                      | 0,6                    | 86,9           | 4,8 | 9,9                                                         |                                      |
|                    | 84,3           | 81,8           | 95,5           | 98,6           | 1                              | 0,3                      | 79,6                   | 77                     | 100,4                  | 103                    | 1                      | 0,3                    | 86,5           | 4,5 | –                                                           |                                      |
|                    | 84,3           | 81,8           | 95,5           | 98,6           | 1                              | 0,3                      | 79,6                   | 77                     | 100,4                  | 103                    | 1                      | 0,3                    | 86,5           | 4,5 | –                                                           |                                      |
|                    | 84,3           | 81,8           | 95,5           | 98,6           | 1                              | 0,3                      | 79,6                   | 77                     | 100,4                  | 103                    | 1                      | 0,3                    | 86,5           | 4,5 | 8,5                                                         |                                      |
|                    | 84,3           | 81,8           | 95,5           | 98,6           | 1                              | 0,3                      | 79,6                   | 77                     | 100,4                  | 103                    | 1                      | 0,3                    | 86,5           | 4,5 | 8,5                                                         |                                      |
|                    | 84,2           | 84,2           | 95,8           | 98,7           | 1                              | 0,3                      | 79,6                   | 79,6                   | 100                    | 103                    | 1                      | 0,3                    | 86,7           | 5,1 | –                                                           |                                      |
|                    | 84,2           | 84,2           | 95,8           | 98,7           | 1                              | 0,3                      | 79,6                   | 79,6                   | 100                    | 103                    | 1                      | 0,3                    | 86,7           | 5,1 | –                                                           |                                      |
|                    | 84,2           | 84,2           | 95,8           | 98,7           | 1                              | 0,3                      | 79,6                   | 79,6                   | 100                    | 103                    | 1                      | 0,3                    | 86,7           | 5,1 | 16,3                                                        |                                      |
|                    | 84,2           | 84,2           | 95,8           | 98,7           | 1                              | 0,3                      | 79,6                   | 79,6                   | 100                    | 103                    | 1                      | 0,3                    | 86,7           | 5,1 | 16,3                                                        |                                      |
| 90                 | 88,2           | 102,8          | 102,8          | 102,8          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111,8                  | 1                      | 0,6                    | 91,1           | 7,7 | –                                                           |                                      |
|                    | 90             | 88,2           | 102,8          | 102,8          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111,8                  | 1                      | 0,6                    | 91,1           | 7,7 | –                                                           |                                      |
|                    | 90             | 88,2           | 102,8          | 102,8          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111,8                  | 1                      | 0,6                    | 91,1           | 7,7 | 9,7                                                         |                                      |
|                    | 90             | 88,2           | 102,8          | 102,8          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111,8                  | 1                      | 0,6                    | 91,1           | 7,7 | 9,7                                                         |                                      |
| 89,3               | 86,8           | 104,1          | 104,1          | 104,1          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 110,8                  | 1                      | 0,6                    | 91,5           | 8,6 | –                                                           |                                      |
|                    | 89,3           | 86,8           | 104,1          | 104,1          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 110,8                  | 1                      | 0,6                    | 91,5           | 8,6 | –                                                           |                                      |
|                    | 89,3           | 86,8           | 104,1          | 104,1          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 110,8                  | 1                      | 0,6                    | 91,5           | 8,6 | 9,5                                                         |                                      |
|                    | 89,3           | 86,8           | 104,1          | 104,1          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 110,8                  | 1                      | 0,6                    | 91,5           | 8,6 | 9,5                                                         |                                      |

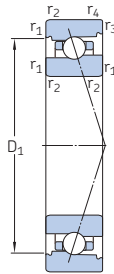
<sup>1)</sup> For calculating the initial grease fill → page 233

## 2.1 Angular contact ball bearings

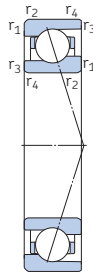
d 75 – 80 mm



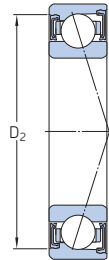
ACD, CD



ACB, CB



719 .. ACE,  
719 .. CE



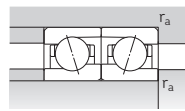
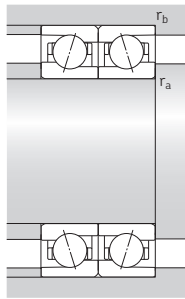
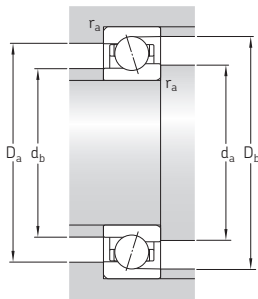
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 75<br>cont.          | 115 | 20 | 49,4               | 46,5                  | 1,96               | 10 000             | 16 000                            | 0,63               | 7015 ACD/P4A    | S                              | H1, L                                    |
|                      | 115 | 20 | 49,4               | 46,5                  | 1,96               | 13 000             | 20 000                            | 0,53               | 7015 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 115 | 20 | 52,7               | 49                    | 2,08               | 11 000             | 18 000                            | 0,63               | 7015 CD/P4A     | S                              | H1, L                                    |
|                      | 115 | 20 | 52,7               | 49                    | 2,08               | 14 000             | 22 000                            | 0,53               | 7015 CD/HCP4A   | S                              | H1, L                                    |
|                      | 130 | 25 | 68,9               | 58,5                  | 2,5                | 9 000              | 15 000                            | 1,2                | 7215 ACD/P4A    | S                              | –                                        |
|                      | 130 | 25 | 68,9               | 58,5                  | 2,5                | 11 000             | 18 000                            | 1,05               | 7215 ACD/HCP4A  | S                              | –                                        |
|                      | 130 | 25 | 71,5               | 62                    | 2,65               | 10 000             | 17 000                            | 1,2                | 7215 CD/P4A     | S                              | –                                        |
|                      | 130 | 25 | 71,5               | 62                    | 2,65               | 14 000             | 20 000                            | 1,05               | 7215 CD/HCP4A   | S                              | –                                        |
|                      | 100 | 10 | 13,8               | 17                    | 0,72               | 11 000             | 17 000                            | 0,15               | 71816 ACD/P4    | –                              | –                                        |
|                      | 100 | 10 | 13,8               | 17                    | 0,72               | 13 000             | 20 000                            | 0,14               | 71816 ACD/HCP4  | –                              | –                                        |
| 80                   | 100 | 10 | 14,6               | 18,3                  | 0,765              | 12 000             | 19 000                            | 0,15               | 71816 CD/P4     | –                              | –                                        |
|                      | 100 | 10 | 14,6               | 18,3                  | 0,765              | 15 000             | 22 000                            | 0,14               | 71816 CD/HCP4   | –                              | –                                        |
|                      | 110 | 16 | 14,8               | 14                    | 0,585              | 14 000             | 22 000                            | 0,38               | 71916 ACB/P4A   | S                              | L                                        |
|                      | 110 | 16 | 14,8               | 14                    | 0,585              | 17 000             | 26 000                            | 0,35               | 71916 ACB/HCP4A | S                              | L                                        |
|                      | 110 | 16 | 15,6               | 14,6                  | 0,63               | 16 000             | 24 000                            | 0,38               | 71916 CB/P4A    | S                              | L                                        |
|                      | 110 | 16 | 15,6               | 14,6                  | 0,63               | 19 000             | 30 000                            | 0,35               | 71916 CB/HCP4A  | S                              | L                                        |
|                      | 110 | 16 | 21,2               | 17                    | 0,71               | 14 500             | 22 000                            | 0,36               | 71916 ACE/P4A   | S                              | H1, L                                    |
|                      | 110 | 16 | 21,2               | 17                    | 0,71               | 17 500             | 27 000                            | 0,31               | 71916 ACE/HCP4A | S                              | H1, L                                    |
|                      | 110 | 16 | 22,5               | 18                    | 0,75               | 16 500             | 25 000                            | 0,36               | 71916 CE/P4A    | S                              | H1, L                                    |
|                      | 110 | 16 | 22,5               | 18                    | 0,75               | 19 000             | 30 000                            | 0,31               | 71916 CE/HCP4A  | S                              | H1, L                                    |
|                      | 110 | 16 | 34,5               | 36,5                  | 1,56               | 9 500              | 16 000                            | 0,37               | 71916 ACD/P4A   | S                              | H1, L                                    |
|                      | 110 | 16 | 34,5               | 36,5                  | 1,56               | 12 000             | 19 000                            | 0,32               | 71916 ACD/HCP4A | S                              | H1, L                                    |
|                      | 110 | 16 | 36,4               | 39                    | 1,66               | 11 000             | 18 000                            | 0,37               | 71916 CD/P4A    | S                              | H1, L                                    |
|                      | 110 | 16 | 36,4               | 39                    | 1,66               | 15 000             | 22 000                            | 0,32               | 71916 CD/HCP4A  | S                              | H1, L                                    |
|                      | 125 | 22 | 25,1               | 21,6                  | 0,9                | 12 000             | 19 000                            | 0,92               | 7016 ACB/P4A    | S                              | L                                        |
|                      | 125 | 22 | 25,1               | 21,6                  | 0,9                | 15 000             | 22 000                            | 0,86               | 7016 ACB/HCP4A  | S                              | L                                        |
|                      | 125 | 22 | 26,5               | 22,8                  | 0,95               | 14 000             | 20 000                            | 0,92               | 7016 CB/P4A     | S                              | L                                        |
|                      | 125 | 22 | 26,5               | 22,8                  | 0,95               | 17 000             | 26 000                            | 0,86               | 7016 CB/HCP4A   | S                              | L                                        |

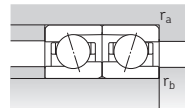
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 234).

<sup>2)</sup> Applicable to open bearings only.

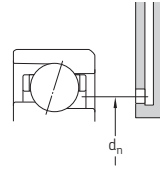
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 234).



ACD, CD, ACB, CB



719 .. ACE, 719 .. CE

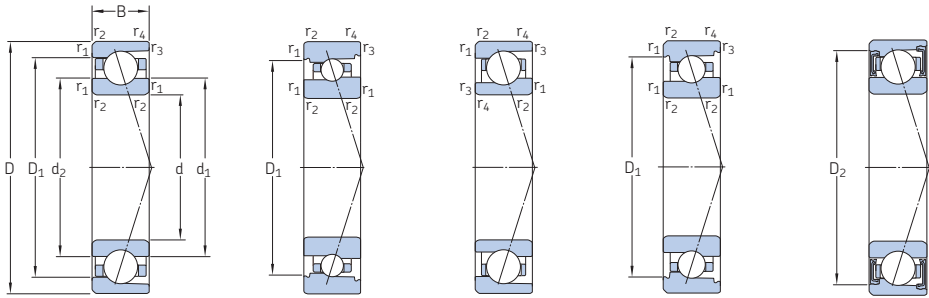


| Dimensions  |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|-------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|------------------------------------------------------|-----------------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     |                                                      |                             |
| mm          |                |                |                |                |                                |                          | mm                     |                        |                        |                        |                        |                        |                |     | cm <sup>3</sup>                                      | –                           |
| 75<br>cont. | 87,3           | 87,3           | 102,7          | 105,6          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111                    | 1                      | 0,6                    | 90             | 8,4 | –                                                    |                             |
|             | 87,3           | 87,3           | 102,7          | 105,6          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111                    | 1                      | 0,6                    | 90             | 8,4 | –                                                    |                             |
|             | 87,3           | 87,3           | 102,7          | 105,6          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111                    | 1                      | 0,6                    | 90             | 8,4 | 15,7                                                 |                             |
|             | 87,3           | 87,3           | 102,7          | 105,6          | 1,1                            | 0,6                      | 81                     | 81                     | 109                    | 111                    | 1                      | 0,6                    | 90             | 8,4 | 15,7                                                 |                             |
|             | 92,9           | 92,9           | 112,1          | 115,3          | 1,5                            | 0,6                      | 84                     | 84                     | 121                    | 125,8                  | 1,5                    | 0,6                    | 96,6           | 15  | –                                                    |                             |
|             | 92,9           | 92,9           | 112,1          | 115,3          | 1,5                            | 0,6                      | 84                     | 84                     | 121                    | 125,8                  | 1,5                    | 0,6                    | 96,6           | 15  | –                                                    |                             |
|             | 92,9           | 92,9           | 112,1          | 115,3          | 1,5                            | 0,6                      | 84                     | 84                     | 121                    | 125,8                  | 1,5                    | 0,6                    | 96,6           | 15  | 15                                                   |                             |
|             | 92,9           | 92,9           | 112,1          | 115,3          | 1,5                            | 0,6                      | 84                     | 84                     | 121                    | 125,8                  | 1,5                    | 0,6                    | 96,6           | 15  | 15                                                   |                             |
|             | 86,7           | 86,7           | 93,5           | –              | 0,6                            | 0,3                      | 83,2                   | 83,2                   | 96,8                   | 98                     | 0,6                    | 0,3                    | 87,4           | 1,6 | –                                                    |                             |
|             | 86,7           | 86,7           | 93,5           | –              | 0,6                            | 0,3                      | 83,2                   | 83,2                   | 96,8                   | 98                     | 0,6                    | 0,3                    | 87,4           | 1,6 | –                                                    |                             |
|             | 86,7           | 86,7           | 93,5           | –              | 0,6                            | 0,3                      | 83,2                   | 83,2                   | 96,8                   | 98                     | 0,6                    | 0,3                    | 87,4           | 1,6 | 17,4                                                 |                             |
| 80          | 86,7           | 86,7           | 93,5           | –              | 0,6                            | 0,3                      | 83,2                   | 83,2                   | 96,8                   | 98                     | 0,6                    | 0,3                    | 87,4           | 1,6 | 17,4                                                 |                             |
|             | 90,7           | 89,2           | 102,2          | 102,2          | 1                              | 0,6                      | 84,6                   | 84,6                   | 105                    | 106,8                  | 1                      | 0,6                    | 91,7           | 5,3 | –                                                    |                             |
|             | 90,7           | 89,2           | 102,2          | 102,2          | 1                              | 0,6                      | 84,6                   | 84,6                   | 105                    | 106,8                  | 1                      | 0,6                    | 91,7           | 5,3 | –                                                    |                             |
|             | 90,7           | 89,2           | 102,2          | 102,2          | 1                              | 0,6                      | 84,6                   | 84,6                   | 105                    | 106,8                  | 1                      | 0,6                    | 91,7           | 5,3 | 9,9                                                  |                             |
|             | 90,7           | 89,2           | 102,2          | 102,2          | 1                              | 0,6                      | 84,6                   | 84,6                   | 105                    | 106,8                  | 1                      | 0,6                    | 91,7           | 5,3 | 9,9                                                  |                             |
|             | 89,3           | 86,8           | 100,5          | 103,6          | 1                              | 0,3                      | 84,6                   | 82                     | 105,4                  | 108                    | 1                      | 0,3                    | 91,5           | 4,8 | –                                                    |                             |
|             | 89,3           | 86,8           | 100,5          | 103,6          | 1                              | 0,3                      | 84,6                   | 82                     | 105,4                  | 108                    | 1                      | 0,3                    | 91,5           | 4,8 | –                                                    |                             |
|             | 89,3           | 86,8           | 100,5          | 103,6          | 1                              | 0,3                      | 84,6                   | 82                     | 105,4                  | 108                    | 1                      | 0,3                    | 91,5           | 4,8 | 8,6                                                  |                             |
|             | 89,3           | 86,8           | 100,5          | 103,6          | 1                              | 0,3                      | 84,6                   | 82                     | 105,4                  | 108                    | 1                      | 0,3                    | 91,5           | 4,8 | 8,6                                                  |                             |
|             | 89,2           | 89,2           | 100,8          | 103,7          | 1                              | 0,3                      | 84,6                   | 84,6                   | 105                    | 108                    | 1                      | 0,3                    | 91,7           | 5,1 | –                                                    |                             |
|             | 89,2           | 89,2           | 100,8          | 103,7          | 1                              | 0,3                      | 84,6                   | 84,6                   | 105                    | 108                    | 1                      | 0,3                    | 91,7           | 5,1 | –                                                    |                             |
|             | 89,2           | 89,2           | 100,8          | 103,7          | 1                              | 0,3                      | 84,6                   | 84,6                   | 105                    | 108                    | 1                      | 0,3                    | 91,7           | 5,1 | 16,5                                                 |                             |
|             | 89,2           | 89,2           | 100,8          | 103,7          | 1                              | 0,3                      | 84,6                   | 84,6                   | 105                    | 108                    | 1                      | 0,3                    | 91,7           | 5,1 | 16,5                                                 |                             |
|             | 96,7           | 94,3           | 111,4          | 111,4          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121,8                  | 1                      | 0,6                    | 98             | 10  | –                                                    |                             |
|             | 96,7           | 94,3           | 111,4          | 111,4          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121,8                  | 1                      | 0,6                    | 98             | 10  | –                                                    |                             |
|             | 96,7           | 94,3           | 111,4          | 111,4          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121,8                  | 1                      | 0,6                    | 98             | 10  | 9,6                                                  |                             |
|             | 96,7           | 94,3           | 111,4          | 111,4          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121,8                  | 1                      | 0,6                    | 98             | 10  | 9,6                                                  |                             |

<sup>1)</sup> For calculating the initial grease fill → page 235

## 2.1 Angular contact ball bearings

d 80 – 85 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

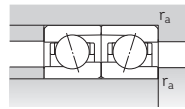
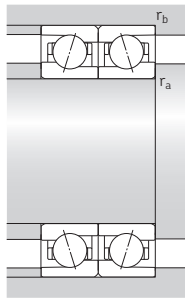
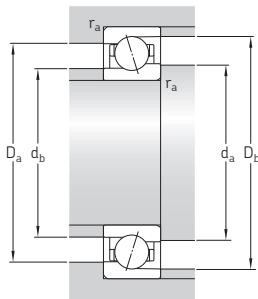
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 80<br>cont.          | 125 | 22 | 32,5               | 26,5                  | 1,12               | 13 700             | 21 000                            | 0,86               | 7016 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 125 | 22 | 32,5               | 26,5                  | 1,12               | 15 500             | 24 000                            | 0,77               | 7016 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 125 | 22 | 33,8               | 28                    | 1,18               | 15 000             | 24 000                            | 0,86               | 7016 CE/P4A     | S                              | H1, L, L1                                |
|                      | 125 | 22 | 33,8               | 28                    | 1,18               | 17 500             | 27 000                            | 0,77               | 7016 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 125 | 22 | 62,4               | 58,5                  | 2,45               | 9 500              | 15 000                            | 0,85               | 7016 ACD/P4A    | S                              | H1, L                                    |
|                      | 125 | 22 | 62,4               | 58,5                  | 2,45               | 12 000             | 18 000                            | 0,71               | 7016 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 125 | 22 | 65                 | 61                    | 2,55               | 10 000             | 17 000                            | 0,85               | 7016 CD/P4A     | S                              | H1, L                                    |
|                      | 125 | 22 | 65                 | 61                    | 2,55               | 13 000             | 20 000                            | 0,71               | 7016 CD/HCP4A   | S                              | H1, L                                    |
|                      | 140 | 26 | 81,9               | 72                    | 2,9                | 8 500              | 14 000                            | 1,45               | 7216 ACD/P4A    | S                              | –                                        |
|                      | 140 | 26 | 81,9               | 72                    | 2,9                | 10 000             | 17 000                            | 1,25               | 7216 ACD/HCP4A  | S                              | –                                        |
|                      | 140 | 26 | 85,2               | 75                    | 3,05               | 9 500              | 16 000                            | 1,45               | 7216 CD/P4A     | S                              | –                                        |
|                      | 140 | 26 | 85,2               | 75                    | 3,05               | 12 000             | 18 000                            | 1,25               | 7216 CD/HCP4A   | S                              | –                                        |
| 85                   | 110 | 13 | 20,3               | 24                    | 1,02               | 10 000             | 16 000                            | 0,27               | 71817 ACD/P4    | –                              | –                                        |
|                      | 110 | 13 | 20,3               | 24                    | 1,02               | 12 000             | 19 000                            | 0,24               | 71817 ACD/HCP4  | –                              | –                                        |
|                      | 110 | 13 | 21,6               | 25,5                  | 1,08               | 11 000             | 17 000                            | 0,27               | 71817 CD/P4     | –                              | –                                        |
|                      | 110 | 13 | 21,6               | 25,5                  | 1,08               | 14 000             | 20 000                            | 0,24               | 71817 CD/HCP4   | –                              | –                                        |
|                      | 120 | 18 | 15,3               | 15,3                  | 0,64               | 13 000             | 20 000                            | 0,57               | 71917 ACB/P4A   | S                              | L                                        |
|                      | 120 | 18 | 15,3               | 15,3                  | 0,64               | 16 000             | 24 000                            | 0,54               | 71917 ACB/HCP4A | S                              | L                                        |
|                      | 120 | 18 | 16,3               | 16,3                  | 0,68               | 15 000             | 22 000                            | 0,57               | 71917 CB/P4A    | S                              | L                                        |
|                      | 120 | 18 | 16,3               | 16,3                  | 0,68               | 18 000             | 28 000                            | 0,54               | 71917 CB/HCP4A  | S                              | L                                        |
|                      | 120 | 18 | 28,1               | 22                    | 0,9                | 13 700             | 21 000                            | 0,5                | 71917 ACE/P4A   | S                              | H1, L                                    |
|                      | 120 | 18 | 28,1               | 22                    | 0,9                | 16 500             | 25 000                            | 0,42               | 71917 ACE/HCP4A | S                              | H1, L                                    |
|                      | 120 | 18 | 29,6               | 23,2                  | 0,95               | 15 500             | 24 000                            | 0,5                | 71917 CE/P4A    | S                              | H1, L                                    |
|                      | 120 | 18 | 29,6               | 23,2                  | 0,95               | 18 000             | 28 000                            | 0,42               | 71917 CE/HCP4A  | S                              | H1, L                                    |
|                      | 120 | 18 | 43,6               | 45,5                  | 1,93               | 9 000              | 15 000                            | 0,53               | 71917 ACD/P4A   | S                              | H1, L                                    |
|                      | 120 | 18 | 43,6               | 45,5                  | 1,93               | 11 000             | 18 000                            | 0,45               | 71917 ACD/HCP4A | S                              | H1, L                                    |
|                      | 120 | 18 | 46,2               | 48                    | 2,04               | 10 000             | 17 000                            | 0,53               | 71917 CD/P4A    | S                              | H1, L                                    |
|                      | 120 | 18 | 46,2               | 48                    | 2,04               | 14 000             | 20 000                            | 0,45               | 71917 CD/HCP4A  | S                              | H1, L                                    |

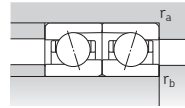
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 236).

<sup>2)</sup> Applicable to open bearings only.

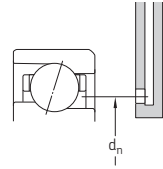
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 236).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

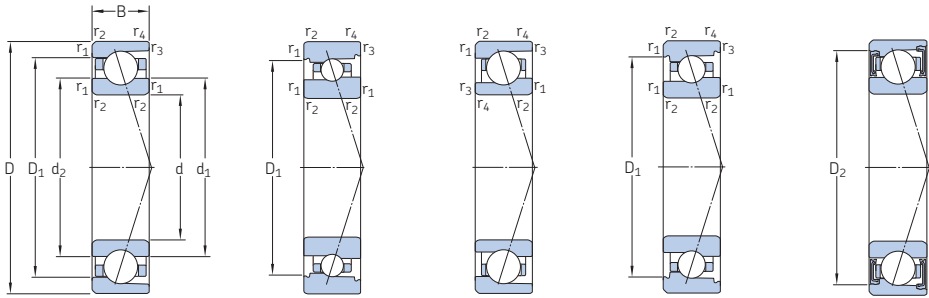


| Dimensions  |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> | Calculation factor<br>f <sub>0</sub> |
|-------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|-------------------------------------------------------------|--------------------------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     | cm <sup>3</sup>                                             | –                                    |
| mm          |                |                |                |                |                                |                          | mm                     |                        |                        |                        |                        |                        |                |     |                                                             |                                      |
| 80<br>cont. | 95,8           | 93             | 112,6          | 112,6          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 120,8                  | 1                      | 0,6                    | 98,5           | 12  | –                                                           |                                      |
|             | 95,8           | 93             | 112,6          | 112,6          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 120,8                  | 1                      | 0,6                    | 98,5           | 12  | –                                                           |                                      |
|             | 95,8           | 93             | 112,6          | 112,6          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 120,8                  | 1                      | 0,6                    | 98,5           | 12  | 9,4                                                         |                                      |
|             | 95,8           | 93             | 112,6          | 112,6          | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 120,8                  | 1                      | 0,6                    | 98,5           | 12  | 9,4                                                         |                                      |
|             | 93,9           | 93,9           | 111,1          | 114            | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121                    | 1                      | 0,6                    | 96,9           | 11  | –                                                           |                                      |
|             | 93,9           | 93,9           | 111,1          | 114            | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121                    | 1                      | 0,6                    | 96,9           | 11  | –                                                           |                                      |
|             | 93,9           | 93,9           | 111,1          | 114            | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121                    | 1                      | 0,6                    | 96,9           | 11  | 15,5                                                        |                                      |
|             | 93,9           | 93,9           | 111,1          | 114            | 1,1                            | 0,6                      | 86                     | 86                     | 119                    | 121                    | 1                      | 0,6                    | 96,9           | 11  | 15,5                                                        |                                      |
|             | 99,5           | 99,5           | 120,5          | 124,3          | 2                              | 1                        | 91                     | 91                     | 129                    | 134,4                  | 2                      | 1                      | 103,4          | 18  | –                                                           |                                      |
|             | 99,5           | 99,5           | 120,5          | 124,3          | 2                              | 1                        | 91                     | 91                     | 129                    | 134,4                  | 2                      | 1                      | 103,4          | 18  | –                                                           |                                      |
|             | 99,5           | 99,5           | 120,5          | 124,3          | 2                              | 1                        | 91                     | 91                     | 129                    | 134,4                  | 2                      | 1                      | 103,4          | 18  | 15,1                                                        |                                      |
|             | 99,5           | 99,5           | 120,5          | 124,3          | 2                              | 1                        | 91                     | 91                     | 129                    | 134,4                  | 2                      | 1                      | 103,4          | 18  | 15,1                                                        |                                      |
| 85          | 93,2           | 93,2           | 102,1          | –              | 1                              | 0,3                      | 89,6                   | 89,6                   | 105,4                  | 108                    | 1                      | 0,3                    | 94,1           | 2,7 | –                                                           |                                      |
|             | 93,2           | 93,2           | 102,1          | –              | 1                              | 0,3                      | 89,6                   | 89,6                   | 105,4                  | 108                    | 1                      | 0,3                    | 94,1           | 2,7 | –                                                           |                                      |
|             | 93,2           | 93,2           | 102,1          | –              | 1                              | 0,3                      | 89,6                   | 89,6                   | 105,4                  | 108                    | 1                      | 0,3                    | 94,1           | 2,7 | 17,1                                                        |                                      |
|             | 93,2           | 93,2           | 102,1          | –              | 1                              | 0,3                      | 89,6                   | 89,6                   | 105,4                  | 108                    | 1                      | 0,3                    | 94,1           | 2,7 | 17,1                                                        |                                      |
|             | 98,2           | 96,7           | 110,2          | 110,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116,8                  | 1                      | 0,6                    | 99,2           | 6,5 | –                                                           |                                      |
|             | 98,2           | 96,7           | 110,2          | 110,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116,8                  | 1                      | 0,6                    | 99,2           | 6,5 | –                                                           |                                      |
|             | 98,2           | 96,7           | 110,2          | 110,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116,8                  | 1                      | 0,6                    | 99,2           | 6,5 | 10                                                          |                                      |
|             | 98,2           | 96,7           | 110,2          | 110,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116,8                  | 1                      | 0,6                    | 99,2           | 6,5 | 10                                                          |                                      |
|             | 96             | 92,9           | 109,2          | 112,3          | 1,1                            | 0,6                      | 91                     | 88,2                   | 114                    | 116,8                  | 1                      | 0,6                    | 98,6           | 7   | –                                                           |                                      |
|             | 96             | 92,9           | 109,2          | 112,3          | 1,1                            | 0,6                      | 91                     | 88,2                   | 114                    | 116,8                  | 1                      | 0,6                    | 98,6           | 7   | –                                                           |                                      |
|             | 96             | 92,9           | 109,2          | 112,3          | 1,1                            | 0,6                      | 91                     | 88,2                   | 114                    | 116,8                  | 1                      | 0,6                    | 98,6           | 7   | 8,4                                                         |                                      |
|             | 96             | 92,9           | 109,2          | 112,3          | 1,1                            | 0,6                      | 91                     | 88,2                   | 114                    | 116,8                  | 1                      | 0,6                    | 98,6           | 7   | 8,4                                                         |                                      |
|             | 95,8           | 95,8           | 109,2          | 112,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116                    | 1                      | 0,6                    | 98,6           | 7,2 | –                                                           |                                      |
|             | 95,8           | 95,8           | 109,2          | 112,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116                    | 1                      | 0,6                    | 98,6           | 7,2 | –                                                           |                                      |
|             | 95,8           | 95,8           | 109,2          | 112,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116                    | 1                      | 0,6                    | 98,6           | 7,2 | 16,2                                                        |                                      |
|             | 95,8           | 95,8           | 109,2          | 112,2          | 1,1                            | 0,6                      | 91                     | 91                     | 114                    | 116                    | 1                      | 0,6                    | 98,6           | 7,2 | 16,2                                                        |                                      |

<sup>1)</sup> For calculating the initial grease fill → page 237

## 2.1 Angular contact ball bearings

d 85 – 90 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

S... 1)

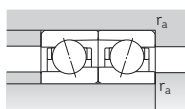
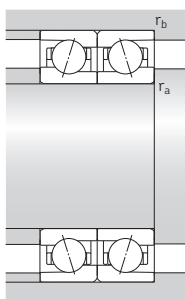
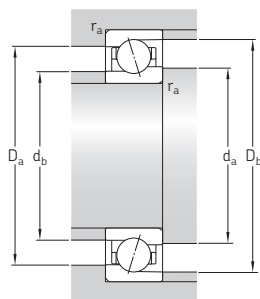
| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 85<br>cont.          | 130 | 22 | 25,1               | 22,4                  | 0,915              | 12 000             | 18 000                            | 0,96               | 7017 ACB/P4A    | S                              | L                                        |
|                      | 130 | 22 | 25,1               | 22,4                  | 0,915              | 14 000             | 22 000                            | 0,9                | 7017 ACB/HCP4A  | S                              | L                                        |
|                      | 130 | 22 | 27                 | 23,6                  | 0,965              | 13 000             | 20 000                            | 0,96               | 7017 CB/P4A     | S                              | L                                        |
|                      | 130 | 22 | 27                 | 23,6                  | 0,965              | 16 000             | 24 000                            | 0,9                | 7017 CB/HCP4A   | S                              | L                                        |
|                      | 130 | 22 | 32,5               | 28                    | 1,14               | 13 000             | 20 000                            | 0,9                | 7017 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 130 | 22 | 32,5               | 28                    | 1,14               | 15 000             | 23 000                            | 0,81               | 7017 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 130 | 22 | 34,5               | 29                    | 1,2                | 14 000             | 22 000                            | 0,9                | 7017 CE/P4A     | S                              | H1, L, L1                                |
|                      | 130 | 22 | 34,5               | 29                    | 1,2                | 16 500             | 26 000                            | 0,81               | 7017 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 130 | 22 | 63,7               | 62                    | 2,5                | 9 000              | 14 000                            | 0,9                | 7017 ACD/P4A    | S                              | H1, L                                    |
|                      | 130 | 22 | 63,7               | 62                    | 2,5                | 11 000             | 17 000                            | 0,75               | 7017 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 130 | 22 | 67,6               | 65,5                  | 2,65               | 10 000             | 16 000                            | 0,9                | 7017 CD/P4A     | S                              | H1, L                                    |
|                      | 130 | 22 | 67,6               | 65,5                  | 2,65               | 12 000             | 19 000                            | 0,75               | 7017 CD/HCP4A   | S                              | H1, L                                    |
|                      | 150 | 28 | 95,6               | 85                    | 3,35               | 8 000              | 13 000                            | 1,85               | 7217 ACD/P4A    | –                              | –                                        |
|                      | 150 | 28 | 95,6               | 85                    | 3,35               | 9 500              | 16 000                            | 1,55               | 7217 ACD/HCP4A  | –                              | –                                        |
|                      | 150 | 28 | 99,5               | 88                    | 3,45               | 9 000              | 15 000                            | 1,85               | 7217 CD/P4A     | –                              | –                                        |
|                      | 150 | 28 | 99,5               | 88                    | 3,45               | 11 000             | 17 000                            | 1,55               | 7217 CD/HCP4A   | –                              | –                                        |
| 90                   | 115 | 13 | 20,3               | 25                    | 1,04               | 10 000             | 15 000                            | 0,28               | 71818 ACD/P4    | –                              | –                                        |
|                      | 115 | 13 | 20,3               | 25                    | 1,04               | 12 000             | 18 000                            | 0,25               | 71818 ACD/HCP4  | –                              | –                                        |
|                      | 115 | 13 | 21,6               | 26,5                  | 1,1                | 11 000             | 17 000                            | 0,28               | 71818 CD/P4     | –                              | –                                        |
|                      | 115 | 13 | 21,6               | 26,5                  | 1,1                | 13 000             | 20 000                            | 0,25               | 71818 CD/HCP4   | –                              | –                                        |
|                      | 125 | 18 | 16,8               | 16,6                  | 0,68               | 12 000             | 19 000                            | 0,59               | 71918 ACB/P4A   | S                              | L                                        |
|                      | 125 | 18 | 16,8               | 16,6                  | 0,68               | 15 000             | 22 000                            | 0,56               | 71918 ACB/HCP4A | S                              | L                                        |
|                      | 125 | 18 | 17,8               | 17,6                  | 0,72               | 14 000             | 22 000                            | 0,59               | 71918 CB/P4A    | S                              | L                                        |
|                      | 125 | 18 | 17,8               | 17,6                  | 0,72               | 16 000             | 26 000                            | 0,56               | 71918 CB/HCP4A  | S                              | L                                        |
|                      | 125 | 18 | 28,6               | 23,2                  | 0,915              | 13 000             | 20 000                            | 0,54               | 71918 ACE/P4A   | S                              | H1, L                                    |
|                      | 125 | 18 | 28,6               | 23,2                  | 0,915              | 15 500             | 24 000                            | 0,46               | 71918 ACE/HCP4A | S                              | H1, L                                    |
|                      | 125 | 18 | 30,2               | 24,5                  | 0,965              | 14 500             | 22 000                            | 0,54               | 71918 CE/P4A    | S                              | H1, L                                    |
|                      | 125 | 18 | 30,2               | 24,5                  | 0,965              | 17 000             | 27 000                            | 0,46               | 71918 CE/HCP4A  | S                              | H1, L                                    |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 238).

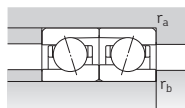
<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 238).

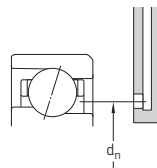




ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

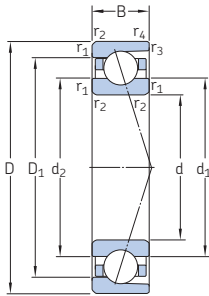


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                |                  | Reference grease quantity <sup>1)</sup> | Calculation factor |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|------------------|-----------------------------------------|--------------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub>                          |                    |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                  |                                         | cm <sup>3</sup>    | – |
| 85<br>cont. | 101,7          | 99,3           | 116,4          | 116,4          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126,8               | 1                   | 0,6                 | 103            | 11               | –                                       |                    |   |
|             | 101,7          | 99,3           | 116,4          | 116,4          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126,8               | 1                   | 0,6                 | 103            | 11               | –                                       |                    |   |
|             | 101,7          | 99,3           | 116,4          | 116,4          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126,8               | 1                   | 0,6                 | 103            | 11               | 9,6                                     |                    |   |
|             | 101,7          | 99,3           | 116,4          | 116,4          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126,8               | 1                   | 0,6                 | 103            | 11               | 9,6                                     |                    |   |
|             | 100,8          | 98             | 117,6          | 117,6          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 125,8               | 1                   | 0,6                 | 103,5          | 12               | –                                       |                    |   |
|             | 100,8          | 98             | 117,6          | 117,6          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 125,8               | 1                   | 0,6                 | 103,5          | 12               | –                                       |                    |   |
|             | 100,8          | 98             | 117,6          | 117,6          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 125,8               | 1                   | 0,6                 | 103,5          | 12               | 9,5                                     |                    |   |
|             | 100,8          | 98             | 117,6          | 117,6          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 125,8               | 1                   | 0,6                 | 103,5          | 12               | 9,5                                     |                    |   |
|             | 98,9           | 98,9           | 116,1          | 119,1          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126                 | 1                   | 0,6                 | 101,9          | 12               | –                                       |                    |   |
|             | 98,9           | 98,9           | 116,1          | 119,1          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126                 | 1                   | 0,6                 | 101,9          | 12               | –                                       |                    |   |
|             | 98,9           | 98,9           | 116,1          | 119,1          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126                 | 1                   | 0,6                 | 101,9          | 12               | 15,7                                    |                    |   |
|             | 98,9           | 98,9           | 116,1          | 119,1          | 1,1                   | 0,6                   | 91                             | 91                  | 124                 | 126                 | 1                   | 0,6                 | 101,9          | 12               | 15,7                                    |                    |   |
|             | 106,5          | 106,5          | 129,5          | –              | 2                     | 1                     | 96                             | 96                  | 139                 | 144,4               | 2                   | 1                   | 111,5          | 22               | –                                       |                    |   |
|             | 106,5          | 106,5          | 129,5          | –              | 2                     | 1                     | 96                             | 96                  | 139                 | 144,4               | 2                   | 1                   | 111,5          | 22               | –                                       |                    |   |
|             | 106,5          | 106,5          | 129,5          | –              | 2                     | 1                     | 96                             | 96                  | 139                 | 144,4               | 2                   | 1                   | 111,5          | 22               | 14,9                                    |                    |   |
|             | 106,5          | 106,5          | 129,5          | –              | 2                     | 1                     | 96                             | 96                  | 139                 | 144,4               | 2                   | 1                   | 111,5          | 22               | 14,9                                    |                    |   |
| 90          | 98,2           | 98,2           | 107,1          | –              | 1                     | 0,3                   | 94,6                           | 94,6                | 110,4               | 113                 | 1                   | 0,3                 | 99,1           | 2,9              | –                                       |                    |   |
|             | 98,2           | 98,2           | 107,1          | –              | 1                     | 0,3                   | 94,6                           | 94,6                | 110,4               | 113                 | 1                   | 0,3                 | 99,1           | 2,9              | –                                       |                    |   |
|             | 98,2           | 98,2           | 107,1          | –              | 1                     | 0,3                   | 94,6                           | 94,6                | 110,4               | 113                 | 1                   | 0,3                 | 99,1           | 2,9              | 17,2                                    |                    |   |
|             | 98,2           | 98,2           | 107,1          | –              | 1                     | 0,3                   | 94,6                           | 94,6                | 110,4               | 113                 | 1                   | 0,3                 | 99,1           | 2,9              | 17,2                                    |                    |   |
|             | 103            | 101,4          | 115            | 115            | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121,8               | 1                   | 0,6                 | 103,9          | 7,4              | –                                       |                    |   |
|             | 103            | 101,4          | 115            | 115            | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121,8               | 1                   | 0,6                 | 103,9          | 7,4              | –                                       |                    |   |
|             | 103            | 101,4          | 115            | 115            | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121,8               | 1                   | 0,6                 | 103,9          | 7,4              | 10                                      |                    |   |
|             | 103            | 101,4          | 115            | 115            | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121,8               | 1                   | 0,6                 | 103,9          | 7,4              | 10                                      |                    |   |
|             | 101            | 97,9           | 114,2          | 117,3          | 1,1                   | 0,6                   | 96                             | 93,2                | 119                 | 121,8               | 1                   | 0,6                 | 103,5          | 7                | –                                       |                    |   |
|             | 101            | 97,9           | 114,2          | 117,3          | 1,1                   | 0,6                   | 96                             | 93,2                | 119                 | 121,8               | 1                   | 0,6                 | 103,5          | 7                | –                                       |                    |   |
|             | 101            | 97,9           | 114,2          | 117,3          | 1,1                   | 0,6                   | 96                             | 93,2                | 119                 | 121,8               | 1                   | 0,6                 | 103,5          | 7                | 8,5                                     |                    |   |
|             | 101            | 97,9           | 114,2          | 117,3          | 1,1                   | 0,6                   | 96                             | 93,2                | 119                 | 121,8               | 1                   | 0,6                 | 103,5          | 7                | 8,5                                     |                    |   |

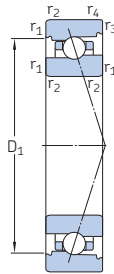
<sup>1)</sup> For calculating the initial grease fill → page 239

## 2.1 Angular contact ball bearings

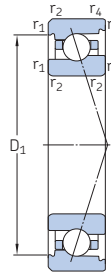
d 90 – 95 mm



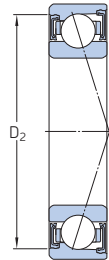
ACD, CD



ACB, CB



70 .. ACE,  
70 .. CE



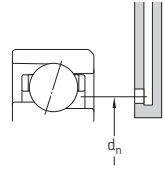
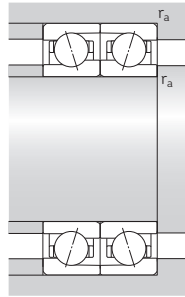
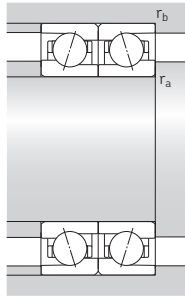
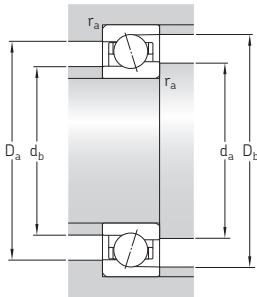
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 90<br>cont.          | 125 | 18 | 44,2               | 48                    | 1,96               | 8 500              | 14 000                            | 0,55               | 71918 ACD/P4A   | S                              | H1, L                                    |
|                      | 125 | 18 | 44,2               | 48                    | 1,96               | 10 000             | 17 000                            | 0,47               | 71918 ACD/HCP4A | S                              | H1, L                                    |
|                      | 125 | 18 | 47,5               | 51                    | 2,08               | 9 500              | 16 000                            | 0,55               | 71918 CD/P4A    | S                              | H1, L                                    |
|                      | 125 | 18 | 47,5               | 51                    | 2,08               | 13 000             | 19 000                            | 0,47               | 71918 CD/HCP4A  | S                              | H1, L                                    |
|                      | 140 | 24 | 27                 | 23,6                  | 0,93               | 11 000             | 17 000                            | 1,25               | 7018 ACB/P4A    | S                              | L                                        |
|                      | 140 | 24 | 27                 | 23,6                  | 0,93               | 13 000             | 20 000                            | 1,2                | 7018 ACB/HCP4A  | S                              | L                                        |
|                      | 140 | 24 | 29,1               | 25                    | 0,98               | 12 000             | 19 000                            | 1,25               | 7018 CB/P4A     | S                              | L                                        |
|                      | 140 | 24 | 29,1               | 25                    | 0,98               | 15 000             | 24 000                            | 1,2                | 7018 CB/HCP4A   | S                              | L                                        |
|                      | 140 | 24 | 33,8               | 30                    | 1,2                | 12 000             | 19 000                            | 1,2                | 7018 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 140 | 24 | 33,8               | 30                    | 1,2                | 14 000             | 22 000                            | 1,1                | 7018 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 140 | 24 | 35,8               | 32                    | 1,27               | 13 300             | 21 000                            | 1,2                | 7018 CE/P4A     | S                              | H1, L, L1                                |
|                      | 140 | 24 | 35,8               | 32                    | 1,27               | 15 500             | 24 000                            | 1,1                | 7018 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 140 | 24 | 74,1               | 72                    | 2,85               | 8 500              | 13 000                            | 1,15               | 7018 ACD/P4A    | S                              | H1, L                                    |
|                      | 140 | 24 | 74,1               | 72                    | 2,85               | 10 000             | 16 000                            | 1                  | 7018 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 140 | 24 | 79,3               | 76,5                  | 3                  | 9 000              | 15 000                            | 1,15               | 7018 CD/P4A     | S                              | H1, L                                    |
|                      | 140 | 24 | 79,3               | 76,5                  | 3                  | 11 000             | 18 000                            | 1                  | 7018 CD/HCP4A   | S                              | H1, L                                    |
| 95                   | 160 | 30 | 121                | 106                   | 4,05               | 7 500              | 12 000                            | 2,25               | 7218 ACD/P4A    | –                              | –                                        |
|                      | 160 | 30 | 121                | 106                   | 4,05               | 9 000              | 15 000                            | 1,85               | 7218 ACD/HCP4A  | –                              | –                                        |
|                      | 160 | 30 | 127                | 112                   | 4,25               | 8 500              | 14 000                            | 2,25               | 7218 CD/P4A     | –                              | –                                        |
|                      | 160 | 30 | 127                | 112                   | 4,25               | 10 000             | 16 000                            | 1,85               | 7218 CD/HCP4A   | –                              | –                                        |
|                      | 120 | 13 | 20,8               | 25,5                  | 1,06               | 9 500              | 14 000                            | 0,29               | 71819 ACD/P4    | –                              | –                                        |
|                      | 120 | 13 | 20,8               | 25,5                  | 1,06               | 11 000             | 17 000                            | 0,26               | 71819 ACD/HCP4  | –                              | –                                        |
|                      | 120 | 13 | 22,1               | 27,5                  | 1,12               | 10 000             | 16 000                            | 0,29               | 71819 CD/P4     | –                              | –                                        |
|                      | 120 | 13 | 22,1               | 27,5                  | 1,12               | 12 000             | 19 000                            | 0,26               | 71819 CD/HCP4   | –                              | –                                        |
|                      | 130 | 18 | 17,2               | 17,6                  | 0,71               | 12 000             | 18 000                            | 0,61               | 71919 ACB/P4A   | S                              | L                                        |
|                      | 130 | 18 | 17,2               | 17,6                  | 0,71               | 14 000             | 22 000                            | 0,58               | 71919 ACB/HCP4A | S                              | L                                        |
|                      | 130 | 18 | 18,2               | 18,6                  | 0,75               | 13 000             | 20 000                            | 0,61               | 71919 CB/P4A    | S                              | L                                        |
|                      | 130 | 18 | 18,2               | 18,6                  | 0,75               | 16 000             | 24 000                            | 0,58               | 71919 CB/HCP4A  | S                              | L                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 240).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 240).

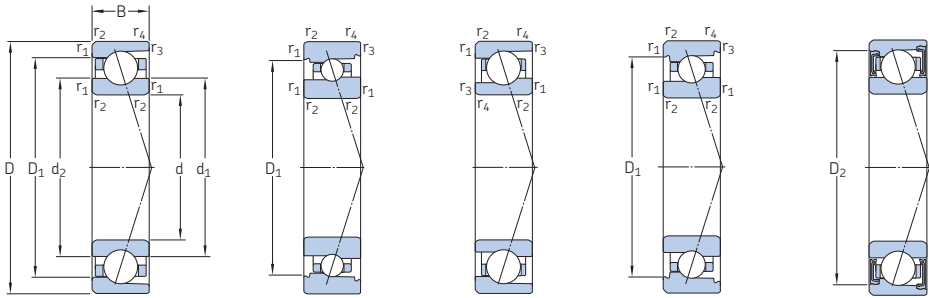


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm          |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 90<br>cont. | 100,8          | 100,8          | 114,2          | 117,2          | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121                 | 1                   | 0,6                 | 103,3          | 7,5                                     | –                  |                 |   |
|             | 100,8          | 100,8          | 114,2          | 117,2          | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121                 | 1                   | 0,6                 | 103,3          | 7,5                                     | –                  |                 |   |
|             | 100,8          | 100,8          | 114,2          | 117,2          | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121                 | 1                   | 0,6                 | 103,3          | 7,5                                     | 16,3               |                 |   |
|             | 100,8          | 100,8          | 114,2          | 117,2          | 1,1                   | 0,6                   | 96                             | 96                  | 119                 | 121                 | 1                   | 0,6                 | 103,3          | 7,5                                     | 16,3               |                 |   |
|             | 108,7          | 106,1          | 125            | 125            | 1,5                   | 1                     | 97                             | 97                  | 133                 | 135,4               | 1,5                 | 1                   | 110            | 14                                      | –                  |                 |   |
|             | 108,7          | 106,1          | 125            | 125            | 1,5                   | 1                     | 97                             | 97                  | 133                 | 135,4               | 1,5                 | 1                   | 110            | 14                                      | –                  |                 |   |
|             | 108,7          | 106,1          | 125            | 125            | 1,5                   | 1                     | 97                             | 97                  | 133                 | 135,4               | 1,5                 | 1                   | 110            | 14                                      | 9,7                |                 |   |
|             | 108,7          | 106,1          | 125            | 125            | 1,5                   | 1                     | 97                             | 97                  | 133                 | 135,4               | 1,5                 | 1                   | 110            | 14                                      | 9,7                |                 |   |
|             | 108,3          | 105,5          | 125,2          | 125,2          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 134,4               | 1,5                 | 1                   | 111            | 14                                      | –                  |                 |   |
|             | 108,3          | 105,5          | 125,2          | 125,2          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 134,4               | 1,5                 | 1                   | 111            | 14                                      | –                  |                 |   |
|             | 108,3          | 105,5          | 125,2          | 125,2          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 134,4               | 1,5                 | 1                   | 111            | 14                                      | 9,6                |                 |   |
|             | 108,3          | 105,5          | 125,2          | 125,2          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 134,4               | 1,5                 | 1                   | 111            | 14                                      | 9,6                |                 |   |
|             | 105,4          | 105,4          | 124,6          | 128,3          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 136                 | 1,5                 | 1                   | 108,7          | 15                                      | –                  |                 |   |
|             | 105,4          | 105,4          | 124,6          | 128,3          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 136                 | 1,5                 | 1                   | 108,7          | 15                                      | –                  |                 |   |
|             | 105,4          | 105,4          | 124,6          | 128,3          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 136                 | 1,5                 | 1                   | 108,7          | 15                                      | 15,6               |                 |   |
|             | 105,4          | 105,4          | 124,6          | 128,3          | 1,5                   | 1                     | 97                             | 97                  | 133                 | 136                 | 1,5                 | 1                   | 108,7          | 15                                      | 15,6               |                 |   |
| 95          | 111,6          | 111,6          | 138,4          | –              | 2                     | 1                     | 101                            | 101                 | 149                 | 154,4               | 2                   | 1                   | 117,5          | 28                                      | –                  |                 |   |
|             | 111,6          | 111,6          | 138,4          | –              | 2                     | 1                     | 101                            | 101                 | 149                 | 154,4               | 2                   | 1                   | 117,5          | 28                                      | –                  |                 |   |
|             | 111,6          | 111,6          | 138,4          | –              | 2                     | 1                     | 101                            | 101                 | 149                 | 154,4               | 2                   | 1                   | 117,5          | 28                                      | 14,6               |                 |   |
|             | 111,6          | 111,6          | 138,4          | –              | 2                     | 1                     | 101                            | 101                 | 149                 | 154,4               | 2                   | 1                   | 117,5          | 28                                      | 14,6               |                 |   |
|             | 103,2          | 103,2          | 112,1          | –              | 1                     | 0,3                   | 99,6                           | 99,6                | 115,4               | 118                 | 1                   | 0,3                 | 104,1          | 3,1                                     | –                  |                 |   |
|             | 103,2          | 103,2          | 112,1          | –              | 1                     | 0,3                   | 99,6                           | 99,6                | 115,4               | 118                 | 1                   | 0,3                 | 104,1          | 3,1                                     | –                  |                 |   |
|             | 103,2          | 103,2          | 112,1          | –              | 1                     | 0,3                   | 99,6                           | 99,6                | 115,4               | 118                 | 1                   | 0,3                 | 104,1          | 3,1                                     | 17,3               |                 |   |
|             | 103,2          | 103,2          | 112,1          | –              | 1                     | 0,3                   | 99,6                           | 99,6                | 115,4               | 118                 | 1                   | 0,3                 | 104,1          | 3,1                                     | 17,3               |                 |   |
|             | 107,9          | 106,4          | 120,7          | 120,7          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126,8               | 1                   | 0,6                 | 109            | 7,5                                     | –                  |                 |   |
|             | 107,9          | 106,4          | 120,7          | 120,7          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126,8               | 1                   | 0,6                 | 109            | 7,5                                     | –                  |                 |   |
|             | 107,9          | 106,4          | 120,7          | 120,7          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126,8               | 1                   | 0,6                 | 109            | 7,5                                     | 10                 |                 |   |
|             | 107,9          | 106,4          | 120,7          | 120,7          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126,8               | 1                   | 0,6                 | 109            | 7,5                                     | 10                 |                 |   |

<sup>1)</sup> For calculating the initial grease fill → page 241

## 2.1 Angular contact ball bearings

d 95 – 100 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

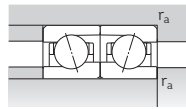
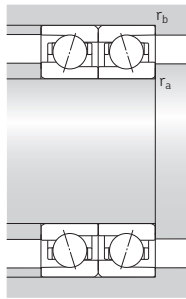
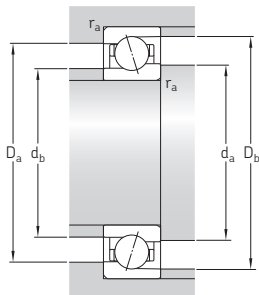
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 95<br>cont.          | 130 | 18 | 29,1               | 24                    | 0,93               | 12 300             | 19 000                            | 0,56               | 71919 ACE/P4A   | S                              | H1, L                                    |
|                      | 130 | 18 | 29,1               | 24                    | 0,93               | 15 000             | 23 000                            | 0,48               | 71919 ACE/HCP4A | S                              | H1, L                                    |
|                      | 130 | 18 | 30,7               | 25,5                  | 0,98               | 14 000             | 21 000                            | 0,56               | 71919 CE/P4A    | S                              | H1, L                                    |
|                      | 130 | 18 | 30,7               | 25,5                  | 0,98               | 16 000             | 25 000                            | 0,48               | 71919 CE/HCP4A  | S                              | H1, L                                    |
|                      | 130 | 18 | 46,2               | 52                    | 2,08               | 8 500              | 14 000                            | 0,58               | 71919 ACD/P4A   | S                              | H1, L                                    |
|                      | 130 | 18 | 46,2               | 52                    | 2,08               | 9 500              | 16 000                            | 0,5                | 71919 ACD/HCP4A | S                              | H1, L                                    |
|                      | 130 | 18 | 49,4               | 55                    | 2,2                | 9 000              | 15 000                            | 0,58               | 71919 CD/P4A    | S                              | H1, L                                    |
|                      | 130 | 18 | 49,4               | 55                    | 2,2                | 12 000             | 18 000                            | 0,5                | 71919 CD/HCP4A  | S                              | H1, L                                    |
|                      | 145 | 24 | 27,6               | 24,5                  | 0,95               | 11 000             | 16 000                            | 1,3                | 7019 ACB/P4A    | S                              | L                                        |
|                      | 145 | 24 | 27,6               | 24,5                  | 0,95               | 13 000             | 19 000                            | 1,25               | 7019 ACB/HCP4A  | S                              | L                                        |
|                      | 145 | 24 | 29,6               | 26                    | 1                  | 12 000             | 18 000                            | 1,3                | 7019 CB/P4A     | S                              | L                                        |
|                      | 145 | 24 | 29,6               | 26                    | 1                  | 14 000             | 22 000                            | 1,25               | 7019 CB/HCP4A   | S                              | L                                        |
|                      | 145 | 24 | 41,6               | 36                    | 1,4                | 11 500             | 18 000                            | 1,2                | 7019 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 145 | 24 | 41,6               | 36                    | 1,4                | 13 300             | 20 500                            | 1,1                | 7019 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 145 | 24 | 44,2               | 38                    | 1,46               | 12 700             | 20 000                            | 1,2                | 7019 CE/P4A     | S                              | H1, L, L1                                |
|                      | 145 | 24 | 44,2               | 38                    | 1,46               | 15 000             | 23 000                            | 1,1                | 7019 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 145 | 24 | 76,1               | 76,5                  | 2,9                | 8 000              | 13 000                            | 1,2                | 7019 ACD/P4A    | S                              | H1, L                                    |
|                      | 145 | 24 | 76,1               | 76,5                  | 2,9                | 10 000             | 16 000                            | 1                  | 7019 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 145 | 24 | 81,9               | 80                    | 3,1                | 8 500              | 14 000                            | 1,2                | 7019 CD/P4A     | S                              | H1, L                                    |
|                      | 145 | 24 | 81,9               | 80                    | 3,1                | 11 000             | 17 000                            | 1                  | 7019 CD/HCP4A   | S                              | H1, L                                    |
|                      | 170 | 32 | 133                | 114                   | 4,25               | 7 500              | 12 000                            | 2,7                | 7219 ACD/P4A    | –                              | –                                        |
|                      | 170 | 32 | 133                | 114                   | 4,25               | 8 500              | 14 000                            | 2,2                | 7219 ACD/HCP4A  | –                              | –                                        |
|                      | 170 | 32 | 138                | 120                   | 4,4                | 8 000              | 13 000                            | 2,7                | 7219 CD/P4A     | –                              | –                                        |
|                      | 170 | 32 | 138                | 120                   | 4,4                | 9 500              | 15 000                            | 2,2                | 7219 CD/HCP4A   | –                              | –                                        |
| 100                  | 125 | 13 | 21,2               | 27,5                  | 1,1                | 8 500              | 13 000                            | 0,31               | 71820 ACD/P4    | –                              | –                                        |
|                      | 125 | 13 | 21,2               | 27,5                  | 1,1                | 10 000             | 15 000                            | 0,28               | 71820 ACD/HCP4  | –                              | –                                        |
|                      | 125 | 13 | 22,5               | 29                    | 1,16               | 9 000              | 14 000                            | 0,31               | 71820 CD/P4     | –                              | –                                        |
|                      | 125 | 13 | 22,5               | 29                    | 1,16               | 11 000             | 17 000                            | 0,28               | 71820 CD/HCP4   | –                              | –                                        |

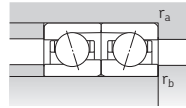
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 242).

<sup>2)</sup> Applicable to open bearings only.

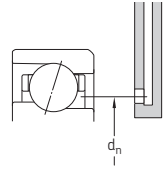
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 242).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

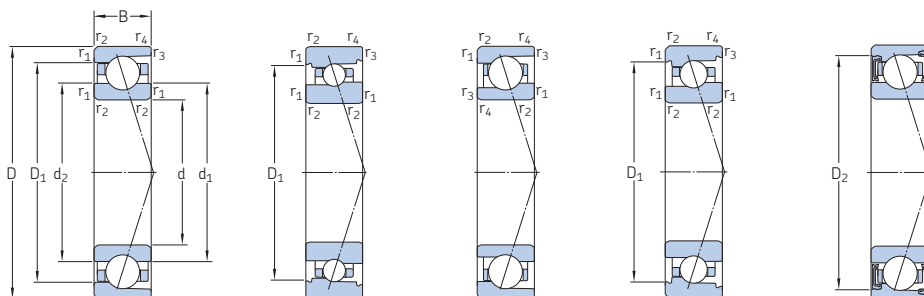


| Dimensions  |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |
|-------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|
| d           | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |
| mm          |                |                |                |                |                       |                       | mm                             |                     |                     |                     |                     |                     |                | cm <sup>3</sup>                         | –                  |
| 95<br>cont. | 106            | 102,9          | 119,2          | 122,6          | 1,1                   | 0,6                   | 101                            | 98,2                | 124                 | 126,8               | 1                   | 0,6                 | 108,5          | 7,3                                     | –                  |
|             | 106            | 102,9          | 119,2          | 122,6          | 1,1                   | 0,6                   | 101                            | 98,2                | 124                 | 126,8               | 1                   | 0,6                 | 108,5          | 7,3                                     | –                  |
|             | 106            | 102,9          | 119,2          | 122,6          | 1,1                   | 0,6                   | 101                            | 98,2                | 124                 | 126,8               | 1                   | 0,6                 | 108,5          | 7,3                                     | 8,6                |
|             | 106            | 102,9          | 119,2          | 122,6          | 1,1                   | 0,6                   | 101                            | 98,2                | 124                 | 126,8               | 1                   | 0,6                 | 108,5          | 7,3                                     | 8,6                |
|             | 105,8          | 105,8          | 119,2          | 122,2          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126                 | 1                   | 0,6                 | 108,6          | 7,8                                     | –                  |
|             | 105,8          | 105,8          | 119,2          | 122,2          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126                 | 1                   | 0,6                 | 108,6          | 7,8                                     | –                  |
|             | 105,8          | 105,8          | 119,2          | 122,2          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126                 | 1                   | 0,6                 | 108,6          | 7,8                                     | 16,4               |
|             | 105,8          | 105,8          | 119,2          | 122,2          | 1,1                   | 0,6                   | 101                            | 101                 | 124                 | 126                 | 1                   | 0,6                 | 108,6          | 7,8                                     | 16,4               |
|             | 113,7          | 111,2          | 130            | 130            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 140,4               | 1,5                 | 1                   | 115            | 15                                      | –                  |
|             | 113,7          | 111,2          | 130            | 130            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 140,4               | 1,5                 | 1                   | 115            | 15                                      | –                  |
|             | 113,7          | 111,2          | 130            | 130            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 140,4               | 1,5                 | 1                   | 115            | 15                                      | 9,7                |
|             | 113,7          | 111,2          | 130            | 130            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 140,4               | 1,5                 | 1                   | 115            | 15                                      | 9,7                |
|             | 112,4          | 109,2          | 131            | 131            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 139,4               | 1,5                 | 1                   | 115,4          | 17                                      | –                  |
|             | 112,4          | 109,2          | 131            | 131            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 139,4               | 1,5                 | 1                   | 115,4          | 17                                      | –                  |
|             | 112,4          | 109,2          | 131            | 131            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 139,4               | 1,5                 | 1                   | 115,4          | 17                                      | 9,4                |
|             | 112,4          | 109,2          | 131            | 131            | 1,5                   | 1                     | 102                            | 102                 | 138                 | 139,4               | 1,5                 | 1                   | 115,4          | 17                                      | 9,4                |
|             | 110,4          | 110,4          | 129,6          | 133,3          | 1,5                   | 1                     | 102                            | 102                 | 138                 | 141                 | 1,5                 | 1                   | 113,7          | 16                                      | –                  |
|             | 110,4          | 110,4          | 129,6          | 133,3          | 1,5                   | 1                     | 102                            | 102                 | 138                 | 141                 | 1,5                 | 1                   | 113,7          | 16                                      | –                  |
|             | 110,4          | 110,4          | 129,6          | 133,3          | 1,5                   | 1                     | 102                            | 102                 | 138                 | 141                 | 1,5                 | 1                   | 113,7          | 16                                      | 15,7               |
|             | 110,4          | 110,4          | 129,6          | 133,3          | 1,5                   | 1                     | 102                            | 102                 | 138                 | 141                 | 1,5                 | 1                   | 113,7          | 16                                      | 15,7               |
|             | 118,1          | 118,1          | 146,9          | –              | 2,1                   | 1,1                   | 107                            | 107                 | 158                 | 163                 | 2                   | 1                   | 124,4          | 34                                      | –                  |
|             | 118,1          | 118,1          | 146,9          | –              | 2,1                   | 1,1                   | 107                            | 107                 | 158                 | 163                 | 2                   | 1                   | 124,4          | 34                                      | –                  |
|             | 118,1          | 118,1          | 146,9          | –              | 2,1                   | 1,1                   | 107                            | 107                 | 158                 | 163                 | 2                   | 1                   | 124,4          | 34                                      | 14,6               |
|             | 118,1          | 118,1          | 146,9          | –              | 2,1                   | 1,1                   | 107                            | 107                 | 158                 | 163                 | 2                   | 1                   | 124,4          | 34                                      | 14,6               |
| 100         | 108,2          | 108,2          | 117            | –              | 1                     | 0,3                   | 104,6                          | 104,6               | 120,4               | 123                 | 1                   | 0,3                 | 109,1          | 3,2                                     | –                  |
|             | 108,2          | 108,2          | 117            | –              | 1                     | 0,3                   | 104,6                          | 104,6               | 120,4               | 123                 | 1                   | 0,3                 | 109,1          | 3,2                                     | –                  |
|             | 108,2          | 108,2          | 117            | –              | 1                     | 0,3                   | 104,6                          | 104,6               | 120,4               | 123                 | 1                   | 0,3                 | 109,1          | 3,2                                     | 17,4               |
|             | 108,2          | 108,2          | 117            | –              | 1                     | 0,3                   | 104,6                          | 104,6               | 120,4               | 123                 | 1                   | 0,3                 | 109,1          | 3,2                                     | 17,4               |

<sup>1)</sup> For calculating the initial grease fill → page 243

## 2.1 Angular contact ball bearings

d 100 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

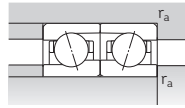
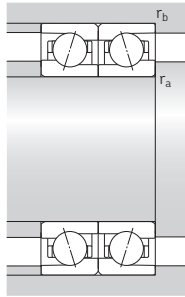
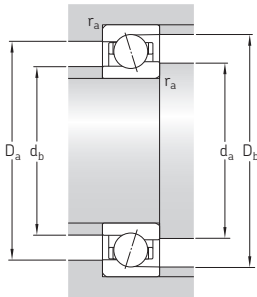
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 100<br>cont.         | 140 | 20 | 20,8               | 21,2                  | 0,815              | 11 000             | 17 000                            | 0,85               | 71920 ACB/P4A   | S                              | L                                        |
|                      | 140 | 20 | 20,8               | 21,2                  | 0,815              | 13 000             | 20 000                            | 0,8                | 71920 ACB/HCP4A | S                              | L                                        |
|                      | 140 | 20 | 21,6               | 22,4                  | 0,865              | 12 000             | 19 000                            | 0,85               | 71920 CB/P4A    | S                              | L                                        |
|                      | 140 | 20 | 21,6               | 22,4                  | 0,865              | 15 000             | 24 000                            | 0,8                | 71920 CB/HCP4A  | S                              | L                                        |
|                      | 140 | 20 | 36,4               | 30                    | 1,14               | 11 500             | 18 000                            | 0,77               | 71920 ACE/P4A   | S                              | H1, L                                    |
|                      | 140 | 20 | 36,4               | 30                    | 1,14               | 13 700             | 22 000                            | 0,65               | 71920 ACE/HCP4A | S                              | H1, L                                    |
|                      | 140 | 20 | 39                 | 31,5                  | 1,2                | 13 300             | 20 500                            | 0,77               | 71920 CE/P4A    | S                              | H1, L                                    |
|                      | 140 | 20 | 39                 | 31,5                  | 1,2                | 15 500             | 24 000                            | 0,65               | 71920 CE/HCP4A  | S                              | H1, L                                    |
|                      | 140 | 20 | 57,2               | 63                    | 2,4                | 8 000              | 13 000                            | 0,8                | 71920 ACD/P4A   | S                              | H1, L                                    |
|                      | 140 | 20 | 57,2               | 63                    | 2,4                | 9 000              | 15 000                            | 0,67               | 71920 ACD/HCP4A | S                              | H1, L                                    |
|                      | 140 | 20 | 60,5               | 65,5                  | 2,55               | 8 500              | 14 000                            | 0,8                | 71920 CD/P4A    | S                              | H1, L                                    |
|                      | 140 | 20 | 60,5               | 65,5                  | 2,55               | 11 000             | 17 000                            | 0,67               | 71920 CD/HCP4A  | S                              | H1, L                                    |
|                      | 150 | 24 | 28,1               | 25,5                  | 0,98               | 10 000             | 15 000                            | 1,35               | 7020 ACB/P4A    | S                              | L                                        |
|                      | 150 | 24 | 28,1               | 25,5                  | 0,98               | 12 000             | 18 000                            | 1,3                | 7020 ACB/HCP4A  | S                              | L                                        |
|                      | 150 | 24 | 29,6               | 27                    | 1,02               | 11 000             | 17 000                            | 1,35               | 7020 CB/P4A     | S                              | L                                        |
|                      | 150 | 24 | 29,6               | 27                    | 1,02               | 13 000             | 20 000                            | 1,3                | 7020 CB/HCP4A   | S                              | L                                        |
|                      | 150 | 24 | 42,3               | 38                    | 1,43               | 11 200             | 17 500                            | 1,25               | 7020 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 150 | 24 | 42,3               | 38                    | 1,43               | 12 700             | 20 000                            | 1,1                | 7020 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 150 | 24 | 44,9               | 40                    | 1,5                | 12 300             | 19 000                            | 1,25               | 7020 CE/P4A     | S                              | H1, L, L1                                |
|                      | 150 | 24 | 44,9               | 40                    | 1,5                | 14 500             | 22 000                            | 1,1                | 7020 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 150 | 24 | 79,3               | 80                    | 3,05               | 8 000              | 12 000                            | 1,25               | 7020 ACD/P4A    | S                              | H1, L                                    |
|                      | 150 | 24 | 79,3               | 80                    | 3,05               | 9 500              | 15 000                            | 1,05               | 7020 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 150 | 24 | 83,2               | 85                    | 3,2                | 8 500              | 14 000                            | 1,25               | 7020 CD/P4A     | S                              | H1, L                                    |
|                      | 150 | 24 | 83,2               | 85                    | 3,2                | 10 000             | 16 000                            | 1,05               | 7020 CD/HCP4A   | S                              | H1, L                                    |
|                      | 180 | 34 | 148                | 129                   | 4,65               | 7 000              | 11 000                            | 3,25               | 7220 ACD/P4A    | –                              | –                                        |
|                      | 180 | 34 | 148                | 129                   | 4,65               | 8 000              | 13 000                            | 2,65               | 7220 ACD/HCP4A  | –                              | –                                        |
|                      | 180 | 34 | 156                | 137                   | 4,9                | 7 500              | 12 000                            | 3,25               | 7220 CD/P4A     | –                              | –                                        |
|                      | 180 | 34 | 156                | 137                   | 4,9                | 9 000              | 14 000                            | 2,65               | 7220 CD/HCP4A   | –                              | –                                        |

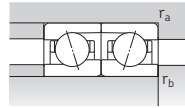
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 244).

<sup>2)</sup> Applicable to open bearings only.

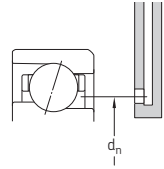
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 244).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

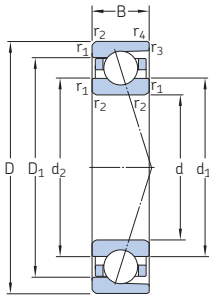


| Dimensions   |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |
|--------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|
| d            | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |
| mm           |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    |
| 100<br>cont. | 114,9          | 113,2          | 128,7          | 128,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136,8               | 1                   | 0,6                 | 116,1          | 10                                      | –                  |
|              | 114,9          | 113,2          | 128,7          | 128,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136,8               | 1                   | 0,6                 | 116,1          | 10                                      | –                  |
|              | 114,9          | 113,2          | 128,7          | 128,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136,8               | 1                   | 0,6                 | 116,1          | 10                                      | 10                 |
|              | 114,9          | 113,2          | 128,7          | 128,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136,8               | 1                   | 0,6                 | 116,1          | 10                                      | 10                 |
|              | 112,4          | 109            | 127,5          | 130,9          | 1,1                   | 0,6                   | 106                            | 103,2               | 134                 | 136,8               | 1                   | 0,6                 | 115,4          | 10                                      | –                  |
|              | 112,4          | 109            | 127,5          | 130,9          | 1,1                   | 0,6                   | 106                            | 103,2               | 134                 | 136,8               | 1                   | 0,6                 | 115,4          | 10                                      | –                  |
|              | 112,4          | 109            | 127,5          | 130,9          | 1,1                   | 0,6                   | 106                            | 103,2               | 134                 | 136,8               | 1                   | 0,6                 | 115,4          | 10                                      | 8,5                |
|              | 112,4          | 109            | 127,5          | 130,9          | 1,1                   | 0,6                   | 106                            | 103,2               | 134                 | 136,8               | 1                   | 0,6                 | 115,4          | 10                                      | 8,5                |
|              | 112,3          | 112,3          | 127,7          | 130,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136                 | 1                   | 0,6                 | 115,6          | 11                                      | –                  |
|              | 112,3          | 112,3          | 127,7          | 130,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136                 | 1                   | 0,6                 | 115,6          | 11                                      | –                  |
|              | 112,3          | 112,3          | 127,7          | 130,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136                 | 1                   | 0,6                 | 115,6          | 11                                      | 16,3               |
|              | 112,3          | 112,3          | 127,7          | 130,7          | 1,1                   | 0,6                   | 106                            | 106                 | 134                 | 136                 | 1                   | 0,6                 | 115,6          | 11                                      | 16,3               |
|              | 118,7          | 116,2          | 135            | 135            | 1,5                   | 1                     | 107                            | 107                 | 143                 | 145,4               | 1,5                 | 1                   | 120            | 15                                      | –                  |
|              | 118,7          | 116,2          | 135            | 135            | 1,5                   | 1                     | 107                            | 107                 | 143                 | 145,4               | 1,5                 | 1                   | 120            | 15                                      | –                  |
|              | 118,7          | 116,2          | 135            | 135            | 1,5                   | 1                     | 107                            | 107                 | 143                 | 145,4               | 1,5                 | 1                   | 120            | 15                                      | 9,8                |
|              | 118,7          | 116,2          | 135            | 135            | 1,5                   | 1                     | 107                            | 107                 | 143                 | 145,4               | 1,5                 | 1                   | 120            | 15                                      | 9,8                |
| 117,4        | 114,2          | 136            | 136            | 1,5            | 1                     | 107                   | 107                            | 143                 | 144,4               | 1,5                 | 1                   | 120,4               | 17             | –                                       |                    |
| 117,4        | 114,2          | 136            | 136            | 1,5            | 1                     | 107                   | 107                            | 143                 | 144,4               | 1,5                 | 1                   | 120,4               | 17             | –                                       |                    |
| 117,4        | 114,2          | 136            | 136            | 1,5            | 1                     | 107                   | 107                            | 143                 | 144,4               | 1,5                 | 1                   | 120,4               | 17             | 9,5                                     |                    |
| 117,4        | 114,2          | 136            | 136            | 1,5            | 1                     | 107                   | 107                            | 143                 | 144,4               | 1,5                 | 1                   | 120,4               | 17             | 9,5                                     |                    |
| 115,4        | 115,4          | 134,6          | 138,2          | 1,5            | 1                     | 107                   | 107                            | 143                 | 146                 | 1,5                 | 1                   | 118,7               | 16             | –                                       |                    |
| 115,4        | 115,4          | 134,6          | 138,2          | 1,5            | 1                     | 107                   | 107                            | 143                 | 146                 | 1,5                 | 1                   | 118,7               | 16             | –                                       |                    |
| 115,4        | 115,4          | 134,6          | 138,2          | 1,5            | 1                     | 107                   | 107                            | 143                 | 146                 | 1,5                 | 1                   | 118,7               | 16             | 15,8                                    |                    |
| 115,4        | 115,4          | 134,6          | 138,2          | 1,5            | 1                     | 107                   | 107                            | 143                 | 146                 | 1,5                 | 1                   | 118,7               | 16             | 15,8                                    |                    |
| 124,7        | 124,7          | 155,3          | –              | 2,1            | 1,1                   | 112                   | 112                            | 168                 | 173                 | 2                   | 1                   | 131,4               | 41             | –                                       |                    |
| 124,7        | 124,7          | 155,3          | –              | 2,1            | 1,1                   | 112                   | 112                            | 168                 | 173                 | 2                   | 1                   | 131,4               | 41             | –                                       |                    |
| 124,7        | 124,7          | 155,3          | –              | 2,1            | 1,1                   | 112                   | 112                            | 168                 | 173                 | 2                   | 1                   | 131,4               | 41             | 14,5                                    |                    |
| 124,7        | 124,7          | 155,3          | –              | 2,1            | 1,1                   | 112                   | 112                            | 168                 | 173                 | 2                   | 1                   | 131,4               | 41             | 14,5                                    |                    |

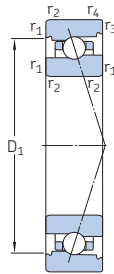
<sup>1)</sup> For calculating the initial grease fill → page 245

## 2.1 Angular contact ball bearings

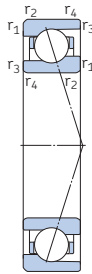
d 105 – 110 mm



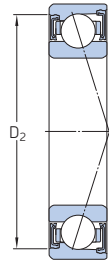
ACD, CD



ACB, CB



719 .. ACE,  
719 .. CE



S... 1)

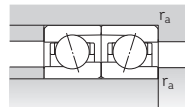
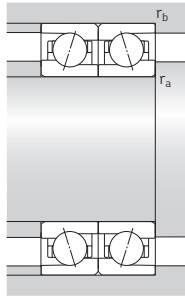
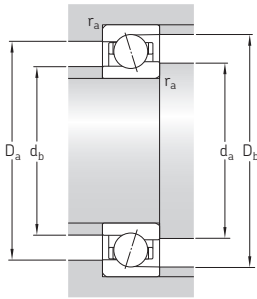
| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 105                  | 130 | 13 | 21,6               | 28,5                  | 1,1                | 8 000              | 12 000                            | 0,32               | 71821 ACD/P4    | –                              | –                                        |
|                      | 130 | 13 | 21,6               | 28,5                  | 1,1                | 9 500              | 15 000                            | 0,29               | 71821 ACD/HCP4  | –                              | –                                        |
|                      | 130 | 13 | 22,9               | 30                    | 1,18               | 9 000              | 14 000                            | 0,32               | 71821 CD/P4     | –                              | –                                        |
|                      | 130 | 13 | 22,9               | 30                    | 1,18               | 11 000             | 16 000                            | 0,29               | 71821 CD/HCP4   | –                              | –                                        |
|                      | 145 | 20 | 57,2               | 65,5                  | 2,5                | 7 500              | 12 000                            | 0,82               | 71921 ACD/P4A   | S                              | H1, L                                    |
|                      | 145 | 20 | 57,2               | 65,5                  | 2,5                | 9 000              | 15 000                            | 0,7                | 71921 ACD/HCP4A | S                              | H1, L                                    |
|                      | 145 | 20 | 61,8               | 69,5                  | 2,6                | 8 500              | 14 000                            | 0,82               | 71921 CD/P4A    | S                              | H1, L                                    |
|                      | 145 | 20 | 61,8               | 69,5                  | 2,6                | 10 000             | 16 000                            | 0,7                | 71921 CD/HCP4A  | S                              | H1, L                                    |
|                      | 160 | 26 | 90,4               | 93                    | 3,4                | 7 500              | 12 000                            | 1,6                | 7021 ACD/P4A    | S                              | H1, L                                    |
|                      | 160 | 26 | 90,4               | 93                    | 3,4                | 9 000              | 14 000                            | 1,3                | 7021 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 160 | 26 | 95,6               | 96,5                  | 3,6                | 8 000              | 13 000                            | 1,6                | 7021 CD/P4A     | S                              | H1, L                                    |
|                      | 160 | 26 | 95,6               | 96,5                  | 3,6                | 10 000             | 15 000                            | 1,3                | 7021 CD/HCP4A   | S                              | H1, L                                    |
|                      | 190 | 36 | 163                | 146                   | 5,1                | 6 700              | 10 000                            | 3,85               | 7221 ACD/P4A    | –                              | –                                        |
|                      | 190 | 36 | 163                | 146                   | 5,1                | 7 500              | 12 000                            | 3,15               | 7221 ACD/HCP4A  | –                              | –                                        |
|                      | 190 | 36 | 172                | 153                   | 5,3                | 7 500              | 12 000                            | 3,85               | 7221 CD/P4A     | –                              | –                                        |
|                      | 190 | 36 | 172                | 153                   | 5,3                | 9 000              | 14 000                            | 3,15               | 7221 CD/HCP4A   | –                              | –                                        |
| 110                  | 140 | 16 | 30,2               | 38                    | 1,46               | 7 500              | 12 000                            | 0,51               | 71822 ACD/P4    | –                              | –                                        |
|                      | 140 | 16 | 30,2               | 38                    | 1,46               | 9 000              | 14 000                            | 0,45               | 71822 ACD/HCP4  | –                              | –                                        |
|                      | 140 | 16 | 31,9               | 40,5                  | 1,53               | 8 000              | 13 000                            | 0,51               | 71822 CD/P4     | –                              | –                                        |
|                      | 140 | 16 | 31,9               | 40,5                  | 1,53               | 10 000             | 15 000                            | 0,45               | 71822 CD/HCP4   | –                              | –                                        |
|                      | 150 | 20 | 24,7               | 25,5                  | 0,95               | 10 000             | 15 000                            | 0,9                | 71922 ACB/P4A   | S                              | L                                        |
|                      | 150 | 20 | 24,7               | 25,5                  | 0,95               | 12 000             | 19 000                            | 0,84               | 71922 ACB/HCP4A | S                              | L                                        |
|                      | 150 | 20 | 26                 | 27                    | 1                  | 11 000             | 17 000                            | 0,9                | 71922 CB/P4A    | S                              | L                                        |
|                      | 150 | 20 | 26                 | 27                    | 1                  | 14 000             | 22 000                            | 0,84               | 71922 CB/HCP4A  | S                              | L                                        |
|                      | 150 | 20 | 37,7               | 32,5                  | 1,18               | 10 300             | 16 000                            | 0,83               | 71922 ACE/P4A   | S                              | H1, L                                    |
|                      | 150 | 20 | 37,7               | 32,5                  | 1,18               | 12 300             | 19 000                            | 0,7                | 71922 ACE/HCP4A | S                              | H1, L                                    |
|                      | 150 | 20 | 39,7               | 34,5                  | 1,25               | 12 000             | 18 000                            | 0,83               | 71922 CE/P4A    | S                              | H1, L                                    |
|                      | 150 | 20 | 39,7               | 34,5                  | 1,25               | 14 000             | 22 000                            | 0,7                | 71922 CE/HCP4A  | S                              | H1, L                                    |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 246).

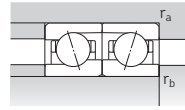
<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 246).

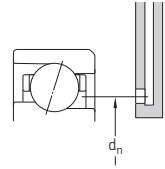




ACD, CD, ACB, CB



719 .. ACE, 719 .. CE



## Dimensions

## Abutment and fillet dimensions

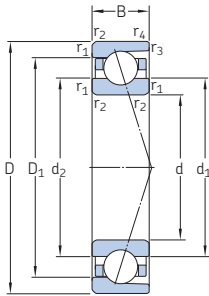
Reference  
grease  
quantity<sup>1)</sup>  
G<sub>ref</sub>Calculation  
factor  
f<sub>0</sub>

| d   | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> | G <sub>ref</sub> | f <sub>0</sub> |
|-----|----------------|----------------|----------------|----------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------------------|----------------|
| mm  |                |                |                |                |                          |                          | mm                     |                        |                        |                        |                        |                        |                | cm <sup>3</sup>  | –              |
| 105 | 113,2          | 113,2          | 122            | –              | 1                        | 0,3                      | 109,6                  | 109,6                  | 125,4                  | 128                    | 1                      | 0,3                    | 114,6          | 4                | –              |
|     | 113,2          | 113,2          | 122            | –              | 1                        | 0,3                      | 109,6                  | 109,6                  | 125,4                  | 128                    | 1                      | 0,3                    | 114,6          | 4                | –              |
|     | 113,2          | 113,2          | 122            | –              | 1                        | 0,3                      | 109,6                  | 109,6                  | 125,4                  | 128                    | 1                      | 0,3                    | 114,6          | 4                | 17,4           |
|     | 113,2          | 113,2          | 122            | –              | 1                        | 0,3                      | 109,6                  | 109,6                  | 125,4                  | 128                    | 1                      | 0,3                    | 114,6          | 4                | 17,4           |
|     | 117,3          | 117,3          | 132,7          | 135,7          | 1,1                      | 0,6                      | 111                    | 111                    | 139                    | 141                    | 1                      | 0,6                    | 120,6          | 11               | –              |
|     | 117,3          | 117,3          | 132,7          | 135,7          | 1,1                      | 0,6                      | 111                    | 111                    | 139                    | 141                    | 1                      | 0,6                    | 120,6          | 11               | –              |
|     | 117,3          | 117,3          | 132,7          | 135,7          | 1,1                      | 0,6                      | 111                    | 111                    | 139                    | 141                    | 1                      | 0,6                    | 120,6          | 11               | 16,4           |
|     | 117,3          | 117,3          | 132,7          | 135,7          | 1,1                      | 0,6                      | 111                    | 111                    | 139                    | 141                    | 1                      | 0,6                    | 120,6          | 11               | 16,4           |
|     | 121,9          | 121,9          | 143,1          | 146,8          | 2                        | 1                        | 114                    | 114                    | 151                    | 155                    | 2                      | 1                      | 125,6          | 20               | –              |
|     | 121,9          | 121,9          | 143,1          | 146,8          | 2                        | 1                        | 114                    | 114                    | 151                    | 155                    | 2                      | 1                      | 125,6          | 20               | –              |
|     | 121,9          | 121,9          | 143,1          | 146,8          | 2                        | 1                        | 114                    | 114                    | 151                    | 155                    | 2                      | 1                      | 125,6          | 20               | 15,7           |
|     | 121,9          | 121,9          | 143,1          | 146,8          | 2                        | 1                        | 114                    | 114                    | 151                    | 155                    | 2                      | 1                      | 125,6          | 20               | 15,7           |
|     | 131,2          | 131,2          | 163,8          | –              | 2,1                      | 1,1                      | 117                    | 117                    | 178                    | 183                    | 2                      | 1                      | 138,4          | 48               | –              |
|     | 131,2          | 131,2          | 163,8          | –              | 2,1                      | 1,1                      | 117                    | 117                    | 178                    | 183                    | 2                      | 1                      | 138,4          | 48               | –              |
|     | 131,2          | 131,2          | 163,8          | –              | 2,1                      | 1,1                      | 117                    | 117                    | 178                    | 183                    | 2                      | 1                      | 138,4          | 48               | 14,5           |
|     | 131,2          | 131,2          | 163,8          | –              | 2,1                      | 1,1                      | 117                    | 117                    | 178                    | 183                    | 2                      | 1                      | 138,4          | 48               | 14,5           |
| 110 | 119,8          | 119,8          | 130,6          | –              | 1                        | 0,3                      | 114,6                  | 114,6                  | 135,4                  | 138                    | 1                      | 0,3                    | 120,9          | 5,1              | –              |
|     | 119,8          | 119,8          | 130,6          | –              | 1                        | 0,3                      | 114,6                  | 114,6                  | 135,4                  | 138                    | 1                      | 0,3                    | 120,9          | 5,1              | –              |
|     | 119,8          | 119,8          | 130,6          | –              | 1                        | 0,3                      | 114,6                  | 114,6                  | 135,4                  | 138                    | 1                      | 0,3                    | 120,9          | 5,1              | 17,2           |
|     | 119,8          | 119,8          | 130,6          | –              | 1                        | 0,3                      | 114,6                  | 114,6                  | 135,4                  | 138                    | 1                      | 0,3                    | 120,9          | 5,1              | 17,2           |
|     | 124,4          | 122,5          | 139            | 139            | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146,8                  | 1                      | 0,6                    | 125,7          | 11               | –              |
|     | 124,4          | 122,5          | 139            | 139            | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146,8                  | 1                      | 0,6                    | 125,7          | 11               | –              |
|     | 124,4          | 122,5          | 139            | 139            | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146,8                  | 1                      | 0,6                    | 125,7          | 11               | 10             |
|     | 124,4          | 122,5          | 139            | 139            | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146,8                  | 1                      | 0,6                    | 125,7          | 11               | 10             |
|     | 122,4          | 119            | 137,5          | 140,9          | 1,1                      | 0,6                      | 116                    | 113,2                  | 144                    | 146,8                  | 1                      | 0,6                    | 125,4          | 11               | –              |
|     | 122,4          | 119            | 137,5          | 140,9          | 1,1                      | 0,6                      | 116                    | 113,2                  | 144                    | 146,8                  | 1                      | 0,6                    | 125,4          | 11               | –              |
|     | 122,4          | 119            | 137,5          | 140,9          | 1,1                      | 0,6                      | 116                    | 113,2                  | 144                    | 146,8                  | 1                      | 0,6                    | 125,4          | 11               | 8,6            |
|     | 122,4          | 119            | 137,5          | 140,9          | 1,1                      | 0,6                      | 116                    | 113,2                  | 144                    | 146,8                  | 1                      | 0,6                    | 125,4          | 11               | 8,6            |

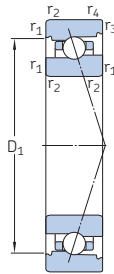
1) For calculating the initial grease fill → page 247

## 2.1 Angular contact ball bearings

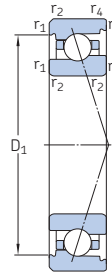
### d 110 – 120 mm



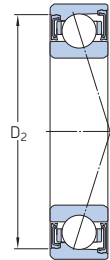
ACD, CD



ACB, CB



70 .. ACE,  
70 .. CE



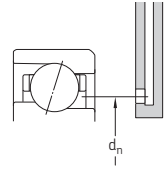
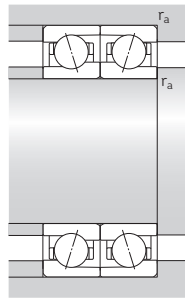
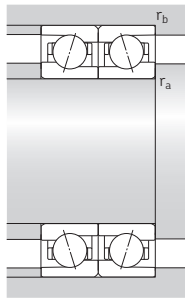
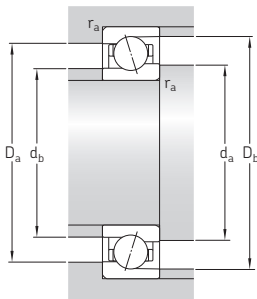
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| <b>110</b><br>cont.  | 150 | 20 | 58,5               | 68                    | 2,55               | 7 500              | 12 000                            | 0,86               | 71922 ACD/P4A   | S                              | H1, L                                    |
|                      | 150 | 20 | 58,5               | 68                    | 2,55               | 8 500              | 14 000                            | 0,73               | 71922 ACD/HCP4A | S                              | H1, L                                    |
|                      | 150 | 20 | 62,4               | 72                    | 2,7                | 8 000              | 13 000                            | 0,86               | 71922 CD/P4A    | S                              | H1, L                                    |
|                      | 150 | 20 | 62,4               | 72                    | 2,7                | 10 000             | 16 000                            | 0,73               | 71922 CD/HCP4A  | S                              | H1, L                                    |
|                      | 170 | 28 | 35,1               | 34                    | 1,22               | 9 000              | 14 000                            | 2,2                | 7022 ACB/P4A    | S                              | L                                        |
|                      | 170 | 28 | 35,1               | 34                    | 1,22               | 11 000             | 16 000                            | 2,1                | 7022 ACB/HCP4A  | S                              | L                                        |
|                      | 170 | 28 | 37,1               | 36                    | 1,29               | 10 000             | 16 000                            | 2,2                | 7022 CB/P4A     | S                              | L                                        |
|                      | 170 | 28 | 37,1               | 36                    | 1,29               | 12 000             | 19 000                            | 2,1                | 7022 CB/HCP4A   | S                              | L                                        |
|                      | 170 | 28 | 44,9               | 42,5                  | 1,53               | 10 000             | 15 500                            | 2,1                | 7022 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 170 | 28 | 44,9               | 42,5                  | 1,53               | 11 500             | 17 500                            | 1,95               | 7022 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 170 | 28 | 47,5               | 45                    | 1,6                | 10 900             | 17 000                            | 2,1                | 7022 CE/P4A     | S                              | H1, L, L1                                |
|                      | 170 | 28 | 47,5               | 45                    | 1,6                | 12 700             | 20 000                            | 1,95               | 7022 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 170 | 28 | 104                | 104                   | 3,75               | 7 000              | 11 000                            | 1,95               | 7022 ACD/P4A    | S                              | H1, L                                    |
|                      | 170 | 28 | 104                | 104                   | 3,75               | 8 500              | 13 000                            | 1,65               | 7022 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 170 | 28 | 111                | 108                   | 3,9                | 7 500              | 12 000                            | 1,95               | 7022 CD/P4A     | S                              | H1, L                                    |
|                      | 170 | 28 | 111                | 108                   | 3,9                | 9 500              | 14 000                            | 1,65               | 7022 CD/HCP4A   | S                              | H1, L                                    |
|                      | 200 | 38 | 168                | 160                   | 5,4                | 6 700              | 10 000                            | 4,65               | 7222 ACD/P4A    | –                              | –                                        |
|                      | 200 | 38 | 168                | 160                   | 5,4                | 7 500              | 12 000                            | 3,85               | 7222 ACD/HCP4A  | –                              | –                                        |
|                      | 200 | 38 | 178                | 166                   | 5,6                | 7 000              | 11 000                            | 4,65               | 7222 CD/P4A     | –                              | –                                        |
|                      | 200 | 38 | 178                | 166                   | 5,6                | 8 500              | 13 000                            | 3,85               | 7222 CD/HCP4A   | –                              | –                                        |
| <b>120</b>           | 150 | 16 | 31,2               | 42,5                  | 1,53               | 6 700              | 11 000                            | 0,55               | 71824 ACD/P4    | –                              | –                                        |
|                      | 150 | 16 | 31,2               | 42,5                  | 1,53               | 8 000              | 13 000                            | 0,49               | 71824 ACD/HCP4  | –                              | –                                        |
|                      | 150 | 16 | 33,2               | 45                    | 1,63               | 7 500              | 12 000                            | 0,55               | 71824 CD/P4     | –                              | –                                        |
|                      | 150 | 16 | 33,2               | 45                    | 1,63               | 9 000              | 14 000                            | 0,49               | 71824 CD/HCP4   | –                              | –                                        |
|                      | 165 | 22 | 25,5               | 28,5                  | 1,02               | 9 000              | 14 000                            | 1,25               | 71924 ACB/P4A   | S                              | L                                        |
|                      | 165 | 22 | 25,5               | 28,5                  | 1,02               | 11 000             | 17 000                            | 1,2                | 71924 ACB/HCP4A | S                              | L                                        |
|                      | 165 | 22 | 27                 | 30,5                  | 1,08               | 10 000             | 16 000                            | 1,25               | 71924 CB/P4A    | S                              | L                                        |
|                      | 165 | 22 | 27                 | 30,5                  | 1,08               | 12 000             | 20 000                            | 1,2                | 71924 CB/HCP4A  | S                              | L                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 248).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 248).



## Dimensions

## Abutment and fillet dimensions

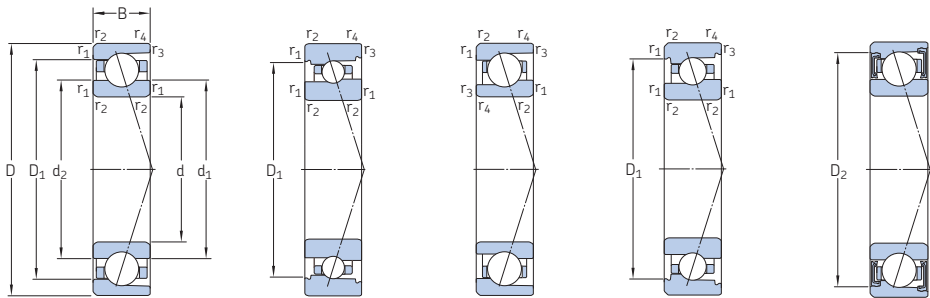
Reference  
grease  
quantity<sup>1)</sup>  
 $G_{ref}$ Calculation  
factor  
 $f_0$ 

| d                   | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> | $G_{ref}$       | $f_0$ |
|---------------------|----------------|----------------|----------------|----------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----------------|-------|
| mm                  |                |                |                |                |                          |                          | mm                     |                        |                        |                        |                        |                        |                | cm <sup>3</sup> | –     |
| <b>110</b><br>cont. | 122,3          | 122,3          | 137,7          | 140,6          | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146                    | 1                      | 0,6                    | 125,6          | 11              | –     |
|                     | 122,3          | 122,3          | 137,7          | 140,6          | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146                    | 1                      | 0,6                    | 125,6          | 11              | –     |
|                     | 122,3          | 122,3          | 137,7          | 140,6          | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146                    | 1                      | 0,6                    | 125,6          | 11              | 16,5  |
|                     | 122,3          | 122,3          | 137,7          | 140,6          | 1,1                      | 0,6                      | 116                    | 116                    | 144                    | 146                    | 1                      | 0,6                    | 125,6          | 11              | 16,5  |
|                     | 133,2          | 130,5          | 151,9          | 151,9          | 2                        | 1                        | 119                    | 119                    | 161                    | 165,4                  | 2                      | 1                      | 134,6          | 22              | –     |
|                     | 133,2          | 130,5          | 151,9          | 151,9          | 2                        | 1                        | 119                    | 119                    | 161                    | 165,4                  | 2                      | 1                      | 134,6          | 22              | –     |
|                     | 133,2          | 130,5          | 151,9          | 151,9          | 2                        | 1                        | 119                    | 119                    | 161                    | 165,4                  | 2                      | 1                      | 134,6          | 22              | 9,7   |
|                     | 133,2          | 130,5          | 151,9          | 151,9          | 2                        | 1                        | 119                    | 119                    | 161                    | 165,4                  | 2                      | 1                      | 134,6          | 22              | 9,7   |
|                     | 132,4          | 129,2          | 152,2          | 152,2          | 2                        | 1                        | 118,8                  | 118,8                  | 161,2                  | 164,4                  | 2                      | 1                      | 135,4          | 23              | –     |
|                     | 132,4          | 129,2          | 152,2          | 152,2          | 2                        | 1                        | 118,8                  | 118,8                  | 161,2                  | 164,4                  | 2                      | 1                      | 135,4          | 23              | –     |
|                     | 132,4          | 129,2          | 152,2          | 152,2          | 2                        | 1                        | 118,8                  | 118,8                  | 161,2                  | 164,4                  | 2                      | 1                      | 135,4          | 23              | 9,6   |
|                     | 132,4          | 129,2          | 152,2          | 152,2          | 2                        | 1                        | 118,8                  | 118,8                  | 161,2                  | 164,4                  | 2                      | 1                      | 135,4          | 23              | 9,6   |
|                     | 128,5          | 128,5          | 151,5          | 155,2          | 2                        | 1                        | 119                    | 119                    | 161                    | 165                    | 2                      | 1                      | 132,6          | 26              | –     |
|                     | 128,5          | 128,5          | 151,5          | 155,2          | 2                        | 1                        | 119                    | 119                    | 161                    | 165                    | 2                      | 1                      | 132,6          | 26              | –     |
|                     | 128,5          | 128,5          | 151,5          | 155,2          | 2                        | 1                        | 119                    | 119                    | 161                    | 165                    | 2                      | 1                      | 132,6          | 26              | 15,5  |
|                     | 128,5          | 128,5          | 151,5          | 155,2          | 2                        | 1                        | 119                    | 119                    | 161                    | 165                    | 2                      | 1                      | 132,6          | 26              | 15,5  |
|                     | 138,7          | 138,7          | 171,3          | –              | 2,1                      | 1,1                      | 122                    | 122                    | 188                    | 193                    | 2                      | 1                      | 145,9          | 54              | –     |
|                     | 138,7          | 138,7          | 171,3          | –              | 2,1                      | 1,1                      | 122                    | 122                    | 188                    | 193                    | 2                      | 1                      | 145,9          | 54              | –     |
|                     | 138,7          | 138,7          | 171,3          | –              | 2,1                      | 1,1                      | 122                    | 122                    | 188                    | 193                    | 2                      | 1                      | 145,9          | 54              | 14,7  |
|                     | 138,7          | 138,7          | 171,3          | –              | 2,1                      | 1,1                      | 122                    | 122                    | 188                    | 193                    | 2                      | 1                      | 145,9          | 54              | 14,7  |
| <b>120</b>          | 129,8          | 129,8          | 140,6          | –              | 1                        | 0,3                      | 124,6                  | 124,6                  | 145,4                  | 148                    | 1                      | 0,3                    | 130,9          | 5,5             | –     |
|                     | 129,8          | 129,8          | 140,6          | –              | 1                        | 0,3                      | 124,6                  | 124,6                  | 145,4                  | 148                    | 1                      | 0,3                    | 130,9          | 5,5             | –     |
|                     | 129,8          | 129,8          | 140,6          | –              | 1                        | 0,3                      | 124,6                  | 124,6                  | 145,4                  | 148                    | 1                      | 0,3                    | 130,9          | 5,5             | 17,3  |
|                     | 129,8          | 129,8          | 140,6          | –              | 1                        | 0,3                      | 124,6                  | 124,6                  | 145,4                  | 148                    | 1                      | 0,3                    | 130,9          | 5,5             | 17,3  |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | –     |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | –     |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | 10    |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | 10    |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | 10    |
|                     | 136,9          | 135            | 151,9          | 151,9          | 1,1                      | 0,6                      | 126                    | 126                    | 159                    | 161,8                  | 1                      | 0,6                    | 138,2          | 14              | 10    |

1) For calculating the initial grease fill → page 249

## 2.1 Angular contact ball bearings

d 120 – 130 mm



ACD, CD

ACB, CB

719 .. ACE,  
719 .. CE

70 .. ACE,  
70 .. CE

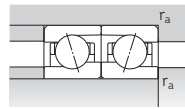
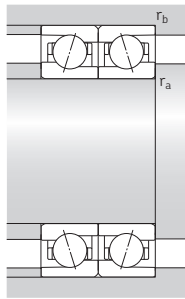
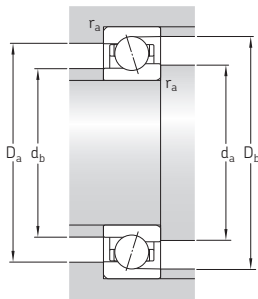
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 120<br>cont.         | 165 | 22 | 44,9               | 38                    | 1,32               | 9 500              | 15 000                            | 1,1                | 71924 ACE/P4A   | S                              | H1, L                                    |
|                      | 165 | 22 | 44,9               | 38                    | 1,32               | 11 500             | 17 500                            | 0,93               | 71924 ACE/HCP4A | S                              | H1, L                                    |
|                      | 165 | 22 | 47,5               | 40,5                  | 1,4                | 11 200             | 16 000                            | 1,1                | 71924 CE/P4A    | S                              | H1, L                                    |
|                      | 165 | 22 | 47,5               | 40,5                  | 1,4                | 12 700             | 19 000                            | 0,93               | 71924 CE/HCP4A  | S                              | H1, L                                    |
|                      | 165 | 22 | 72,8               | 86,5                  | 3,05               | 7 000              | 11 000                            | 1,15               | 71924 ACD/P4A   | S                              | H1, L                                    |
|                      | 165 | 22 | 72,8               | 86,5                  | 3,05               | 8 000              | 13 000                            | 0,99               | 71924 ACD/HCP4A | S                              | H1, L                                    |
|                      | 165 | 22 | 78                 | 91,5                  | 3,25               | 7 500              | 12 000                            | 1,15               | 71924 CD/P4A    | S                              | H1, L                                    |
|                      | 165 | 22 | 78                 | 91,5                  | 3,25               | 9 000              | 14 000                            | 0,99               | 71924 CD/HCP4A  | S                              | H1, L                                    |
|                      | 180 | 28 | 35,8               | 36,5                  | 1,27               | 8 500              | 13 000                            | 2,35               | 7024 ACB/P4A    | S                              | L                                        |
|                      | 180 | 28 | 35,8               | 36,5                  | 1,27               | 10 000             | 15 000                            | 2,25               | 7024 ACB/HCP4A  | S                              | L                                        |
|                      | 180 | 28 | 37,7               | 39                    | 1,34               | 9 500              | 14 000                            | 2,35               | 7024 CB/P4A     | S                              | L                                        |
|                      | 180 | 28 | 37,7               | 39                    | 1,34               | 11 000             | 17 000                            | 2,25               | 7024 CB/HCP4A   | S                              | L                                        |
|                      | 180 | 28 | 54                 | 52                    | 1,8                | 8 300              | 13 000                            | 2,15               | 7024 ACE/P4A    | S                              | H1, L, L1                                |
|                      | 180 | 28 | 54                 | 52                    | 1,8                | 10 000             | 15 500                            | 1,95               | 7024 ACE/HCP4A  | S                              | H1, L, L1                                |
|                      | 180 | 28 | 57,2               | 55                    | 1,9                | 9 300              | 14 500                            | 2,15               | 7024 CE/P4A     | S                              | H1, L, L1                                |
|                      | 180 | 28 | 57,2               | 55                    | 1,9                | 11 200             | 17 500                            | 1,95               | 7024 CE/HCP4A   | S                              | H1, L, L1                                |
|                      | 180 | 28 | 111                | 116                   | 4                  | 6 700              | 10 000                            | 2,15               | 7024 ACD/P4A    | S                              | H1, L                                    |
|                      | 180 | 28 | 111                | 116                   | 4                  | 8 000              | 12 000                            | 1,75               | 7024 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 180 | 28 | 114                | 122                   | 4,25               | 7 000              | 11 000                            | 2,15               | 7024 CD/P4A     | S                              | H1, L                                    |
|                      | 180 | 28 | 114                | 122                   | 4,25               | 8 500              | 13 000                            | 1,75               | 7024 CD/HCP4A   | S                              | H1, L                                    |
| 130                  | 215 | 40 | 190                | 183                   | 6                  | 6 000              | 9 000                             | 5,4                | 7224 ACD/P4A    | –                              | –                                        |
|                      | 215 | 40 | 190                | 183                   | 6                  | 7 000              | 11 000                            | 4,4                | 7224 ACD/HCP4A  | –                              | –                                        |
|                      | 215 | 40 | 199                | 193                   | 6,3                | 6 700              | 10 000                            | 5,4                | 7224 CD/P4A     | –                              | –                                        |
|                      | 215 | 40 | 199                | 193                   | 6,3                | 8 000              | 12 000                            | 4,4                | 7224 CD/HCP4A   | –                              | –                                        |
|                      | 165 | 18 | 36,4               | 50                    | 1,76               | 6 300              | 9 500                             | 0,77               | 71826 ACD/P4    | –                              | –                                        |
|                      | 165 | 18 | 36,4               | 50                    | 1,76               | 7 500              | 12 000                            | 0,7                | 71826 ACD/HCP4  | –                              | –                                        |
|                      | 165 | 18 | 39                 | 53                    | 1,86               | 7 000              | 11 000                            | 0,77               | 71826 CD/P4     | –                              | –                                        |
|                      | 165 | 18 | 39                 | 53                    | 1,86               | 8 500              | 13 000                            | 0,7                | 71826 CD/HCP4   | –                              | –                                        |

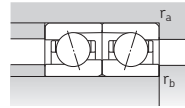
<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 250).

<sup>2)</sup> Applicable to open bearings only.

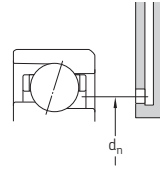
<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 250).



ACD, CD, ACB, CB,  
70 .. ACE, 70 .. CE



719 .. ACE, 719 .. CE

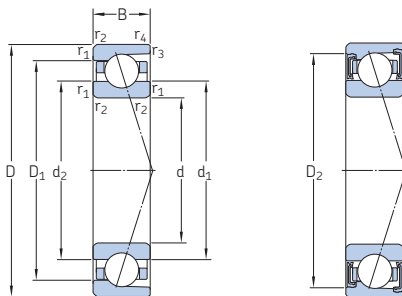


| Dimensions          |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> | Calculation factor<br>f <sub>0</sub> |
|---------------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|-------------------------------------------------------------|--------------------------------------|
| d                   | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     |                                                             |                                      |
| mm                  |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     |                                                             |                                      |
|                     |                |                |                |                |                                |                          |                        |                        |                        |                        |                        |                        |                |     | cm <sup>3</sup>                                             | –                                    |
| <b>120</b><br>cont. | 134            | 130,2          | 151            | 154,4          | 1,1                            | 0,6                      | 126                    | 123,2                  | 159                    | 161,8                  | 1                      | 0,6                    | 137,4          | 15  | –                                                           |                                      |
|                     | 134            | 130,2          | 151            | 154,4          | 1,1                            | 0,6                      | 126                    | 123,2                  | 159                    | 161,8                  | 1                      | 0,6                    | 137,4          | 15  | –                                                           |                                      |
|                     | 134            | 130,2          | 151            | 154,4          | 1,1                            | 0,6                      | 126                    | 123,2                  | 159                    | 161,8                  | 1                      | 0,6                    | 137,4          | 15  | 8,5                                                         |                                      |
|                     | 134            | 130,2          | 151            | 154,4          | 1,1                            | 0,6                      | 126                    | 123,2                  | 159                    | 161,8                  | 1                      | 0,6                    | 137,4          | 15  | 8,5                                                         |                                      |
|                     | 133,9          | 133,9          | 151,1          | 154,1          | 1,1                            | 0,6                      | 126                    | 126                    | 159                    | 161                    | 1                      | 0,6                    | 137,6          | 15  | –                                                           |                                      |
|                     | 133,9          | 133,9          | 151,1          | 154,1          | 1,1                            | 0,6                      | 126                    | 126                    | 159                    | 161                    | 1                      | 0,6                    | 137,6          | 15  | –                                                           |                                      |
|                     | 133,9          | 133,9          | 151,1          | 154,1          | 1,1                            | 0,6                      | 126                    | 126                    | 159                    | 161                    | 1                      | 0,6                    | 137,6          | 15  | 16,5                                                        |                                      |
|                     | 133,9          | 133,9          | 151,1          | 154,1          | 1,1                            | 0,6                      | 126                    | 126                    | 159                    | 161                    | 1                      | 0,6                    | 137,6          | 15  | 16,5                                                        |                                      |
|                     | 143,2          | 140,8          | 161,9          | 161,9          | 2                              | 1                        | 129                    | 129                    | 171                    | 175,4                  | 2                      | 1                      | 144,7          | 24  | –                                                           |                                      |
|                     | 143,2          | 140,8          | 161,9          | 161,9          | 2                              | 1                        | 129                    | 129                    | 171                    | 175,4                  | 2                      | 1                      | 144,7          | 24  | –                                                           |                                      |
|                     | 143,2          | 140,8          | 161,9          | 161,9          | 2                              | 1                        | 129                    | 129                    | 171                    | 175,4                  | 2                      | 1                      | 144,7          | 24  | 9,8                                                         |                                      |
|                     | 143,2          | 140,8          | 161,9          | 161,9          | 2                              | 1                        | 129                    | 129                    | 171                    | 175,4                  | 2                      | 1                      | 144,7          | 24  | 9,8                                                         |                                      |
|                     | 141,4          | 137,8          | 163,2          | 163,2          | 2                              | 1                        | 128,8                  | 128,8                  | 171,2                  | 174,4                  | 2                      | 1                      | 144,9          | 28  | –                                                           |                                      |
|                     | 141,4          | 137,8          | 163,2          | 163,2          | 2                              | 1                        | 128,8                  | 128,8                  | 171,2                  | 174,4                  | 2                      | 1                      | 144,9          | 28  | –                                                           |                                      |
|                     | 141,4          | 137,8          | 163,2          | 163,2          | 2                              | 1                        | 128,8                  | 128,8                  | 171,2                  | 174,4                  | 2                      | 1                      | 144,9          | 28  | 9,6                                                         |                                      |
|                     | 141,4          | 137,8          | 163,2          | 163,2          | 2                              | 1                        | 128,8                  | 128,8                  | 171,2                  | 174,4                  | 2                      | 1                      | 144,9          | 28  | 9,6                                                         |                                      |
|                     | 138,5          | 138,5          | 161,5          | 165,1          | 2                              | 1                        | 129                    | 129                    | 171                    | 175                    | 2                      | 1                      | 142,6          | 27  | –                                                           |                                      |
|                     | 138,5          | 138,5          | 161,5          | 165,1          | 2                              | 1                        | 129                    | 129                    | 171                    | 175                    | 2                      | 1                      | 142,6          | 27  | –                                                           |                                      |
|                     | 138,5          | 138,5          | 161,5          | 165,1          | 2                              | 1                        | 129                    | 129                    | 171                    | 175                    | 2                      | 1                      | 142,6          | 27  | 15,7                                                        |                                      |
|                     | 138,5          | 138,5          | 161,5          | 165,1          | 2                              | 1                        | 129                    | 129                    | 171                    | 175                    | 2                      | 1                      | 142,6          | 27  | 15,7                                                        |                                      |
| <b>130</b>          | 150,3          | 150,3          | 186,7          | –              | 2,1                            | 1,1                      | 132                    | 132                    | 203                    | 208                    | 2                      | 1                      | 158,2          | 69  | –                                                           |                                      |
|                     | 150,3          | 150,3          | 186,7          | –              | 2,1                            | 1,1                      | 132                    | 132                    | 203                    | 208                    | 2                      | 1                      | 158,2          | 69  | –                                                           |                                      |
|                     | 150,3          | 150,3          | 186,7          | –              | 2,1                            | 1,1                      | 132                    | 132                    | 203                    | 208                    | 2                      | 1                      | 158,2          | 69  | 14,6                                                        |                                      |
|                     | 150,3          | 150,3          | 186,7          | –              | 2,1                            | 1,1                      | 132                    | 132                    | 203                    | 208                    | 2                      | 1                      | 158,2          | 69  | 14,6                                                        |                                      |
|                     | 141,8          | 141,8          | 153,2          | –              | 1,1                            | 0,6                      | 136                    | 136                    | 159                    | 161,8                  | 1                      | 0,6                    | 144            | 9,3 | –                                                           |                                      |
|                     | 141,8          | 141,8          | 153,2          | –              | 1,1                            | 0,6                      | 136                    | 136                    | 159                    | 161,8                  | 1                      | 0,6                    | 144            | 9,3 | –                                                           |                                      |
|                     | 141,8          | 141,8          | 153,2          | –              | 1,1                            | 0,6                      | 136                    | 136                    | 159                    | 161,8                  | 1                      | 0,6                    | 144            | 9,3 | 17,3                                                        |                                      |
|                     | 141,8          | 141,8          | 153,2          | –              | 1,1                            | 0,6                      | 136                    | 136                    | 159                    | 161,8                  | 1                      | 0,6                    | 144            | 9,3 | 17,3                                                        |                                      |

<sup>1)</sup> For calculating the initial grease fill → page 251

## 2.1 Angular contact ball bearings

d 130 – 140 mm



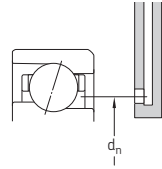
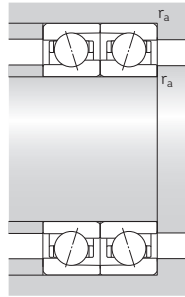
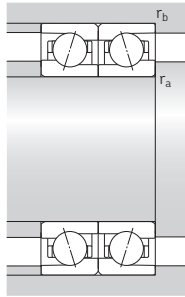
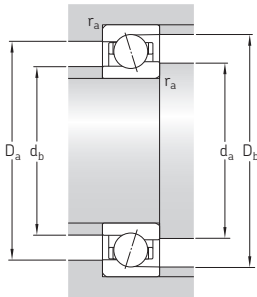
S... 1)

| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 130<br>cont.         | 180 | 24 | 87,1               | 102                   | 3,45               | 6 700              | 10 000                            | 1,55               | 71926 ACD/P4A   | S                              | H1, L                                    |
|                      | 180 | 24 | 87,1               | 102                   | 3,45               | 7 500              | 12 000                            | 1,3                | 71926 ACD/HCP4A | S                              | H1, L                                    |
|                      | 180 | 24 | 92,3               | 108                   | 3,65               | 7 000              | 11 000                            | 1,55               | 71926 CD/P4A    | S                              | H1, L                                    |
|                      | 180 | 24 | 92,3               | 108                   | 3,65               | 8 500              | 13 000                            | 1,3                | 71926 CD/HCP4A  | S                              | H1, L                                    |
|                      | 200 | 33 | 140                | 150                   | 4,9                | 6 000              | 9 000                             | 3,25               | 7026 ACD/P4A    | S                              | H1, L                                    |
|                      | 200 | 33 | 140                | 150                   | 4,9                | 7 500              | 12 000                            | 2,65               | 7026 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 200 | 33 | 148                | 156                   | 5,2                | 7 000              | 10 000                            | 3,25               | 7026 CD/P4A     | S                              | H1, L                                    |
|                      | 200 | 33 | 148                | 156                   | 5,2                | 8 000              | 13 000                            | 2,65               | 7026 CD/HCP4A   | S                              | H1, L                                    |
|                      | 230 | 40 | 203                | 212                   | 6,7                | 5 600              | 8 500                             | 6,35               | 7226 ACD/P4A    | –                              | –                                        |
|                      | 230 | 40 | 203                | 212                   | 6,7                | 6 700              | 10 000                            | 5,2                | 7226 ACD/HCP4A  | –                              | –                                        |
|                      | 230 | 40 | 216                | 224                   | 6,95               | 6 300              | 9 500                             | 6,35               | 7226 CD/P4A     | –                              | –                                        |
|                      | 230 | 40 | 216                | 224                   | 6,95               | 7 500              | 11 000                            | 5,2                | 7226 CD/HCP4A   | –                              | –                                        |
| 140                  | 175 | 18 | 42,3               | 58,5                  | 2                  | 6 000              | 9 000                             | 0,8                | 71828 ACD/P4    | –                              | –                                        |
|                      | 175 | 18 | 42,3               | 58,5                  | 2                  | 7 000              | 11 000                            | 0,71               | 71828 ACD/HCP4  | –                              | –                                        |
|                      | 175 | 18 | 44,9               | 62                    | 2,12               | 6 300              | 10 000                            | 0,8                | 71828 CD/P4     | –                              | –                                        |
|                      | 175 | 18 | 44,9               | 62                    | 2,12               | 8 000              | 12 000                            | 0,71               | 71828 CD/HCP4   | –                              | –                                        |
|                      | 190 | 24 | 90,4               | 110                   | 3,65               | 6 000              | 9 000                             | 1,65               | 71928 ACD/P4A   | S                              | H1, L                                    |
|                      | 190 | 24 | 90,4               | 110                   | 3,65               | 7 000              | 11 000                            | 1,4                | 71928 ACD/HCP4A | S                              | H1, L                                    |
|                      | 190 | 24 | 95,6               | 116                   | 3,9                | 6 700              | 10 000                            | 1,65               | 71928 CD/P4A    | S                              | H1, L                                    |
|                      | 190 | 24 | 95,6               | 116                   | 3,9                | 8 000              | 12 000                            | 1,4                | 71928 CD/HCP4A  | S                              | H1, L                                    |
|                      | 210 | 33 | 146                | 156                   | 5,1                | 5 600              | 8 500                             | 3,4                | 7028 ACD/P4A    | S                              | H1, L                                    |
|                      | 210 | 33 | 146                | 156                   | 5,1                | 7 000              | 11 000                            | 2,85               | 7028 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 210 | 33 | 153                | 166                   | 5,3                | 6 700              | 10 000                            | 3,4                | 7028 CD/P4A     | S                              | H1, L                                    |
|                      | 210 | 33 | 153                | 166                   | 5,3                | 7 500              | 12 000                            | 2,85               | 7028 CD/HCP4A   | S                              | H1, L                                    |
|                      | 250 | 42 | 212                | 228                   | 6,95               | 5 000              | 7 500                             | 8,15               | 7228 ACD/P4A    | –                              | –                                        |
|                      | 250 | 42 | 212                | 228                   | 6,95               | 6 000              | 9 000                             | 6,9                | 7228 ACD/HCP4A  | –                              | –                                        |
|                      | 250 | 42 | 221                | 240                   | 7,35               | 5 600              | 8 500                             | 8,15               | 7228 CD/P4A     | –                              | –                                        |
|                      | 250 | 42 | 221                | 240                   | 7,35               | 7 000              | 10 000                            | 6,9                | 7228 CD/HCP4A   | –                              | –                                        |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 252).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 252).

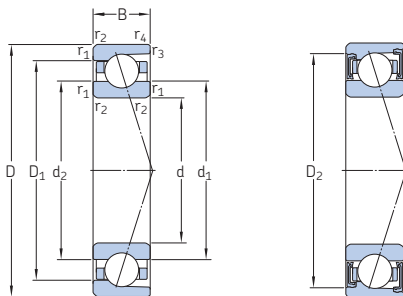


| Dimensions |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |                 |   |
|------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|-----------------|---|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |                 |   |
| mm         |                |                |                |                |                       |                       |                                |                     |                     |                     |                     |                     |                |                                         |                    | cm <sup>3</sup> | – |
| 130 cont.  | 145,4          | 145,4          | 164,6          | 168,3          | 1,5                   | 0,6                   | 137                            | 137                 | 173                 | 176                 | 1,5                 | 0,6                 | 149,5          | 20                                      | –                  |                 |   |
|            | 145,4          | 145,4          | 164,6          | 168,3          | 1,5                   | 0,6                   | 137                            | 137                 | 173                 | 176                 | 1,5                 | 0,6                 | 149,5          | 20                                      | –                  |                 |   |
|            | 145,4          | 145,4          | 164,6          | 168,3          | 1,5                   | 0,6                   | 137                            | 137                 | 173                 | 176                 | 1,5                 | 0,6                 | 149,5          | 20                                      | 16,4               |                 |   |
|            | 145,4          | 145,4          | 164,6          | 168,3          | 1,5                   | 0,6                   | 137                            | 137                 | 173                 | 176                 | 1,5                 | 0,6                 | 149,5          | 20                                      | 16,4               |                 |   |
|            | 151,6          | 151,6          | 178,4          | 183,1          | 2                     | 1                     | 139                            | 139                 | 191                 | 195                 | 2                   | 1                   | 156,4          | 42                                      | –                  |                 |   |
|            | 151,6          | 151,6          | 178,4          | 183,1          | 2                     | 1                     | 139                            | 139                 | 191                 | 195                 | 2                   | 1                   | 156,4          | 42                                      | –                  |                 |   |
|            | 151,6          | 151,6          | 178,4          | 183,1          | 2                     | 1                     | 139                            | 139                 | 191                 | 195                 | 2                   | 1                   | 156,4          | 42                                      | 15,6               |                 |   |
|            | 151,6          | 151,6          | 178,4          | 183,1          | 2                     | 1                     | 139                            | 139                 | 191                 | 195                 | 2                   | 1                   | 156,4          | 42                                      | 15,6               |                 |   |
|            | 162,8          | 162,8          | 199,2          | –              | 3                     | 1,1                   | 144                            | 144                 | 216                 | 223                 | 2,5                 | 1                   | 170,7          | 72                                      | –                  |                 |   |
|            | 162,8          | 162,8          | 199,2          | –              | 3                     | 1,1                   | 144                            | 144                 | 216                 | 223                 | 2,5                 | 1                   | 170,7          | 72                                      | –                  |                 |   |
|            | 162,8          | 162,8          | 199,2          | –              | 3                     | 1,1                   | 144                            | 144                 | 216                 | 223                 | 2,5                 | 1                   | 170,7          | 72                                      | 14,9               |                 |   |
|            | 162,8          | 162,8          | 199,2          | –              | 3                     | 1,1                   | 144                            | 144                 | 216                 | 223                 | 2,5                 | 1                   | 170,7          | 72                                      | 14,9               |                 |   |
| 140        | 151,3          | 151,3          | 163,7          | –              | 1,1                   | 0,6                   | 146                            | 146                 | 169                 | 171,8               | 1                   | 0,6                 | 153,2          | 9,9                                     | –                  |                 |   |
|            | 151,3          | 151,3          | 163,7          | –              | 1,1                   | 0,6                   | 146                            | 146                 | 169                 | 171,8               | 1                   | 0,6                 | 153,2          | 9,9                                     | –                  |                 |   |
|            | 151,3          | 151,3          | 163,7          | –              | 1,1                   | 0,6                   | 146                            | 146                 | 169                 | 171,8               | 1                   | 0,6                 | 153,2          | 9,9                                     | 17,3               |                 |   |
|            | 151,3          | 151,3          | 163,7          | –              | 1,1                   | 0,6                   | 146                            | 146                 | 169                 | 171,8               | 1                   | 0,6                 | 153,2          | 9,9                                     | 17,3               |                 |   |
|            | 155,4          | 155,4          | 174,6          | 178,3          | 1,5                   | 0,6                   | 147                            | 147                 | 183                 | 186                 | 1,5                 | 0,6                 | 159,5          | 22                                      | –                  |                 |   |
|            | 155,4          | 155,4          | 174,6          | 178,3          | 1,5                   | 0,6                   | 147                            | 147                 | 183                 | 186                 | 1,5                 | 0,6                 | 159,5          | 22                                      | –                  |                 |   |
|            | 155,4          | 155,4          | 174,6          | 178,3          | 1,5                   | 0,6                   | 147                            | 147                 | 183                 | 186                 | 1,5                 | 0,6                 | 159,5          | 22                                      | 16,6               |                 |   |
|            | 155,4          | 155,4          | 174,6          | 178,3          | 1,5                   | 0,6                   | 147                            | 147                 | 183                 | 186                 | 1,5                 | 0,6                 | 159,5          | 22                                      | 16,6               |                 |   |
|            | 161,6          | 161,6          | 188,4          | 193,1          | 2                     | 1                     | 149                            | 149                 | 201                 | 205                 | 2                   | 1                   | 166,3          | 45                                      | –                  |                 |   |
|            | 161,6          | 161,6          | 188,4          | 193,1          | 2                     | 1                     | 149                            | 149                 | 201                 | 205                 | 2                   | 1                   | 166,3          | 45                                      | –                  |                 |   |
|            | 161,6          | 161,6          | 188,4          | 193,1          | 2                     | 1                     | 149                            | 149                 | 201                 | 205                 | 2                   | 1                   | 166,3          | 45                                      | 15,8               |                 |   |
|            | 161,6          | 161,6          | 188,4          | 193,1          | 2                     | 1                     | 149                            | 149                 | 201                 | 205                 | 2                   | 1                   | 166,3          | 45                                      | 15,8               |                 |   |
|            | 176,9          | 176,9          | 213,2          | –              | 3                     | 1,5                   | 154                            | 154                 | 236                 | 241                 | 2,5                 | 1,5                 | 184,8          | 84                                      | –                  |                 |   |
|            | 176,9          | 176,9          | 213,2          | –              | 3                     | 1,5                   | 154                            | 154                 | 236                 | 241                 | 2,5                 | 1,5                 | 184,8          | 84                                      | –                  |                 |   |
|            | 176,9          | 176,9          | 213,2          | –              | 3                     | 1,5                   | 154                            | 154                 | 236                 | 241                 | 2,5                 | 1,5                 | 184,8          | 84                                      | 15,2               |                 |   |
|            | 176,9          | 176,9          | 213,2          | –              | 3                     | 1,5                   | 154                            | 154                 | 236                 | 241                 | 2,5                 | 1,5                 | 184,8          | 84                                      | 15,2               |                 |   |

<sup>1)</sup> For calculating the initial grease fill → page 253

## 2.1 Angular contact ball bearings

d 150 – 170 mm



S... 1)

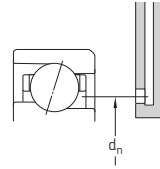
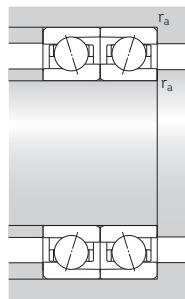
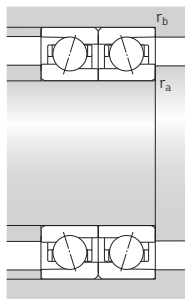
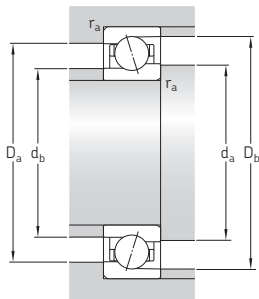
| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                                   | Mass <sup>2)</sup> | Designation     | Available variants             |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|-----------------------------------|--------------------|-----------------|--------------------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication <sup>2)</sup> |                    |                 | Sealing solution <sup>1)</sup> | Direct oil-air lubrication <sup>3)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                                   | kg                 | –               | –                              |                                          |
| 150                  | 190 | 20 | 48,8               | 68                    | 2,2                | 5 300              | 8 500                             | 1,1                | 71830 ACD/P4    | –                              | –                                        |
|                      | 190 | 20 | 48,8               | 68                    | 2,2                | 6 300              | 10 000                            | 0,98               | 71830 ACD/HCP4  | –                              | –                                        |
|                      | 190 | 20 | 52                 | 72                    | 2,36               | 6 000              | 9 000                             | 1,1                | 71830 CD/P4     | –                              | –                                        |
|                      | 190 | 20 | 52                 | 72                    | 2,36               | 7 000              | 11 000                            | 0,98               | 71830 CD/HCP4   | –                              | –                                        |
|                      | 210 | 28 | 119                | 140                   | 4,5                | 5 600              | 8 500                             | 2,55               | 71930 ACD/P4A   | S                              | H1, L                                    |
|                      | 210 | 28 | 119                | 140                   | 4,5                | 6 700              | 10 000                            | 2,05               | 71930 ACD/HCP4A | S                              | H1, L                                    |
|                      | 210 | 28 | 125                | 146                   | 4,75               | 6 300              | 9 500                             | 2,55               | 71930 CD/P4A    | S                              | H1, L                                    |
|                      | 210 | 28 | 125                | 146                   | 4,75               | 7 500              | 11 000                            | 2,05               | 71930 CD/HCP4A  | S                              | H1, L                                    |
|                      | 225 | 35 | 163                | 180                   | 5,6                | 5 300              | 8 000                             | 4,15               | 7030 ACD/P4A    | S                              | H1, L                                    |
|                      | 225 | 35 | 163                | 180                   | 5,6                | 6 700              | 10 000                            | 3,45               | 7030 ACD/HCP4A  | S                              | H1, L                                    |
|                      | 225 | 35 | 172                | 190                   | 5,85               | 6 000              | 9 000                             | 4,15               | 7030 CD/P4A     | S                              | H1, L                                    |
|                      | 225 | 35 | 172                | 190                   | 5,85               | 7 000              | 11 000                            | 3,45               | 7030 CD/HCP4A   | S                              | H1, L                                    |
| 160                  | 200 | 20 | 50,7               | 75                    | 2,36               | 5 000              | 8 000                             | 1,25               | 71832 ACD/P4    | –                              | –                                        |
|                      | 200 | 20 | 50,7               | 75                    | 2,36               | 6 000              | 9 500                             | 1,1                | 71832 ACD/HCP4  | –                              | –                                        |
|                      | 200 | 20 | 54                 | 78                    | 2,5                | 5 600              | 8 500                             | 1,25               | 71832 CD/P4     | –                              | –                                        |
|                      | 200 | 20 | 54                 | 78                    | 2,5                | 6 700              | 10 000                            | 1,1                | 71832 CD/HCP4   | –                              | –                                        |
|                      | 220 | 28 | 124                | 153                   | 4,75               | 5 300              | 8 000                             | 2,7                | 71932 ACD/P4A   | –                              | H1, L                                    |
|                      | 220 | 28 | 124                | 153                   | 4,75               | 6 300              | 9 500                             | 2,25               | 71932 ACD/HCP4A | –                              | H1, L                                    |
|                      | 220 | 28 | 130                | 160                   | 5                  | 6 000              | 9 000                             | 2,7                | 71932 CD/P4A    | –                              | H1, L                                    |
|                      | 220 | 28 | 130                | 160                   | 5                  | 7 500              | 11 000                            | 2,25               | 71932 CD/HCP4A  | –                              | H1, L                                    |
|                      | 240 | 38 | 182                | 204                   | 6,2                | 5 000              | 7 500                             | 5,15               | 7032 ACD/P4A    | –                              | H1, L                                    |
|                      | 240 | 38 | 182                | 204                   | 6,2                | 6 300              | 9 500                             | 4,25               | 7032 ACD/HCP4A  | –                              | H1, L                                    |
|                      | 240 | 38 | 195                | 216                   | 6,55               | 5 600              | 8 500                             | 5,15               | 7032 CD/P4A     | –                              | H1, L                                    |
|                      | 240 | 38 | 195                | 216                   | 6,55               | 6 700              | 11 000                            | 4,25               | 7032 CD/HCP4A   | –                              | H1, L                                    |
| 170                  | 230 | 28 | 124                | 160                   | 4,8                | 5 000              | 7 500                             | 2,85               | 71934 ACD/P4A   | –                              | H1                                       |
|                      | 230 | 28 | 124                | 160                   | 4,8                | 6 000              | 9 000                             | 2,35               | 71934 ACD/HCP4A | –                              | H1                                       |
|                      | 230 | 28 | 133                | 166                   | 5,1                | 5 600              | 8 500                             | 2,85               | 71934 CD/P4A    | –                              | H1                                       |
|                      | 230 | 28 | 133                | 166                   | 5,1                | 7 000              | 10 000                            | 2,35               | 71934 CD/HCP4A  | –                              | H1                                       |

<sup>1)</sup> Designation prefix S. For details, refer to *Sealing solutions* (→ page 254).

<sup>2)</sup> Applicable to open bearings only.

<sup>3)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 254).



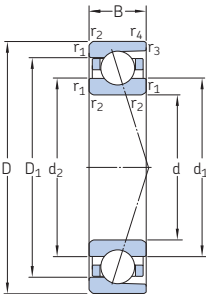


| Dimensions |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |    | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|----|------------------------------------------------------|-----------------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |    |                                                      |                             |
| mm         |                |                |                |                |                                |                          | mm                     |                        |                        |                        |                        |                        |                |    | cm <sup>3</sup>                                      | –                           |
| 150        | 163,4          | 163,4          | 176,7          | –              | 1,1                            | 0,6                      | 156                    | 156                    | 184                    | 186,8                  | 1                      | 0,6                    | 165,6          | 13 | –                                                    | –                           |
|            | 163,4          | 163,4          | 176,7          | –              | 1,1                            | 0,6                      | 156                    | 156                    | 184                    | 186,8                  | 1                      | 0,6                    | 165,6          | 13 | –                                                    | –                           |
|            | 163,4          | 163,4          | 176,7          | –              | 1,1                            | 0,6                      | 156                    | 156                    | 184                    | 186,8                  | 1                      | 0,6                    | 165,6          | 13 | 17,3                                                 | 17,3                        |
|            | 163,4          | 163,4          | 176,7          | –              | 1,1                            | 0,6                      | 156                    | 156                    | 184                    | 186,8                  | 1                      | 0,6                    | 165,6          | 13 | 17,3                                                 | 17,3                        |
|            | 168,5          | 168,5          | 191,5          | 195,2          | 2                              | 1                        | 159                    | 159                    | 201                    | 205                    | 2                      | 1                      | 173,5          | 33 | –                                                    | –                           |
|            | 168,5          | 168,5          | 191,5          | 195,2          | 2                              | 1                        | 159                    | 159                    | 201                    | 205                    | 2                      | 1                      | 173,5          | 33 | –                                                    | –                           |
|            | 168,5          | 168,5          | 191,5          | 195,2          | 2                              | 1                        | 159                    | 159                    | 201                    | 205                    | 2                      | 1                      | 173,5          | 33 | 16,2                                                 | 16,2                        |
|            | 168,5          | 168,5          | 191,5          | 195,2          | 2                              | 1                        | 159                    | 159                    | 201                    | 205                    | 2                      | 1                      | 173,5          | 33 | 16,2                                                 | 16,2                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | –                                                    | –                           |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | –                                                    | –                           |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
|            | 173,1          | 173,1          | 201,9          | 206,6          | 2,1                            | 1                        | 161                    | 161                    | 214                    | 220                    | 2                      | 1                      | 178,2          | 54 | 15,8                                                 | 15,8                        |
| 160        | 173,4          | 173,4          | 186,7          | –              | 1,1                            | 0,6                      | 166                    | 166                    | 194                    | 196,8                  | 1                      | 0,6                    | 175,6          | 14 | –                                                    | –                           |
|            | 173,4          | 173,4          | 186,7          | –              | 1,1                            | 0,6                      | 166                    | 166                    | 194                    | 196,8                  | 1                      | 0,6                    | 175,6          | 14 | –                                                    | –                           |
|            | 173,4          | 173,4          | 186,7          | –              | 1,1                            | 0,6                      | 166                    | 166                    | 194                    | 196,8                  | 1                      | 0,6                    | 175,6          | 14 | 17,4                                                 | 17,4                        |
|            | 173,4          | 173,4          | 186,7          | –              | 1,1                            | 0,6                      | 166                    | 166                    | 194                    | 196,8                  | 1                      | 0,6                    | 175,6          | 14 | 17,4                                                 | 17,4                        |
|            | 178,5          | 178,5          | 201,5          | –              | 2                              | 1                        | 169                    | 169                    | 211                    | 215                    | 2                      | 1                      | 183,5          | 33 | –                                                    | –                           |
|            | 178,5          | 178,5          | 201,5          | –              | 2                              | 1                        | 169                    | 169                    | 211                    | 215                    | 2                      | 1                      | 183,5          | 33 | –                                                    | –                           |
|            | 178,5          | 178,5          | 201,5          | –              | 2                              | 1                        | 169                    | 169                    | 211                    | 215                    | 2                      | 1                      | 183,5          | 33 | 16,4                                                 | 16,4                        |
|            | 178,5          | 178,5          | 201,5          | –              | 2                              | 1                        | 169                    | 169                    | 211                    | 215                    | 2                      | 1                      | 183,5          | 33 | 16,4                                                 | 16,4                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | –                                                    | –                           |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | –                                                    | –                           |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
|            | 184,7          | 184,7          | 215,3          | –              | 2,1                            | 1                        | 171                    | 171                    | 229                    | 235                    | 2                      | 1                      | 191,4          | 66 | 15,8                                                 | 15,8                        |
| 170        | 188,5          | 188,5          | 211,5          | –              | 2                              | 1                        | 179                    | 179                    | 221                    | 225                    | 2                      | 1                      | 193,5          | 36 | –                                                    | –                           |
|            | 188,5          | 188,5          | 211,5          | –              | 2                              | 1                        | 179                    | 179                    | 221                    | 225                    | 2                      | 1                      | 193,5          | 36 | –                                                    | –                           |
|            | 188,5          | 188,5          | 211,5          | –              | 2                              | 1                        | 179                    | 179                    | 221                    | 225                    | 2                      | 1                      | 193,5          | 36 | 16,5                                                 | 16,5                        |
|            | 188,5          | 188,5          | 211,5          | –              | 2                              | 1                        | 179                    | 179                    | 221                    | 225                    | 2                      | 1                      | 193,5          | 36 | 16,5                                                 | 16,5                        |

<sup>1)</sup> For calculating the initial grease fill → page 255

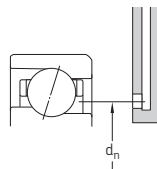
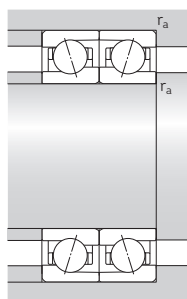
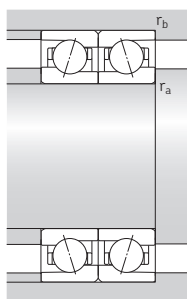
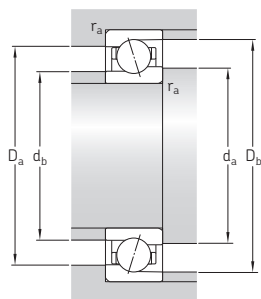
# 2.1 Angular contact ball bearings

d 170 – 200 mm



| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass | Designation     | Available variants |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|---------------------|------|-----------------|--------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |      |                 | Sealing solution   | Direct oil-air lubrication <sup>1)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                     | kg   | –               | –                  |                                          |
| <b>170</b><br>cont.  | 260 | 42 | 199                | 232                   | 6,7                | 4 800              | 7 000               | 7    | 7034 ACD/P4A    | –                  | H1, L                                    |
|                      | 260 | 42 | 199                | 232                   | 6,7                | 6 000              | 9 000               | 5,95 | 7034 ACD/HCP4A  | –                  | H1, L                                    |
|                      | 260 | 42 | 212                | 245                   | 7,1                | 5 300              | 8 000               | 7    | 7034 CD/P4A     | –                  | H1, L                                    |
|                      | 260 | 42 | 212                | 245                   | 7,1                | 6 300              | 10 000              | 5,95 | 7034 CD/HCP4A   | –                  | H1, L                                    |
| <b>180</b>           | 250 | 33 | 159                | 200                   | 5,85               | 4 800              | 7 000               | 4,2  | 71936 ACD/P4A   | –                  | H1                                       |
|                      | 250 | 33 | 159                | 200                   | 5,85               | 5 600              | 8 500               | 3,5  | 71936 ACD/HCP4A | –                  | H1                                       |
|                      | 250 | 33 | 168                | 212                   | 6,1                | 5 300              | 8 000               | 4,2  | 71936 CD/P4A    | –                  | H1                                       |
|                      | 250 | 33 | 168                | 212                   | 6,1                | 6 700              | 9 500               | 3,5  | 71936 CD/HCP4A  | –                  | H1                                       |
|                      | 280 | 46 | 229                | 275                   | 7,65               | 4 300              | 6 300               | 9,1  | 7036 ACD/P4A    | –                  | H1, L                                    |
|                      | 280 | 46 | 229                | 275                   | 7,65               | 5 300              | 8 000               | 7,7  | 7036 ACD/HCP4A  | –                  | H1, L                                    |
|                      | 280 | 46 | 242                | 290                   | 8,15               | 5 000              | 7 500               | 9,1  | 7036 CD/P4A     | –                  | H1, L                                    |
|                      | 280 | 46 | 242                | 290                   | 8,15               | 6 000              | 9 000               | 7,7  | 7036 CD/HCP4A   | –                  | H1, L                                    |
| <b>190</b>           | 260 | 33 | 163                | 208                   | 5,85               | 4 500              | 6 700               | 4,35 | 71938 ACD/P4A   | –                  | H1                                       |
|                      | 260 | 33 | 163                | 208                   | 5,85               | 5 300              | 8 000               | 3,65 | 71938 ACD/HCP4A | –                  | H1                                       |
|                      | 260 | 33 | 172                | 220                   | 6,2                | 5 000              | 7 500               | 4,35 | 71938 CD/P4A    | –                  | H1                                       |
|                      | 260 | 33 | 172                | 220                   | 6,2                | 6 300              | 9 000               | 3,65 | 71938 CD/HCP4A  | –                  | H1                                       |
|                      | 290 | 46 | 234                | 290                   | 8                  | 4 300              | 6 300               | 9,5  | 7038 ACD/P4A    | –                  | H1                                       |
|                      | 290 | 46 | 234                | 290                   | 8                  | 5 300              | 8 000               | 8,05 | 7038 ACD/HCP4A  | –                  | H1                                       |
|                      | 290 | 46 | 247                | 305                   | 8,3                | 4 800              | 7 000               | 9,5  | 7038 CD/P4A     | –                  | H1                                       |
|                      | 290 | 46 | 247                | 305                   | 8,3                | 5 600              | 9 000               | 8,05 | 7038 CD/HCP4A   | –                  | H1                                       |
| <b>200</b>           | 280 | 38 | 199                | 250                   | 6,8                | 4 300              | 6 300               | 6,1  | 71940 ACD/P4A   | –                  | H1                                       |
|                      | 280 | 38 | 199                | 250                   | 6,8                | 5 000              | 7 500               | 5,1  | 71940 ACD/HCP4A | –                  | H1                                       |
|                      | 280 | 38 | 208                | 265                   | 7,2                | 4 800              | 7 000               | 6,1  | 71940 CD/P4A    | –                  | H1                                       |
|                      | 280 | 38 | 208                | 265                   | 7,2                | 6 000              | 8 500               | 5,1  | 71940 CD/HCP4A  | –                  | H1                                       |
|                      | 310 | 51 | 281                | 365                   | 9,8                | 4 000              | 6 000               | 12,5 | 7040 ACD/P4A    | –                  | H1                                       |
|                      | 310 | 51 | 281                | 365                   | 9,8                | 5 000              | 7 500               | 10   | 7040 ACD/HCP4A  | –                  | H1                                       |
|                      | 310 | 51 | 296                | 390                   | 10,2               | 4 500              | 6 700               | 12,5 | 7040 CD/P4A     | –                  | H1                                       |
|                      | 310 | 51 | 296                | 390                   | 10,2               | 5 300              | 8 000               | 10   | 7040 CD/HCP4A   | –                  | H1                                       |

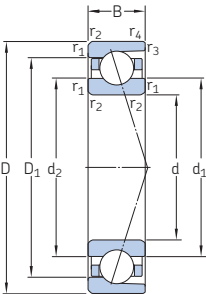
<sup>1)</sup> Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 256).



| Dimensions |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |
|------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |
| mm         |                |                |                |                |                       |                       | mm                             |                     |                     |                     |                     |                     |                | cm <sup>3</sup>                         | –                  |
| 170 cont.  | 198,7          | 198,7          | 231,3          | –              | 2,1                   | 1,1                   | 181                            | 181                 | 249                 | 254                 | 2                   | 1                   | 205,8          | 84                                      | –                  |
|            | 198,7          | 198,7          | 231,3          | –              | 2,1                   | 1,1                   | 181                            | 181                 | 249                 | 254                 | 2                   | 1                   | 205,8          | 84                                      | –                  |
|            | 198,7          | 198,7          | 231,3          | –              | 2,1                   | 1,1                   | 181                            | 181                 | 249                 | 254                 | 2                   | 1                   | 205,8          | 84                                      | 15,9               |
|            | 198,7          | 198,7          | 231,3          | –              | 2,1                   | 1,1                   | 181                            | 181                 | 249                 | 254                 | 2                   | 1                   | 205,8          | 84                                      | 15,9               |
| 180        | 201,6          | 201,6          | 228,4          | –              | 2                     | 1                     | 189                            | 189                 | 241                 | 245                 | 2                   | 1                   | 207,4          | 54                                      | –                  |
|            | 201,6          | 201,6          | 228,4          | –              | 2                     | 1                     | 189                            | 189                 | 241                 | 245                 | 2                   | 1                   | 207,4          | 54                                      | –                  |
|            | 201,6          | 201,6          | 228,4          | –              | 2                     | 1                     | 189                            | 189                 | 241                 | 245                 | 2                   | 1                   | 207,4          | 54                                      | 16,3               |
|            | 201,6          | 201,6          | 228,4          | –              | 2                     | 1                     | 189                            | 189                 | 241                 | 245                 | 2                   | 1                   | 207,4          | 54                                      | 16,3               |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | –                  |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | –                  |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | 15,7               |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | 15,7               |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | 15,7               |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | 15,7               |
|            | 211,8          | 211,8          | 248,2          | –              | 2,1                   | 1,1                   | 191                            | 191                 | 269                 | 274                 | 2                   | 1                   | 219,7          | 111                                     | 15,7               |
| 190        | 211,6          | 211,6          | 238,4          | –              | 2                     | 1                     | 199                            | 199                 | 251                 | 255                 | 2                   | 1                   | 217,4          | 57                                      | –                  |
|            | 211,6          | 211,6          | 238,4          | –              | 2                     | 1                     | 199                            | 199                 | 251                 | 255                 | 2                   | 1                   | 217,4          | 57                                      | –                  |
|            | 211,6          | 211,6          | 238,4          | –              | 2                     | 1                     | 199                            | 199                 | 251                 | 255                 | 2                   | 1                   | 217,4          | 57                                      | 16,4               |
|            | 211,6          | 211,6          | 238,4          | –              | 2                     | 1                     | 199                            | 199                 | 251                 | 255                 | 2                   | 1                   | 217,4          | 57                                      | 16,4               |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | –                  |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | –                  |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | 15,9               |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | 15,9               |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | 15,9               |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | 15,9               |
|            | 221,8          | 221,8          | 258,2          | –              | 2,1                   | 1,1                   | 201                            | 201                 | 279                 | 284                 | 2                   | 1                   | 229,7          | 114                                     | 15,9               |
| 200        | 224,7          | 224,7          | 255,3          | –              | 2,1                   | 1                     | 209                            | 209                 | 271                 | 275                 | 2                   | 1                   | 231,4          | 81                                      | –                  |
|            | 224,7          | 224,7          | 255,3          | –              | 2,1                   | 1                     | 209                            | 209                 | 271                 | 275                 | 2                   | 1                   | 231,4          | 81                                      | –                  |
|            | 224,7          | 224,7          | 255,3          | –              | 2,1                   | 1                     | 209                            | 209                 | 271                 | 275                 | 2                   | 1                   | 231,4          | 81                                      | 16,3               |
|            | 224,7          | 224,7          | 255,3          | –              | 2,1                   | 1                     | 209                            | 209                 | 271                 | 275                 | 2                   | 1                   | 231,4          | 81                                      | 16,3               |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | –                  |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | –                  |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | 15,6               |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | 15,6               |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | 15,6               |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | 15,6               |
|            | 233,9          | 233,9          | 276,1          | –              | 2,1                   | 1,1                   | 211                            | 211                 | 299                 | 304                 | 2                   | 1                   | 243,2          | 153                                     | 15,6               |

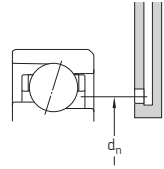
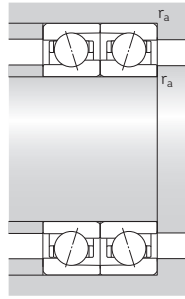
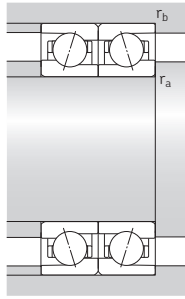
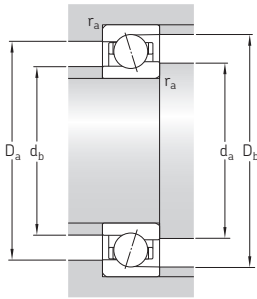
<sup>1)</sup> For calculating the initial grease fill → page 257

# 2.1 Angular contact ball bearings d 220 – 300 mm



| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass | Designation       | Available variants |                                          |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|---------------------|------|-------------------|--------------------|------------------------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |      |                   | Sealing solution   | Direct oil-air lubrication <sup>1)</sup> |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                     | kg   | –                 | –                  |                                          |
| 220                  | 300 | 38 | 208                | 285                   | 7,5                | 3 800              | 5 600               | 6,6  | 71944 ACD/P4A     | –                  | L                                        |
|                      | 300 | 38 | 208                | 285                   | 7,5                | 4 500              | 6 700               | 5,55 | 71944 ACD/HCP4A   | –                  | L                                        |
|                      | 300 | 38 | 221                | 300                   | 7,8                | 4 300              | 6 300               | 6,6  | 71944 CD/P4A      | –                  | L                                        |
|                      | 300 | 38 | 221                | 300                   | 7,8                | 5 300              | 7 500               | 5,55 | 71944 CD/HCP4A    | –                  | L                                        |
|                      | 340 | 56 | 319                | 440                   | 11                 | 3 600              | 5 300               | 16   | 7044 ACD/P4A      | –                  | –                                        |
|                      | 340 | 56 | 319                | 440                   | 11                 | 4 500              | 6 700               | 13   | 7044 ACD/HCP4A    | –                  | –                                        |
|                      | 340 | 56 | 338                | 455                   | 11,6               | 4 000              | 6 000               | 16   | 7044 CD/P4A       | –                  | –                                        |
|                      | 340 | 56 | 338                | 455                   | 11,6               | 4 800              | 7 500               | 13   | 7044 CD/HCP4A     | –                  | –                                        |
|                      | 320 | 38 | 216                | 305                   | 7,8                | 3 200              | 4 800               | 8,5  | 71948 ACD/P4A     | –                  | L                                        |
|                      | 320 | 38 | 216                | 305                   | 7,8                | 3 800              | 5 600               | 6    | 71948 ACD/HCP4A   | –                  | L                                        |
|                      | 320 | 38 | 229                | 325                   | 8,15               | 3 800              | 5 600               | 8,5  | 71948 CD/P4A      | –                  | L                                        |
|                      | 320 | 38 | 229                | 325                   | 8,15               | 4 800              | 6 700               | 6    | 71948 CD/HCP4A    | –                  | L                                        |
| 240                  | 360 | 56 | 325                | 465                   | 11,4               | 3 400              | 5 000               | 17   | 7048 ACD/P4A      | –                  | –                                        |
|                      | 360 | 56 | 325                | 465                   | 11,4               | 4 300              | 6 300               | 14   | 7048 ACD/HCP4A    | –                  | –                                        |
|                      | 360 | 56 | 345                | 490                   | 12                 | 3 800              | 5 600               | 17   | 7048 CD/P4A       | –                  | –                                        |
|                      | 360 | 56 | 345                | 490                   | 12                 | 4 500              | 7 000               | 14   | 7048 CD/HCP4A     | –                  | –                                        |
|                      | 360 | 46 | 265                | 400                   | 9,65               | 2 800              | 4 300               | 12   | 71952 ACD/P4A     | –                  | L                                        |
|                      | 360 | 46 | 265                | 400                   | 9,65               | 3 600              | 5 300               | 10,5 | 71952 ACD/HCP4A   | –                  | L                                        |
| 260                  | 360 | 46 | 281                | 425                   | 10,2               | 3 400              | 5 000               | 12   | 71952 CD/P4A      | –                  | L                                        |
|                      | 360 | 46 | 281                | 425                   | 10,2               | 4 300              | 6 000               | 10,5 | 71952 CD/HCP4A    | –                  | L                                        |
|                      | 400 | 65 | 397                | 600                   | 14                 | 3 000              | 4 500               | 25,5 | 7052 ACD/P4A      | –                  | –                                        |
|                      | 400 | 65 | 416                | 630                   | 14,6               | 3 400              | 5 300               | 25,5 | 7052 CD/P4A       | –                  | –                                        |
|                      | 380 | 46 | 276                | 430                   | 10                 | 2 600              | 4 000               | 13   | 71956 ACD/P4A     | –                  | –                                        |
|                      | 380 | 46 | 276                | 430                   | 10                 | 3 200              | 4 800               | 11   | 71956 ACD/HCP4A   | –                  | –                                        |
| 280                  | 380 | 46 | 291                | 455                   | 10,6               | 3 200              | 4 800               | 13   | 71956 CD/P4A      | –                  | –                                        |
|                      | 380 | 46 | 291                | 455                   | 10,6               | 4 000              | 5 600               | 11   | 71956 CD/HCP4A    | –                  | –                                        |
|                      | 420 | 56 | 351                | 560                   | 12,7               | 2 200              | 3 400               | 23   | 71960 ACDMA/P4A   | –                  | –                                        |
|                      | 420 | 56 | 351                | 560                   | 12,7               | 2 600              | 4 000               | 19,5 | 71960 ACDMA/HCP4A | –                  | –                                        |
|                      | 420 | 56 | 371                | 600                   | 13,4               | 3 000              | 4 500               | 23   | 71960 CDMA/P4A    | –                  | –                                        |
|                      | 420 | 56 | 371                | 600                   | 13,4               | 3 800              | 5 300               | 19,5 | 71960 CDMA/HCP4A  | –                  | –                                        |

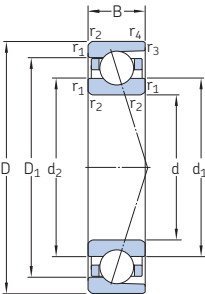
1) Designation suffix H, H1, L or L1. For details, refer to *Direct oil-air lubrication* (→ page 258).



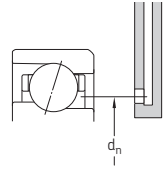
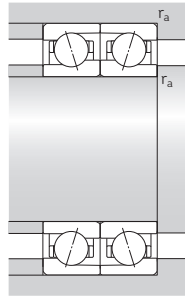
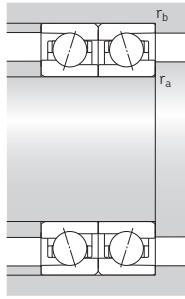
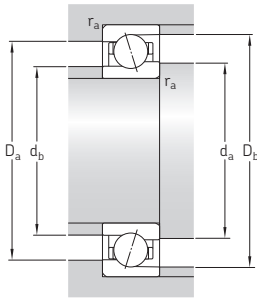
| Dimensions |                |                |                |                |                       |                       | Abutment and fillet dimensions |                     |                     |                     |                     |                     |                | Reference grease quantity <sup>1)</sup> | Calculation factor |
|------------|----------------|----------------|----------------|----------------|-----------------------|-----------------------|--------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------|-----------------------------------------|--------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub> min. | r <sub>3,4</sub> min. | d <sub>a</sub> min.            | d <sub>b</sub> min. | D <sub>a</sub> max. | D <sub>b</sub> max. | r <sub>a</sub> max. | r <sub>b</sub> max. | d <sub>n</sub> | G <sub>ref</sub>                        | f <sub>0</sub>     |
| mm         |                |                |                |                |                       |                       | mm                             |                     |                     |                     |                     |                     |                | cm <sup>3</sup>                         | –                  |
| 220        | 244,7          | 244,7          | 275,3          | –              | 2,1                   | 1                     | 231                            | 231                 | 289                 | 295                 | 2                   | 1                   | 251,4          | 84                                      | –                  |
|            | 244,7          | 244,7          | 275,3          | –              | 2,1                   | 1                     | 231                            | 231                 | 289                 | 295                 | 2                   | 1                   | 251,4          | 84                                      | –                  |
|            | 244,7          | 244,7          | 275,3          | –              | 2,1                   | 1                     | 231                            | 231                 | 289                 | 295                 | 2                   | 1                   | 251,4          | 84                                      | 16,5               |
|            | 244,7          | 244,7          | 275,3          | –              | 2,1                   | 1                     | 231                            | 231                 | 289                 | 295                 | 2                   | 1                   | 251,4          | 84                                      | 16,5               |
|            | 257            | 257            | 303            | –              | 3                     | 1,5                   | 233                            | 233                 | 327                 | 334                 | 2,5                 | 1,5                 | 267,1          | 201                                     | –                  |
|            | 257            | 257            | 303            | –              | 3                     | 1,5                   | 233                            | 233                 | 327                 | 334                 | 2,5                 | 1,5                 | 267,1          | 201                                     | –                  |
|            | 257            | 257            | 303            | –              | 3                     | 1,5                   | 233                            | 233                 | 327                 | 334                 | 2,5                 | 1,5                 | 267,1          | 201                                     | 15,6               |
|            | 257            | 257            | 303            | –              | 3                     | 1,5                   | 233                            | 233                 | 327                 | 334                 | 2,5                 | 1,5                 | 267,1          | 201                                     | 15,6               |
|            | 264,7          | 264,7          | 295,3          | –              | 2,1                   | 1                     | 251                            | 251                 | 309                 | 315                 | 2                   | 1                   | 271,4          | 93                                      | –                  |
|            | 264,7          | 264,7          | 295,3          | –              | 2,1                   | 1                     | 251                            | 251                 | 309                 | 315                 | 2                   | 1                   | 271,4          | 93                                      | –                  |
|            | 264,7          | 264,7          | 295,3          | –              | 2,1                   | 1                     | 251                            | 251                 | 309                 | 315                 | 2                   | 1                   | 271,4          | 93                                      | 16,7               |
|            | 264,7          | 264,7          | 295,3          | –              | 2,1                   | 1                     | 251                            | 251                 | 309                 | 315                 | 2                   | 1                   | 271,4          | 93                                      | 16,7               |
| 240        | 277            | 277            | 323            | –              | 3                     | 1,5                   | 253                            | 253                 | 347                 | 354                 | 2,5                 | 1,5                 | 287            | 216                                     | –                  |
|            | 277            | 277            | 323            | –              | 3                     | 1,5                   | 253                            | 253                 | 347                 | 354                 | 2,5                 | 1,5                 | 287            | 216                                     | –                  |
|            | 277            | 277            | 323            | –              | 3                     | 1,5                   | 253                            | 253                 | 347                 | 354                 | 2,5                 | 1,5                 | 287            | 216                                     | 15,8               |
|            | 277            | 277            | 323            | –              | 3                     | 1,5                   | 253                            | 253                 | 347                 | 354                 | 2,5                 | 1,5                 | 287            | 216                                     | 15,8               |
|            | 277            | 277            | 323            | –              | 3                     | 1,5                   | 253                            | 253                 | 347                 | 354                 | 2,5                 | 1,5                 | 287            | 216                                     | 15,8               |
| 260        | 291,8          | 291,8          | 328,2          | –              | 2,1                   | 1,1                   | 271                            | 271                 | 349                 | 354                 | 2                   | 1                   | 299,7          | 150                                     | –                  |
|            | 291,8          | 291,8          | 328,2          | –              | 2,1                   | 1,1                   | 271                            | 271                 | 349                 | 354                 | 2                   | 1                   | 299,7          | 150                                     | –                  |
|            | 291,8          | 291,8          | 328,2          | –              | 2,1                   | 1,1                   | 271                            | 271                 | 349                 | 354                 | 2                   | 1                   | 299,7          | 150                                     | 16,5               |
|            | 291,8          | 291,8          | 328,2          | –              | 2,1                   | 1,1                   | 271                            | 271                 | 349                 | 354                 | 2                   | 1                   | 299,7          | 150                                     | 16,5               |
|            | 303,2          | 303,2          | 356,8          | –              | 4                     | 1,5                   | 275                            | 275                 | 385                 | 393                 | 3                   | 1,5                 | 315            | 324                                     | –                  |
|            | 303,2          | 303,2          | 356,8          | –              | 4                     | 1,5                   | 275                            | 275                 | 385                 | 393                 | 3                   | 1,5                 | 315            | 324                                     | 15,7               |
| 280        | 311,8          | 311,8          | 348,2          | –              | 2,1                   | 1,1                   | 291                            | 291                 | 369                 | 374                 | 2                   | 1                   | 319,7          | 159                                     | –                  |
|            | 311,8          | 311,8          | 348,2          | –              | 2,1                   | 1,1                   | 291                            | 291                 | 369                 | 374                 | 2                   | 1                   | 319,7          | 159                                     | –                  |
|            | 311,8          | 311,8          | 348,2          | –              | 2,1                   | 1,1                   | 291                            | 291                 | 369                 | 374                 | 2                   | 1                   | 319,7          | 159                                     | 16,7               |
|            | 311,8          | 311,8          | 348,2          | –              | 2,1                   | 1,1                   | 291                            | 291                 | 369                 | 374                 | 2                   | 1                   | 319,7          | 159                                     | 16,7               |
| 300        | 337            | 337            | 383            | –              | 3                     | 1,1                   | 313                            | 313                 | 405                 | 414                 | 2,5                 | 1                   | 347            | 265                                     | –                  |
|            | 337            | 337            | 383            | –              | 3                     | 1,1                   | 313                            | 313                 | 405                 | 414                 | 2,5                 | 1                   | 347            | 265                                     | –                  |
|            | 337            | 337            | 383            | –              | 3                     | 1,1                   | 313                            | 313                 | 405                 | 414                 | 2,5                 | 1                   | 347            | 265                                     | 16,3               |
|            | 337            | 337            | 383            | –              | 3                     | 1,1                   | 313                            | 313                 | 405                 | 414                 | 2,5                 | 1                   | 347            | 265                                     | 16,3               |

<sup>1)</sup> For calculating the initial grease fill → page 259

2.1 Angular contact ball bearings  
d 320 – 360 mm



| Principal dimensions |     |    | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass | Designation       | Available variants |                            |
|----------------------|-----|----|--------------------|-----------------------|--------------------|--------------------|---------------------|------|-------------------|--------------------|----------------------------|
| d                    | D   | B  | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |      |                   | Sealing solution   | Direct oil-air lubrication |
| mm                   |     |    | kN                 |                       | kN                 | r/min              |                     | kg   | –                 | –                  |                            |
| 320                  | 440 | 56 | 351                | 585                   | 12,9               | 2 200              | 3 400               | 24   | 71964 ACDMA/P4A   | –                  | –                          |
|                      | 440 | 56 | 351                | 585                   | 12,9               | 2 600              | 4 000               | 20,5 | 71964 ACDMA/HCP4A | –                  | –                          |
|                      | 440 | 56 | 377                | 620                   | 13,7               | 2 600              | 4 300               | 24   | 71964 CDMA/P4A    | –                  | –                          |
|                      | 440 | 56 | 377                | 620                   | 13,7               | 3 600              | 5 000               | 20,5 | 71964 CDMA/HCP4A  | –                  | –                          |
| 340                  | 460 | 56 | 364                | 640                   | 13,4               | 2 000              | 3 200               | 25,5 | 71968 ACDMA/P4A   | –                  | –                          |
|                      | 460 | 56 | 364                | 640                   | 13,4               | 2 400              | 3 800               | 21,5 | 71968 ACDMA/HCP4A | –                  | –                          |
|                      | 460 | 56 | 390                | 670                   | 14,3               | 2 400              | 4 000               | 25,5 | 71968 CDMA/P4A    | –                  | –                          |
|                      | 460 | 56 | 390                | 670                   | 14,3               | 3 400              | 4 800               | 21,5 | 71968 CDMA/HCP4A  | –                  | –                          |
| 360                  | 480 | 56 | 371                | 670                   | 13,7               | 1 900              | 3 000               | 26,5 | 71972 ACDMA/P4A   | –                  | –                          |
|                      | 480 | 56 | 371                | 670                   | 13,7               | 2 200              | 3 600               | 22,5 | 71972 ACDMA/HCP4A | –                  | –                          |
|                      | 480 | 56 | 397                | 710                   | 14,6               | 2 400              | 4 000               | 26,5 | 71972 CDMA/P4A    | –                  | –                          |
|                      | 480 | 56 | 397                | 710                   | 14,6               | 3 400              | 4 800               | 22,5 | 71972 CDMA/HCP4A  | –                  | –                          |



| Dimensions |                |                |                |                | Abutment and fillet dimensions |                          |                        |                        |                        |                        |                        |                        |                |     | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ | Calculation factor<br>$f_0$ |
|------------|----------------|----------------|----------------|----------------|--------------------------------|--------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----|------------------------------------------------------|-----------------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min.       | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min. | d <sub>b</sub><br>min. | D <sub>a</sub><br>max. | D <sub>b</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |     |                                                      |                             |
| mm         |                |                |                |                |                                |                          | mm                     |                        |                        |                        |                        |                        |                |     | cm <sup>3</sup>                                      | –                           |
| 320        | 357            | 357            | 403            | –              | 3                              | 1,1                      | 333                    | 333                    | 425                    | 434                    | 2,5                    | 1                      | 367            | 282 | –                                                    | –                           |
|            | 357            | 357            | 403            | –              | 3                              | 1,1                      | 333                    | 333                    | 425                    | 434                    | 2,5                    | 1                      | 367            | 282 | –                                                    | –                           |
|            | 357            | 357            | 403            | –              | 3                              | 1,1                      | 333                    | 333                    | 425                    | 434                    | 2,5                    | 1                      | 367            | 282 | 16,5                                                 | 16,5                        |
|            | 357            | 357            | 403            | –              | 3                              | 1,1                      | 333                    | 333                    | 425                    | 434                    | 2,5                    | 1                      | 367            | 282 | 16,5                                                 | 16,5                        |
| 340        | 377            | 377            | 423            | –              | 3                              | 1,1                      | 353                    | 353                    | 445                    | 454                    | 2,5                    | 1                      | 387            | 294 | –                                                    | –                           |
|            | 377            | 377            | 423            | –              | 3                              | 1,1                      | 353                    | 353                    | 445                    | 454                    | 2,5                    | 1                      | 387            | 294 | –                                                    | –                           |
|            | 377            | 377            | 423            | –              | 3                              | 1,1                      | 353                    | 353                    | 445                    | 454                    | 2,5                    | 1                      | 387            | 294 | 16,6                                                 | 16,6                        |
|            | 377            | 377            | 423            | –              | 3                              | 1,1                      | 353                    | 353                    | 445                    | 454                    | 2,5                    | 1                      | 387            | 294 | 16,6                                                 | 16,6                        |
| 360        | 397            | 397            | 443            | –              | 3                              | 1,1                      | 373                    | 373                    | 465                    | 474                    | 2,5                    | 1                      | 407            | 313 | –                                                    | –                           |
|            | 397            | 397            | 443            | –              | 3                              | 1,1                      | 373                    | 373                    | 465                    | 474                    | 2,5                    | 1                      | 407            | 313 | –                                                    | –                           |
|            | 397            | 397            | 443            | –              | 3                              | 1,1                      | 373                    | 373                    | 465                    | 474                    | 2,5                    | 1                      | 407            | 313 | 16,7                                                 | 16,7                        |
|            | 397            | 397            | 443            | –              | 3                              | 1,1                      | 373                    | 373                    | 465                    | 474                    | 2,5                    | 1                      | 407            | 313 | 16,7                                                 | 16,7                        |

<sup>1)</sup> For calculating the initial grease fill → page 261





# Cylindrical roller bearings

|                                                                                                |                |
|------------------------------------------------------------------------------------------------|----------------|
| <b>Designs and variants</b> . . . . .                                                          | <b>264</b>     |
| Single row cylindrical roller bearings . . .                                                   | 264            |
| Basic design bearings . . . . .                                                                | 264            |
| High-speed design bearings . . . . .                                                           | 264            |
| Double row cylindrical roller bearings . .                                                     | 265            |
| Annular groove and lubrication holes .                                                         | 266            |
| Bearings with a pre-ground raceway .                                                           | 267            |
| Cages. . . . .                                                                                 | 267            |
| Hybrid bearings . . . . .                                                                      | 268            |
| <br><b>Bearing data</b> . . . . .                                                              | <br><b>269</b> |
| (Boundary dimensions, tolerances, axial displacement)                                          |                |
| Radial internal clearance . . . . .                                                            | 273            |
| <br><b>Radial internal clearance or preload in mounted bearings</b> . . . . .                  | <br><b>275</b> |
| <br><b>Radial stiffness</b> . . . . .                                                          | <br><b>275</b> |
| <br><b>Equivalent bearing loads</b> . . . . .                                                  | <br><b>277</b> |
| <br><b>Attainable speeds</b> . . . . .                                                         | <br><b>277</b> |
| <br><b>Design considerations</b> . . . . .                                                     | <br><b>278</b> |
| Adjusting for clearance or preload . . . .                                                     | 278            |
| Free space on both sides of the bearing .                                                      | 280            |
| <br><b>Mounting</b> . . . . .                                                                  | <br><b>280</b> |
| Mounting a bearing in the NN 30 K series using a GB 30 series gauge. . . . .                   | 282            |
| Mounting bearings with a tapered bore by measuring radial clearance prior to mounting. . . . . | 284            |
| Mounting and dismounting, using the oil injection method . . . . .                             | 285            |
| <br><b>Designation system</b> . . . . .                                                        | <br><b>286</b> |

## Product tables

|                                                            |     |
|------------------------------------------------------------|-----|
| <b>3.1</b> Single row cylindrical roller bearings. . . . . | 288 |
| <b>3.2</b> Double row cylindrical roller bearings. . . . . | 294 |

## More information

|                                         |     |
|-----------------------------------------|-----|
| Bearing life and load ratings . . . . . | 263 |
| Requisite minimum load . . . . .        | 263 |
| Chamfer dimension limits . . . . .      | 263 |
| Materials . . . . .                     | 263 |
| Design considerations. . . . .          | 263 |
| Lubrication . . . . .                   | 263 |
| Mounting and dismounting. . . . .       | 263 |
| Bearing storage. . . . .                | 263 |
| Gauges. . . . .                         | 263 |

## Designs and variants

SKF manufactures super-precision single row and double row cylindrical roller bearings in three different designs and series. The bearings, which can accommodate axial displacement of the shaft relative to the housing in both directions, are separable, i.e. the bearing ring with the roller and cage assembly can be separated from the other ring. This simplifies mounting and dismounting, particularly when load conditions require both rings to have an interference fit.

SKF super-precision cylindrical roller bearings are characterized by:

- high speed capability
- high radial load carrying capacity
- high rigidity
- low friction
- low cross-sectional height

These bearings are therefore particularly well suited for machine tool spindles where the bearing arrangement must accommodate heavy radial loads and high speeds, while providing a high degree of stiffness.

SKF super-precision single row cylindrical roller bearings have a higher speed capability than double row bearings while double row bearings are more suitable for heavier loads.

### Single row cylindrical roller bearings

SKF super-precision single row cylindrical roller bearings in the N 10 series (→ **fig. 1**) have, as standard, a 1:12 tapered bore (designation suffix K). A tapered bore is preferred because the taper enables accurate adjustment of clearance or preload during mounting. The bearings have two integral flanges on the inner ring and no flanges on the outer ring. To improve lubricant flow, these bearings can be supplied with a lubrication hole in the outer ring on request.

### Basic design bearings

Basic design single row cylindrical roller bearings are equipped as standard with a roller centred PA66 cage without glass fibre reinforcement for bore diameters up to 80 mm (designation suffix TN), and with glass fibre reinforcement for larger sizes (designation suffix TN9). These bearings are well suited for most precision applications.

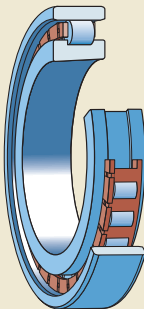
### High-speed design bearings

The internal geometry and cages of high-speed design single row cylindrical roller bearings have been optimized to accommodate higher speeds. High-speed design bearings contain fewer rollers than basic design bearings. They are equipped with either an asymmetrical cage, made of glass fibre reinforced PEEK (designation suffix TNHA), or a symmetrical cage, made of carbon fibre reinforced PEEK (designation suffix PHA). Both are outer ring centred cages, designed to optimize the effectiveness of the lubricant and avoid kinematic lubricant starvation at high speeds. When comparing the two cages, the symmetrical PHA cage provides better guidance and promotes better lubrication conditions for superior performance.

Compared to bearings with a glass fibre reinforced PEEK cage, bearings with a carbon fibre reinforced PEEK cage can accommodate speeds up to 30% higher in grease lubricated applications and up to 15% higher when lubricated with an oil-air system.

For applications like the non-tool end of a motorized spindle, where the requirement for higher speed outweighs that for higher rigidity, bearings containing cages with half the number of rollers can be supplied on request.

Fig. 1



## Double row cylindrical roller bearings

SKF super-precision double row cylindrical roller bearings (→ **fig. 2**) are manufactured as standard in the NN 30 and NNU 49 series.

Both series are available with either a cylindrical or a 1:12 tapered bore (designation suffix K). In machine tool applications, cylindrical roller bearings with a tapered bore are preferred over bearings with a cylindrical bore, because the taper enables more accurate adjustment of clearance or preload during mounting.

### NN 30 series

Bearings in the NN 30 series can provide a unique balance between load carrying capacity, rigidity and speed. They are therefore typically used as the non-tool end bearing in machine tool spindles.

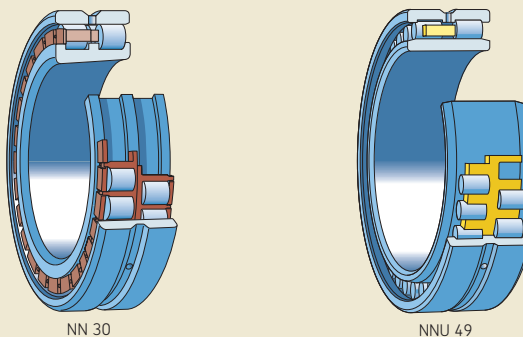
NN 30 series bearings have three integral flanges on the inner ring and no flanges on the outer ring.

### NNU 49 series

Bearings in the NNU 49 series, with a very low cross-sectional height, provide a higher degree of stiffness than bearings in the NN 30 series, but a somewhat lower load carrying capacity.

NNU 49 series bearings have three integral flanges on the outer ring and no flanges on the inner ring.

Fig. 2



Annular groove and lubrication holes

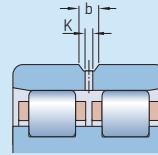
To facilitate efficient lubrication, all bearings in the NNU 49 series and bearings in the NN 30 series with a bore diameter  $d \geq 140$  mm, have an annular groove and three lubrication holes in the outer ring (→ **fig. 3**, designation suffix W33).

Bearings without an annular groove and lubrication holes are typically lubricated either with the requisite minimum quantity of grease or with accurately metered, small quantities of oil or oil-air. In this case, the lubricant is delivered through a nozzle, positioned to the side of the bearing (→ **fig. 4** and **product tables**, **page 266**).

If NN 30 series bearings with a bore diameter  $d \leq 130$  mm (→ **table 1**) require an annular groove and lubrication holes, check SKF for availability early in the design phase.

Table 1

Annular groove and lubrication hole dimensions for NN 30 .. W33 series bearings ( $d \leq 130$  mm)



| Bore diameter<br>$d$ | Dimensions<br>$b$ | $K$ |
|----------------------|-------------------|-----|
| mm                   | mm                |     |
| 50                   | 3,7               | 2   |
| 55                   | 3,7               | 2   |
| 60                   | 3,7               | 2   |
| 65                   | 3,7               | 2   |
| 70                   | 5,5               | 3   |
| 75                   | 5,5               | 3   |
| 80                   | 5,5               | 3   |
| 85                   | 5,5               | 3   |
| 90                   | 5,5               | 3   |
| 95                   | 5,5               | 3   |
| 100                  | 5,5               | 3   |
| 105                  | 5,5               | 3   |
| 110                  | 5,5               | 3   |
| 120                  | 5,5               | 3   |
| 130                  | 8,3               | 4,5 |

Fig. 3

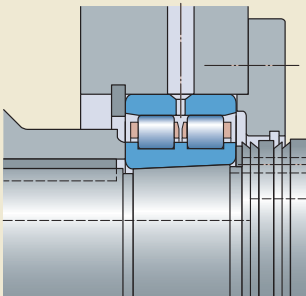
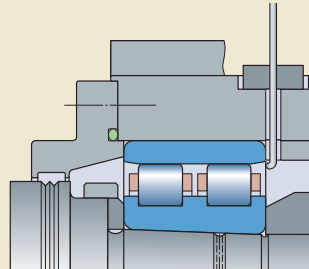


Fig. 4



Bearings with a pre-ground raceway

When there is a demand for an exceptionally high degree of running accuracy, SKF recommends mounting the flangeless inner ring of an NNU 49 series bearing onto the shaft and then finish-grinding the inner ring raceway and other shaft diameters in one operation.

For these applications, SKF can supply NNU 49 series bearings with a tapered bore and a finish-grinding allowance on the inner ring raceway (designation suffix VU001). The finish-grinding allowance, which depends on the bore diameter of the inner ring, is listed in **table 2**.

Cages

SKF super-precision single row cylindrical roller bearings can be fitted with one of the following cages:

- a PA66 cage, window-type, roller centred, designation suffix TN
- a glass fibre reinforced PA66 cage, window-type, roller centred, designation suffix TN9
- a glass fibre reinforced PEEK cage, window-type, outer ring centred, designation suffix TNHA
- a carbon fibre reinforced PEEK cage, window-type, outer ring centred, designation suffix PHA

Depending on their design, series and size, SKF super-precision double row cylindrical roller bearings are fitted as standard with the following cages:

- two PA66 cages, window-type, roller centred, designation suffix TN
- two glass fibre reinforced PA66 cages, window-type, roller centred, designation suffix TN9
- one or two machined brass cages, prong-type, roller centred, no designation suffix

For information about the suitability of cages, refer to *Cage materials* (→ **page 267**).

Table 2

| Finish-grinding allowance on the inner ring raceway of NNU 49.. K/VU001 bearings |       |                    |
|----------------------------------------------------------------------------------|-------|--------------------|
| Bore diameter                                                                    |       | Grinding allowance |
| over                                                                             | incl. |                    |
| mm                                                                               |       | mm                 |
| –                                                                                | 110   | 0,2                |
| 110                                                                              | 360   | 0,3                |
| 360                                                                              | –     | 0,4                |

### Hybrid bearings

Hybrid cylindrical roller bearings (designation suffix HC5) are available in the N 10 series and can be supplied on request in the NN 30 series. They have rings made of bearing steel and rollers made of bearing grade silicon nitride (ceramic). As ceramic rollers are lighter and have a higher modulus of elasticity and lower coefficient of thermal expansion than steel rollers, hybrid bearings can provide the following advantages:

- higher degree of rigidity
- higher speed capability
- reduced centrifugal and inertial forces within the bearing
- minimized stress at the outer ring rolling contacts at high speeds
- reduced frictional heat
- less energy consumption
- extended bearing and grease service life
- less prone to skid smearing damage and cage damage when subjected to frequent rapid starts and stops
- less sensitive to temperature differences within the bearing
- more accurate preload control

For additional information about silicon nitride, refer to *Materials for bearing rings and rolling elements* (→ **page 268**).

In order to maximize the performance of a hybrid bearing, SKF recommends using hybrid single row bearings with an outer ring centred window-type PEEK cage (designation suffix PHA or TNHA). These bearings, depending on the cage design, can attain speeds up to  $A = 2\,200\,000\text{ mm/min}$ , when under light load and lubricated with an oil-air system, (→ **diagram 5, page 268**). They can attain speeds up to  $A = 1\,800\,000\text{ mm/min}$ , when grease lubricated (→ **diagram 6, page 268**). As an option to further improve lubricant flow, bearings in the N 10 series with a lubrication hole in the outer ring can be supplied on request.

## Bearing data

|                                                           |                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Boundary dimensions                                       | ISO 15                                                                                                                                                                                                                                                                                       |
| Tolerances<br><br>For additional information (→ page 269) | <ul style="list-style-type: none"><li>• SP class tolerances (→ table 3, page 269) as standard</li><li>• higher precision UP class tolerances (→ table 4, page 269) on request</li><li>• SP and UP class tolerances for 1:12 tapered bore (→ table 5, page 269)</li></ul>                     |
| Axial displacement                                        | Accommodate axial displacement of the shaft relative to the housing within certain limits (→ product tables). During operation, axial displacement occurs within the bearing and not between the bearing and shaft or housing bore. As a result, there is virtually no increase in friction. |

Table 3

SP class tolerances

| Inner ring<br>d<br>over    incl. |       | $\Delta_{ds}, \Delta_{dmp}^{1) 2)}$<br>high    low |     | $V_{dp}$<br>max. | $\Delta_{Bs}$<br>high    low                                          |      | $V_{Bs}$<br>max. | $K_{ia}$<br>max. | $S_d$<br>max. |
|----------------------------------|-------|----------------------------------------------------|-----|------------------|-----------------------------------------------------------------------|------|------------------|------------------|---------------|
| mm                               |       | $\mu m$                                            |     | $\mu m$          | $\mu m$                                                               |      | $\mu m$          | $\mu m$          | $\mu m$       |
| –                                | 18    | 0                                                  | –5  | 3                | 0                                                                     | –100 | 5                | 3                | 8             |
| 18                               | 30    | 0                                                  | –6  | 3                | 0                                                                     | –100 | 5                | 3                | 8             |
| 30                               | 50    | 0                                                  | –8  | 4                | 0                                                                     | –120 | 5                | 4                | 8             |
| 50                               | 80    | 0                                                  | –9  | 5                | 0                                                                     | –150 | 6                | 4                | 8             |
| 80                               | 120   | 0                                                  | –10 | 5                | 0                                                                     | –200 | 7                | 5                | 9             |
| 120                              | 180   | 0                                                  | –13 | 7                | 0                                                                     | –250 | 8                | 6                | 10            |
| 180                              | 250   | 0                                                  | –15 | 8                | 0                                                                     | –300 | 10               | 8                | 11            |
| 250                              | 315   | 0                                                  | –18 | 9                | 0                                                                     | –350 | 13               | 10               | 13            |
| 315                              | 400   | 0                                                  | –23 | 12               | 0                                                                     | –400 | 15               | 12               | 15            |
| 400                              | 500   | 0                                                  | –28 | 14               | 0                                                                     | –450 | 25               | 12               | 18            |
| 500                              | 630   | 0                                                  | –35 | 18               | 0                                                                     | –500 | 30               | 15               | 20            |
| 630                              | 800   | 0                                                  | –45 | 23               | 0                                                                     | –750 | 35               | 15               | 23            |
| Outer ring<br>D<br>over    incl. |       | $\Delta_{Ds}, \Delta_{Dmp}^{2)}$<br>high    low    |     | $V_{Dp}$<br>max. | $\Delta_{Cs}, V_{Cs}$                                                 |      |                  | $K_{ea}$<br>max. | $S_D$<br>max. |
| mm                               |       | $\mu m$                                            |     | $\mu m$          |                                                                       |      |                  | $\mu m$          | $\mu m$       |
| 30                               | 50    | 0                                                  | –7  | 4                | Values are identical to those for the inner ring of the same bearing. |      |                  | 5                | 8             |
| 50                               | 80    | 0                                                  | –9  | 5                |                                                                       |      |                  | 5                | 8             |
| 80                               | 120   | 0                                                  | –10 | 5                |                                                                       |      |                  | 6                | 9             |
| 120                              | 150   | 0                                                  | –11 | 6                |                                                                       |      |                  | 7                | 10            |
| 150                              | 180   | 0                                                  | –13 | 7                |                                                                       |      |                  | 8                | 10            |
| 180                              | 250   | 0                                                  | –15 | 8                |                                                                       |      |                  | 10               | 11            |
| 250                              | 315   | 0                                                  | –18 | 9                |                                                                       |      |                  | 11               | 13            |
| 315                              | 400   | 0                                                  | –20 | 10               |                                                                       |      |                  | 13               | 13            |
| 400                              | 500   | 0                                                  | –23 | 12               |                                                                       |      |                  | 15               | 15            |
| 500                              | 630   | 0                                                  | –28 | 14               |                                                                       |      |                  | 17               | 18            |
| 630                              | 800   | 0                                                  | –35 | 18               |                                                                       |      |                  | 20               | 20            |
| 800                              | 1 000 | 0                                                  | –50 | 25               |                                                                       |      |                  | 25               | 30            |

Tolerance symbols and definitions → table 4, page 270

<sup>1)</sup> SP tolerances for 1:12 tapered bore → table 5, page 270

<sup>2)</sup> Tolerances  $\Delta_{ds}$  and  $\Delta_{Ds}$  apply to NNU design bearings with an outside diameter  $D \leq 630$  mm. Tolerances  $\Delta_{dmp}$  and  $\Delta_{Dmp}$  apply to larger NNU design bearings and to N and NN design bearings.



Table 4

## UP class tolerances

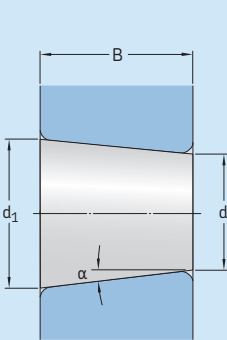
| Inner ring<br>d |       | $\Delta_{ds}^{1)}$ |     | $V_{dp}$<br>max. | $\Delta_{Bs}$                                                         |      | $V_{Bs}$<br>max. | $K_{ia}$<br>max. | $S_d$<br>max. |
|-----------------|-------|--------------------|-----|------------------|-----------------------------------------------------------------------|------|------------------|------------------|---------------|
| over            | incl. | high               | low |                  | high                                                                  | low  |                  |                  |               |
| mm              |       | $\mu m$            |     | $\mu m$          | $\mu m$                                                               |      | $\mu m$          | $\mu m$          |               |
| –               | 18    | 0                  | –4  | 2                | 0                                                                     | –70  | 1,5              | 1,5              | 2             |
| 18              | 30    | 0                  | –5  | 2,5              | 0                                                                     | –80  | 1,5              | 1,5              | 3             |
| 30              | 50    | 0                  | –6  | 3                | 0                                                                     | –100 | 2                | 2                | 3             |
| 50              | 80    | 0                  | –7  | 3,5              | 0                                                                     | –100 | 3                | 2                | 4             |
| 80              | 120   | 0                  | –8  | 4                | 0                                                                     | –100 | 3                | 3                | 4             |
| 120             | 180   | 0                  | –10 | 5                | 0                                                                     | –100 | 4                | 3                | 5             |
| 180             | 250   | 0                  | –12 | 6                | 0                                                                     | –150 | 5                | 4                | 6             |
| 250             | 315   | 0                  | –15 | 8                | 0                                                                     | –150 | 5                | 4                | 6             |
| 315             | 400   | 0                  | –19 | 10               | 0                                                                     | –150 | 6                | 5                | 7             |
| 400             | 500   | 0                  | –23 | 12               | 0                                                                     | –200 | 7                | 5                | 8             |
| 500             | 630   | 0                  | –26 | 13               | 0                                                                     | –200 | 8                | 6                | 9             |
| 630             | 800   | 0                  | –34 | 17               | 0                                                                     | –200 | 10               | 7                | 11            |
|                 |       |                    |     |                  |                                                                       |      |                  |                  |               |
| Outer ring<br>D |       | $\Delta_{Ds}$      |     | $V_{Dp}$<br>max. | $\Delta_{Cs}, V_{Cs}$                                                 |      | $K_{ea}$<br>max. | $S_D$<br>max.    |               |
| over            | incl. | high               | low |                  |                                                                       |      |                  |                  |               |
| mm              |       | $\mu m$            |     | $\mu m$          |                                                                       |      | $\mu m$          | $\mu m$          |               |
| 30              | 50    | 0                  | –5  | 3                | Values are identical to those for the inner ring of the same bearing. |      | 3                | 2                |               |
| 50              | 80    | 0                  | –6  | 3                |                                                                       |      | 3                | 2                |               |
| 80              | 120   | 0                  | –7  | 4                |                                                                       |      | 3                | 3                |               |
| 120             | 150   | 0                  | –8  | 4                |                                                                       |      | 4                | 3                |               |
| 150             | 180   | 0                  | –9  | 5                |                                                                       |      | 4                | 3                |               |
| 180             | 250   | 0                  | –10 | 5                |                                                                       |      | 5                | 4                |               |
| 250             | 315   | 0                  | –12 | 6                |                                                                       |      | 6                | 4                |               |
| 315             | 400   | 0                  | –14 | 7                |                                                                       |      | 7                | 5                |               |
| 400             | 500   | 0                  | –17 | 9                |                                                                       |      | 8                | 5                |               |
| 500             | 630   | 0                  | –20 | 10               |                                                                       |      | 9                | 6                |               |
| 630             | 800   | 0                  | –25 | 13               |                                                                       |      | 11               | 7                |               |
| 800             | 1 000 | 0                  | –30 | 15               |                                                                       |      | 12               | 10               |               |

Tolerance symbols and definitions → table 4, page 271

<sup>1)</sup> UP tolerances for 1:12 tapered bore → table 5, page 271

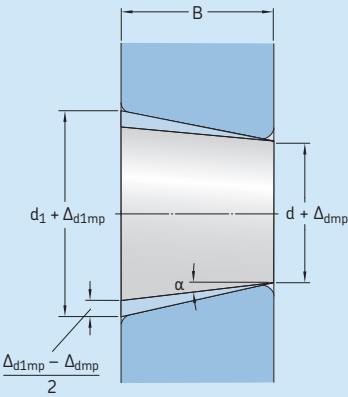
Table 5

SP and UP class tolerances for 1:12 tapered bore



Half angle of taper 1:12

$$\alpha = 2^{\circ} 23' 9,4''$$



Largest theoretical diameter  $d_1$

$$d_1 = d + \frac{1}{12} B$$

| Bore diameter |       | SP class tolerances |   |                |     | UP class tolerances |                 |                |     |                 |                 |
|---------------|-------|---------------------|---|----------------|-----|---------------------|-----------------|----------------|-----|-----------------|-----------------|
| d             | incl. | $\Delta_{dmp}$      |   | $V_{dp}^{(1)}$ |     | $\Delta_{d1mp}$     | $-\Delta_{dmp}$ | $\Delta_{dmp}$ |     | $\Delta_{d1mp}$ | $-\Delta_{dmp}$ |
| mm            |       | $\mu m$             |   | $\mu m$        |     | $\mu m$             |                 | $\mu m$        |     | $\mu m$         |                 |
| 18            | 30    | +10                 | 0 | 3              | +4  | 0                   | +6              | 0              | 2,5 | +2              | 0               |
| 30            | 50    | +12                 | 0 | 4              | +4  | 0                   | +7              | 0              | 3   | +3              | 0               |
| 50            | 80    | +15                 | 0 | 5              | +5  | 0                   | +8              | 0              | 3,5 | +3              | 0               |
| 80            | 120   | +20                 | 0 | 5              | +6  | 0                   | +10             | 0              | 4   | +4              | 0               |
| 120           | 180   | +25                 | 0 | 7              | +8  | 0                   | +12             | 0              | 5   | +4              | 0               |
| 180           | 250   | +30                 | 0 | 8              | +10 | 0                   | +14             | 0              | 6   | +5              | 0               |
| 250           | 315   | +35                 | 0 | 9              | +12 | 0                   | +15             | 0              | 8   | +6              | 0               |
| 315           | 400   | +40                 | 0 | 12             | +12 | 0                   | +17             | 0              | 10  | +6              | 0               |
| 400           | 500   | +45                 | 0 | 14             | +14 | 0                   | +19             | 0              | 12  | +7              | 0               |
| 500           | 630   | +50                 | 0 | 18             | +15 | 0                   | +20             | 0              | 13  | +11             | 0               |
| 630           | 800   | +65                 | 0 | 23             | +19 | 0                   | +22             | 0              | 17  | +13             | 0               |

Tolerance symbols and definitions → table 4, page 272

<sup>1)</sup> Applies to any single radial plane of the bore.

## Radial internal clearance

SKF super-precision cylindrical roller bearings manufactured to the SP tolerance class are supplied with C1 radial internal clearance (no designation suffix) as standard.

On request, bearings in the N 10 and NN 30 series can also be supplied with a special reduced radial clearance (smaller than C1), when a minimum operating clearance or a preload after mounting is required. For information about clearance values and availability, contact the SKF application engineering service.

Bearings made to the SP tolerance class, particularly those in the NNU 49 series, are also available with a radial internal clearance greater than C1. When ordering, the requisite clearance should be indicated in the designation by the suffix:

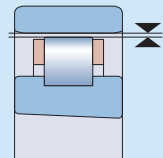
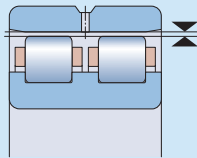
- SPC2 for clearance greater than C1
- CN for Normal clearance, greater than SPC2
- C3 for clearance greater than Normal

The values for radial internal clearance are listed in **table 6 (→ page 273)**. They are in accordance with ISO 5753-1 (except for SPC2) and are valid for new, unmounted bearings under zero measuring load. SPC2 radial clearance values deviate from those standardized for C2. The clearance range is reduced and displaced toward the lower limit.

To achieve the required radial internal clearance, the rings of individual bearings are matched at the factory, marked with the same identification number and usually packaged together in a single box. Be sure to check that the numbers on both rings match prior to mounting. Any mismatch could have a negative impact on the radial internal clearance and the performance characteristics of the final assembly.

Table 6

Radial internal clearance of super-precision cylindrical roller bearings



| Bore diameter |       | Radial internal clearance        |      |      |      |      |      |      |      | Bearings with a tapered bore |      |      |      |
|---------------|-------|----------------------------------|------|------|------|------|------|------|------|------------------------------|------|------|------|
| d             | incl. | Bearings with a cylindrical bore |      |      |      |      |      |      |      | C1                           |      | SPC2 |      |
| over          |       | min.                             | max. | min. | max. | min. | max. | min. | max. | min.                         | max. | min. | max. |
| mm            |       | μm                               |      |      |      |      |      |      |      | μm                           |      |      |      |
| 24            | 30    | 5                                | 15   | 10   | 25   | 20   | 45   | 35   | 60   | 15                           | 25   | 25   | 35   |
| 30            | 40    | 5                                | 15   | 12   | 25   | 25   | 50   | 45   | 70   | 15                           | 25   | 25   | 40   |
| 40            | 50    | 5                                | 18   | 15   | 30   | 30   | 60   | 50   | 80   | 17                           | 30   | 30   | 45   |
| 50            | 65    | 5                                | 20   | 15   | 35   | 40   | 70   | 60   | 90   | 20                           | 35   | 35   | 50   |
| 65            | 80    | 10                               | 25   | 20   | 40   | 40   | 75   | 65   | 100  | 25                           | 40   | 40   | 60   |
| 80            | 100   | 10                               | 30   | 25   | 45   | 50   | 85   | 75   | 110  | 35                           | 55   | 45   | 70   |
| 100           | 120   | 10                               | 30   | 25   | 50   | 50   | 90   | 85   | 125  | 40                           | 60   | 50   | 80   |
| 120           | 140   | 10                               | 35   | 30   | 60   | 60   | 105  | 100  | 145  | 45                           | 70   | 60   | 90   |
| 140           | 160   | 10                               | 35   | 35   | 65   | 70   | 120  | 115  | 165  | 50                           | 75   | 65   | 100  |
| 160           | 180   | 10                               | 40   | 35   | 75   | 75   | 125  | 120  | 170  | 55                           | 85   | 75   | 110  |
| 180           | 200   | 15                               | 45   | 40   | 80   | 90   | 145  | 140  | 195  | 60                           | 90   | 80   | 120  |
| 200           | 225   | 15                               | 50   | 45   | 90   | 105  | 165  | 160  | 220  | 60                           | 95   | 90   | 135  |
| 225           | 250   | 15                               | 50   | 50   | 100  | 110  | 175  | 170  | 235  | 65                           | 100  | 100  | 150  |
| 250           | 280   | 20                               | 55   | 55   | 110  | 125  | 195  | 190  | 260  | 75                           | 110  | 110  | 165  |
| 280           | 315   | 20                               | 60   | 60   | 120  | 130  | 205  | 200  | 275  | 80                           | 120  | 120  | 180  |
| 315           | 355   | 20                               | 65   | 65   | 135  | 145  | 225  | 225  | 305  | 90                           | 135  | 135  | 200  |
| 355           | 400   | 25                               | 75   | 75   | 150  | 190  | 280  | 280  | 370  | 100                          | 150  | 150  | 225  |
| 400           | 450   | 25                               | 85   | 85   | 170  | 210  | 310  | 310  | 410  | 110                          | 170  | 170  | 255  |
| 450           | 500   | 25                               | 95   | 95   | 190  | 220  | 330  | 330  | 440  | 120                          | 190  | 190  | 285  |
| 500           | 560   | 25                               | 105  | 105  | 210  | 240  | 360  | 360  | 480  | 130                          | 210  | 210  | 315  |
| 560           | 630   | 25                               | 115  | 115  | 230  | 260  | 380  | 380  | 500  | 140                          | 230  | 230  | 345  |
| 630           | 710   | 30                               | 130  | 130  | 260  | 285  | 425  | 425  | 565  | 160                          | 260  | 260  | 390  |
| 710           | 800   | 35                               | 145  | 145  | 290  | 310  | 470  | 470  | 630  | 180                          | 290  | 290  | 435  |

## Radial internal clearance or preload in mounted bearings

To optimize running accuracy and stiffness, super-precision cylindrical roller bearings should have a minimum radial internal clearance or preload after mounting. Cylindrical roller bearings with a tapered bore are generally mounted with preload.

The required operating clearance or preload depends on the speed, load, lubricant and required stiffness of the complete spindle / bearing system. The geometrical accuracy of the bearing seats also play a key role in being able to obtain the necessary clearance or preload. The operating temperature and temperature distribution within the bearing should also be taken into consideration, since a reduction in operating clearance or an increase in preload may result.

## Radial stiffness

Radial stiffness depends on the elastic deformation (deflection) of the bearing under load and can be expressed as a ratio of load to deflection. However, since the relationship between deflection and load is not linear, only guideline values can be provided (→ **table 7, page 275**). These values apply to moderately preloaded, mounted bearings under static conditions, subjected to moderate loads.

More accurate values for radial stiffness can be calculated using advanced computer programs. For additional information, contact the SKF application engineering service and refer to *Bearing stiffness* (→ **page 275**).

Table 7

Static radial stiffness

| Bore diameter<br>d | Static radial stiffness<br>N 10  |          |     |                                    |          |       | NN 30 <sup>1)</sup><br>with steel<br>rollers | NNU 49 <sup>1)</sup><br>with steel<br>rollers |
|--------------------|----------------------------------|----------|-----|------------------------------------|----------|-------|----------------------------------------------|-----------------------------------------------|
|                    | with steel rollers<br>TN(9) cage |          |     | with ceramic rollers<br>TN(9) cage |          |       |                                              |                                               |
|                    | TNHA cage                        | PHA cage |     | TNHA cage                          | PHA cage |       |                                              |                                               |
| mm                 | N/μm                             |          |     |                                    |          |       | N/μm                                         | N/μm                                          |
| 25                 | —                                | —        | —   | —                                  | —        | —     | 640                                          | —                                             |
| 30                 | —                                | —        | —   | —                                  | —        | —     | 690                                          | —                                             |
| 35                 | —                                | —        | —   | —                                  | —        | —     | 820                                          | —                                             |
| 40                 | 450                              | 430      | 390 | 610                                | 580      | 510   | 890                                          | —                                             |
| 45                 | 480                              | 460      | 410 | 620                                | 590      | 530   | 940                                          | —                                             |
| 50                 | 530                              | 510      | 460 | 690                                | 660      | 590   | 1 040                                        | —                                             |
| 55                 | 620                              | 590      | 540 | 810                                | 770      | 700   | 1 220                                        | —                                             |
| 60                 | 680                              | 650      | 590 | 890                                | 850      | 770   | 1 330                                        | —                                             |
| 65                 | 740                              | 710      | 650 | 970                                | 930      | 840   | 1 450                                        | —                                             |
| 70                 | 810                              | 780      | 720 | 1 090                              | 1 050    | 950   | 1 610                                        | —                                             |
| 75                 | 820                              | 790      | 720 | 1 090                              | 1 050    | 960   | 1 610                                        | —                                             |
| 80                 | 920                              | 880      | 810 | 1 190                              | 1 140    | 1 040 | 1 820                                        | —                                             |
| 85                 | 990                              | 950      | —   | 1 280                              | 1 230    | —     | 1 970                                        | —                                             |
| 90                 | 980                              | 940      | —   | 1 320                              | 1 270    | —     | 2 010                                        | —                                             |
| 95                 | 1 060                            | 1 020    | —   | 1 430                              | 1 380    | —     | 2 190                                        | —                                             |
| 100                | 1 140                            | 1 100    | —   | 1 540                              | 1 490    | —     | 2 350                                        | 2 950                                         |
| 105                | 1 140                            | 1 100    | —   | 1 540                              | 1 490    | —     | 2 330                                        | 3 040                                         |
| 110                | 1 210                            | 1 160    | —   | 1 600                              | 1 540    | —     | 2 470                                        | 3 130                                         |
| 120                | 1 310                            | 1 260    | —   | 1 730                              | 1 670    | —     | 2 760                                        | 3 140                                         |
| 130                | —                                | —        | —   | —                                  | —        | —     | 2 900                                        | 3 570                                         |
| 140                | —                                | —        | —   | —                                  | —        | —     | 3 070                                        | 3 670                                         |
| 150                | —                                | —        | —   | —                                  | —        | —     | 3 310                                        | 4 160                                         |
| 160                | —                                | —        | —   | —                                  | —        | —     | 3 540                                        | 4 310                                         |
| 170                | —                                | —        | —   | —                                  | —        | —     | 3 790                                        | 4 460                                         |
| 180                | —                                | —        | —   | —                                  | —        | —     | 3 970                                        | 5 190                                         |
| 190                | —                                | —        | —   | —                                  | —        | —     | 4 280                                        | 5 380                                         |
| 200                | —                                | —        | —   | —                                  | —        | —     | 4 380                                        | 5 480                                         |
| 220                | —                                | —        | —   | —                                  | —        | —     | 4 700                                        | 5 990                                         |
| 240                | —                                | —        | —   | —                                  | —        | —     | 5 180                                        | 6 340                                         |
| 260                | —                                | —        | —   | —                                  | —        | —     | 5 570                                        | 6 830                                         |
| 280                | —                                | —        | —   | —                                  | —        | —     | 6 010                                        | 7 260                                         |

<sup>1)</sup> For bearings in the NN 30 and NNU 49 series with d > 280 mm, contact the SKF application engineering service.

## Equivalent bearing loads

The equivalent dynamic bearing load can be calculated using

$$P = F_r$$

The equivalent static bearing load can be calculated using

$$P_0 = F_r$$

where

$P$  = equivalent dynamic bearing load [kN]

$P_0$  = equivalent static bearing load [kN]

$F_r$  = radial load [kN]

## Attainable speeds

The attainable speeds listed in the product tables are guideline values based on cylindrical roller bearings with a near zero radial internal clearance (→ *Attainable speeds*, **page 277**).

In applications where operating radial internal clearance > 0,002 mm or preload is applied or where seats and abutments do not meet accuracy requirements, the speed ratings must be reduced (→ *Recommended shaft and housing fits* and *Accuracy of seats and abutments*, **pages 277** and **277**).

The attainable speeds for preloaded bearings in the N 10 and NN 30 series can be estimated using the guideline values listed in **table 8**. For attainable speeds of preloaded bearings in the NNU 49 series, contact the SKF application engineering service.

Table 8

Attainable speed factor for preloaded bearings in the N 10 and NN 30 series

| Preload       |      | Speed factor       |
|---------------|------|--------------------|
| min.          | max. | $A = n d_m$        |
| $\mu\text{m}$ |      | mm/min             |
| 0             | 2    | $\leq 1\,300\,000$ |
| 1             | 3    | $\leq 1\,000\,000$ |
| 2             | 5    | $\leq 500\,000$    |

$n$  = rotational speed [r/min]  
 $d_m$  = bearing mean diameter [mm]  
 $= 0,5 (d + D)$

# Design considerations

## Adjusting for clearance or preload

When mounting a cylindrical roller bearing with a tapered bore, radial internal clearance or preload is determined by how far the bearing inner ring is driven up on its tapered seat. The further up the seat the ring is driven, the more it expands and the less radial internal clearance there will be, until eventually, there is a radial preload in the bearing. To quickly and accurately obtain the specified clearance or preload when mounting a bearing, SKF recommends using gauges (→ **page 278**). Gauges are particularly useful when mounting two or three bearings as it is not necessary to measure and calculate the axial drive-up distance for each bearing (→ *Mounting*, **page 278**).

If obtaining an exact radial internal clearance or preload is not critical or SKF gauges are not available, it is possible to determine the required axial drive-up distance. To do this, locate the assembled bearing at a reference point on the shaft and measure the radial internal clearance with a dial indicator positioned on the outside surface of the outer ring (→ *Mounting bearings with a tapered bore by measuring radial clearance prior to mounting*, **page 278**).

With the radial internal clearance measured using either of the above methods, the axial drive-up distance can be obtained using

$$B_a = \frac{e c}{1\,000}$$

If the bearing is to be mounted against a distance ring (→ **fig. 5**), the width of the distance ring must be adjusted to obtain the value  $B_a$ .

If there is no fixed abutment and a threaded nut is used to drive the inner ring assembly up on its tapered seat, the angle through which the nut should be turned can be calculated using

$$\alpha = \frac{360 e c}{1\,000 p}$$

where

$B_a$  = axial drive-up [mm]

$\alpha$  = requisite nut tightening angle [°]

$c$  = measured radial internal clearance at the reference point

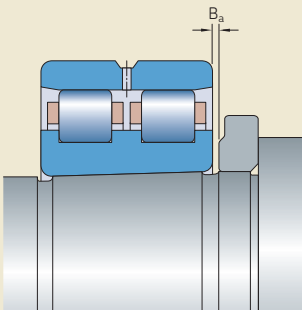
- plus the required preload [μm] for preload
- minus the required clearance [μm] for clearance
- minus the adjustment [μm] for an interference fit in the housing bore when not using SKF gauges (→ *Mounting bearings with a tapered bore by measuring radial clearance prior to mounting*)

$e$  = a factor depending on the diameter ratio of the hollow shaft and the bearing series (→ **fig. 6** and **table 9**)

$p$  = thread lead of the nut [mm]

For mounting procedures for super-precision cylindrical roller bearings, refer to *Mounting* (→ **page 278**).

Fig. 5





Calculation example

Determine the axial drive-up for a double row cylindrical roller bearing mounted on a hollow shaft. Input data:

- bearing NN 3040 K/SPW33
- measured residual radial internal clearance = 10 μm
- requisite preload = 2 μm
- mean bearing seat diameter  $d_{om}$  = 203 mm
- internal diameter of the hollow shaft  $d_i$  = 140 mm

From **table 9**  $e = 18$  for  $d_i/d_{om} = 140/203 = 0,69$   
With  $c = 10 + 2 = 12 \mu\text{m}$

$$B_a = \frac{18 \times 12}{1\,000} = 0,216 \text{ mm}$$

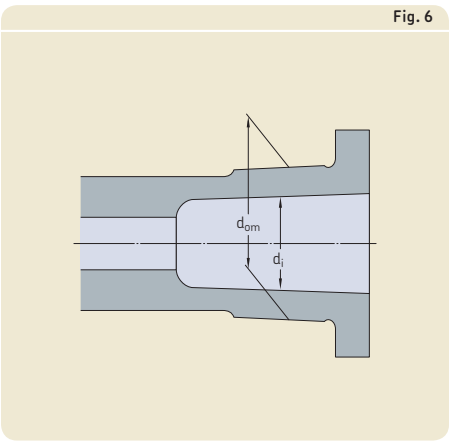


Table 9

| Factor e                                 |       | Factor e for bearings in the series |    |
|------------------------------------------|-------|-------------------------------------|----|
| Hollow shaft diameter ratio $d_i/d_{om}$ |       | N 10 K, NN 30 K    NNU 49 K         |    |
| over                                     | incl. |                                     |    |
| –                                        | 0,2   | 12,5                                | 12 |
| 0,2                                      | 0,3   | 14,5                                | 13 |
| 0,3                                      | 0,4   | 15                                  | 14 |
| 0,4                                      | 0,5   | 16                                  | 15 |
| 0,5                                      | 0,6   | 17                                  | 16 |
| 0,6                                      | 0,7   | 18                                  | 17 |

## Free space on both sides of the bearing

To be sure that N 10 and NN 30 series bearings, with a polymer cage (designation suffix TN, TN9, TNHA or PHA), can accommodate axial displacement of the shaft relative to the housing, free space must be provided on both sides of the bearing (→ **fig. 7**). This prevents damage that might otherwise occur if the cage makes contact with an adjacent component. The minimum width of this free space should be

$$C_a = 1,3 s$$

where

$C_a$  = minimum width of free space [mm]

$s$  = permissible axial displacement from the normal position of one bearing ring relative to the other [mm] (→ **product tables**)

## Mounting

To achieve the required radial internal clearance, the rings of individual bearings are matched at the factory, marked with the same identification number and usually packaged together in a single box. Be sure to check that the numbers on both rings match prior to mounting. Any mismatch could have a negative impact on the radial internal clearance and the performance characteristics of the final assembly.

When mounting super-precision cylindrical roller bearings with a tapered bore, the radial internal clearance or preload must be adjusted accurately. This is done by driving the inner ring up on its tapered shaft seat (→ **fig. 8**). The resulting expansion of the inner ring determines the internal clearance or preload in the mounted bearing. For proper mounting, the inside or outside envelope diameter of the roller set must be accurately measured. SKF internal clearance gauges in the GB 30 and GB 10 (→ **fig. 9**) or GB 49 (→ **fig. 10**) series enable simple and accurate measurements. For additional information about internal clearance gauges, refer to *Gauges* (→ **page 280**).

Mounting a cylindrical roller bearing in the NN 30 K series using a GB 30 series gauge is described in the following. The same procedure can be applied when mounting cylindrical roller bearings in the N 10 K series using either a GB 10 or GB 30 series gauge. A similar procedure can be applied when mounting cylin-

Fig. 7

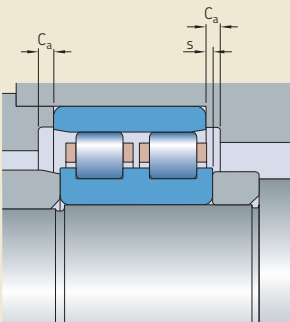


Fig. 8

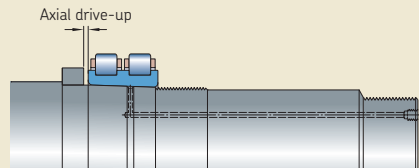


Fig. 9



GB 3006 ... GB 3020  
GB 1010 ... GB 1020

GB 3021 ... GB 3068

Fig. 10



GB 4920 ... GB 4938

GB 4940 ... GB 4960

dricl roller bearings in the NNU 49 K series using a GB 49 series gauge.

When mounting without the assistance of an internal clearance gauge, be sure that the accuracy of the readings is sufficient for the application requirements.

### Mounting a bearing in the NN 30 K series using a GB 30 series gauge

To mount a bearing in the NN 30 K series, SKF recommends using a GB 30 gauge (→ **page 282**), a bore gauge and the appropriate hydraulic tools to drive the bearing up onto its seat. Provisions for oil injection are useful for dismantling (→ *Provisions for mounting and dismantling*, **page 282**). The typical mounting procedure comprises the following steps:

- 1 Mounting the outer ring
  - Heat the housing to the appropriate temperature and slide the outer ring in position.
- 2 Preparing the gauge
  - Let the housing and the outer ring cool to ambient temperature. Set a bore gauge to the raceway diameter and zero the indicator (→ **fig. 11**).
  - Place the gauge in the centre of the gauging zone of the GB 30 gauge (→ **fig. 12**). Adjust the GB 30 gauge, using the adjustment screw until the bore gauge indicates zero minus the correction value listed in the GB 30 user instructions.
  - Increase the inside diameter of the GB 30 gauge by the value of the desired preload or reduce the inside diameter by the value of the desired clearance, using the adjustment screw. Then set the GB 30 gauge indicator to zero. Keep this indicator setting unchanged during the mounting process.
- 3 Mounting the inner ring (trial)
  - Coat the tapered shaft seat with a thin layer of light oil and push the inner ring, roller and cage assembly until the bearing bore makes good contact with its seat.
  - Expand the GB 30 gauge with the adjustment screw, place it over the roller set and release the adjustment screw so that the gauge makes contact with the roller set (→ **fig. 13**).
- Drive the inner ring roller and cage assembly together with the gauge further up on its seat until the indicator on the gauge reads zero. The inner ring is now in the correct position for the desired preload or clearance.
  - Expand the gauge using the adjustment screw and remove it from the roller and cage assembly.
- 4 Mounting the inner ring (final)
  - Measure the distance between the bearing side face and the shaft abutment using gauge blocks (→ **fig. 14**). Take measurements at different diametrical positions to check accuracy and misalignment. The difference between the single measurements should not exceed 3 to 4 µm.
  - Grind a pre-machined spacer ring to the measured width.
  - Remove the inner ring, mount the spacer ring, and drive up the inner ring again, until it firmly abuts the spacer ring.
  - Place the GB 30 gauge over the roller set as described earlier. Release the adjustment screw. If the indicator reads zero again, the inner ring is properly mounted. Remove the gauge and locate the inner ring, using a suitable locking device.

Fig. 11



Fig. 12



Fig. 13



Fig. 14



## Mounting bearings with a tapered bore by measuring radial clearance prior to mounting

If obtaining an exact radial internal clearance or preload is not critical or if SKF gauges are not available, it is possible to determine the required axial drive-up distance. To do this, locate the assembled bearing at a reference point on the shaft and measure the radial internal clearance with a dial indicator positioned on the outside surface of the outer ring. This method does not take into account that the outer ring is compressed when mounted with an interference fit in the housing. To compensate for this, it can be assumed that the outer ring raceway diameter will decrease by 80% of the diametric interference fit. The procedure comprises the following steps:

- 1 Mounting the inner ring (trial)
  - Coat the tapered shaft seat with a thin layer of light oil and push the assembled bearing in place until the bearing bore makes good contact with its seat.
  - There should still be clearance between the outer ring and rollers.
  - Keep in mind that small bearings may have only 15 µm internal clearance prior to mounting and that an axial drive-up of 0,1 mm causes a clearance reduction of ~ 8 µm.

- 2 Measuring the internal clearance prior to mounting
  - Place a spacer ring onto the shaft and position it between the bearing inner ring side face and drive-up device. The spacer, which must be parallel to the bearing inner ring side face, is there to guide the outer ring side face when measuring clearance (→ fig. 15).
  - To measure the radial clearance, place a dial indicator on the outer ring circumference and set the indicator to zero.
  - Holding the outer ring firmly against the spacer, move the outer ring up or down, and measure the total displacement. This measured distance is the radial clearance in the bearing, prior to mounting.
  - Do not apply excessive force to the outer ring. Elastic deformation may cause measurement errors.
- 3 Determine the required axial drive-up distance  $B_a$  (→ *Adjusting for clearance or preload*, page 284) remembering to include the allowance for outer ring interference fit, if one exists.
- 4 Determining the spacer ring width
  - Measure the distance  $L$  between the bearing side face and the shaft abutment (→ fig. 15). Take measurements at different diametrical positions to check accuracy and misalignment. The difference between the single measurements should not exceed 3 to 4 µm.
  - Calculate the required width of the spacer ring using

$$B = L - B_a$$

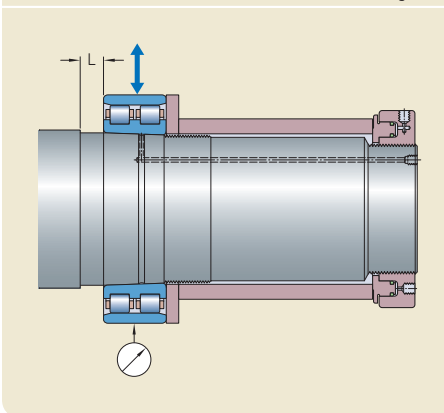
where

$B$  = required width of the spacer ring

$L$  = mean measured distance from the bearing inner ring to the abutment

$B_a$  = the required axial drive-up distance to achieve the desired clearance reduction or preload (→ *Adjusting for clearance or preload*, page 284)

Fig. 15



### 5 Mounting the bearing (final)

- Grind the pre-machined spacer ring to the required width.
- Remove the assembled bearing, mount the spacer ring, and drive up the inner ring roller and cage assembly again until it firmly abuts the spacer ring.
- Locate the inner ring using a suitable locking device.
- Heat the housing to the required temperature and mount the outer ring.

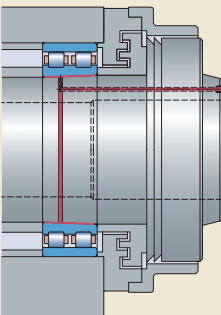
### Mounting and dismounting, using the oil injection method

Particularly where large bearings are involved, it is often necessary to make provisions during the design stage, to facilitate mounting and dismounting of a bearing, or even to make it possible at all.

For super-precision cylindrical roller bearings with a bore diameter  $d > 80$  mm, SKF recommends the oil injection method. With the oil injection method, oil under high pressure is injected via ducts and distribution grooves between the bearing and bearing seat to form an oil film (→ **fig. 16**). This oil film separates the mating surfaces and considerably reduces the friction between them and virtually eliminates the risk of damaging the bearing or the spindle shaft. This method is typically used when mounting or dismounting bearings directly on tapered shaft seats. Where bearings with a cylindrical bore are concerned, the oil injection method can only be used for dismounting.

To apply the oil injection method, the spindle must contain ducts and grooves (→ *Provisions for mounting and dismounting*, **page 285**).

Fig. 16



# Designation system

**Examples:** N 1016 KPHA/HC5SP  
NN 3020 KTN9/SPVR521  
NNU 49/500 B/SPC3W33X

|     |    |      |   |     |   |     |      |       |
|-----|----|------|---|-----|---|-----|------|-------|
| N   | 10 | 16   | K | PHA | / | HC5 | SP   |       |
| NN  | 30 | 20   | K | TN9 | / |     | SP   | VR521 |
| NNU | 49 | /500 | B |     | / |     | SPC3 | W33X  |

## Bearing design

**N** Single row cylindrical roller bearing  
**NN** Double row cylindrical roller bearing  
**NNU** Double row cylindrical roller bearing

## Dimension series

**10** In accordance with ISO dimension series 10  
**30** In accordance with ISO dimension series 30  
**49** In accordance with ISO dimension series 49

## Bearing size

**05** (x5) 25 mm bore diameter  
to  
**92** (x5) 460 mm bore diameter  
from  
**/500** Bore diameter uncoded [mm]

## Internal design and bore shape

**–** Cylindrical bore (no designation suffix)  
**B** Modified internal design  
**K** Tapered bore, taper 1:12

## Cage

**–** Machined brass cage, roller centred (no designation suffix)  
**PHA** Carbon fibre reinforced PEEK cage, outer ring centred  
**TN** PA66 cage, roller centred  
**TN9** Glass fibre reinforced PA66 cage, roller centred  
**TNHA** Glass fibre reinforced PEEK cage, outer ring centred

## Roller material

**–** Carbon chromium steel (no designation suffix)  
**HC5** Rollers made of bearing grade silicon nitride Si<sub>3</sub>N<sub>4</sub> (hybrid bearing)

## Tolerance class and internal clearance

**SP** Dimensional accuracy in accordance with ISO tolerance class 5, running accuracy in accordance with ISO tolerance class 4  
**UP** Dimensional accuracy in accordance with ISO tolerance class 4, running accuracy better than ISO tolerance class 4  
**–** Standard radial internal clearance C1 (no designation suffix)  
**C2** Radial internal clearance greater than C1  
**CN** Normal radial internal clearance  
**C3** Radial internal clearance greater than Normal

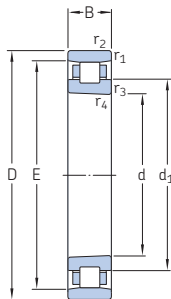
## Other variants

**VR521** Bearing supplied with measuring report (standard for NN 30 series bearings with d > 130 mm)  
**VU001** Inner ring raceway with finish-grinding allowance  
**W33** Annular groove and three lubrication holes in the outer ring  
**W33X** Annular groove and six lubrication holes in the outer ring

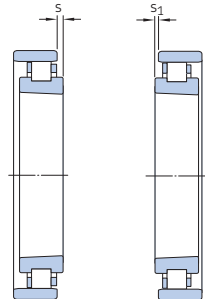




3.1 Single row cylindrical roller bearings  
d 40 – 60 mm

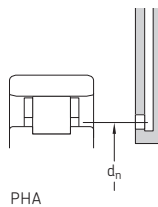
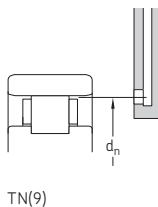
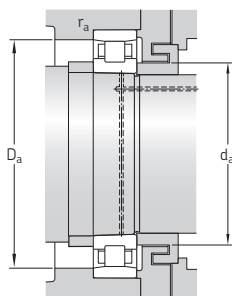


TN(9), PHA



TNHA

| Principal dimensions |    |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds          |                        | Mass | Designation                 |
|----------------------|----|----|--------------------|--------------------------|--------------------|----------------------------|------------------------|------|-----------------------------|
| d                    | D  | B  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrica-<br>tion | Oil-air<br>lubrication | kg   | Bearing with a tapered bore |
| mm                   |    |    | kN                 |                          | kN                 | r/min                      |                        |      | –                           |
| 40                   | 68 | 15 | 23,3               | 25                       | 2,9                | 30 000                     | 36 000                 | 0,19 | N 1008 KPHA/SP              |
|                      | 68 | 15 | 23,3               | 25                       | 2,9                | 32 000                     | 38 000                 | 0,17 | N 1008 KPHA/HC5SP           |
|                      | 68 | 15 | 24,2               | 26,5                     | 3,05               | 22 000                     | 32 000                 | 0,19 | N 1008 KTNHA/SP             |
|                      | 68 | 15 | 24,2               | 26,5                     | 3,05               | 26 000                     | 36 000                 | 0,17 | N 1008 KTNHA/HC5SP          |
|                      | 68 | 15 | 25,1               | 28                       | 3,2                | 15 000                     | 17 000                 | 0,19 | N 1008 KTN/SP               |
|                      | 68 | 15 | 25,1               | 28                       | 3,2                | 18 000                     | 20 000                 | 0,17 | N 1008 KTN/HC5SP            |
| 45                   | 75 | 16 | 27                 | 30                       | 3,45               | 28 000                     | 34 000                 | 0,24 | N 1009 KPHA/SP              |
|                      | 75 | 16 | 27                 | 30                       | 3,45               | 30 000                     | 36 000                 | 0,2  | N 1009 KPHA/HC5SP           |
|                      | 75 | 16 | 28,1               | 31                       | 3,65               | 20 000                     | 28 000                 | 0,24 | N 1009 KTNHA/SP             |
|                      | 75 | 16 | 28,1               | 31                       | 3,65               | 22 000                     | 32 000                 | 0,21 | N 1009 KTNHA/HC5SP          |
|                      | 75 | 16 | 29,2               | 32,5                     | 3,8                | 14 000                     | 15 000                 | 0,24 | N 1009 KTN/SP               |
|                      | 75 | 16 | 29,2               | 32,5                     | 3,8                | 16 000                     | 18 000                 | 0,22 | N 1009 KTN/HC5SP            |
| 50                   | 80 | 16 | 28,6               | 33,5                     | 3,8                | 26 000                     | 30 000                 | 0,26 | N 1010 KPHA/SP              |
|                      | 80 | 16 | 28,6               | 33,5                     | 3,8                | 28 000                     | 32 000                 | 0,22 | N 1010 KPHA/HC5SP           |
|                      | 80 | 16 | 29,7               | 34,5                     | 4,05               | 19 000                     | 26 000                 | 0,26 | N 1010 KTNHA/SP             |
|                      | 80 | 16 | 29,7               | 34,5                     | 4,05               | 20 000                     | 28 000                 | 0,23 | N 1010 KTNHA/HC5SP          |
|                      | 80 | 16 | 30,8               | 36,5                     | 4,25               | 13 000                     | 14 000                 | 0,26 | N 1010 KTN/SP               |
|                      | 80 | 16 | 30,8               | 36,5                     | 4,25               | 15 000                     | 17 000                 | 0,23 | N 1010 KTN/HC5SP            |
| 55                   | 90 | 18 | 37,4               | 44                       | 5,2                | 22 000                     | 28 000                 | 0,38 | N 1011 KPHA/SP              |
|                      | 90 | 18 | 37,4               | 44                       | 5,2                | 24 000                     | 30 000                 | 0,32 | N 1011 KPHA/HC5SP           |
|                      | 90 | 18 | 39,1               | 46,5                     | 5,5                | 17 000                     | 24 000                 | 0,39 | N 1011 KTNHA/SP             |
|                      | 90 | 18 | 39,1               | 46,5                     | 5,5                | 19 000                     | 26 000                 | 0,35 | N 1011 KTNHA/HC5SP          |
|                      | 90 | 18 | 40,2               | 48                       | 5,7                | 12 000                     | 13 000                 | 0,39 | N 1011 KTN/SP               |
|                      | 90 | 18 | 40,2               | 48                       | 5,7                | 13 000                     | 15 000                 | 0,35 | N 1011 KTN/HC5SP            |
| 60                   | 95 | 18 | 40,2               | 49                       | 5,85               | 20 000                     | 26 000                 | 0,4  | N 1012 KPHA/SP              |
|                      | 95 | 18 | 40,2               | 49                       | 5,85               | 22 000                     | 28 000                 | 0,33 | N 1012 KPHA/HC5SP           |
|                      | 95 | 18 | 41,3               | 51                       | 6,1                | 16 000                     | 22 000                 | 0,41 | N 1012 KTNHA/SP             |
|                      | 95 | 18 | 41,3               | 51                       | 6,1                | 18 000                     | 24 000                 | 0,37 | N 1012 KTNHA/HC5SP          |
|                      | 95 | 18 | 42,9               | 53                       | 6,3                | 11 000                     | 12 000                 | 0,41 | N 1012 KTN/SP               |
|                      | 95 | 18 | 42,9               | 53                       | 6,3                | 12 000                     | 14 000                 | 0,37 | N 1012 KTN/HC5SP            |



| Dimensions |                |      |                          |                          |                 |                              | Abutment and fillet dimensions |                        |                        |                        |                              | Reference grease quantity <sup>1)</sup> |
|------------|----------------|------|--------------------------|--------------------------|-----------------|------------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------------|-----------------------------------------|
| d          | d <sub>1</sub> | E    | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | s <sup>2)</sup> | s <sub>1</sub> <sup>2)</sup> | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | d <sub>n</sub> <sup>3)</sup> | G <sub>ref</sub>                        |
| mm         |                |      |                          |                          |                 |                              | mm                             |                        |                        |                        |                              | cm <sup>3</sup>                         |
| 40         | 50,6           | 61   | 1                        | 0,6                      | 2               | –                            | 45                             | 62                     | 63                     | 1                      | 52,1                         | 3,1                                     |
|            | 50,6           | 61   | 1                        | 0,6                      | 2               | –                            | 45                             | 62                     | 63                     | 1                      | 52,1                         | 3,1                                     |
|            | 50,6           | 61   | 1                        | 0,6                      | 2               | 1,5                          | 45                             | 62                     | 63                     | 1                      | –                            | 2,5                                     |
|            | 50,6           | 61   | 1                        | 0,6                      | 2               | 1,5                          | 45                             | 62                     | 63                     | 1                      | –                            | 2,5                                     |
|            | 50,6           | 61   | 1                        | 0,6                      | 2               | –                            | 45                             | 62                     | 63                     | 1                      | 60                           | 2,3                                     |
|            | 50,6           | 61   | 1                        | 0,6                      | 2               | –                            | 45                             | 62                     | 63                     | 1                      | 60                           | 2,3                                     |
| 45         | 56,3           | 67,5 | 1                        | 0,6                      | 2               | –                            | 50                             | 69                     | 70                     | 1                      | 57,9                         | 4,1                                     |
|            | 56,3           | 67,5 | 1                        | 0,6                      | 2               | –                            | 50                             | 69                     | 70                     | 1                      | 57,9                         | 4,1                                     |
|            | 56,3           | 67,5 | 1                        | 0,6                      | 2               | 1,5                          | 50                             | 69                     | 70                     | 1                      | –                            | 3,2                                     |
|            | 56,3           | 67,5 | 1                        | 0,6                      | 2               | 1,5                          | 50                             | 69                     | 70                     | 1                      | –                            | 3,2                                     |
|            | 56,3           | 67,5 | 1                        | 0,6                      | 2               | –                            | 50                             | 69                     | 70                     | 1                      | 66,4                         | 2,9                                     |
|            | 56,3           | 67,5 | 1                        | 0,6                      | 2               | –                            | 50                             | 69                     | 70                     | 1                      | 66,4                         | 2,9                                     |
| 50         | 61,3           | 72,5 | 1                        | 0,6                      | 2               | –                            | 55                             | 74                     | 75                     | 1                      | 63                           | 4,4                                     |
|            | 61,3           | 72,5 | 1                        | 0,6                      | 2               | –                            | 55                             | 74                     | 75                     | 1                      | 63                           | 4,4                                     |
|            | 61,3           | 72,5 | 1                        | 0,6                      | 2               | 1,5                          | 55                             | 74                     | 75                     | 1                      | –                            | 3,5                                     |
|            | 61,3           | 72,5 | 1                        | 0,6                      | 2               | 1,5                          | 55                             | 74                     | 75                     | 1                      | –                            | 3,5                                     |
|            | 61,3           | 72,5 | 1                        | 0,6                      | 2               | –                            | 55                             | 74                     | 75                     | 1                      | 71,4                         | 3,2                                     |
|            | 61,3           | 72,5 | 1                        | 0,6                      | 2               | –                            | 55                             | 74                     | 75                     | 1                      | 71,4                         | 3,2                                     |
| 55         | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | –                            | 61,5                           | 82                     | 83,5                   | 1                      | 70,1                         | 6,1                                     |
|            | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | –                            | 61,5                           | 82                     | 83,5                   | 1                      | 70,1                         | 6,1                                     |
|            | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | 1,5                          | 61,5                           | 82                     | 83,5                   | 1                      | –                            | 4,9                                     |
|            | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | 1,5                          | 61,5                           | 82                     | 83,5                   | 1                      | –                            | 4,9                                     |
|            | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | –                            | 61,5                           | 82                     | 83,5                   | 1                      | 79,8                         | 4,4                                     |
|            | 68,2           | 81   | 1,1                      | 0,6                      | 2,5             | –                            | 61,5                           | 82                     | 83,5                   | 1                      | 79,8                         | 4,4                                     |
| 60         | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | –                            | 66,5                           | 87                     | 88,5                   | 1                      | 75,2                         | 6,5                                     |
|            | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | –                            | 66,5                           | 87                     | 88,5                   | 1                      | 75,2                         | 6,5                                     |
|            | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | 1,5                          | 66,5                           | 87                     | 88,5                   | 1                      | –                            | 5,2                                     |
|            | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | 1,5                          | 66,5                           | 87                     | 88,5                   | 1                      | –                            | 5,2                                     |
|            | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | –                            | 66,5                           | 87                     | 88,5                   | 1                      | 85                           | 4,7                                     |
|            | 73,3           | 86,1 | 1,1                      | 0,6                      | 2,5             | –                            | 66,5                           | 87                     | 88,5                   | 1                      | 85                           | 4,7                                     |

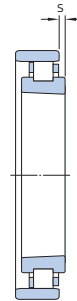
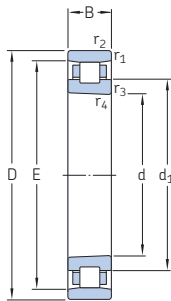
<sup>1)</sup> For calculating the initial grease fill → page 289

<sup>2)</sup> Permissible axial displacement from the normal position of one bearing ring relative to the other.

<sup>3)</sup> For bearings equipped with a TNHA cage, contact the SKF application engineering service.

### 3.1 Single row cylindrical roller bearings

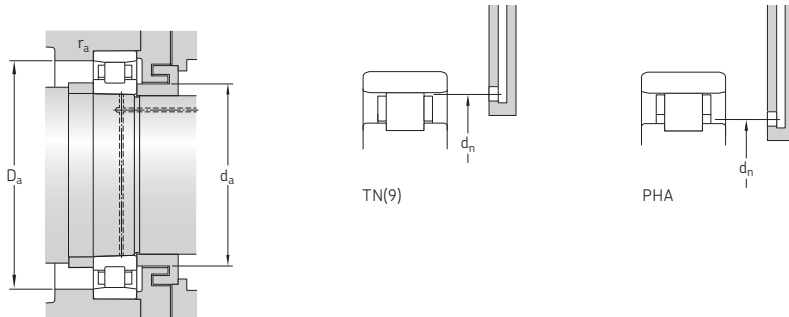
d 65 – 90 mm



TN(9), PHA

TNHA

| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds          |                        | Mass | Designation                 |
|----------------------|-----|----|--------------------|--------------------------|--------------------|----------------------------|------------------------|------|-----------------------------|
| d                    | D   | B  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrica-<br>tion | Oil-air<br>lubrication | kg   | Bearing with a tapered bore |
| mm                   |     |    | kN                 |                          | kN                 | r/min                      |                        |      | –                           |
| 65                   | 100 | 18 | 42,9               | 54                       | 6,3                | 20 000                     | 24 000                 | 0,43 | N 1013 KPHA/SP              |
|                      | 100 | 18 | 42,9               | 54                       | 6,3                | 22 000                     | 26 000                 | 0,35 | N 1013 KPHA/HC5SP           |
|                      | 100 | 18 | 44                 | 56                       | 6,55               | 15 000                     | 20 000                 | 0,44 | N 1013 KTNHA/SP             |
|                      | 100 | 18 | 44                 | 56                       | 6,55               | 17 000                     | 22 000                 | 0,39 | N 1013 KTNHA/HC5SP          |
|                      | 100 | 18 | 44,6               | 58,5                     | 6,8                | 10 000                     | 11 000                 | 0,44 | N 1013 KTN/SP               |
|                      | 100 | 18 | 44,6               | 58,5                     | 6,8                | 11 000                     | 13 000                 | 0,39 | N 1013 KTN/HC5SP            |
| 70                   | 110 | 20 | 53,9               | 69,5                     | 8                  | 18 000                     | 22 000                 | 0,61 | N 1014 KPHA/SP              |
|                      | 110 | 20 | 53,9               | 69,5                     | 8                  | 20 000                     | 24 000                 | 0,5  | N 1014 KPHA/HC5SP           |
|                      | 110 | 20 | 55                 | 72                       | 8,3                | 13 000                     | 19 000                 | 0,62 | N 1014 KTNHA/SP             |
|                      | 110 | 20 | 55                 | 72                       | 8,3                | 15 000                     | 20 000                 | 0,55 | N 1014 KTNHA/HC5SP          |
|                      | 110 | 20 | 57,2               | 75                       | 8,65               | 9 500                      | 10 000                 | 0,62 | N 1014 KTN/SP               |
|                      | 110 | 20 | 57,2               | 75                       | 8,65               | 10 000                     | 12 000                 | 0,55 | N 1014 KTN/HC5SP            |
| 75                   | 115 | 20 | 52,8               | 69,5                     | 8,15               | 17 000                     | 20 000                 | 0,64 | N 1015 KPHA/SP              |
|                      | 115 | 20 | 52,8               | 69,5                     | 8,15               | 19 000                     | 22 000                 | 0,53 | N 1015 KPHA/HC5SP           |
|                      | 115 | 20 | 55                 | 72                       | 8,5                | 13 000                     | 18 000                 | 0,65 | N 1015 KTNHA/SP             |
|                      | 115 | 20 | 55                 | 72                       | 8,5                | 14 000                     | 20 000                 | 0,57 | N 1015 KTNHA/HC5SP          |
|                      | 115 | 20 | 56,1               | 75                       | 8,8                | 9 000                      | 9 500                  | 0,65 | N 1015 KTN/SP               |
|                      | 115 | 20 | 56,1               | 75                       | 8,8                | 9 500                      | 11 000                 | 0,57 | N 1015 KTN/HC5SP            |
| 80                   | 125 | 22 | 66                 | 86,5                     | 10,2               | 16 000                     | 19 000                 | 0,88 | N 1016 KPHA/SP              |
|                      | 125 | 22 | 66                 | 86,5                     | 10,2               | 18 000                     | 20 000                 | 0,73 | N 1016 KPHA/HC5SP           |
|                      | 125 | 22 | 67,1               | 90                       | 10,6               | 12 000                     | 16 000                 | 0,88 | N 1016 KTNHA/SP             |
|                      | 125 | 22 | 67,1               | 90                       | 10,6               | 13 000                     | 18 000                 | 0,79 | N 1016 KTNHA/HC5SP          |
|                      | 125 | 22 | 69,3               | 93                       | 11                 | 8 500                      | 9 000                  | 0,89 | N 1016 KTN/SP               |
|                      | 125 | 22 | 69,3               | 93                       | 11                 | 9 000                      | 10 000                 | 0,79 | N 1016 KTN/HC5SP            |
| 85                   | 130 | 22 | 70,4               | 98                       | 11,2               | 11 000                     | 16 000                 | 0,89 | N 1017 KTNHA/SP             |
|                      | 130 | 22 | 70,4               | 98                       | 11,2               | 13 000                     | 17 000                 | 0,79 | N 1017 KTNHA/HC5SP          |
|                      | 130 | 22 | 73,7               | 102                      | 11,6               | 8 000                      | 8 500                  | 0,9  | N 1017 KTN9/SP              |
|                      | 130 | 22 | 73,7               | 102                      | 11,6               | 9 000                      | 10 000                 | 0,8  | N 1017 KTN9/HC5SP           |
| 90                   | 140 | 24 | 76,5               | 104                      | 12,5               | 10 000                     | 14 000                 | 1,2  | N 1018 KTNHA/SP             |
|                      | 140 | 24 | 76,5               | 104                      | 12,5               | 12 000                     | 16 000                 | 1,05 | N 1018 KTNHA/HC5SP          |
|                      | 140 | 24 | 79,2               | 108                      | 12,9               | 7 000                      | 8 000                  | 1,2  | N 1018 KTN9/SP              |
|                      | 140 | 24 | 79,2               | 108                      | 12,9               | 8 500                      | 9 500                  | 1,1  | N 1018 KTN9/HC5SP           |



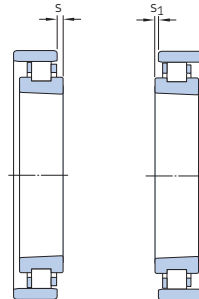
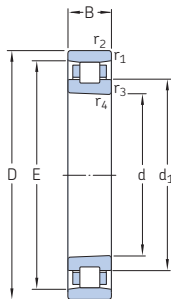
| Dimensions |                |     |                          |                          |                 |                              | Abutment and fillet dimensions |                        |                        |                        |                              | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> |
|------------|----------------|-----|--------------------------|--------------------------|-----------------|------------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------------|-------------------------------------------------------------|
| d          | d <sub>1</sub> | E   | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | s <sup>2)</sup> | s <sub>1</sub> <sup>2)</sup> | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | d <sub>n</sub> <sup>3)</sup> |                                                             |
| mm         |                |     |                          |                          |                 |                              | mm                             |                        |                        |                        |                              | cm <sup>3</sup>                                             |
| 65         | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | –                            | 71,5                           | 92                     | 93,5                   | 1                      | 80,1                         | 6,9                                                         |
|            | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | –                            | 71,5                           | 92                     | 93,5                   | 1                      | 80,1                         | 6,9                                                         |
|            | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | 1,5                          | 71,5                           | 92                     | 93,5                   | 1                      | –                            | 5,5                                                         |
|            | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | 1,5                          | 71,5                           | 92                     | 93,5                   | 1                      | –                            | 5,5                                                         |
|            | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | –                            | 71,5                           | 92                     | 93,5                   | 1                      | 89,7                         | 5                                                           |
|            | 78,2           | 91  | 1,1                      | 0,6                      | 2,5             | –                            | 71,5                           | 92                     | 93,5                   | 1                      | 89,7                         | 5                                                           |
| 70         | 85,6           | 100 | 1,1                      | 0,6                      | 3               | –                            | 76,5                           | 101                    | 103,5                  | 1                      | 87,7                         | 9,2                                                         |
|            | 85,6           | 100 | 1,1                      | 0,6                      | 3               | –                            | 76,5                           | 101                    | 103,5                  | 1                      | 87,7                         | 9,2                                                         |
|            | 85,6           | 100 | 1,1                      | 0,6                      | 3               | 1,5                          | 76,5                           | 101                    | 103,5                  | 1                      | –                            | 7,2                                                         |
|            | 85,6           | 100 | 1,1                      | 0,6                      | 3               | 1,5                          | 76,5                           | 101                    | 103,5                  | 1                      | –                            | 7,2                                                         |
|            | 85,6           | 100 | 1,1                      | 0,6                      | 3               | –                            | 76,5                           | 101                    | 103,5                  | 1                      | 98,5                         | 6,7                                                         |
|            | 85,6           | 100 | 1,1                      | 0,6                      | 3               | –                            | 76,5                           | 101                    | 103,5                  | 1                      | 98,5                         | 6,7                                                         |
| 75         | 90,6           | 105 | 1,1                      | 0,6                      | 3               | –                            | 81,5                           | 106                    | 108,5                  | 1                      | 92,7                         | 9,6                                                         |
|            | 90,6           | 105 | 1,1                      | 0,6                      | 3               | –                            | 81,5                           | 106                    | 108,5                  | 1                      | 92,7                         | 9,6                                                         |
|            | 90,6           | 105 | 1,1                      | 0,6                      | 3               | 1,5                          | 81,5                           | 106                    | 108,5                  | 1                      | –                            | 7,7                                                         |
|            | 90,6           | 105 | 1,1                      | 0,6                      | 3               | 1,5                          | 81,5                           | 106                    | 108,5                  | 1                      | –                            | 7,7                                                         |
|            | 90,6           | 105 | 1,1                      | 0,6                      | 3               | –                            | 81,5                           | 106                    | 108,5                  | 1                      | 103,5                        | 7,1                                                         |
|            | 90,6           | 105 | 1,1                      | 0,6                      | 3               | –                            | 81,5                           | 106                    | 108,5                  | 1                      | 103,5                        | 7,1                                                         |
| 80         | 97             | 113 | 1,1                      | 0,6                      | 3               | –                            | 86,5                           | 114                    | 118,5                  | 1                      | 99,3                         | 13                                                          |
|            | 97             | 113 | 1,1                      | 0,6                      | 3               | –                            | 86,5                           | 114                    | 118,5                  | 1                      | 99,3                         | 13                                                          |
|            | 97             | 113 | 1,1                      | 0,6                      | 3               | 1                            | 86,5                           | 114                    | 118,5                  | 1                      | –                            | 9,8                                                         |
|            | 97             | 113 | 1,1                      | 0,6                      | 3               | 1                            | 86,5                           | 114                    | 118,5                  | 1                      | –                            | 9,8                                                         |
|            | 97             | 113 | 1,1                      | 0,6                      | 3               | –                            | 86,5                           | 114                    | 118,5                  | 1                      | 111,4                        | 9                                                           |
|            | 97             | 113 | 1,1                      | 0,6                      | 3               | –                            | 86,5                           | 114                    | 118,5                  | 1                      | 111,4                        | 9                                                           |
| 85         | 102            | 118 | 1,1                      | 0,6                      | 3               | 1                            | 91,5                           | 119                    | 123,5                  | 1                      | –                            | 10                                                          |
|            | 102            | 118 | 1,1                      | 0,6                      | 3               | 1                            | 91,5                           | 119                    | 123,5                  | 1                      | –                            | 10                                                          |
|            | 102            | 118 | 1,1                      | 0,6                      | 3               | –                            | 91,5                           | 119                    | 123,5                  | 1                      | 116,5                        | 9,2                                                         |
|            | 102            | 118 | 1,1                      | 0,6                      | 3               | –                            | 91,5                           | 119                    | 123,5                  | 1                      | 116,5                        | 9,2                                                         |
| 90         | 109,4          | 127 | 1,5                      | 1                        | 3               | 1                            | 98                             | 129                    | 132                    | 1,5                    | –                            | 14                                                          |
|            | 109,4          | 127 | 1,5                      | 1                        | 3               | 1                            | 98                             | 129                    | 132                    | 1,5                    | –                            | 14                                                          |
|            | 109,4          | 127 | 1,5                      | 1                        | 3               | –                            | 98                             | 129                    | 132                    | 1,5                    | 125,4                        | 12                                                          |
|            | 109,4          | 127 | 1,5                      | 1                        | 3               | –                            | 98                             | 129                    | 132                    | 1,5                    | 125,4                        | 12                                                          |

<sup>1)</sup> For calculating the initial grease fill → **page 291**

<sup>2)</sup> Permissible axial displacement from the normal position of one bearing ring relative to the other.

<sup>3)</sup> For bearings equipped with a TNHA cage, contact the SKF application engineering service.

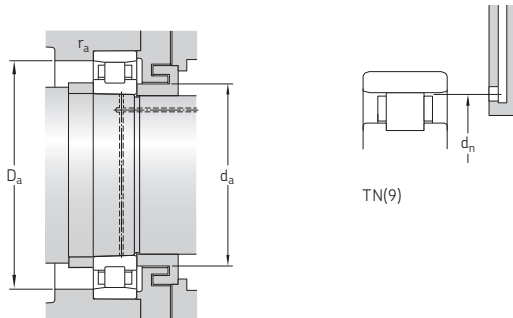
3.1 Single row cylindrical roller bearings  
d 95 – 120 mm



TN(9)

TNHA

| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds          |                        | Mass | Designation                 |
|----------------------|-----|----|--------------------|--------------------------|--------------------|----------------------------|------------------------|------|-----------------------------|
| d                    | D   | B  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrica-<br>tion | Oil-air<br>lubrication |      | Bearing with a tapered bore |
| mm                   |     |    | kN                 |                          | kN                 | r/min                      |                        | kg   | –                           |
| 95                   | 145 | 24 | 80,9               | 112                      | 13,4               | 10 000                     | 14 000                 | 1,25 | N 1019 KTNHA/SP             |
|                      | 145 | 24 | 80,9               | 112                      | 13,4               | 11 000                     | 15 000                 | 1,1  | N 1019 KTNHA/HC5SP          |
|                      | 145 | 24 | 84,2               | 116                      | 14                 | 6 700                      | 7 500                  | 1,25 | N 1019 KTN9/SP              |
|                      | 145 | 24 | 84,2               | 116                      | 14                 | 8 000                      | 9 000                  | 1,1  | N 1019 KTN9/HC5SP           |
| 100                  | 150 | 24 | 85,8               | 120                      | 14,3               | 9 500                      | 13 000                 | 1,3  | N 1020 KTNHA/SP             |
|                      | 150 | 24 | 85,8               | 120                      | 14,3               | 11 000                     | 15 000                 | 1,15 | N 1020 KTNHA/HC5SP          |
|                      | 150 | 24 | 88                 | 125                      | 14,6               | 6 700                      | 7 500                  | 1,3  | N 1020 KTN9/SP              |
|                      | 150 | 24 | 88                 | 125                      | 14,6               | 7 500                      | 8 500                  | 1,15 | N 1020 KTN9/HC5SP           |
| 105                  | 160 | 26 | 108                | 146                      | 17,3               | 9 000                      | 13 000                 | 1,65 | N 1021 KTNHA/SP             |
|                      | 160 | 26 | 108                | 146                      | 17,3               | 10 000                     | 14 000                 | 1,45 | N 1021 KTNHA/HC5SP          |
|                      | 160 | 26 | 110                | 153                      | 18                 | 6 300                      | 7 000                  | 1,65 | N 1021 KTN9/SP              |
|                      | 160 | 26 | 110                | 153                      | 18                 | 7 000                      | 8 000                  | 1,45 | N 1021 KTN9/HC5SP           |
| 110                  | 170 | 28 | 125                | 173                      | 20                 | 8 500                      | 12 000                 | 2,05 | N 1022 KTNHA/SP             |
|                      | 170 | 28 | 125                | 173                      | 20                 | 9 500                      | 13 000                 | 1,8  | N 1022 KTNHA/HC5SP          |
|                      | 170 | 28 | 128                | 180                      | 20,8               | 5 600                      | 6 300                  | 2,05 | N 1022 KTN9/SP              |
|                      | 170 | 28 | 128                | 180                      | 20,8               | 6 700                      | 7 500                  | 1,8  | N 1022 KTN9/HC5SP           |
| 120                  | 180 | 28 | 130                | 186                      | 21,2               | 8 000                      | 11 000                 | 2,2  | N 1024 KTNHA/SP             |
|                      | 180 | 28 | 130                | 186                      | 21,2               | 9 000                      | 12 000                 | 1,9  | N 1024 KTNHA/HC5SP          |
|                      | 180 | 28 | 134                | 196                      | 22                 | 5 300                      | 6 000                  | 2,2  | N 1024 KTN9/SP              |
|                      | 180 | 28 | 134                | 196                      | 22                 | 6 300                      | 7 000                  | 1,9  | N 1024 KTN9/HC5SP           |



TN(9)

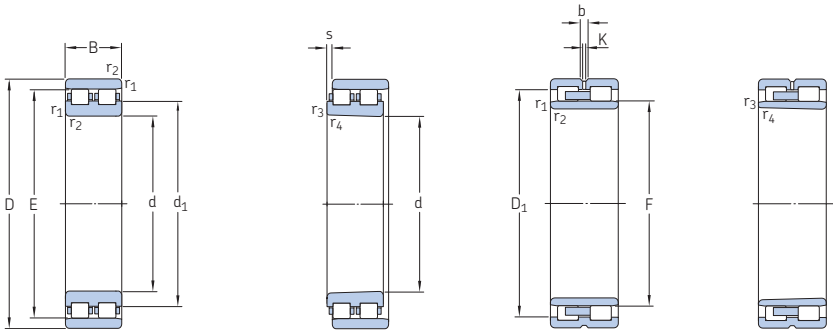
| Dimensions |                |     |                          |                          |                 |                              | Abutment and fillet dimensions |                        |                        |                        |                              | Reference grease quantity <sup>1)</sup><br>G <sub>ref</sub> |
|------------|----------------|-----|--------------------------|--------------------------|-----------------|------------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------------|-------------------------------------------------------------|
| d          | d <sub>1</sub> | E   | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | s <sup>2)</sup> | s <sub>1</sub> <sup>2)</sup> | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | d <sub>n</sub> <sup>3)</sup> |                                                             |
| mm         |                |     |                          |                          |                 |                              | mm                             |                        |                        |                        |                              | cm <sup>3</sup>                                             |
| 95         | 114,4          | 132 | 1,5                      | 1                        | 3               | 1                            | 103                            | 134                    | 137                    | 1,5                    | –                            | 14                                                          |
|            | 114,4          | 132 | 1,5                      | 1                        | 3               | 1                            | 103                            | 134                    | 137                    | 1,5                    | –                            | 14                                                          |
|            | 114,4          | 132 | 1,5                      | 1                        | 3               | –                            | 103                            | 134                    | 137                    | 1,5                    | 130,3                        | 13                                                          |
|            | 114,4          | 132 | 1,5                      | 1                        | 3               | –                            | 103                            | 134                    | 137                    | 1,5                    | 130,3                        | 13                                                          |
| 100        | 119,4          | 137 | 1,5                      | 1                        | 3               | 1                            | 108                            | 139                    | 142                    | 1,5                    | –                            | 14                                                          |
|            | 119,4          | 137 | 1,5                      | 1                        | 3               | 1                            | 108                            | 139                    | 142                    | 1,5                    | –                            | 14                                                          |
|            | 119,4          | 137 | 1,5                      | 1                        | 3               | –                            | 108                            | 139                    | 142                    | 1,5                    | 135,3                        | 13                                                          |
|            | 119,4          | 137 | 1,5                      | 1                        | 3               | –                            | 108                            | 139                    | 142                    | 1,5                    | 135,3                        | 13                                                          |
| 105        | 125,2          | 146 | 2                        | 1,1                      | 3               | 1                            | 114                            | 148                    | 151                    | 2                      | –                            | 18                                                          |
|            | 125,2          | 146 | 2                        | 1,1                      | 3               | 1                            | 114                            | 148                    | 151                    | 2                      | –                            | 18                                                          |
|            | 125,2          | 146 | 2                        | 1,1                      | 3               | –                            | 114                            | 148                    | 151                    | 2                      | 144,1                        | 18                                                          |
|            | 125,2          | 146 | 2                        | 1,1                      | 3               | –                            | 114                            | 148                    | 151                    | 2                      | 144,1                        | 18                                                          |
| 110        | 132,6          | 155 | 2                        | 1,1                      | 3               | 1                            | 119                            | 157                    | 161                    | 2                      | –                            | 21                                                          |
|            | 132,6          | 155 | 2                        | 1,1                      | 3               | 1                            | 119                            | 157                    | 161                    | 2                      | –                            | 21                                                          |
|            | 132,6          | 155 | 2                        | 1,1                      | 3               | –                            | 119                            | 157                    | 161                    | 2                      | 153                          | 21                                                          |
|            | 132,6          | 155 | 2                        | 1,1                      | 3               | –                            | 119                            | 157                    | 161                    | 2                      | 153                          | 21                                                          |
| 120        | 142,6          | 165 | 2                        | 1,1                      | 3               | 1                            | 129                            | 167                    | 171                    | 2                      | –                            | 34                                                          |
|            | 142,6          | 165 | 2                        | 1,1                      | 3               | 1                            | 129                            | 167                    | 171                    | 2                      | –                            | 34                                                          |
|            | 142,6          | 165 | 2                        | 1,1                      | 3               | –                            | 129                            | 167                    | 171                    | 2                      | 162,9                        | 22                                                          |
|            | 142,6          | 165 | 2                        | 1,1                      | 3               | –                            | 129                            | 167                    | 171                    | 2                      | 162,9                        | 22                                                          |

1) For calculating the initial grease fill → page 293

2) Permissible axial displacement from the normal position of one bearing ring relative to the other.

3) For bearings equipped with a TNHA cage, contact the SKF application engineering service.

3.2 Double row cylindrical roller bearings  
d 25 – 105 mm



NN 30 TN(9)

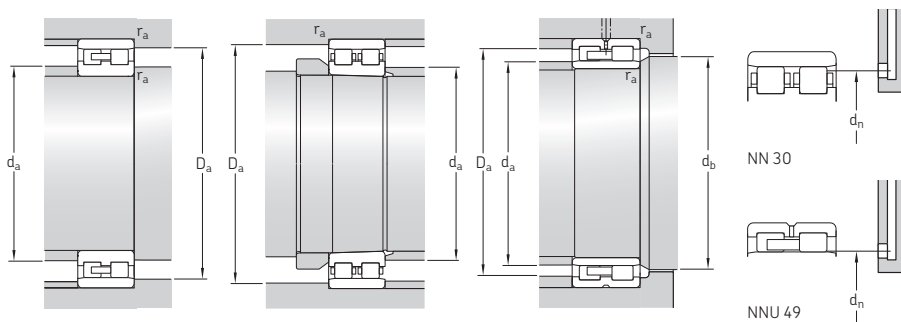
NN 30 KTN(9)

NNU 49 B/W33

NNU 49 BK/W33

| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds  |                     | Mass | Designations                |                  |
|----------------------|-----|----|--------------------|--------------------------|--------------------|--------------------|---------------------|------|-----------------------------|------------------|
| d                    | D   | B  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |      | Bearing with a tapered bore | cylindrical bore |
| mm                   |     |    | kN                 |                          | kN                 | r/min              |                     | kg   | –                           |                  |
| 25                   | 47  | 16 | 26                 | 30                       | 3,15               | 19 000             | 22 000              | 0,12 | NN 3005 K/SP                | NN 3005/SP       |
| 30                   | 55  | 19 | 30,8               | 37,5                     | 4                  | 17 000             | 19 000              | 0,19 | NN 3006 KTN/SP              | NN 3006 TN/SP    |
| 35                   | 62  | 20 | 39,1               | 50                       | 5,4                | 14 000             | 16 000              | 0,25 | NN 3007 K/SP                | NN 3007/SP       |
| 40                   | 68  | 21 | 42,9               | 56                       | 6,4                | 13 000             | 15 000              | 0,3  | NN 3008 KTN/SP              | NN 3008 TN/SP    |
| 45                   | 75  | 23 | 50,1               | 65,5                     | 7,65               | 12 000             | 14 000              | 0,38 | NN 3009 KTN/SP              | NN 3009 TN/SP    |
| 50                   | 80  | 23 | 52,8               | 73,5                     | 8,5                | 11 000             | 13 000              | 0,42 | NN 3010 KTN/SP              | NN 3010 TN/SP    |
| 55                   | 90  | 26 | 69,3               | 96,5                     | 11,6               | 10 000             | 12 000              | 0,62 | NN 3011 KTN/SP              | NN 3011 TN/SP    |
| 60                   | 95  | 26 | 73,7               | 106                      | 12,7               | 9 500              | 11 000              | 0,66 | NN 3012 KTN/SP              | NN 3012 TN/SP    |
| 65                   | 100 | 26 | 76,5               | 116                      | 13,7               | 9 000              | 10 000              | 0,71 | NN 3013 KTN/SP              | NN 3013 TN/SP    |
| 70                   | 110 | 30 | 96,8               | 150                      | 17,3               | 8 000              | 9 000               | 1    | NN 3014 KTN/SP              | NN 3014 TN/SP    |
| 75                   | 115 | 30 | 96,8               | 150                      | 17,6               | 7 500              | 8 500               | 1,1  | NN 3015 KTN/SP              | NN 3015 TN/SP    |
| 80                   | 125 | 34 | 119                | 186                      | 22                 | 7 000              | 8 000               | 1,5  | NN 3016 KTN/SP              | NN 3016 TN/SP    |
| 85                   | 130 | 34 | 125                | 204                      | 23,2               | 6 700              | 7 500               | 1,55 | NN 3017 KTN9/SP             | NN 3017 TN9/SP   |
| 90                   | 140 | 37 | 138                | 216                      | 26                 | 6 300              | 7 000               | 1,95 | NN 3018 KTN9/SP             | NN 3018 TN9/SP   |
| 95                   | 145 | 37 | 142                | 232                      | 27,5               | 6 000              | 6 700               | 2,05 | NN 3019 KTN9/SP             | NN 3019 TN9/SP   |
| 100                  | 140 | 40 | 128                | 255                      | 29                 | 5 600              | 6 300               | 1,9  | NNU 4920 BK/SPW33           | NNU 4920 B/SPW33 |
|                      | 150 | 37 | 151                | 250                      | 29                 | 5 600              | 6 300               | 2,1  | NN 3020 KTN9/SP             | NN 3020 TN9/SP   |
| 105                  | 145 | 40 | 130                | 260                      | 30                 | 5 300              | 6 000               | 2    | NNU 4921 BK/SPW33           | NNU 4921 B/SPW33 |
|                      | 160 | 41 | 190                | 305                      | 36                 | 5 300              | 6 000               | 2,7  | NN 3021 KTN9/SP             | NN 3021 TN9/SP   |





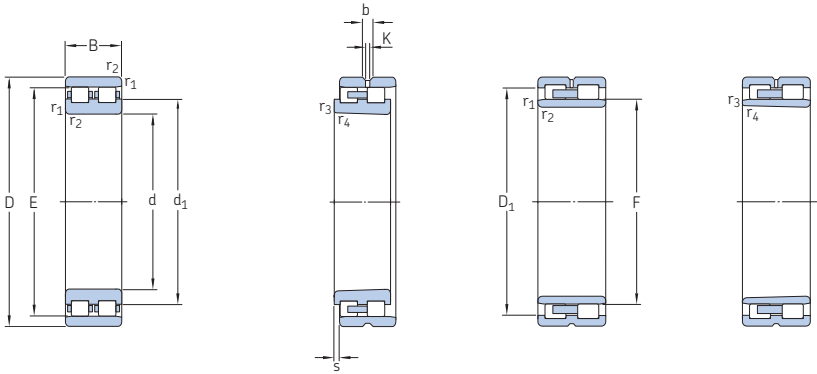
| Dimensions |            |      |     |   |                   |                   |          |               | Abutment and fillet dimensions |               |               |               |               |       | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ |
|------------|------------|------|-----|---|-------------------|-------------------|----------|---------------|--------------------------------|---------------|---------------|---------------|---------------|-------|------------------------------------------------------|
| d          | $d_1, D_1$ | E, F | b   | K | $r_{1,2}$<br>min. | $r_{3,4}$<br>min. | $s^{2)}$ | $d_a$<br>min. | $d_a$<br>max.                  | $d_b$<br>min. | $D_a$<br>min. | $D_a$<br>max. | $r_a$<br>max. | $d_n$ |                                                      |
| mm         |            |      |     |   |                   |                   |          | mm            |                                |               |               |               |               |       | cm <sup>3</sup>                                      |
| 25         | 33,7       | 41,3 | –   | – | 0,6               | 0,3               | 1        | 29            | –                              | –             | 42            | 43            | 0,6           | 40,5  | 0,9                                                  |
| 30         | 40,1       | 48,5 | –   | – | 1                 | 0,6               | 1,5      | 35            | –                              | –             | 49            | 50            | 1             | 47,6  | 1                                                    |
| 35         | 45,8       | 55   | –   | – | 1                 | 0,6               | 1,5      | 40            | –                              | –             | 56            | 57            | 1             | 54    | 1,9                                                  |
| 40         | 50,6       | 61   | –   | – | 1                 | 0,6               | 1,5      | 45            | –                              | –             | 62            | 63            | 1             | 60    | 1,8                                                  |
| 45         | 56,3       | 67,5 | –   | – | 1                 | 0,6               | 1,5      | 50            | –                              | –             | 69            | 70            | 1             | 66,4  | 2,4                                                  |
| 50         | 61,3       | 72,5 | –   | – | 1                 | 0,6               | 1,5      | 55            | –                              | –             | 74            | 75            | 1             | 71,4  | 2,7                                                  |
| 55         | 68,2       | 81   | –   | – | 1,1               | 0,6               | 1,5      | 61,5          | –                              | –             | 82            | 83,5          | 1             | 79,8  | 3,6                                                  |
| 60         | 73,3       | 86,1 | –   | – | 1,1               | 0,6               | 1,5      | 66,5          | –                              | –             | 87            | 88,5          | 1             | 85    | 3,8                                                  |
| 65         | 78,2       | 91   | –   | – | 1,1               | 0,6               | 1,5      | 71,5          | –                              | –             | 92            | 93,5          | 1             | 89,7  | 4,1                                                  |
| 70         | 85,6       | 100  | –   | – | 1,1               | 0,6               | 2        | 76,5          | –                              | –             | 101           | 103,5         | 1             | 98,5  | 5,9                                                  |
| 75         | 90,6       | 105  | –   | – | 1,1               | 0,6               | 2        | 81,5          | –                              | –             | 106           | 108,5         | 1             | 103,5 | 6,3                                                  |
| 80         | 97         | 113  | –   | – | 1,1               | 0,6               | 2        | 86,5          | –                              | –             | 114           | 118,5         | 1             | 111,4 | 8,3                                                  |
| 85         | 102        | 118  | –   | – | 1,1               | 0,6               | 2        | 91,5          | –                              | –             | 119           | 123,5         | 1             | 116,5 | 8,4                                                  |
| 90         | 109,4      | 127  | –   | – | 1,5               | 1                 | 2        | 98            | –                              | –             | 129           | 132           | 1,5           | 125,4 | 11                                                   |
| 95         | 114,4      | 132  | –   | – | 1,5               | 1                 | 2        | 103           | –                              | –             | 134           | 137           | 1,5           | 130,3 | 12                                                   |
| 100        | 125,8      | 113  | 5,5 | 3 | 1,1               | 0,6               | 1,1      | 106           | 111                            | 116           | –             | 133,5         | 1             | 113,8 | 13                                                   |
|            | 119,4      | 137  | –   | – | 1,5               | 1                 | 2        | 108           | –                              | –             | 139           | 142           | 1,5           | 135,3 | 12                                                   |
| 105        | 130,8      | 118  | 5,5 | 3 | 1,1               | 0,6               | 1,1      | 111           | 116                            | 121           | –             | 138,5         | 1             | 119   | 15                                                   |
|            | 125,2      | 146  | –   | – | 2                 | 1,1               | 2        | 115           | –                              | –             | 148           | 150           | 2             | 144,1 | 17                                                   |

<sup>1)</sup> For calculating the initial grease fill → page 295

<sup>2)</sup> Permissible axial displacement from the normal position of one bearing ring relative to the other.

### 3.2 Double row cylindrical roller bearings

d 110 – 240 mm



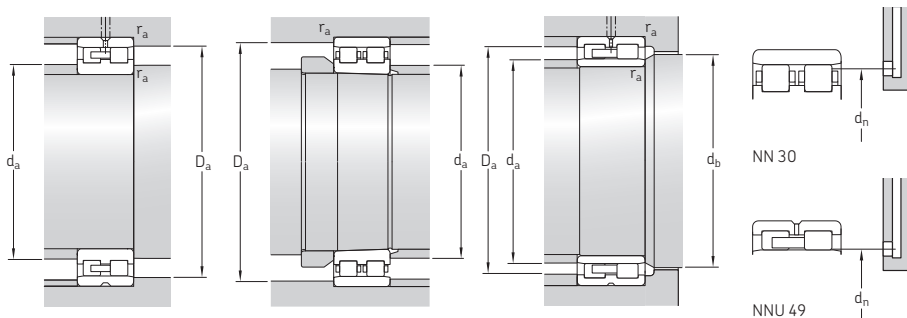
NN 30 TN9

NN 30 K/W33

NNU 49 B/W33

NNU 49 BK/W33

| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds          |                             | Mass | Designations                   |                   | cylindrical bore |
|----------------------|-----|----|--------------------|--------------------------|--------------------|----------------------------|-----------------------------|------|--------------------------------|-------------------|------------------|
| d                    | D   | B  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrica-<br>tion | Oil-air<br>lubrica-<br>tion | kg   | Bearing with a<br>tapered bore |                   |                  |
| mm                   |     |    | kN                 |                          | kN                 | r/min                      |                             |      | –                              |                   |                  |
| 110                  | 150 | 40 | 132                | 270                      | 30                 | 5 300                      | 6 000                       | 2,05 | NNU 4922 BK/SPW33              | NNU 4922 B/SPW33  |                  |
|                      | 170 | 45 | 220                | 360                      | 41,5               | 5 000                      | 5 600                       | 3,4  | NN 3022 KTN9/SP                | NN 3022 TN9/SP    |                  |
| 120                  | 165 | 45 | 176                | 340                      | 37,5               | 4 800                      | 5 300                       | 2,8  | NNU 4924 BK/SPW33              | NNU 4924 B/SPW33  |                  |
|                      | 180 | 46 | 229                | 390                      | 44                 | 4 800                      | 5 300                       | 3,7  | NN 3024 KTN9/SP                | NN 3024 TN9/SP    |                  |
| 130                  | 180 | 50 | 187                | 390                      | 41,5               | 4 300                      | 4 800                       | 3,85 | NNU 4926 BK/SPW33              | NNU 4926 B/SPW33  |                  |
|                      | 200 | 52 | 292                | 500                      | 55                 | 4 300                      | 4 800                       | 5,55 | NN 3026 KTN9/SP                | NN 3026 TN9/SP    |                  |
| 140                  | 190 | 50 | 190                | 400                      | 41,5               | 4 000                      | 4 500                       | 4,1  | NNU 4928 BK/SPW33              | NNU 4928 B/SPW33  |                  |
|                      | 210 | 53 | 297                | 520                      | 56                 | 4 000                      | 4 500                       | 6    | NN 3028 K/SPW33                | –                 |                  |
| 150                  | 210 | 60 | 330                | 655                      | 71                 | 3 800                      | 4 300                       | 6,25 | NNU 4930 B/SPW33               | NNU 4930 BK/SPW33 |                  |
|                      | 225 | 56 | 330                | 570                      | 62                 | 3 800                      | 4 300                       | 7,3  | NN 3030 K/SPW33                | –                 |                  |
| 160                  | 220 | 60 | 330                | 680                      | 72                 | 3 600                      | 4 000                       | 6,6  | NNU 4932 BK/SPW33              | NNU 4932 B/SPW33  |                  |
|                      | 240 | 60 | 369                | 655                      | 69,5               | 3 600                      | 4 000                       | 8,8  | NN 3032 K/SPW33                | –                 |                  |
| 170                  | 230 | 60 | 336                | 695                      | 73,5               | 3 400                      | 3 800                       | 6,95 | NNU 4934 BK/SPW33              | NNU 4934 B/SPW33  |                  |
|                      | 260 | 67 | 457                | 815                      | 83                 | 3 200                      | 3 600                       | 12   | NN 3034 K/SPW33                | –                 |                  |
| 180                  | 250 | 69 | 402                | 850                      | 88                 | 3 000                      | 3 400                       | 10,5 | NNU 4936 BK/SPW33              | NNU 4936 B/SPW33  |                  |
|                      | 280 | 74 | 561                | 1 000                    | 102                | 3 000                      | 3 400                       | 16   | NN 3036 K/SPW33                | –                 |                  |
| 190                  | 260 | 69 | 402                | 880                      | 90                 | 2 800                      | 3 200                       | 11   | NNU 4938 BK/SPW33              | NNU 4938 B/SPW33  |                  |
|                      | 290 | 75 | 594                | 1 080                    | 108                | 2 800                      | 3 200                       | 17   | NN 3038 K/SPW33                | –                 |                  |
| 200                  | 280 | 80 | 484                | 1 040                    | 106                | 2 600                      | 3 000                       | 15   | NNU 4940 BK/SPW33              | NNU 4940 B/SPW33  |                  |
|                      | 310 | 82 | 644                | 1 140                    | 118                | 2 600                      | 3 000                       | 21   | NN 3040 K/SPW33                | –                 |                  |
| 220                  | 300 | 80 | 512                | 1 140                    | 114                | 2 400                      | 2 800                       | 16,5 | NNU 4944 BK/SPW33              | NNU 4944 B/SPW33  |                  |
|                      | 340 | 90 | 809                | 1 460                    | 143                | 2 400                      | 2 800                       | 27,5 | NN 3044 K/SPW33                | –                 |                  |
| 240                  | 320 | 80 | 528                | 1 220                    | 118                | 2 200                      | 2 600                       | 17,5 | NNU 4948 BK/SPW33              | NNU 4948 B/SPW33  |                  |
|                      | 360 | 92 | 842                | 1 560                    | 153                | 2 200                      | 2 600                       | 30,5 | NN 3048 K/SPW33                | –                 |                  |



3.2

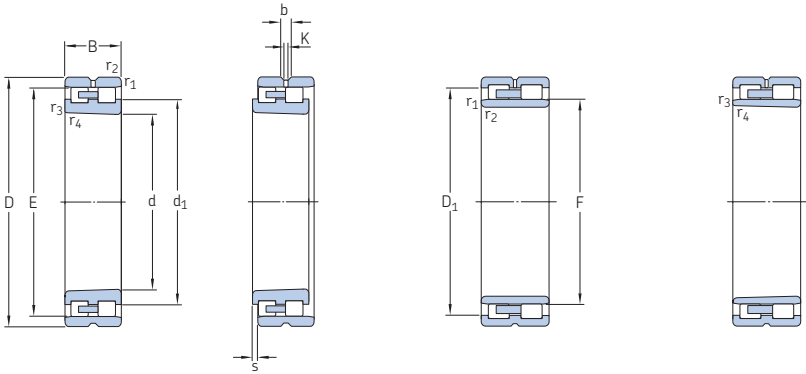
| Dimensions |                                 |       |      |     |                          |                          |                 | Abutment and fillet dimensions |                        |                        |                        |                        |                        |                | Reference grease quantity <sup>1)</sup> |  |
|------------|---------------------------------|-------|------|-----|--------------------------|--------------------------|-----------------|--------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------|-----------------------------------------|--|
| d          | d <sub>1</sub> , D <sub>1</sub> | E, F  | b    | K   | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | s <sup>2)</sup> | d <sub>a</sub><br>min.         | d <sub>a</sub><br>max. | d <sub>b</sub><br>min. | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | d <sub>n</sub> | G <sub>ref</sub>                        |  |
| mm         |                                 |       |      |     |                          |                          |                 | mm                             |                        |                        |                        |                        |                        |                | cm <sup>3</sup>                         |  |
| 110        | 135,8                           | 123   | 5,5  | 3   | 1,1                      | 0,6                      | 1,1             | 116                            | 121                    | 126                    | –                      | 143,5                  | 1                      | 124            | 17                                      |  |
|            | 132,6                           | 155   | –    | –   | 2                        | 1,1                      | 3               | 120                            | –                      | –                      | 157                    | 160                    | 2                      | 153            | 20                                      |  |
| 120        | 150,5                           | 134,5 | 5,5  | 3   | 1,1                      | 0,6                      | 1,1             | 126                            | 133                    | 137                    | –                      | 158,5                  | 1                      | 136,8          | 27                                      |  |
|            | 142,6                           | 165   | –    | –   | 2                        | 1,1                      | 3               | 130                            | –                      | –                      | 167                    | 170                    | 2                      | 162,9          | 23                                      |  |
| 130        | 162                             | 146   | 5,5  | 3   | 1,5                      | 1                        | 2,2             | 137                            | 144                    | 149                    | –                      | 172                    | 1,5                    | 147            | 31                                      |  |
|            | 156,4                           | 182   | –    | –   | 2                        | 1,1                      | 3               | 140                            | –                      | –                      | 183                    | 190                    | 2                      | 179,6          | 34                                      |  |
| 140        | 172                             | 156   | 5,5  | 3   | 1,5                      | 1                        | 2,2             | 147                            | 154                    | 159                    | –                      | 182                    | 1,5                    | 157            | 45                                      |  |
|            | 166,5                           | 192   | 8,7  | 4,5 | 2                        | 1,1                      | 2,5             | 150                            | –                      | –                      | 194                    | 200                    | 2                      | 188            | 52                                      |  |
| 150        | 190,9                           | 168,5 | 5,5  | 3   | 2                        | 1                        | 2               | 160                            | 166                    | 172                    | –                      | 200                    | 2                      | 169,9          | 57                                      |  |
|            | 179                             | 206   | 8,7  | 4,5 | 2,1                      | 1,1                      | 2,5             | 161                            | –                      | –                      | 208                    | 214                    | 2                      | 201,7          | 63                                      |  |
| 160        | 200,9                           | 178,5 | 5,5  | 3   | 2                        | 2                        | 2               | 170                            | 176                    | 182                    | –                      | 210                    | 2                      | 179,8          | 63                                      |  |
|            | 190                             | 219   | 8,5  | 4,5 | 2,1                      | 1,1                      | 2,5             | 171                            | –                      | –                      | 221                    | 229                    | 2                      | 214,4          | 78                                      |  |
| 170        | 210,9                           | 188,5 | 5,5  | 3   | 2                        | 2                        | 2               | 180                            | 186                    | 192                    | –                      | 220                    | 2                      | 189,8          | 72                                      |  |
|            | 204                             | 236   | 8,9  | 4,5 | 2,1                      | 1,1                      | 2,5             | 181                            | –                      | –                      | 238                    | 249                    | 2                      | 230,8          | 105                                     |  |
| 180        | 226,05                          | 202   | 8,3  | 3   | 2                        | 1                        | 1,1             | 190                            | 199                    | 205                    | –                      | 240                    | 2                      | 203,5          | 81                                      |  |
|            | 218,2                           | 255   | 11,3 | 6   | 2,1                      | 1,1                      | 3               | 191                            | –                      | –                      | 257                    | 269                    | 2                      | 248,9          | 138                                     |  |
| 190        | 236                             | 212   | 8,3  | 3   | 2                        | 1                        | 1,1             | 200                            | 209                    | 215                    | –                      | 250                    | 2                      | 213            | 85                                      |  |
|            | 228,2                           | 265   | 11,3 | 6   | 2,1                      | 1,1                      | 3               | 201                            | –                      | –                      | 267                    | 279                    | 2                      | 258,9          | 144                                     |  |
| 200        | 252,2                           | 225   | 11,1 | 3   | 2,1                      | 1,1                      | 3,7             | 211                            | 222                    | 228                    | –                      | 269                    | 2                      | 227            | 117                                     |  |
|            | 242                             | 282   | 12,2 | 6   | 2,1                      | 1,1                      | 3               | 211                            | –                      | –                      | 285                    | 299                    | 2                      | 275,3          | 191                                     |  |
| 220        | 272,2                           | 245   | 11,1 | 3   | 2,1                      | 1,1                      | 3,7             | 231                            | 242                    | 249                    | –                      | 289                    | 2                      | 247            | 150                                     |  |
|            | 265,2                           | 310   | 15   | 7,5 | 3                        | 1,1                      | 2               | 233                            | –                      | –                      | 313                    | 327                    | 2,5                    | 302,4          | 260                                     |  |
| 240        | 292,2                           | 265,3 | 11,1 | 3   | 2,1                      | 1,1                      | 3,7             | 251                            | 262                    | 269                    | –                      | 309                    | 2                      | 267            | 171                                     |  |
|            | 285,2                           | 330   | 15,2 | 7,5 | 3                        | 1,1                      | 2               | 253                            | –                      | –                      | 333                    | 347                    | 2,5                    | 322,4          | 288                                     |  |

<sup>1)</sup> For calculating the initial grease fill → page 297

<sup>2)</sup> Permissible axial displacement from the normal position of one bearing ring relative to the other.

### 3.2 Double row cylindrical roller bearings

d 260 – 670 mm

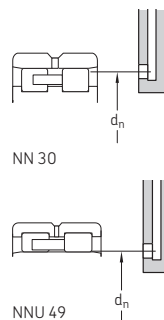
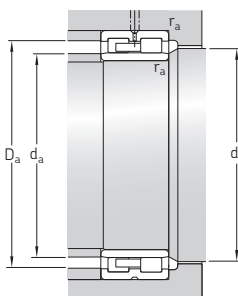
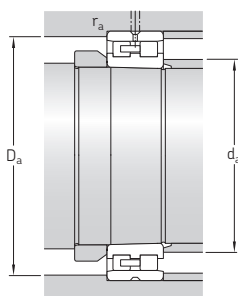


NN 30 K/W33

NNU 49 B/W33

NNU 49 BK/W33

| Principal dimensions |            |            | Basic load ratings |                       | Fatigue load limit | Attainable speeds  |                     | Mass         | Designations                         |                       | cylindrical bore |
|----------------------|------------|------------|--------------------|-----------------------|--------------------|--------------------|---------------------|--------------|--------------------------------------|-----------------------|------------------|
| d                    | D          | B          | dynamic C          | static C <sub>0</sub> | P <sub>u</sub>     | Grease lubrication | Oil-air lubrication |              | Bearing with a tapered bore          |                       |                  |
| mm                   |            |            | kN                 |                       | kN                 | r/min              |                     | kg           | –                                    |                       |                  |
| 260                  | 360<br>400 | 100<br>104 | 748<br>1 020       | 1 700<br>1 930        | 163<br>183         | 2 000<br>2 000     | 2 400<br>2 400      | 30,5<br>44   | NNU 4952 BK/SPW33<br>NN 3052 K/SPW33 | NNU 4952 B/SPW33<br>– |                  |
| 280                  | 380<br>420 | 100<br>106 | 765<br>1 080       | 1 800<br>2 080        | 170<br>196         | 1 900<br>1 900     | 2 200<br>2 200      | 32,5<br>47,5 | NNU 4956 BK/SPW33<br>NN 3056 K/SPW33 | NNU 4956 B/SPW33<br>– |                  |
| 300                  | 420<br>460 | 118<br>118 | 1 020<br>1 250     | 2 360<br>2 400        | 224<br>228         | 1 800<br>1 700     | 2 000<br>1 900      | 50<br>66,5   | NNU 4960 BK/SPW33<br>NN 3060 K/SPW33 | NNU 4960 B/SPW33<br>– |                  |
| 320                  | 440<br>480 | 118<br>121 | 1 060<br>1 320     | 2 500<br>2 600        | 232<br>240         | 1 700<br>1 600     | 1 900<br>1 800      | 50<br>71     | NNU 4964 BK/SPW33<br>NN 3064 K/SPW33 | NNU 4964 B/SPW33<br>– |                  |
| 340                  | 460<br>520 | 118<br>133 | 1 100<br>1 650     | 2 650<br>3 250        | 245<br>290         | 1 500<br>1 400     | 1 700<br>1 600      | 53<br>94,5   | NNU 4968 BK/SPW33<br>NN 3068 K/SPW33 | NNU 4968 B/SPW33<br>– |                  |
| 360                  | 480<br>540 | 118<br>134 | 1 120<br>1 720     | 2 800<br>3 450        | 250<br>310         | 1 500<br>1 300     | 1 700<br>1 500      | 55<br>102    | NNU 4972 BK/SPW33<br>NN 3072 K/SPW33 | NNU 4972 B/SPW33<br>– |                  |
| 380                  | 520<br>560 | 140<br>135 | 1 450<br>1 680     | 3 600<br>3 450        | 320<br>305         | 1 300<br>1 300     | 1 500<br>1 500      | 83,5<br>105  | NNU 4976 BK/SPW33<br>NN 3076 K/SPW33 | NNU 4976 B/SPW33<br>– |                  |
| 400                  | 540<br>600 | 140<br>148 | 1 470<br>2 160     | 3 800<br>4 500        | 335<br>380         | 1 300<br>1 200     | 1 500<br>1 400      | 87,5<br>135  | NNU 4980 BK/SPW33<br>NN 3080 K/SPW33 | NNU 4980 B/SPW33<br>– |                  |
| 420                  | 560<br>620 | 140<br>150 | 1 510<br>2 120     | 4 000<br>4 500        | 345<br>380         | 1 200<br>1 100     | 1 400<br>1 300      | 91<br>140    | NNU 4984 BK/SPW33<br>NN 3084 K/SPW33 | NNU 4984 B/SPW33<br>– |                  |
| 460                  | 620<br>680 | 160<br>163 | 2 090<br>2 600     | 5 500<br>5 500        | 465<br>440         | 1 000<br>1 000     | 1 200<br>1 200      | 130<br>190   | NNU 4992 BK/SPW33<br>NN 3092 K/SPW33 | NNU 4992 B/SPW33<br>– |                  |
| 500                  | 670        | 170        | 2 330              | 6 100                 | 490                | 950                | 1 100               | 165          | NNU 49/500 BK/SPW33X                 | NNU 49/500 B/SPW33X   |                  |
| 600                  | 800        | 200        | 3 580              | 10 200                | 800                | 800                | 900                 | 280          | NNU 49/600 BK/SPW33X                 | NNU 49/600 B/SPW33X   |                  |
| 670                  | 900        | 230        | 4 950              | 13 700                | 930                | 700                | 800                 | 410          | NNU 49/670 BK/SPW33X                 | NNU 49/670 B/SPW33X   |                  |



3.2

## Dimensions

## Abutment and fillet dimensions

## Reference grease quantity<sup>1) 3)</sup> G<sub>ref</sub>

| d          | d <sub>1</sub> , D <sub>1</sub> | E, F       | b            | K        | r <sub>1,2</sub><br>min. | s <sup>2)</sup> | d <sub>a</sub><br>min. | d <sub>a</sub><br>max. | d <sub>b</sub><br>min. | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | d <sub>n</sub> <sup>3)</sup> | G <sub>ref</sub> | G <sub>ref</sub> |
|------------|---------------------------------|------------|--------------|----------|--------------------------|-----------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------------|------------------|------------------|
| mm         |                                 |            |              |          |                          |                 | mm                     |                        |                        |                        |                        |                        |                              | cm <sup>3</sup>  |                  |
| <b>260</b> | 325,6<br>312,8                  | 292<br>364 | 13,9<br>15,3 | 3<br>7,5 | 2,1<br>4                 | 1,1<br>1,5      | 4,5<br>5               | 271<br>275             | 288<br>–               | 296<br>–               | –<br>367               | 349<br>384             | 2<br>3                       | 294,5<br>355,2   | 366<br>392       |
| <b>280</b> | 345,6<br>332,8                  | 312<br>384 | 13,9<br>15,3 | 3<br>7,5 | 2,1<br>4                 | 1,1<br>1,5      | 4,5<br>5               | 291<br>295             | 308<br>–               | 316<br>–               | –<br>387               | 369<br>404             | 2<br>3                       | 313,5<br>375,3   | 384<br>420       |
| <b>300</b> | 379<br>359                      | 339<br>418 | 16,7<br>16,7 | 3<br>9   | 3<br>4                   | 1,1<br>2        | 5,5<br>8,9             | 313<br>315             | 335<br>–               | 343<br>–               | –<br>421               | 407<br>445             | 2,5<br>3                     | 362<br>–         | 420<br>–         |
| <b>320</b> | 399<br>379                      | 359<br>438 | 16,7<br>16,7 | 9<br>9   | 3<br>4                   | 2<br>2          | 5,5<br>8,9             | 333<br>335             | 355<br>–               | 363<br>–               | –<br>442               | 427<br>465             | 2,5<br>4                     | –<br>–           | –<br>–           |
| <b>340</b> | 419<br>408                      | 379<br>473 | 16,7<br>16,7 | 9<br>9   | 3<br>5                   | 1,5<br>3        | 5,5<br>10,9            | 353<br>358             | 375<br>–               | 383<br>–               | –<br>477               | 447<br>502             | 2,5<br>4                     | –<br>–           | –<br>–           |
| <b>360</b> | 439<br>428                      | 399<br>493 | 16,7<br>16,7 | 9<br>9   | 3<br>5                   | 1,5<br>2,5      | 5,5<br>10,9            | 373<br>378             | 395<br>–               | 403<br>–               | –<br>497               | 467<br>520             | 2,5<br>4                     | –<br>–           | –<br>–           |
| <b>380</b> | 470,8<br>448                    | 426<br>513 | 16,7<br>16,7 | 9<br>9   | 4<br>5                   | 2,5<br>2,5      | 5,5<br>11,9            | 395<br>398             | 421<br>–               | 431<br>–               | –<br>517               | 505<br>542             | 3<br>4                       | –<br>–           | –<br>–           |
| <b>400</b> | 490,8<br>475                    | 446<br>549 | 16,7<br>16,7 | 9<br>9   | 4<br>5                   | 2,5<br>2,5      | 5,5<br>12,4            | 415<br>418             | 441<br>–               | 451<br>–               | –<br>553               | 524<br>582             | 3<br>4                       | –<br>–           | –<br>–           |
| <b>420</b> | 510,5<br>495                    | 466<br>569 | 16,7<br>16,7 | 9<br>9   | 4<br>5                   | 2<br>2          | 5,5<br>12,4            | 435<br>438             | 461<br>–               | 471<br>–               | –<br>574               | 544<br>602             | 3<br>4                       | –<br>–           | –<br>–           |
| <b>460</b> | 567<br>542                      | 510<br>624 | 16,7<br>22,3 | 9<br>12  | 4<br>6                   | 2<br>3          | 3,2<br>14,4            | 475<br>483             | 504<br>–               | 515<br>–               | –<br>627               | 605<br>657             | 3<br>5                       | –<br>–           | –<br>–           |
| <b>500</b> | 611,6                           | 554        | 22,3         | 12       | 5                        | 3               | 3,5                    | 548                    | 548                    | 559                    | –                      | 652                    | 4                            | –                | –                |
| <b>600</b> | 733,2                           | 666        | 22,3         | 12       | 5                        | 2,5             | 5,5                    | 648                    | 662                    | 672                    | –                      | 782                    | 4                            | –                | –                |
| <b>670</b> | 821,2                           | 738        | 22,3         | 12       | 6                        | 3               | 6                      | 693                    | 732                    | 744                    | –                      | 877                    | 5                            | –                | –                |

<sup>1)</sup> For calculating the initial grease fill → **page 299**

<sup>2)</sup> Permissible axial displacement from the normal position of one bearing ring relative to the other.

<sup>3)</sup> For bearings with D > 420 mm, contact the SKF application engineering service.



# Double direction angular contact thrust ball bearings

|                                                     |            |                                                                            |     |
|-----------------------------------------------------|------------|----------------------------------------------------------------------------|-----|
| <b>Designs and variants</b> . . . . .               | <b>302</b> | <b>Product table</b>                                                       |     |
| Basic design bearings, BTW series . . . .           | 303        | <b>4.1</b> Double direction angular contact thrust ball bearings . . . . . | 312 |
| High-speed design bearings, BTM series . . . . .    | 303        |                                                                            |     |
| Hybrid bearings . . . . .                           | 304        |                                                                            |     |
| Cages. . . . .                                      | 304        |                                                                            |     |
| <b>Markings on bearings</b> . . . . .               | <b>305</b> |                                                                            |     |
| Identification numbers . . . . .                    | 305        |                                                                            |     |
| Additional markings on BTM series bearings. . . . . | 305        |                                                                            |     |
| <b>Bearing data</b> . . . . .                       | <b>306</b> |                                                                            |     |
| (Boundary dimensions, tolerances)                   |            |                                                                            |     |
| <b>Preload</b> . . . . .                            | <b>308</b> |                                                                            |     |
| Effect of interference on preload . . . . .         | 308        |                                                                            |     |
| <b>Axial stiffness</b> . . . . .                    | <b>309</b> |                                                                            |     |
| <b>Equivalent bearing loads</b> . . . . .           | <b>310</b> |                                                                            |     |
| <b>Attainable speeds</b> . . . . .                  | <b>310</b> |                                                                            |     |
| <b>Mounting</b> . . . . .                           | <b>310</b> |                                                                            |     |
| <b>Designation system</b> . . . . .                 | <b>311</b> |                                                                            |     |
|                                                     |            | <b>More information</b>                                                    |     |
|                                                     |            | Bearing life and load ratings . . . . .                                    | 301 |
|                                                     |            | Requisite minimum load . . . . .                                           | 301 |
|                                                     |            | Chamfer dimension limits . . . . .                                         | 301 |
|                                                     |            | Materials . . . . .                                                        | 301 |
|                                                     |            | Design considerations . . . . .                                            | 301 |
|                                                     |            | Lubrication . . . . .                                                      | 301 |
|                                                     |            | Mounting and dismounting . . . . .                                         | 301 |
|                                                     |            | Bearing storage. . . . .                                                   | 301 |

SKF double direction angular contact thrust ball bearings are designed to locate spindle shafts axially in both directions. These bearings are intended for mounting in combination with cylindrical roller bearings in the NN 30 K or N 10 K series in the same housing bore (→ **fig. 1**). This bearing combination simplifies machining of the housing bore.

Double direction angular contact thrust ball bearings are manufactured with the same nominal bore size and outside diameter as corresponding cylindrical roller bearings. However, the outside diameter tolerance of the housing washers, combined with the housing bore diameter and geometric tolerances recommended for super-precision cylindrical roller bearings under light to normal load and rotating inner ring load (→ *Recommended shaft and housing fits*, **page 302**) will result in an appropriate radial clearance in the housing bore. This clearance is sufficient to prevent radial loads from acting on the thrust bearing provided that its outer ring is not axially clamped in the housing.

## Designs and variants

SKF supplies two designs of double direction angular contact thrust ball bearings:

- the basic design (BTW series, → **fig. 2**) for maximum load carrying capacity and maximum system rigidity for shaft diameters from 35 to 200 mm
- the high-speed design (BTM series, → **fig. 3**) for maximum speed capability for shaft diameters from 60 to 180 mm

Both designs are available either with steel balls or ceramic balls (hybrid bearings).

BTM and BTW series bearings share the same bore and outside diameters. But BTM

Fig. 1

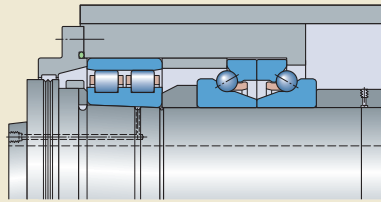
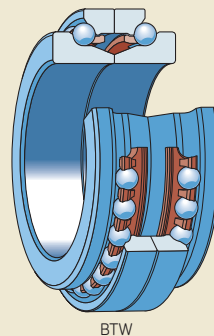


Fig. 2





series bearings have a 25% lower bearing height (→ **fig. 4**), which makes them particularly suitable for compact arrangements. They do not have the same load carrying capacity and axial stiffness as bearings in the BTW series, but can operate at higher speeds.

### Basic design bearings, BTW series

Bearings in the BTW series (→ **fig. 2**) consist of two single row angular contact thrust ball bearings with a 60° contact angle, arranged back-to-back. This configuration, combined with the large number of balls, enables these bearings to accommodate high axial loads in both directions and provides a high degree of system rigidity. Bearings in the BTW series are separable. When the shaft washers are pressed together, preload within a predetermined range will result.

On request, bearings in the BTW series can be provided with an annular groove and three lubrication holes in the housing washer (designation suffix W33, → **table 1, page 303**). They can also be supplied with a larger bore diameter so that they can be mounted immediately adjacent to the large diameter side of a cylindrical roller bearing with a tapered bore (e.g. BTW 60 CATN9/SP).

### High-speed design bearings, BTM series

Bearings in the BTM series (→ **fig. 3**) consist of two non-separable single row angular contact ball bearings arranged back-to-back. They are designed to accommodate axial loads in both directions. When the inner rings are pressed together, preload within a predetermined range will result.

These high-speed design bearings are available with two different contact angles:

- a 30° contact angle, designation suffix A
- a 40° contact angle, designation suffix B

Bearings with a 30° contact angle can accommodate higher speeds while bearings with a 40° contact angle are more suitable for applications that require a higher degree of axial rigidity.

According to the ISO definition, BTM series bearings are radial bearings because they have a 30° or 40° contact angle. However, since these bearings are only intended to accommodate axial loads, only their basic load rating in the axial direction is listed in the product tables (→ **page 303**).

Fig. 3

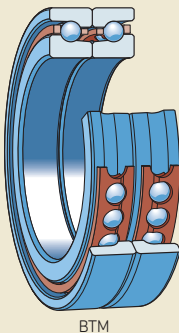


Fig. 4

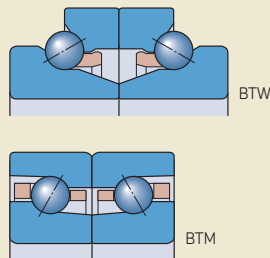
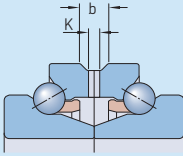


Table 1

Annular groove and lubrication hole dimensions for BTW .. W33 series bearings



| Bore diameter | Dimensions |     |
|---------------|------------|-----|
| d             | b          | K   |
| mm            | mm         |     |
| 35            | 5,5        | 3   |
| 40            | 5,5        | 3   |
| 45            | 5,5        | 3   |
| 50            | 5,5        | 3   |
| 55            | 5,5        | 3   |
| 60            | 5,5        | 3   |
| 65            | 5,5        | 3   |
| 70            | 5,5        | 3   |
| 75            | 5,5        | 3   |
| 80            | 8,4        | 4,5 |
| 85            | 8,4        | 4,5 |
| 90            | 8,4        | 4,5 |
| 95            | 8,4        | 4,5 |
| 100           | 8,4        | 4,5 |
| 110           | 8,4        | 4,5 |
| 120           | 8,4        | 4,5 |
| 130           | 11,2       | 6   |
| 140           | 11,2       | 6   |
| 150           | 14         | 7,5 |
| 160           | 14         | 7,5 |
| 170           | 14         | 7,5 |
| 180           | 16,8       | 9   |
| 190           | 16,8       | 9   |
| 200           | 16,8       | 9   |

### Hybrid bearings

Hybrid angular contact thrust ball bearings (designation suffix HC) have rings made of bearing steel and rolling elements made of bearing grade silicon nitride (ceramic). As ceramic balls are lighter and have a higher modulus of elasticity and lower coefficient of thermal expansion than steel balls, hybrid bearings can provide the following advantages:

- higher degree of rigidity
- higher speed capability
- reduced centrifugal and inertial forces within the bearing
- minimized stress at the outer ring rolling contacts at high speeds
- reduced frictional heat
- less energy consumption
- extended bearing and grease service life
- less prone to skid smearing damage and cage damage when subjected to frequent rapid starts and stops
- less sensitive to temperature differences within the bearing
- more accurate preload control

For additional information about silicon nitride, refer to *Materials for bearing rings and rolling elements* (→ **page 304**).

### Cages

Bearings in the BTW series are fitted as standard with the following cages:

- $d \leq 130$  mm  
two glass fibre reinforced PA66 cages, snap-type, ball centred, designation suffix TN9
- $d \geq 140$  mm  
two machined brass cages, snap-type, ball centred, designation suffix M

Bearings in the BTM series are fitted as standard with the following cages:

- $d \leq 130$  mm  
two glass fibre reinforced PA66 cages, window-type, ball centred, designation suffix TN9
- $d \geq 140$  mm  
two machined brass cages, window-type, ball centred, designation suffix M

The cages enable the preloaded bearings to run reliably at high speeds and to withstand rapid starts and stops as well as alternating loads. They also provide good grease retention.

For information about the suitability of cages, refer to *Cage materials* (→ **page 305**).

## Markings on bearings

Each super-precision double direction angular contact thrust ball bearing has various markings on the side faces of the washers/rings (→ **fig. 5**):

- 1 SKF trademark
- 2 Complete designation of the bearing
- 3 Country of manufacture
- 4 Date of manufacture, coded
- 5 Identification/serial number of the shaft washer / inner ring
- 6 Identification number on the housing washer (for BTW series only)

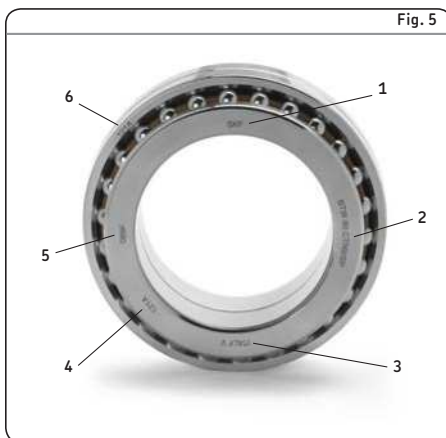


Fig. 5

## Identification numbers on BTW series bearings

Identification numbers on the washers indicate bearing components that must be kept together as supplied. To distinguish the two halves of BTW series bearing washers, the identification numbers are followed by the letters "A" or "B" (e.g. 121A in **fig. 5**).

## Additional markings on BTM series bearings

A "V-shaped" marking on the outside surface of the outer rings indicates how the bearings should be mounted to obtain the proper preload in the set (→ **fig. 6**).

The deviation of the mean bore diameter from nominal in microns is marked on the inner ring side face.

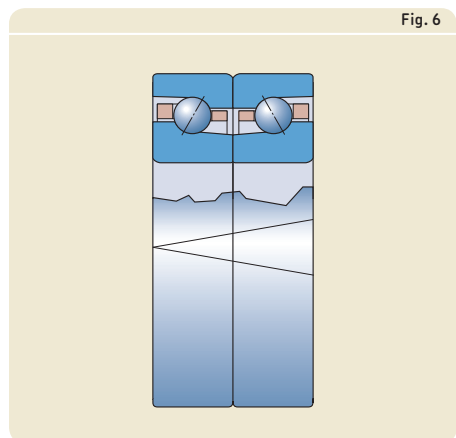


Fig. 6

Bearing data

|                     |                                                                                                                                                                                                                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Boundary dimensions | <ul style="list-style-type: none"><li>Bore and outside diameters in accordance with ISO 15, diameter series 0 for radial bearings</li><li>Remaining boundary dimensions not standardized, but common in the marketplace</li></ul>                                                                   |
| Tolerances          | <b>BTW series bearings</b> <ul style="list-style-type: none"><li>SP tolerance class (→ table 2) as standard</li><li>higher precision UP tolerance class (→ table 3) on request</li></ul> <b>BTM series bearings</b> <ul style="list-style-type: none"><li>P4C tolerance class (→ table 4)</li></ul> |

For additional information (→ page 306)

Table 2

SP class tolerances

Shaft washer and bearing height

| d over | incl. | $\Delta_{\text{dmp}}$ high | low | $\Delta_{\text{B1s}}$ high | low  | $\Delta_{\text{T2s}}$ high | low  | $S_i^{1)}$ max. |
|--------|-------|----------------------------|-----|----------------------------|------|----------------------------|------|-----------------|
| mm     |       | $\mu\text{m}$              |     | $\mu\text{m}$              |      | $\mu\text{m}$              |      | $\mu\text{m}$   |
| 30     | 50    | 1                          | -11 | 0                          | -100 | 0                          | -200 | 3               |
| 50     | 80    | 2                          | -14 | 0                          | -100 | 0                          | -200 | 4               |
| 80     | 120   | 3                          | -18 | 0                          | -200 | 0                          | -400 | 4               |
| 120    | 180   | 3                          | -21 | 0                          | -250 | 0                          | -500 | 5               |
| 180    | 250   | 4                          | -26 | 0                          | -250 | 0                          | -500 | 5               |

Housing washer

| D over | incl. | $\Delta_{\text{dmp}}$ high | low | $\Delta_{\text{C1s}}$ high | low  | $S_e$ max.                                                          |
|--------|-------|----------------------------|-----|----------------------------|------|---------------------------------------------------------------------|
| mm     |       | $\mu\text{m}$              |     | $\mu\text{m}$              |      |                                                                     |
| 50     | 80    | -24                        | -33 | 0                          | -50  | Values are identical to those for shaft washer of the same bearing. |
| 80     | 120   | -28                        | -38 | 0                          | -50  |                                                                     |
| 120    | 150   | -33                        | -44 | 0                          | -100 |                                                                     |
| 150    | 180   | -33                        | -46 | 0                          | -100 |                                                                     |
| 180    | 250   | -37                        | -52 | 0                          | -125 |                                                                     |
| 250    | 315   | -41                        | -59 | 0                          | -125 |                                                                     |

Tolerance symbols and definitions → table 4, page 306

<sup>1)</sup> The quoted tolerances are approximate, as raceway run-out is measured in the direction of the ball load. When the bearing has been mounted, axial run-out is generally smaller than what is quoted in the table.

Table 3

## UP class tolerances

## Shaft washer and bearing height

| d<br>over | incl. | $\Delta_{dmp}$<br>high | low | $\Delta_{B1s}$<br>high | low  | $\Delta_{T2s}$<br>high | low  | $S_i^{(1)}$<br>max. |
|-----------|-------|------------------------|-----|------------------------|------|------------------------|------|---------------------|
| mm        |       | $\mu\text{m}$          |     | $\mu\text{m}$          |      | $\mu\text{m}$          |      | $\mu\text{m}$       |
| 30        | 50    | 0                      | -8  | 0                      | -100 | 0                      | -200 | 1,5                 |
| 50        | 80    | 0                      | -9  | 0                      | -100 | 0                      | -200 | 2                   |
| 80        | 120   | 0                      | -10 | 0                      | -200 | 0                      | -400 | 2                   |
| 120       | 180   | 0                      | -13 | 0                      | -250 | 0                      | -500 | 3                   |
| 180       | 250   | 0                      | -15 | 0                      | -250 | 0                      | -500 | 3                   |

## Housing washer

| D<br>over | incl. | $\Delta_{Dmp}$<br>high | low | $\Delta_{C1s}$<br>high | low  | $S_e$<br>max.                                                       |
|-----------|-------|------------------------|-----|------------------------|------|---------------------------------------------------------------------|
| mm        |       | $\mu\text{m}$          |     | $\mu\text{m}$          |      |                                                                     |
| 50        | 80    | -24                    | -33 | 0                      | -50  | Values are identical to those for shaft washer of the same bearing. |
| 80        | 120   | -28                    | -38 | 0                      | -50  |                                                                     |
| 120       | 150   | -33                    | -44 | 0                      | -100 |                                                                     |
| 150       | 180   | -33                    | -46 | 0                      | -100 |                                                                     |
| 180       | 250   | -37                    | -52 | 0                      | -125 |                                                                     |
| 250       | 315   | -41                    | -59 | 0                      | -125 |                                                                     |

Tolerance symbols and definitions → table 4, page 307

<sup>1)</sup> The quoted tolerances are approximate, as raceway run-out is measured in the direction of the ball load. When the bearing has been mounted, axial run-out is generally smaller than what is quoted in the table.

Table 4

## P4C class tolerances

## Inner ring

| d<br>over | incl. | $\Delta_{ds}$<br>high | low | $\Delta_{B1s}$<br>high | low  | $\Delta_{T2s}$<br>high | low  | $S_i^{(1)}$<br>max. |
|-----------|-------|-----------------------|-----|------------------------|------|------------------------|------|---------------------|
| mm        |       | $\mu\text{m}$         |     | $\mu\text{m}$          |      | $\mu\text{m}$          |      | $\mu\text{m}$       |
| 50        | 80    | 0                     | -7  | 0                      | -100 | 0                      | -200 | 3                   |
| 80        | 120   | 0                     | -8  | 0                      | -200 | 0                      | -400 | 4                   |
| 120       | 180   | 0                     | -10 | 0                      | -250 | 0                      | -500 | 4                   |

## Outer ring

| D<br>over | incl. | $\Delta_{Ds}$<br>high | low | $\Delta_{C1s}$<br>high | low  | $S_e$<br>max.                                                     |
|-----------|-------|-----------------------|-----|------------------------|------|-------------------------------------------------------------------|
| mm        |       | $\mu\text{m}$         |     | $\mu\text{m}$          |      |                                                                   |
| 80        | 120   | -28                   | -38 | 0                      | -100 | Values are identical to those for inner ring of the same bearing. |
| 120       | 150   | -33                   | -44 | 0                      | -200 |                                                                   |
| 150       | 180   | -33                   | -46 | 0                      | -250 |                                                                   |
| 180       | 250   | -37                   | -52 | 0                      | -250 |                                                                   |

Tolerance symbols and definitions → table 4, page 307

<sup>1)</sup> The quoted tolerances are approximate, as raceway run-out is measured in the direction of the ball load. When the bearing has been mounted, axial run-out is generally smaller than what is quoted in the table.

# Preload

Double direction angular contact thrust ball bearings are manufactured so that they have a suitable operating preload when mounted.

Bearings in the BTM series are available with different preloads:

- light preload, designation suffix DBA
- heavy preload, designation suffix DBB

The preload is obtained during manufacturing by precisely adjusting the standout of the shaft washers / inner rings relative to their housing washers / outer rings. The preload values are listed in **table 5** and apply to new bearings prior to mounting. Bearing components and bearing sets must be kept together as supplied and mounted in the indicated order. For additional information, refer to *Markings on bearings* (→ **page 308**).

## Effect of interference on preload

When double direction angular contact thrust ball bearings are mounted onto a shaft seat machined to the recommended h4 $\oplus$  diameter tolerance, a transition fit, which can be either a loose or an interference fit, will result. A loose fit will not affect preload. An interference fit increases preload. For additional information, contact the SKF application engineering service.

Table 5

### Axial preload for unmounted bearings

| Bore diameter<br>d | Axial preload<br>BTW | BTM .. A<br>DBA | DBB   | BTM .. B<br>DBA | DBB   |
|--------------------|----------------------|-----------------|-------|-----------------|-------|
| mm                 | N                    | N               |       | N               |       |
| <b>35</b>          | 340                  | –               | –     | –               | –     |
| <b>40</b>          | 360                  | –               | –     | –               | –     |
| <b>45</b>          | 390                  | –               | –     | –               | –     |
| <b>50</b>          | 415                  | –               | –     | –               | –     |
| <b>55</b>          | 440                  | –               | –     | –               | –     |
| <b>60</b>          | 470                  | 200             | 600   | 250             | 750   |
| <b>65</b>          | 490                  | 200             | 600   | 250             | 750   |
| <b>70</b>          | 515                  | 250             | 750   | 350             | 1 050 |
| <b>75</b>          | 545                  | 250             | 750   | 350             | 1 050 |
| <b>80</b>          | 575                  | 300             | 900   | 400             | 1 200 |
| <b>85</b>          | 600                  | 300             | 900   | 400             | 1 200 |
| <b>90</b>          | 625                  | 400             | 1 200 | 550             | 1 650 |
| <b>95</b>          | 655                  | 400             | 1 200 | 550             | 1 650 |
| <b>100</b>         | 690                  | 400             | 1 200 | 550             | 1 650 |
| <b>110</b>         | 735                  | 600             | 1 800 | 750             | 2 250 |
| <b>120</b>         | 800                  | 600             | 1 800 | 850             | 2 550 |
| <b>130</b>         | 870                  | 800             | 2 400 | 1 050           | 3 150 |
| <b>140</b>         | 940                  | 800             | 2 400 | 1 050           | 3 150 |
| <b>150</b>         | 1 015                | 1 000           | 3 000 | 1 300           | 3 900 |
| <b>160</b>         | 1 100                | 1 100           | 3 300 | 1 500           | 4 500 |
| <b>170</b>         | 1 185                | 1 350           | 4 050 | 1 800           | 5 400 |
| <b>180</b>         | 1 290                | 1 600           | 4 800 | 2 100           | 6 300 |
| <b>190</b>         | 1 385                | –               | –     | –               | –     |
| <b>200</b>         | 1 525                | –               | –     | –               | –     |

## Axial stiffness

Axial stiffness depends on the elastic deformation (deflection) of the bearing under load and can be expressed as a ratio of load to deflection. However, since the relationship between deflection and load is not linear, only guideline values can be provided (→ **table 6**). These values apply to mounted bearings under static conditions and subjected to moderate loads. More accurate values for axial stiffness can be calculated using advanced computer methods. For additional information, contact the SKF application engineering service and refer to *Bearing stiffness* (→ **page 309**).

Table 6

### Static axial stiffness

| Bore diameter<br>d | Static axial stiffness |                    | BTM .. A/DBA     |                    | BTM .. A/DBB     |                    | BTM .. B/DBA     |                    | BTM .. B/DBB     |                    |
|--------------------|------------------------|--------------------|------------------|--------------------|------------------|--------------------|------------------|--------------------|------------------|--------------------|
|                    | with steel balls       | with ceramic balls | with steel balls | with ceramic balls | with steel balls | with ceramic balls | with steel balls | with ceramic balls | with steel balls | with ceramic balls |
| mm                 | N/μm                   |                    | N/μm             |                    | N/μm             |                    | N/μm             |                    | N/μm             |                    |
| 35                 | 455                    | 500                | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 40                 | 481                    | 529                | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 45                 | 513                    | 564                | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 50                 | 559                    | 614                | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 55                 | 580                    | 639                | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 60                 | 618                    | 680                | 196              | 218                | 296              | 328                | 321              | 356                | 484              | 537                |
| 65                 | 653                    | 719                | 206              | 229                | 313              | 347                | 342              | 380                | 510              | 566                |
| 70                 | 673                    | 741                | 227              | 252                | 342              | 380                | 389              | 432                | 587              | 651                |
| 75                 | 714                    | 786                | 234              | 259                | 354              | 393                | 402              | 447                | 603              | 670                |
| 80                 | 735                    | 809                | 252              | 280                | 380              | 422                | 426              | 472                | 635              | 705                |
| 85                 | 763                    | 840                | 259              | 287                | 390              | 432                | 435              | 483                | 656              | 728                |
| 90                 | 792                    | 871                | 292              | 324                | 441              | 490                | 495              | 550                | 747              | 829                |
| 95                 | 822                    | 904                | 299              | 331                | 453              | 503                | 509              | 565                | 767              | 852                |
| 100                | 880                    | 968                | 315              | 350                | 476              | 529                | 534              | 593                | 809              | 898                |
| 110                | 893                    | 982                | 357              | 396                | 541              | 600                | 591              | 656                | 886              | 983                |
| 120                | 979                    | 1 077              | 377              | 419                | 571              | 634                | 649              | 720                | 985              | 1 093              |
| 130                | 1 032                  | 1 135              | 428              | 475                | 649              | 720                | 719              | 798                | 1 082            | 1 202              |
| 140                | 1 089                  | 1 198              | 440              | 488                | 667              | 740                | 739              | 821                | 1 113            | 1 236              |
| 150                | 1 125                  | 1 238              | 483              | 536                | 733              | 814                | 807              | 896                | 1 219            | 1 353              |
| 160                | 1 220                  | 1 341              | 516              | 573                | 784              | 870                | 882              | 979                | 1 331            | 1 478              |
| 170                | 1 225                  | 1 348              | 551              | 612                | 833              | 925                | 928              | 1 030              | 1 399            | 1 553              |
| 180                | 1 314                  | 1 445              | 597              | 663                | 902              | 1 002              | 1 000            | 1 110              | 1 504            | 1 669              |
| 190                | 1 361                  | 1 497              | –                | –                  | –                | –                  | –                | –                  | –                | –                  |
| 200                | 1 395                  | 1 535              | –                | –                  | –                | –                  | –                | –                  | –                | –                  |

## Equivalent bearing loads

### Equivalent dynamic bearing load

For bearings that accommodate axial loads only:

$$P = F_a$$

### Equivalent static bearing load

For bearings that accommodate axial loads only:

$$P_0 = F_a$$

## Mounting

Bearing components and bearing sets must be kept together as supplied and mounted in the indicated order. For additional information, refer to *Markings on bearings* (→ **page 310**).

## Attainable speeds

The attainable speeds listed in the product tables (→ **page 310**) are guideline values and are valid under certain conditions. For additional information, refer to *Attainable speeds* on **page 310**.

For bearings in the BTM series with a heavy preload (designation suffix DBB), the attainable speeds are 75% of the values for the same bearing with a light preload (designation suffix DBA).



# Designation system

**Examples:** BTW 70 CTN9/SPW33  
BTM 150 AM/HCP4CDBA

|     |     |   |     |   |    |     |     |    |   |
|-----|-----|---|-----|---|----|-----|-----|----|---|
| BTW | 70  | C | TN9 | / |    | SP  | W33 |    |   |
| BTM | 150 | A | M   | / | HC | P4C |     | DB | A |

## Bearing series

**BTW** Basic design double direction angular contact thrust ball bearing  
**BTM** High-speed design double direction angular contact thrust ball bearing

## Bearing size

**35 to 200** Bore diameter [mm]

## Internal design

**A** 30° contact angle  
**B** 40° contact angle  
**C** 60° contact angle  
**A** As a second letter after the contact angle information (for BTW series only): Bearing with a larger bore to be mounted on the large diameter side of a cylindrical roller bearing with a tapered bore.

## Cage

**M** Two machined brass cages, snap-type (for BTW series), window-type (for BTM series), ball centred  
**TN9** Two glass fibre reinforced PA66 cages, snap-type (for BTW series), window-type (for BTM series), ball centred

## Ball material

– Carbon chromium steel (no designation suffix)  
**HC** Balls made of bearing grade silicon nitride Si<sub>3</sub>N<sub>4</sub> (hybrid bearing)

## Accuracy

**P4C** Dimensional accuracy approximately to ISO tolerance class 4 and running accuracy better than ISO tolerance class 4 for radial bearings (for BTM series bearings only).  
**SP** Dimensional accuracy approximately to ISO tolerance class 5 and running accuracy better than ISO tolerance class 4 for thrust bearings (for BTW series bearings only).  
**UP** Dimensional accuracy approximately to ISO tolerance class 4 and running accuracy better than ISO tolerance class 4 for thrust bearings (for BTW series bearings only).

## Lubrication feature (for BTW series bearings only)

**W33** Annular groove and three lubrication holes in the housing washer

## Arrangement (for BTM series bearings only)

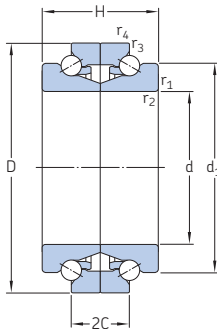
**DB** Two bearings arranged back-to-back

## Preload (for BTM series bearings only)

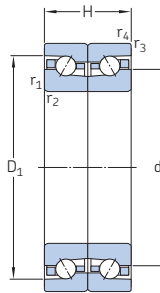
**A** Light preload  
**B** Heavy preload  
**G...** Special preload, expressed in daN e.g. G240

## 4.1 Double direction angular contact thrust ball bearings

d 35 – 80 mm



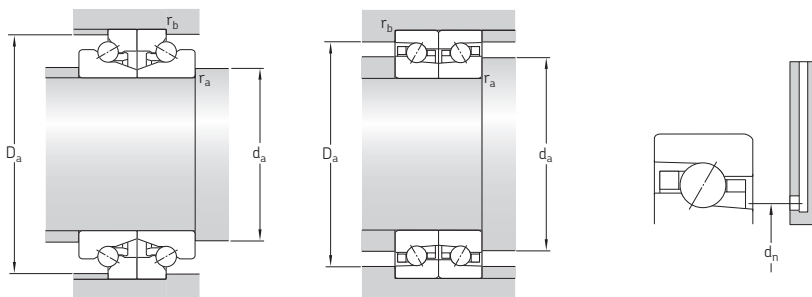
BTW



BTM

| Principal dimensions |     |      | Basic load ratings |                          | Fatigue load limit | Attainable speeds <sup>1)</sup> |                        | Mass | Designation         |
|----------------------|-----|------|--------------------|--------------------------|--------------------|---------------------------------|------------------------|------|---------------------|
| d                    | D   | H    | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrication           | Oil-air<br>lubrication | kg   | –                   |
| mm                   |     |      | kN                 |                          | kN                 | r/min                           |                        |      |                     |
| 35                   | 62  | 34   | 16,8               | 39                       | 1,83               | 11 000                          | 14 000                 | 0,35 | BTW 35 CTN9/SP      |
| 40                   | 68  | 36   | 19,5               | 46,5                     | 2,24               | 10 000                          | 13 000                 | 0,42 | BTW 40 CTN9/SP      |
| 45                   | 75  | 38   | 22,1               | 54                       | 2,6                | 9 500                           | 12 000                 | 0,53 | BTW 45 CTN9/SP      |
| 50                   | 80  | 38   | 22,5               | 60                       | 2,85               | 9 000                           | 11 000                 | 0,58 | BTW 50 CTN9/SP      |
| 55                   | 90  | 44   | 30,2               | 80                       | 3,8                | 7 500                           | 9 000                  | 0,87 | BTW 55 CTN9/SP      |
| 60                   | 95  | 33   | 21,6               | 43                       | 1,86               | 10 100                          | 12 900                 | 0,85 | BTM 60 ATN9/P4CDB   |
|                      | 95  | 33   | 21,6               | 43                       | 1,86               | 12 700                          | 15 200                 | 0,8  | BTM 60 ATN9/HCP4CDB |
|                      | 95  | 33   | 25                 | 50                       | 2,12               | 9 000                           | 11 500                 | 0,85 | BTM 60 BTN9/P4CDB   |
|                      | 95  | 33   | 25                 | 50                       | 2,12               | 11 100                          | 13 300                 | 0,8  | BTM 60 BTN9/HCP4CDB |
|                      | 95  | 44   | 30,7               | 83                       | 4                  | 7 500                           | 9 000                  | 0,93 | BTW 60 CTN9/SP      |
| 65                   | 100 | 33   | 22                 | 47,5                     | 2                  | 9 500                           | 12 100                 | 0,9  | BTM 65 ATN9/P4CDB   |
|                      | 100 | 33   | 22                 | 47,5                     | 2                  | 11 900                          | 14 200                 | 0,85 | BTM 65 ATN9/HCP4CDB |
|                      | 100 | 33   | 26                 | 54                       | 2,32               | 8 400                           | 10 900                 | 0,9  | BTM 65 BTN9/P4CDB   |
|                      | 100 | 33   | 26                 | 54                       | 2,32               | 10 400                          | 12 400                 | 0,85 | BTM 65 BTN9/HCP4CDB |
|                      | 100 | 44   | 31,9               | 90                       | 4,3                | 7 000                           | 8 500                  | 1    | BTW 65 CTN9/SP      |
| 70                   | 110 | 36   | 27,5               | 58,5                     | 2,45               | 8 700                           | 11 100                 | 1,2  | BTM 70 ATN9/P4CDB   |
|                      | 110 | 36   | 27,5               | 58,5                     | 2,45               | 10 900                          | 13 000                 | 1,15 | BTM 70 ATN9/HCP4CDB |
|                      | 110 | 36   | 32                 | 67                       | 2,85               | 7 700                           | 9 900                  | 1,2  | BTM 70 BTN9/P4CDB   |
|                      | 110 | 36   | 32                 | 67                       | 2,85               | 9 500                           | 11 300                 | 1,15 | BTM 70 BTN9/HCP4CDB |
|                      | 110 | 48   | 39                 | 112                      | 5,3                | 6 700                           | 8 000                  | 1,35 | BTW 70 CTN9/SP      |
| 75                   | 115 | 36   | 27,5               | 61                       | 2,6                | 8 200                           | 10 400                 | 1,3  | BTM 75 ATN9/P4CDB   |
|                      | 115 | 36   | 27,5               | 61                       | 2,6                | 10 300                          | 12 300                 | 1,2  | BTM 75 ATN9/HCP4CDB |
|                      | 115 | 36   | 32,5               | 69,5                     | 2,9                | 7 300                           | 9 400                  | 1,3  | BTM 75 BTN9/P4CDB   |
|                      | 115 | 36   | 32,5               | 69,5                     | 2,9                | 9 000                           | 10 700                 | 1,2  | BTM 75 BTN9/HCP4CDB |
|                      | 115 | 48   | 39,7               | 116                      | 5,6                | 6 300                           | 7 500                  | 1,45 | BTW 75 CTN9/SP      |
| 80                   | 125 | 40,5 | 33,5               | 73,5                     | 3,1                | 7 600                           | 9 700                  | 1,75 | BTM 80 ATN9/P4CDB   |
|                      | 125 | 40,5 | 33,5               | 73,5                     | 3,1                | 9 600                           | 11 500                 | 1,65 | BTM 80 ATN9/HCP4CDB |
|                      | 125 | 40,5 | 39                 | 85                       | 3,55               | 6 800                           | 8 700                  | 1,75 | BTM 80 BTN9/P4CDB   |
|                      | 125 | 40,5 | 39                 | 85                       | 3,55               | 8 400                           | 10 000                 | 1,65 | BTM 80 BTN9/HCP4CDB |
|                      | 125 | 54   | 47,5               | 140                      | 6,55               | 5 600                           | 6 700                  | 1,95 | BTW 80 CTN9/SP      |

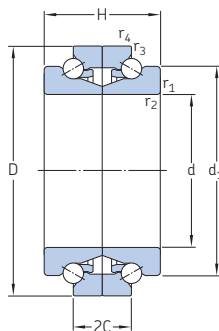
<sup>1)</sup> Speed values for BTM series bearings are applicable to those with a light preload (suffix DBA). For bearings with a heavy preload (suffix DBB), attainable speeds are about 75% of the quoted values.



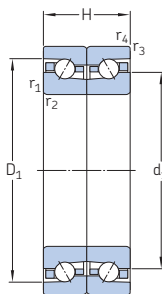
| Dimensions |                |    |                |                          |                          | Abutment and fillet dimensions |                        |                        |                        |                        |                | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ |
|------------|----------------|----|----------------|--------------------------|--------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------------------------------------------------------|
| d          | d <sub>1</sub> | 2C | D <sub>1</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> | cm <sup>3</sup>                                      |
| mm         |                |    |                |                          |                          | mm                             |                        |                        |                        |                        |                |                                                      |
| 35         | 50,8           | 17 | 50,2           | 1                        | 0,3                      | 45                             | 57,3                   | 58                     | 1                      | 0,3                    | –              | 1,9                                                  |
| 40         | 56,4           | 18 | 55,9           | 1                        | 0,3                      | 50                             | 63,4                   | 64                     | 1                      | 0,3                    | –              | 2,5                                                  |
| 45         | 62,5           | 19 | 61,9           | 1                        | 0,3                      | 56                             | 69,9                   | 71                     | 1                      | 0,3                    | –              | 3,1                                                  |
| 50         | 67,5           | 19 | 66,9           | 1                        | 0,3                      | 61                             | 74,9                   | 76                     | 1                      | 0,3                    | –              | 3,3                                                  |
| 55         | 75,2           | 22 | 74,4           | 1,1                      | 0,6                      | 68                             | 84                     | 85                     | 1                      | 0,6                    | –              | 4,8                                                  |
| 60         | 75,9           | –  | 81,5           | 1,1                      | 0,6                      | 66                             | –                      | 91,8                   | 1                      | 0,6                    | 74             | 7,8                                                  |
|            | 75,9           | –  | 81,5           | 1,1                      | 0,6                      | 66                             | –                      | 91,8                   | 1                      | 0,6                    | 74             | 7,8                                                  |
|            | 75,9           | –  | 81,5           | 1,1                      | 0,6                      | 66                             | –                      | 91,8                   | 1                      | 0,6                    | 74             | 7,8                                                  |
|            | 75,9           | –  | 81,5           | 1,1                      | 0,6                      | 66                             | –                      | 91,8                   | 1                      | 0,6                    | 74             | 7,8                                                  |
|            | 80,2           | 22 | 79,4           | 1,1                      | 0,6                      | 73                             | 89                     | 90                     | 1                      | 0,6                    | –              | 5,2                                                  |
| 65         | 80,9           | –  | 86,5           | 1,1                      | 0,6                      | 71                             | –                      | 96,8                   | 1                      | 0,6                    | 79             | 8,4                                                  |
|            | 80,9           | –  | 86,5           | 1,1                      | 0,6                      | 71                             | –                      | 96,8                   | 1                      | 0,6                    | 79             | 8,4                                                  |
|            | 80,9           | –  | 86,5           | 1,1                      | 0,6                      | 71                             | –                      | 96,8                   | 1                      | 0,6                    | 79             | 8,4                                                  |
|            | 80,9           | –  | 86,5           | 1,1                      | 0,6                      | 71                             | –                      | 96,8                   | 1                      | 0,6                    | 79             | 8,4                                                  |
|            | 85,2           | 22 | 84,4           | 1,1                      | 0,6                      | 78                             | 94                     | 95                     | 1                      | 0,6                    | –              | 5,6                                                  |
| 70         | 88,55          | –  | 94,9           | 1,1                      | 0,6                      | 76                             | –                      | 106                    | 1                      | 0,6                    | 86             | 11                                                   |
|            | 88,55          | –  | 94,9           | 1,1                      | 0,6                      | 76                             | –                      | 106                    | 1                      | 0,6                    | 86             | 11                                                   |
|            | 88,55          | –  | 94,9           | 1,1                      | 0,6                      | 76                             | –                      | 106                    | 1                      | 0,6                    | 86             | 11                                                   |
|            | 88,55          | –  | 94,9           | 1,1                      | 0,6                      | 76                             | –                      | 106                    | 1                      | 0,6                    | 86             | 11                                                   |
|            | 93,5           | 24 | 92,5           | 1,1                      | 0,6                      | 85                             | 103,4                  | 105                    | 1                      | 0,6                    | –              | 7,4                                                  |
| 75         | 93,55          | –  | 99,9           | 1,1                      | 0,6                      | 81                             | –                      | 111                    | 1                      | 0,6                    | 91             | 11,8                                                 |
|            | 93,55          | –  | 99,9           | 1,1                      | 0,6                      | 81                             | –                      | 111                    | 1                      | 0,6                    | 91             | 11,8                                                 |
|            | 93,55          | –  | 99,9           | 1,1                      | 0,6                      | 81                             | –                      | 111                    | 1                      | 0,6                    | 91             | 11,8                                                 |
|            | 93,55          | –  | 99,9           | 1,1                      | 0,6                      | 81                             | –                      | 111                    | 1                      | 0,6                    | 91             | 11,8                                                 |
|            | 98,5           | 24 | 97,5           | 1,1                      | 0,6                      | 90                             | 108,4                  | 110                    | 1                      | 0,6                    | –              | 7,8                                                  |
| 80         | 100,8          | –  | 107,8          | 1,1                      | 0,6                      | 86                             | –                      | 121                    | 1                      | 0,6                    | 98             | 16                                                   |
|            | 100,8          | –  | 107,8          | 1,1                      | 0,6                      | 86                             | –                      | 121                    | 1                      | 0,6                    | 98             | 16                                                   |
|            | 100,8          | –  | 107,8          | 1,1                      | 0,6                      | 86                             | –                      | 121                    | 1                      | 0,6                    | 98             | 16                                                   |
|            | 100,8          | –  | 107,8          | 1,1                      | 0,6                      | 86                             | –                      | 121                    | 1                      | 0,6                    | 98             | 16                                                   |
|            | 106,2          | 27 | 105            | 1,1                      | 0,6                      | 97                             | 117,3                  | 119                    | 1                      | 0,6                    | –              | 11                                                   |

<sup>1)</sup> For calculating the initial grease fill → page 313.

4.1 Double direction angular contact thrust ball bearings  
d 85 – 120 mm



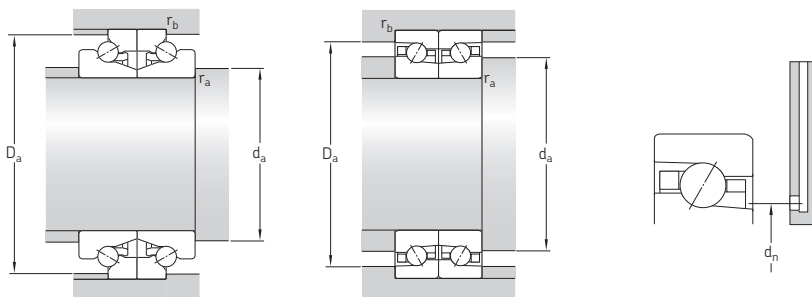
BTW



BTM

| Principal dimensions |     |      | Basic load ratings |                          | Fatigue load limit | Attainable speeds <sup>1)</sup> |                        | Mass | Designation          |
|----------------------|-----|------|--------------------|--------------------------|--------------------|---------------------------------|------------------------|------|----------------------|
| d                    | D   | H    | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrication           | Oil-air<br>lubrication | kg   | –                    |
| mm                   |     |      |                    |                          |                    |                                 |                        |      |                      |
| 85                   | 130 | 40,5 | 33,5               | 78                       | 3,15               | 7 300                           | 9 300                  | 1,85 | BTM 85 ATN9/P4CDB    |
|                      | 130 | 40,5 | 33,5               | 78                       | 3,15               | 9 100                           | 10 900                 | 1,7  | BTM 85 ATN9/HCP4CDB  |
|                      | 130 | 40,5 | 40                 | 88                       | 3,6                | 6 400                           | 8 300                  | 1,85 | BTM 85 BTN9/P4CDB    |
|                      | 130 | 40,5 | 40                 | 88                       | 3,6                | 8 000                           | 9 500                  | 1,7  | BTM 85 BTN9/HCP4CDB  |
|                      | 130 | 54   | 48,8               | 146                      | 6,7                | 5 600                           | 6 700                  | 2,05 | BTW 85 CTN9/SP       |
| 90                   | 140 | 45   | 39                 | 91,5                     | 3,55               | 6 800                           | 8 700                  | 2,45 | BTM 90 ATN9/P4CDB    |
|                      | 140 | 45   | 39                 | 91,5                     | 3,55               | 8 500                           | 10 100                 | 2,3  | BTM 90 ATN9/HCP4CDB  |
|                      | 140 | 45   | 46,5               | 102                      | 4                  | 6 000                           | 7 700                  | 2,45 | BTM 90 BTN9/P4CDB    |
|                      | 140 | 45   | 46,5               | 102                      | 4                  | 7 400                           | 8 800                  | 2,3  | BTM 90 BTN9/HCP4CDB  |
|                      | 140 | 60   | 55,9               | 173                      | 7,65               | 5 000                           | 6 000                  | 2,7  | BTW 90 CTN9/SP       |
| 95                   | 145 | 45   | 40                 | 93                       | 3,6                | 6 500                           | 8 300                  | 2,55 | BTM 95 ATN9/P4CDB    |
|                      | 145 | 45   | 40                 | 93                       | 3,6                | 8 200                           | 9 800                  | 2,4  | BTM 95 ATN9/HCP4CDB  |
|                      | 145 | 45   | 46,5               | 106                      | 4,05               | 5 800                           | 7 400                  | 2,55 | BTM 95 BTN9/P4CDB    |
|                      | 145 | 45   | 46,5               | 106                      | 4,05               | 7 200                           | 8 600                  | 2,4  | BTM 95 BTN9/HCP4CDB  |
|                      | 145 | 60   | 57,2               | 180                      | 7,8                | 5 000                           | 6 000                  | 2,8  | BTW 95 CTN9/SP       |
| 100                  | 150 | 45   | 41,5               | 102                      | 3,8                | 6 300                           | 7 900                  | 2,65 | BTM 100 ATN9/P4CDB   |
|                      | 150 | 45   | 41,5               | 102                      | 3,8                | 7 900                           | 9 400                  | 2,5  | BTM 100 ATN9/HCP4CDB |
|                      | 150 | 45   | 48                 | 116                      | 4,3                | 5 600                           | 7 100                  | 2,65 | BTM 100 BTN9/P4CDB   |
|                      | 150 | 45   | 48                 | 116                      | 4,3                | 6 900                           | 8 200                  | 2,5  | BTM 100 BTN9/HCP4CDB |
|                      | 150 | 60   | 59,2               | 193                      | 8,15               | 5 000                           | 6 000                  | 2,95 | BTW 100 CTN9/SP      |
| 110                  | 170 | 54   | 57                 | 137                      | 4,8                | 5 600                           | 7 100                  | 4,25 | BTM 110 ATN9/P4CDB   |
|                      | 170 | 54   | 57                 | 137                      | 4,8                | 7 000                           | 8 300                  | 3,95 | BTM 110 ATN9/HCP4CDB |
|                      | 170 | 54   | 65,5               | 153                      | 5,5                | 4 900                           | 6 400                  | 4,25 | BTM 110 BTN9/P4CDB   |
|                      | 170 | 54   | 65,5               | 153                      | 5,5                | 6 100                           | 7 300                  | 3,95 | BTM 110 BTN9/HCP4CDB |
|                      | 170 | 72   | 81,9               | 260                      | 10,4               | 4 300                           | 5 000                  | 4,7  | BTW 110 CTN9/SP      |
| 120                  | 180 | 54   | 58,5               | 146                      | 5                  | 5 200                           | 6 700                  | 4,55 | BTM 120 ATN9/P4CDB   |
|                      | 180 | 54   | 58,5               | 146                      | 5                  | 6 500                           | 7 700                  | 4,2  | BTM 120 ATN9/HCP4CDB |
|                      | 180 | 54   | 69,5               | 166                      | 5,7                | 4 600                           | 5 900                  | 4,55 | BTM 120 BTN9/P4CDB   |
|                      | 180 | 54   | 69,5               | 166                      | 5,7                | 5 700                           | 6 800                  | 4,2  | BTM 120 BTN9/HCP4CDB |
|                      | 180 | 72   | 85,2               | 280                      | 10,8               | 4 000                           | 4 800                  | 5,05 | BTW 120 CTN9/SP      |

<sup>1)</sup> Speed values for BTM series bearings are applicable to those with a light preload (suffix DBA). For bearings with a heavy preload (suffix DBB), attainable speeds are about 75% of the quoted values.

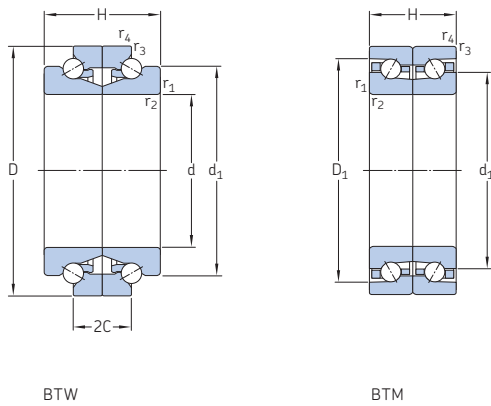


| Dimensions |                |    |                |                          |                          | Abutment and fillet dimensions |                        |                        |                        |                        | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ |                 |
|------------|----------------|----|----------------|--------------------------|--------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------------------------------------|-----------------|
| d          | d <sub>1</sub> | 2C | D <sub>1</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub>                                       |                 |
| mm         |                |    |                |                          |                          | mm                             |                        |                        |                        |                        |                                                      | cm <sup>3</sup> |
| 85         | 105,8          | –  | 112,8          | 1,1                      | 0,6                      | 91                             | –                      | 126                    | 1                      | 0,6                    | 103                                                  | 16,8            |
|            | 105,8          | –  | 112,8          | 1,1                      | 0,6                      | 91                             | –                      | 126                    | 1                      | 0,6                    | 103                                                  | 16,8            |
|            | 105,8          | –  | 112,8          | 1,1                      | 0,6                      | 91                             | –                      | 126                    | 1                      | 0,6                    | 103                                                  | 16,8            |
|            | 105,8          | –  | 112,8          | 1,1                      | 0,6                      | 91                             | –                      | 126                    | 1                      | 0,6                    | 103                                                  | 16,8            |
|            | 112            | 27 | 110            | 1,1                      | 0,6                      | 102                            | 122,3                  | 124                    | 1                      | 0,6                    | –                                                    | 11              |
| 90         | 113            | –  | 120,6          | 1,5                      | 1                        | 97                             | –                      | 135                    | 1,5                    | 1                      | 110                                                  | 22              |
|            | 113            | –  | 120,6          | 1,5                      | 1                        | 97                             | –                      | 135                    | 1,5                    | 1                      | 110                                                  | 22              |
|            | 113            | –  | 120,6          | 1,5                      | 1                        | 97                             | –                      | 135                    | 1,5                    | 1                      | 110                                                  | 22              |
|            | 113            | –  | 120,6          | 1,5                      | 1                        | 97                             | –                      | 135                    | 1,5                    | 1                      | 110                                                  | 22              |
|            | 119            | 30 | 117,5          | 1,5                      | 0,6                      | 109                            | 130,9                  | 132                    | 1,5                    | 0,6                    | –                                                    | 14              |
| 95         | 118            | –  | 125,6          | 1,5                      | 1                        | 102                            | –                      | 140                    | 1,5                    | 1                      | 115                                                  | 22              |
|            | 118            | –  | 125,6          | 1,5                      | 1                        | 102                            | –                      | 140                    | 1,5                    | 1                      | 115                                                  | 22              |
|            | 118            | –  | 125,6          | 1,5                      | 1                        | 102                            | –                      | 140                    | 1,5                    | 1                      | 115                                                  | 22              |
|            | 118            | –  | 125,6          | 1,5                      | 1                        | 102                            | –                      | 140                    | 1,5                    | 1                      | 115                                                  | 22              |
|            | 124            | 30 | 122,5          | 1,5                      | 0,6                      | 114                            | 135,9                  | 137                    | 1,5                    | 0,6                    | –                                                    | 15              |
| 100        | 123            | –  | 130,6          | 1,5                      | 1                        | 107                            | –                      | 145                    | 1,5                    | 1                      | 120                                                  | 22              |
|            | 123            | –  | 130,6          | 1,5                      | 1                        | 107                            | –                      | 145                    | 1,5                    | 1                      | 120                                                  | 22              |
|            | 123            | –  | 130,6          | 1,5                      | 1                        | 107                            | –                      | 145                    | 1,5                    | 1                      | 120                                                  | 22              |
|            | 123            | –  | 130,6          | 1,5                      | 1                        | 107                            | –                      | 145                    | 1,5                    | 1                      | 120                                                  | 22              |
|            | 129            | 30 | 127,5          | 1,5                      | 0,6                      | 119                            | 140,9                  | 142                    | 1,5                    | 0,6                    | –                                                    | 16              |
| 110        | 137,9          | –  | 147,1          | 2                        | 1                        | 119                            | –                      | 165                    | 2                      | 1                      | 134                                                  | 38              |
|            | 137,9          | –  | 147,1          | 2                        | 1                        | 119                            | –                      | 165                    | 2                      | 1                      | 134                                                  | 38              |
|            | 137,9          | –  | 147,1          | 2                        | 1                        | 119                            | –                      | 165                    | 2                      | 1                      | 134                                                  | 38              |
|            | 137,9          | –  | 147,1          | 2                        | 1                        | 119                            | –                      | 165                    | 2                      | 1                      | 134                                                  | 38              |
|            | 145            | 36 | 143,1          | 2                        | 1                        | 132                            | 159,8                  | 161                    | 2                      | 1                      | –                                                    | 27              |
| 120        | 147,7          | –  | 157,1          | 2                        | 1                        | 129                            | –                      | 175                    | 2                      | 1                      | 144                                                  | 40              |
|            | 147,7          | –  | 157,1          | 2                        | 1                        | 129                            | –                      | 175                    | 2                      | 1                      | 144                                                  | 40              |
|            | 147,7          | –  | 157,1          | 2                        | 1                        | 129                            | –                      | 175                    | 2                      | 1                      | 144                                                  | 40              |
|            | 147,7          | –  | 157,1          | 2                        | 1                        | 129                            | –                      | 175                    | 2                      | 1                      | 144                                                  | 40              |
|            | 155            | 36 | 153,1          | 2                        | 1                        | 142                            | 169,8                  | 171                    | 2                      | 1                      | –                                                    | 28              |

<sup>1)</sup> For calculating the initial grease fill → page 315.

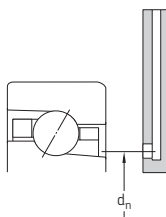
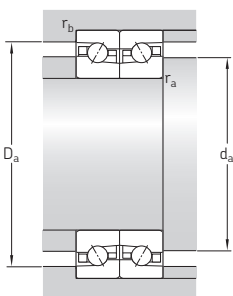
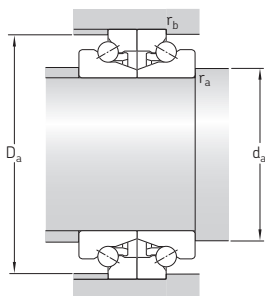
# 4.1 Double direction angular contact thrust ball bearings

d 130 – 200 mm



| Principal dimensions |     |      | Basic load ratings |                          | Fatigue load limit | Attainable speeds <sup>1)</sup> |                        | Mass | Designation          |
|----------------------|-----|------|--------------------|--------------------------|--------------------|---------------------------------|------------------------|------|----------------------|
| d                    | D   | H    | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrication           | Oil-air<br>lubrication | kg   | –                    |
| mm                   |     |      | kN                 |                          | kN                 | r/min                           |                        |      |                      |
| 130                  | 200 | 63   | 73,5               | 186                      | 6,1                | 4 700                           | 6 000                  | 6,9  | BTM 130 ATN9/P4CDB   |
|                      | 200 | 63   | 73,5               | 186                      | 6,1                | 5 900                           | 7 000                  | 6,45 | BTM 130 ATN9/HCP4CDB |
|                      | 200 | 63   | 85                 | 208                      | 6,8                | 4 200                           | 5 400                  | 6,9  | BTM 130 BTN9/P4CDB   |
|                      | 200 | 63   | 85                 | 208                      | 6,8                | 5 100                           | 6 100                  | 6,45 | BTM 130 BTN9/HCP4CDB |
|                      | 200 | 84   | 106                | 360                      | 13,2               | 3 600                           | 4 300                  | 7,6  | BTW 130 CTN9/SP      |
| 140                  | 210 | 63   | 73,5               | 190                      | 6,1                | 4 400                           | 5 700                  | 7,85 | BTM 140 AM/P4CDB     |
|                      | 210 | 63   | 73,5               | 190                      | 6,1                | 5 600                           | 6 700                  | 7,4  | BTM 140 AM/HCP4CDB   |
|                      | 210 | 63   | 86,5               | 216                      | 6,95               | 3 900                           | 5 100                  | 7,85 | BTM 140 BM/P4CDB     |
|                      | 210 | 63   | 86,5               | 216                      | 6,95               | 4 900                           | 5 800                  | 7,4  | BTM 140 BM/HCP4CDB   |
|                      | 210 | 84   | 106                | 375                      | 13,2               | 3 200                           | 3 800                  | 8,6  | BTW 140 CM/SP        |
| 150                  | 225 | 67,5 | 86,5               | 228                      | 7,1                | 4 100                           | 5 300                  | 9,6  | BTM 150 AM/P4CDB     |
|                      | 225 | 67,5 | 86,5               | 228                      | 7,1                | 5 200                           | 6 200                  | 9    | BTM 150 AM/HCP4CDB   |
|                      | 225 | 67,5 | 104                | 260                      | 8                  | 3 700                           | 4 800                  | 9,6  | BTM 150 BM/P4CDB     |
|                      | 225 | 67,5 | 104                | 260                      | 8                  | 4 500                           | 5 300                  | 9    | BTM 150 BM/HCP4CDB   |
|                      | 225 | 90   | 127                | 440                      | 15,3               | 3 000                           | 3 600                  | 10,5 | BTW 150 CM/SP        |
| 160                  | 240 | 72   | 98                 | 260                      | 7,8                | 3 900                           | 5 000                  | 12   | BTM 160 AM/P4CDB     |
|                      | 240 | 72   | 98                 | 260                      | 7,8                | 4 900                           | 5 800                  | 11   | BTM 160 AM/HCP4CDB   |
|                      | 240 | 72   | 114                | 290                      | 8,8                | 3 400                           | 4 500                  | 12   | BTM 160 BM/P4CDB     |
|                      | 240 | 72   | 114                | 290                      | 8,8                | 4 300                           | 5 100                  | 11   | BTM 160 BM/HCP4CDB   |
|                      | 240 | 96   | 140                | 510                      | 16,6               | 2 800                           | 3 400                  | 13   | BTW 160 CM/SP        |
| 170                  | 260 | 81   | 118                | 315                      | 9,15               | 3 600                           | 4 700                  | 16   | BTM 170 AM/P4CDB     |
|                      | 260 | 81   | 118                | 315                      | 9,15               | 4 500                           | 5 300                  | 15   | BTM 170 AM/HCP4CDB   |
|                      | 260 | 81   | 140                | 360                      | 10,4               | 3 200                           | 4 100                  | 16   | BTM 170 BM/P4CDB     |
|                      | 260 | 81   | 140                | 360                      | 10,4               | 3 900                           | 4 600                  | 15   | BTM 170 BM/HCP4CDB   |
|                      | 260 | 108  | 174                | 610                      | 19,6               | 2 400                           | 3 000                  | 17,5 | BTW 170 CM/SP        |
| 180                  | 280 | 90   | 140                | 365                      | 10,4               | 3 400                           | 4 400                  | 21,5 | BTM 180 AM/P4CDB     |
|                      | 280 | 90   | 140                | 365                      | 10,4               | 4 200                           | 5 000                  | 20   | BTM 180 AM/HCP4CDB   |
|                      | 280 | 90   | 163                | 425                      | 11,8               | 3 000                           | 3 800                  | 21,5 | BTM 180 BM/P4CDB     |
|                      | 280 | 90   | 163                | 425                      | 11,8               | 3 600                           | 4 300                  | 20   | BTM 180 BM/HCP4CDB   |
|                      | 280 | 120  | 199                | 710                      | 22,4               | 2 000                           | 2 600                  | 23   | BTW 180 CM/SP        |
| 190                  | 290 | 120  | 203                | 735                      | 22,8               | 2 000                           | 2 600                  | 24   | BTW 190 CM/SP        |
| 200                  | 310 | 132  | 238                | 865                      | 25,5               | 1 900                           | 2 400                  | 31   | BTW 200 CM/SP        |

<sup>1)</sup> Speed values for BTM series bearings are applicable to those with a light preload (suffix DBA). For bearings with a heavy preload (suffix DBB), attainable speeds are about 75% of the quoted values.



| Dimensions |                |    |                |                          |                          | Abutment and fillet dimensions |                        |                        |                        |                        |                | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ |
|------------|----------------|----|----------------|--------------------------|--------------------------|--------------------------------|------------------------|------------------------|------------------------|------------------------|----------------|------------------------------------------------------|
| d          | d <sub>1</sub> | 2C | D <sub>1</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | d <sub>a</sub><br>min.         | D <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. | d <sub>n</sub> |                                                      |
| mm         |                |    |                |                          |                          | mm                             |                        |                        |                        |                        |                | cm <sup>3</sup>                                      |
| 130        | 162,6          | –  | 173,3          | 2                        | 1                        | 139                            | –                      | 195                    | 2                      | 1                      | 158            | 58                                                   |
|            | 162,6          | –  | 173,3          | 2                        | 1                        | 139                            | –                      | 195                    | 2                      | 1                      | 158            | 58                                                   |
|            | 162,6          | –  | 173,3          | 2                        | 1                        | 139                            | –                      | 195                    | 2                      | 1                      | 158            | 58                                                   |
|            | 162,6          | –  | 173,3          | 2                        | 1                        | 139                            | –                      | 195                    | 2                      | 1                      | 158            | 58                                                   |
|            | 171            | 42 | 168,6          | 2                        | 1                        | 156                            | 187,5                  | 190                    | 2                      | 1                      | –              | 40                                                   |
| 140        | 172,6          | –  | 183,3          | 2,1                      | 1                        | 151                            | –                      | 205                    | 2                      | 1                      | 168            | 62                                                   |
|            | 172,6          | –  | 183,3          | 2,1                      | 1                        | 151                            | –                      | 205                    | 2                      | 1                      | 168            | 62                                                   |
|            | 172,6          | –  | 183,3          | 2,1                      | 1                        | 151                            | –                      | 205                    | 2                      | 1                      | 168            | 62                                                   |
|            | 172,6          | –  | 183,3          | 2,1                      | 1                        | 151                            | –                      | 205                    | 2                      | 1                      | 168            | 62                                                   |
|            | 181            | 42 | 178,6          | 2,1                      | 1                        | 166                            | 197,7                  | 200                    | 2                      | 1                      | –              | 45                                                   |
| 150        | 184,9          | –  | 196,4          | 2,1                      | 1,1                      | 161                            | –                      | 219                    | 2                      | 1                      | 180            | 80                                                   |
|            | 184,9          | –  | 196,4          | 2,1                      | 1,1                      | 161                            | –                      | 219                    | 2                      | 1                      | 180            | 80                                                   |
|            | 184,9          | –  | 196,4          | 2,1                      | 1,1                      | 161                            | –                      | 219                    | 2                      | 1                      | 180            | 80                                                   |
|            | 184,9          | –  | 196,4          | 2,1                      | 1,1                      | 161                            | –                      | 219                    | 2                      | 1                      | 180            | 80                                                   |
|            | 194            | 45 | 191,2          | 2,1                      | 1                        | 178                            | 212,4                  | 213                    | 2                      | 1                      | –              | 56                                                   |
| 160        | 196,8          | –  | 209,2          | 2,1                      | 1,1                      | 171                            | –                      | 234                    | 2                      | 1                      | 192            | 94                                                   |
|            | 196,8          | –  | 209,2          | 2,1                      | 1,1                      | 171                            | –                      | 234                    | 2                      | 1                      | 192            | 94                                                   |
|            | 196,8          | –  | 209,2          | 2,1                      | 1,1                      | 171                            | –                      | 234                    | 2                      | 1                      | 192            | 94                                                   |
|            | 196,8          | –  | 209,2          | 2,1                      | 1,1                      | 171                            | –                      | 234                    | 2                      | 1                      | 192            | 94                                                   |
|            | 207            | 48 | 203,7          | 2,1                      | 1                        | 190                            | 226                    | 227                    | 2                      | 1                      | –              | 67                                                   |
| 170        | 211,3          | –  | 225,6          | 2,1                      | 1,1                      | 181                            | –                      | 254                    | 2                      | 1                      | 205            | 126                                                  |
|            | 211,3          | –  | 225,6          | 2,1                      | 1,1                      | 181                            | –                      | 254                    | 2                      | 1                      | 205            | 126                                                  |
|            | 211,3          | –  | 225,6          | 2,1                      | 1,1                      | 181                            | –                      | 254                    | 2                      | 1                      | 205            | 126                                                  |
|            | 211,3          | –  | 225,6          | 2,1                      | 1,1                      | 181                            | –                      | 254                    | 2                      | 1                      | 205            | 126                                                  |
|            | 223            | 54 | 219,3          | 2,1                      | 1                        | 204                            | 244,9                  | 246                    | 2                      | 1                      | –              | 90                                                   |
| 180        | 226,5          | –  | 241,7          | 2,1                      | 1,1                      | 191                            | –                      | 274                    | 2                      | 1                      | 220            | 160                                                  |
|            | 226,5          | –  | 241,7          | 2,1                      | 1,1                      | 191                            | –                      | 274                    | 2                      | 1                      | 220            | 160                                                  |
|            | 226,5          | –  | 241,7          | 2,1                      | 1,1                      | 191                            | –                      | 274                    | 2                      | 1                      | 220            | 160                                                  |
|            | 226,5          | –  | 241,7          | 2,1                      | 1,1                      | 191                            | –                      | 274                    | 2                      | 1                      | 220            | 160                                                  |
|            | 239            | 60 | 234,8          | 2,1                      | 1                        | 214                            | 262,6                  | 264                    | 2                      | 1                      | –              | 117                                                  |
| 190        | 249            | 60 | 244,8          | 2,1                      | 1                        | 224                            | 272,6                  | 274                    | 2                      | 1                      | –              | 122                                                  |
| 200        | 264            | 66 | 259,9          | 2,1                      | 1                        | 236                            | 291                    | 292                    | 2                      | 1                      | –              | 157                                                  |

<sup>1)</sup> For calculating the initial grease fill → page 317.

Super-precision bearing

SKF





# Axial-radial cylindrical roller bearings

|                                           |            |                                                               |     |
|-------------------------------------------|------------|---------------------------------------------------------------|-----|
| <b>Designs and variants</b> . . . . .     | <b>320</b> | <b>Product table</b>                                          |     |
| <b>Bearing data</b> . . . . .             | <b>321</b> | <b>5.1</b> Axial-radial cylindrical roller bearings . . . . . | 334 |
| (Boundary dimensions, tolerances)         |            |                                                               |     |
| <b>Preload and stiffness</b> . . . . .    | <b>322</b> |                                                               |     |
| <b>Friction</b> . . . . .                 | <b>322</b> |                                                               |     |
| <b>Lubrication</b> . . . . .              | <b>324</b> |                                                               |     |
| <b>Design considerations</b> . . . . .    | <b>324</b> |                                                               |     |
| <b>Load carrying capacity</b> . . . . .   | <b>327</b> |                                                               |     |
| <b>Equivalent bearing loads</b> . . . . . | <b>327</b> |                                                               |     |
| <b>Permissible moment load</b> . . . . .  | <b>328</b> |                                                               |     |
| <b>Mounting</b> . . . . .                 | <b>330</b> |                                                               |     |
| <b>Designation system</b> . . . . .       | <b>333</b> |                                                               |     |

|                                         |     |
|-----------------------------------------|-----|
| <b>More information</b>                 |     |
| Bearing life and load ratings . . . . . | 319 |
| Requisite minimum load . . . . .        | 319 |
| Chamfer dimension limits . . . . .      | 319 |
| Materials . . . . .                     | 319 |
| Design considerations . . . . .         | 319 |
| Lubrication . . . . .                   | 319 |
| Mounting and dismounting . . . . .      | 319 |
| Bearing storage . . . . .               | 319 |

Super-precision axial-radial cylindrical roller bearings are commonly used to support rotary tables, indexing heads and multi-spindle heads on machining centres. SKF manufactures super-precision axial-radial cylindrical roller bearings for shaft diameters from 80 to 850 mm. Their internal design, together with close tolerance manufacturing processes, enables these bearings to attain radial run-out better than, and axial run-out close to, P4 tolerance class.

## Designs and variants

Axial-radial cylindrical roller bearings can accommodate radial loads, axial loads in both directions and moment loads, whether acting singly, or simultaneously, in any combination.

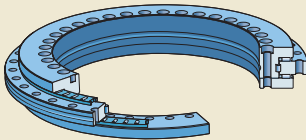
These bearings consist of (→ **fig. 1**):

- Two roller and cage thrust assemblies and a full complement radial roller set.
- An inner ring which has an L-shaped cross section and two raceways. One raceway accommodates the roller and cage thrust assembly and the other accommodates the full complement radial roller set. The inner ring is drilled for attachment bolts.
- A loose flange which acts as a raceway to accommodate the second roller and cage thrust assembly. The flange is held in place to the inner ring with transport bolts that should not be removed until after the bearing has been mounted. The flange is drilled for attachment bolts.
- An outer ring which has three raceways to accommodate both roller and cage thrust assemblies and the full complement radial roller set.

The bearings are supplied standard without grease (no designation suffix) but can also be supplied greased (designation suffix G).

Bearings supplied without grease must be adequately lubricated with either grease or oil through the lubrication holes in the bearing rings. Bearings, greased at the factory, are filled with a grease that is suitable for most applications over the normal speed range for the bearing.

Fig. 1



Bearing data

|                                                          |                                                                                                                                                                                |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Boundary dimensions                                      | Not standardized                                                                                                                                                               |
| Tolerances<br>For additional information<br>(→ page 321) | <ul style="list-style-type: none"><li>• manufactured to the tolerances listed in <b>table 1</b></li><li>• improved radial and axial run-out (50% tighter) on request</li></ul> |

Table 1

Tolerances for axial-radial cylindrical roller bearings

| Inner ring |       |                       |     |                  |                   |                       |      |                        |      |                                                                            |               |
|------------|-------|-----------------------|-----|------------------|-------------------|-----------------------|------|------------------------|------|----------------------------------------------------------------------------|---------------|
| d<br>over  | incl. | $\Delta_{ds}$<br>high | low | $V_{dp}$<br>max. | $V_{dmp}$<br>max. | $\Delta_{Hs}$<br>high | low  | $\Delta_{H1s}$<br>high | low  | $K_{ia}$<br>max.                                                           | $S_i$<br>max. |
| mm         |       | $\mu m$               |     | $\mu m$          | $\mu m$           | $\mu m$               |      | $\mu m$                |      | $\mu m$                                                                    | $\mu m$       |
| 50         | 80    | 0                     | −9  | 5                | 3,5               | 0                     | −175 | 25                     | −25  | 3                                                                          | 3             |
| 80         | 120   | 0                     | −10 | 6                | 4                 | 0                     | −175 | 25                     | −25  | 3                                                                          | 3             |
| 120        | 150   | 0                     | −13 | 8                | 5                 | 0                     | −175 | 30                     | −30  | 3                                                                          | 3             |
| 150        | 180   | 0                     | −13 | 8                | 5                 | 0                     | −175 | 30                     | −30  | 4                                                                          | 4             |
| 180        | 250   | 0                     | −15 | 9                | 6                 | 0                     | −200 | 30                     | −30  | 4                                                                          | 4             |
| 250        | 315   | 0                     | −18 | 11               | 8                 | 0                     | −400 | 40                     | −40  | 6                                                                          | 6             |
| 315        | 400   | 0                     | −23 | 14               | 10                | 0                     | −400 | 50                     | −50  | 6                                                                          | 6             |
| 400        | 500   | 0                     | −27 | 17               | 12                | 0                     | −450 | 60                     | −60  | 6                                                                          | 6             |
| 500        | 630   | 0                     | −33 | 20               | 14                | 0                     | −500 | 75                     | −75  | 10                                                                         | 10            |
| 630        | 800   | 0                     | −40 | 24               | 16                | 0                     | −700 | 100                    | −100 | 10                                                                         | 10            |
| 800        | 1 000 | 0                     | −50 | 30               | 20                | 0                     | −850 | 120                    | −120 | 12                                                                         | 12            |
| Outer ring |       |                       |     |                  |                   |                       |      |                        |      |                                                                            |               |
| D<br>over  | incl. | $\Delta_{Ds}$<br>high | low | $V_{Dp}$<br>max. | $V_{Dmp}$<br>max. |                       |      |                        |      | $K_{ea}$<br>max.                                                           | $S_e$<br>max. |
| mm         |       | $\mu m$               |     | $\mu m$          | $\mu m$           |                       |      |                        |      |                                                                            |               |
| 120        | 150   | 0                     | −11 | 7                | 5                 |                       |      |                        |      | Values are identical<br>to those for inner<br>ring of the same<br>bearing. |               |
| 150        | 180   | 0                     | −13 | 8                | 5                 |                       |      |                        |      |                                                                            |               |
| 180        | 250   | 0                     | −15 | 8                | 6                 |                       |      |                        |      |                                                                            |               |
| 250        | 315   | 0                     | −18 | 10               | 7                 |                       |      |                        |      |                                                                            |               |
| 315        | 400   | 0                     | −20 | 11               | 8                 |                       |      |                        |      |                                                                            |               |
| 400        | 500   | 0                     | −23 | 14               | 9                 |                       |      |                        |      |                                                                            |               |
| 500        | 630   | 0                     | −28 | 17               | 11                |                       |      |                        |      |                                                                            |               |
| 630        | 800   | 0                     | −35 | 20               | 13                |                       |      |                        |      |                                                                            |               |
| 800        | 1 000 | 0                     | −45 | 26               | 17                |                       |      |                        |      |                                                                            |               |
| 1 000      | 1 250 | 0                     | −55 | 34               | 20                |                       |      |                        |      |                                                                            |               |

Tolerance symbols and definitions → table 4, page 321

### Preload and stiffness

Due to the large number of cylindrical rollers in each of the rows, with line contact between them and the raceways, there is a minimal amount of elastic deformation in the bearing under load from any direction.

To provide maximum stiffness the rollers are calibrated during assembly so that a preload is achieved in each row once mounting is complete. Appropriate preload extends bearing service life, improves rigidity and running accuracy, while reducing noise levels.

As a result of the closely controlled preload, stiffness in any direction can be considered constant.

In cases where a heavy axial load acts on an axial-radial cylindrical roller bearing, the loaded roller set can deflect and reduce the preload on the second thrust roller set. In severe cases, the second thrust roller set can become completely unloaded, which can cause the rollers to skid and damage the raceways or subject the cage to impermissible stresses. For additional information, contact the SKF application engineering service.

Preload for the thrust roller sets and stiffness values, together with the axial unloading force, are listed in **table 2**. They are valid for bearings mounted properly and attachment bolts tightened to the recommended torque values (→ **table 7, page 322**).

### Friction

The frictional losses in axial-radial cylindrical roller bearings, as with other rolling bearings, depend on different factors. For general information, refer to *Friction* (→ **page 322**).

The values for the frictional moment listed in **table 3** were measured in functional tests and are average values. They should be used as guideline values only. The tests were conducted under the following operating conditions:

- lubrication: grease, kinematic viscosity 150 mm<sup>2</sup>/s at 40 °C (105 °F)
- rotational speed: 5 r/min
- ambient temperature: 30 to 40 °C (85 to 105 °F)
- attachment bolts tightened to the recommended torque values (→ **table 7, page 322**)

Table 2

## Preload and stiffness

| Bearing   | Axial preload <sup>1)</sup> | Axial unloading force <sup>1)</sup> | Axial stiffness <sup>2)</sup> | Radial stiffness <sup>2)</sup> | Moment stiffness <sup>2)</sup> |
|-----------|-----------------------------|-------------------------------------|-------------------------------|--------------------------------|--------------------------------|
| –         | kN                          | kN                                  | kN/μm                         | kN/μm                          | kNm/mrad                       |
| NRT 80 B  | 1,3                         | 2,8                                 | 4,9                           | 3,1                            | 7                              |
| NRT 100 B | 1,7                         | 3,8                                 | 7,2                           | 3,7                            | 15                             |
| NRT 120 B | 1,9                         | 4,3                                 | 8,1                           | 4,5                            | 22                             |
| NRT 150 B | 2,2                         | 4,8                                 | 9                             | 5,5                            | 35                             |
| NRT 180 B | 2,5                         | 5,5                                 | 10,3                          | 5,8                            | 53                             |
| NRT 200 B | 2,8                         | 6,2                                 | 11,6                          | 6,5                            | 73                             |
| NRT 260 B | 7,2                         | 16                                  | 14,5                          | 8,3                            | 150                            |
| NRT 325 B | 12                          | 26                                  | 28,6                          | 8,9                            | 413                            |
| NRT 395 B | 14                          | 30                                  | 33,6                          | 10,6                           | 672                            |
| NRT 460 A | 16                          | 34                                  | 38,5                          | 12,1                           | 1 036                          |
| NRT 580 A | 25                          | 55                                  | 43,5                          | 18,6                           | 1 838                          |
| NRT 650 A | 27                          | 59                                  | 60                            | 17,2                           | 3 209                          |
| NRT 850 A | 47                          | 103                                 | 77                            | 22,4                           | 7 011                          |

<sup>1)</sup> These values are averages.

<sup>2)</sup> Stiffness values refer to the roller set.

Table 3

## Frictional moment

| Bearing   | Frictional moment<br>$C_{RL}$ |
|-----------|-------------------------------|
| –         | Nm                            |
| NRT 80 B  | 3                             |
| NRT 100 B | 3                             |
| NRT 120 B | 6                             |
| NRT 150 B | 12                            |
| NRT 180 B | 13                            |
| NRT 200 B | 14                            |
| NRT 260 B | 25                            |
| NRT 325 B | 45                            |
| NRT 395 B | 55                            |
| NRT 460 A | 70                            |
| NRT 580 A | 140                           |
| NRT 650 A | 200                           |
| NRT 850 A | 300                           |

Guideline values only

## Lubrication

The choice of whether to use grease or oil should be based on the speed and operating temperature of the application. Axial-radial cylindrical roller bearings are typically lubricated by an oil bath or circulating oil system. Grease is normally reserved for lower speed and lower temperature applications.

Grease or oil can be introduced into the bearing via the lubrication holes in the bearing rings. Note that if the bearing is over-lubricated, excessive frictional heat increases bearing operating temperature.

The technical specifications of the standard grease in greased axial-radial cylindrical roller bearings (designation suffix G) are listed in **table 4**.

To achieve the lowest frictional moment and temperature, axial-radial cylindrical roller bearings need to be properly run-in. A typical running-in procedure consists of rotating the bearing for one hour at different speed steps, starting from an initial value of ~ 15% of the maximum operating speed and increasing by steps of 10% each time. During running-in, the bearing operating temperature should not exceed 70 °C (160 °F).

Table 4

| Technical specifications of the standard grease in greased bearings (designation suffix G) |                            |
|--------------------------------------------------------------------------------------------|----------------------------|
| Properties                                                                                 | Grease specification       |
| Thickener                                                                                  | Lithium complex soap       |
| Base oil type                                                                              | Mineral                    |
| NLGI consistency class                                                                     | 2                          |
| Temperature range<br>[°C]<br>[°F]                                                          | -30 to +140<br>-20 to +285 |
| Kinematic viscosity [mm <sup>2</sup> /s]<br>at 40 °C (105 °F)<br>at 100 °C (210 °F)        | 185<br>15                  |

## Design considerations

### Recommended shaft and housing fits

Shaft and housing seats for super-precision axial-radial cylindrical roller bearings should be manufactured to the following tolerance classes:

- h5  for the shaft (→ **table 5**)
- J6  for the housing bore (→ **table 6**, **page 324**)

### Accuracy of seats and abutments

If a super-precision axial-radial cylindrical roller bearing is to obtain a high degree of running accuracy and low operating temperature, its associated components must be manufactured to similar levels of precision.

Recommendations for the geometrical tolerances and surface roughness are provided in:

- **table 5** for the shaft
- **table 6**, **page 324** for the housing

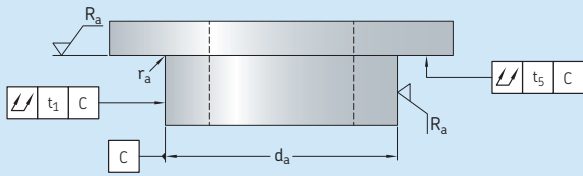
The recommended shaft and housing diameter tolerances, relative to the bearing bore and outside diameter tolerances result in a transition fit, tending towards clearance. In some cases, however, an interference fit may result for either the bearing inner or outer ring. When this occurs, preload on the radial roller set will increase, as will contact stresses, friction and frictional heat.

To optimize operating conditions and running accuracy in applications where there is inner ring rotation, the fit between the shaft and inner ring should be a loose fit that is as close to zero as possible. A near-zero loose fit should be applied to the outer ring and housing when the outer ring rotates.

To help obtain a near-zero loose fit on a shaft, SKF supplies axial-radial cylindrical roller bearings with an inspection report. The report includes the measured deviation from nominal of the inner ring bore diameter. It also includes the measured deviation from nominal of the bearing height and measured running accuracy.

Table 5

Geometrical accuracy for bearing shaft seats



| Shaft diameter |       | Tolerance             |     |            | Total radial run-out | Total axial run-out | Surface roughness |
|----------------|-------|-----------------------|-----|------------|----------------------|---------------------|-------------------|
| $d_a$ over     | incl. | $h5 \text{ (E)}$ high | low | $r_a$ max. | $t_1$ max.           | $t_5$ max.          | $R_a$ max.        |
| mm             |       | $\mu\text{m}$         |     | mm         | $\mu\text{m}$        | $\mu\text{m}$       | $\mu\text{m}$     |
| 50             | 80    | 0                     | -13 | 0,2        | 3                    | 3                   | 0,8               |
| 80             | 120   | 0                     | -15 | 0,2        | 4                    | 4                   | 0,8               |
| 120            | 150   | 0                     | -18 | 0,2        | 5                    | 5                   | 0,8               |
| 150            | 180   | 0                     | -18 | 0,2        | 5                    | 5                   | 0,8               |
| 180            | 250   | 0                     | -20 | 0,2        | 7                    | 7                   | 0,8               |
| 250            | 315   | 0                     | -23 | 0,5        | 8                    | 8                   | 0,8               |
| 315            | 400   | 0                     | -25 | 0,5        | 9                    | 9                   | 0,8               |
| 400            | 500   | 0                     | -27 | 0,9        | 10                   | 10                  | 0,8               |
| 500            | 630   | 0                     | -32 | 0,9        | 11                   | 11                  | 0,8               |
| 630            | 800   | 0                     | -36 | 1,3        | 13                   | 13                  | 0,8               |
| 800            | 1 000 | 0                     | -40 | 1,3        | 15                   | 15                  | 0,8               |

Surface roughness  $R_a$  in accordance with ISO 1302

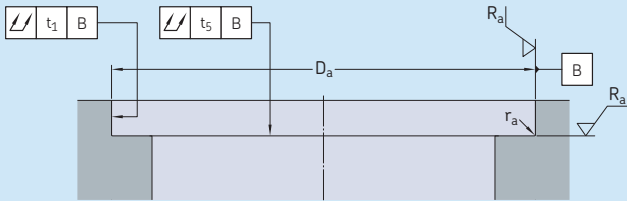
Attachment bolt holes

Axial-radial cylindrical roller bearings require threaded holes for attachment bolts in the shaft and housing. Details about spacing and thread sizes are listed in the product table (→ page 325). At the position of retaining bolts and removal threads, no attachment bolt holes are required.

Bearing NRT 80 A should be fixed with 12 attachment bolts each in the inner and outer ring. For this bearing, the retaining bolts and removal threads are positioned between the attachment bolt holes, evenly spaced at 120°.

Table 6

Geometrical accuracy for bearing housing seats



| Housing diameter |       | Tolerance |     |            | Total radial run-out | Total axial run-out | Surface roughness |
|------------------|-------|-----------|-----|------------|----------------------|---------------------|-------------------|
| $D_a$ over       | incl. | J6Ⓔ high  | low | $r_a$ max. | $t_1$ max.           | $t_5$ max.          | $R_a$ max.        |
| mm               |       | μm        |     | mm         | μm                   | μm                  | μm                |
| 120              | 150   | 18        | -7  | 0,2        | 5                    | 5                   | 0,8               |
| 150              | 180   | 18        | -7  | 0,5        | 5                    | 5                   | 0,8               |
| 180              | 250   | 22        | -7  | 0,5        | 7                    | 7                   | 0,8               |
| 250              | 315   | 25        | -7  | 0,5        | 8                    | 8                   | 0,8               |
| 315              | 400   | 29        | -7  | 0,5        | 9                    | 9                   | 0,8               |
| 400              | 500   | 33        | -7  | 0,5        | 10                   | 10                  | 0,8               |
| 500              | 630   | 34        | -10 | 0,9        | 11                   | 11                  | 0,8               |
| 630              | 800   | 38        | -12 | 0,9        | 13                   | 13                  | 0,8               |
| 800              | 1 000 | 44        | -12 | 0,9        | 15                   | 15                  | 0,8               |
| 1 000            | 1 250 | 52        | -14 | 1,3        | 18                   | 18                  | 0,8               |

Surface roughness  $R_a$  in accordance with ISO 1302



## Load carrying capacity

Axial-radial cylindrical roller bearings can accommodate radial loads, axial loads in both directions and moment loads, whether acting singly, or simultaneously, in any combination. As the bearing is preloaded and normally used to support axial and radial loads acting offset from, or eccentrically to, the bearing axis, the evaluation of the equivalent bearing loads by manual methods can only be approximated. Equivalent bearing loads in the radial and axial directions should be calculated separately. From these, the life ratings can be calculated for each row of rollers. If a more accurate bearing load analysis and calculation for rated life are required, contact the SKF application engineering service.

Basic load ratings are listed in the product table (→ **page 327**).

## Equivalent bearing loads

The equivalent dynamic bearing load can be calculated:

- for the radial roller set using  
 $P = F_r$
- for the thrust roller set using  
 $P = F_a + 4,4 M/d_1$

The equivalent static bearing load can be calculated:

- for the radial roller set using  
 $P_0 = F_r$
- for the thrust roller set using  
 $P_0 = F_a + 4,4 M/d_1$

where

$P$  = equivalent dynamic bearing load [kN]

$P_0$  = equivalent static bearing load [kN]

$d_1$  = outside diameter of inner ring [mm]

(→ **product table, page 327**)

$F_a$  = axial load [kN]

$F_r$  = radial load [kN]

$M$  = moment load [kNmm]

## Permissible moment load

Axial-radial cylindrical roller bearings generally rotate slowly, perform slow slewing movements, or are subjected to load when stationary. Under these conditions, the maximum permissible moment load is limited by the static load limit and can be determined using

$$M_{\text{perm}} = 0,23 d_1 (C_{0a}/s_0 - F_a)$$

where

$M_{\text{perm}}$  = permissible moment [kNmm]

$C_{0a}$  = basic static load rating of thrust roller set [kN] (→ **product table, page 328**)

$d_1$  = outside diameter of inner ring [mm]  
(→ **product table**)

$F_a$  = centrally acting axial load [kN]

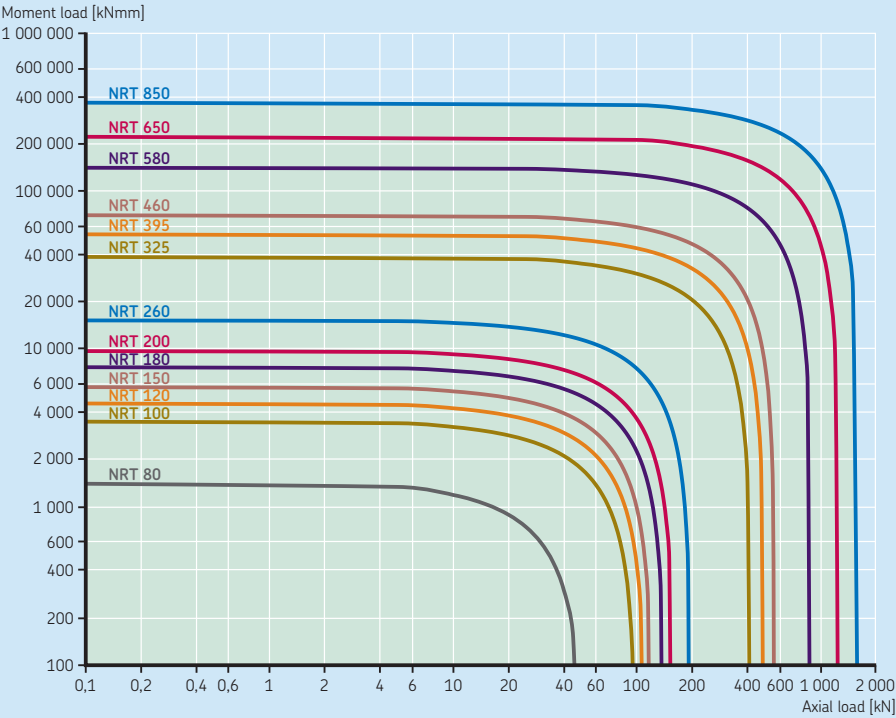
$s_0$  = safety factor (→ *Permissible static loads, page 328*)  
= 4

If frequent rotation or oscillation apply, rating life may limit the permissible moment load. In these cases, contact the SKF application engineering service.

**Diagram 1** can be used for a quick check of the suitability of the selected bearing size under predominantly static loads.

Diagram 1

Permissible moment load – static limiting load



# Mounting

Axial-radial cylindrical roller bearings are precision machine elements that can provide long service life, provided they are mounted and maintained properly. Proper mounting requires experience, accuracy, a clean work environment and the appropriate tools.

### Mounting instructions

For general information about mounting bearings, refer to *Mounting and dismounting* (→ page 330).

When mounting axial-radial cylindrical roller bearings the inner ring can be unsupported (→ fig. 2) or supported (→ fig. 3). When a support ring is used, it should support the inner ring over its entire width. The support ring should be approximately twice the thickness of the flange.

**CAUTION:** To reduce the risk of damaging the bearing, do not apply any force through the rolling elements. Force should only be applied directly through the ring that is being mounted.

### Mounting procedure

- 1 Coat all mating surfaces on the shaft and inner ring with a thin layer of light oil.
- 2 Loosen the retaining bolts (used to secure the bearing during transportation) 1/2 a turn.
- 3 Mount the bearing onto the shaft, loose flange first, aligning the attachment bolt holes in the bearing with the tapped holes in the shaft. To facilitate this process, an induction heater can be used and/or a guide stud can be inserted into one of the attachment bolt holes in the shaft. SKF does not recommend heating axial-radial cylindrical roller bearings above 80 °C (175 °F).
- 4 Once the bearing (and support ring where applicable) is in position against the shaft abutment and the assembly is at ambient temperature, insert the attachment bolts and tighten them "finger tight" while rotating the outer ring. This procedure helps to settle the rollers and centre the inner ring assembly.

- 5 With the inner ring centred, gradually tighten each attachment bolt in a criss-cross pattern in three stages (→ fig. 4), tightening the bolts to 35%, then 70% and then 100% of the recommended torque values listed in table 7 (→ page 330).
- 6 After the bearing is fitted, the retaining bolts must not be left loose. Either retighten them to the recommended torque values or remove them completely.
- 7 A similar procedure can be applied for fitting the outer ring. Coat all mating surfaces in the housing and on the outer ring with a thin layer of light oil.
- 8 Mount the bearing/shaft assembly into the housing (→ fig. 5).
- 9 Insert and tighten the attachment bolts "finger tight" while rotating the bearing/shaft assembly. Tighten each attachment bolt in a criss-cross pattern in three stages (→ fig. 6), as described in step 5.

### Checking running accuracy and friction

Once mounting is complete, the running accuracy and friction need to be checked. In cases where friction is particularly high, there are three potential explanations:

- The mating parts are not machined according to specification.
- The attachment bolts are over-tightened.
- There is too much grease in the bearing.

To eliminate possible stresses that may have occurred during mounting, loosen all attachment bolts and retighten them in a criss-cross pattern using the three stage process described above.

### Storage/Transport

Axial-radial cylindrical roller bearings should always be stored flat.

Fig. 2

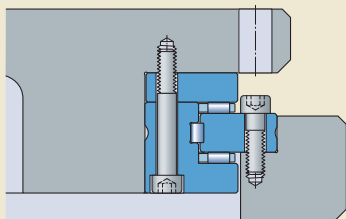


Fig. 3

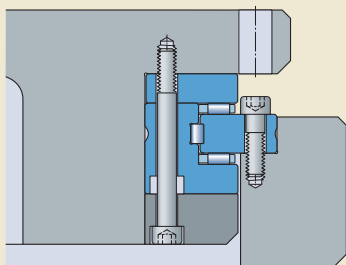


Fig. 4

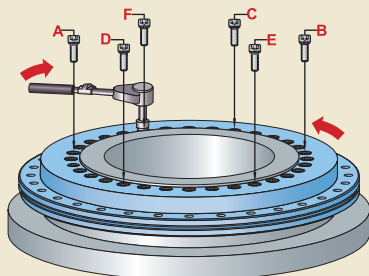


Fig. 5

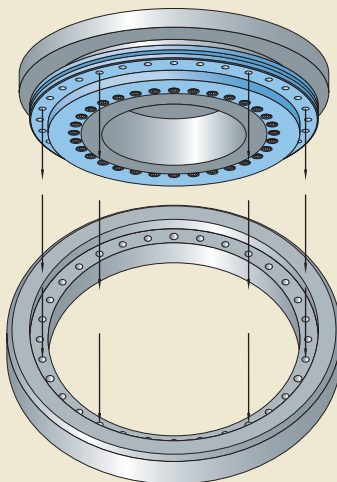


Fig. 6

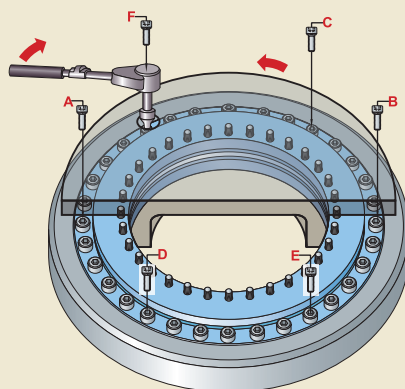


Table 7

| Recommended bolt tightening torque |                   |                           |
|------------------------------------|-------------------|---------------------------|
| Bearing                            | Tightening torque | Bolt size<br>quality 10,9 |
| –                                  | Nm                | –                         |
| NRT 80 B                           | 4,5               | M4                        |
|                                    | 8,5               | M5                        |
| NRT 100 B                          | 8,5               | M5                        |
| NRT 120 B                          | 14                | M6                        |
| NRT 150 B                          | 14                | M6                        |
| NRT 180 B                          | 14                | M6                        |
| NRT 200 B                          | 14                | M6                        |
| NRT 260 B                          | 34                | M8                        |
| NRT 325 B                          | 34                | M8                        |
| NRT 395 B                          | 34                | M8                        |
| NRT 460 A                          | 34                | M8                        |
| NRT 580 A                          | 68                | M10                       |
| NRT 650 A                          | 116               | M12                       |
| NRT 850 A                          | 284               | M16                       |

Do not use a higher torque value which could increase the bearing preload.

# Designation system

Example: NRT 260 A/G



**Bearing series**

NRT      Axial-radial cylindrical roller bearing

**Bearing size**

80      Bore diameter [mm]  
to  
850

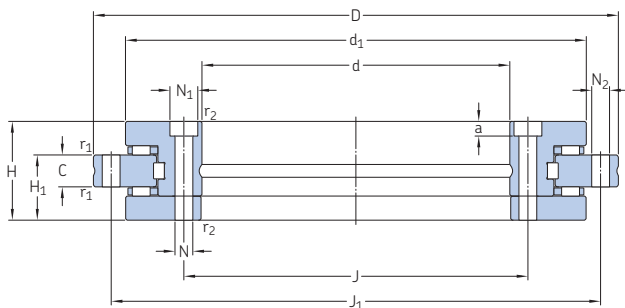
**Internal design**

A      Basic internal design  
B      Modified internal design

**Other features**

G      Bearing greased at the factory

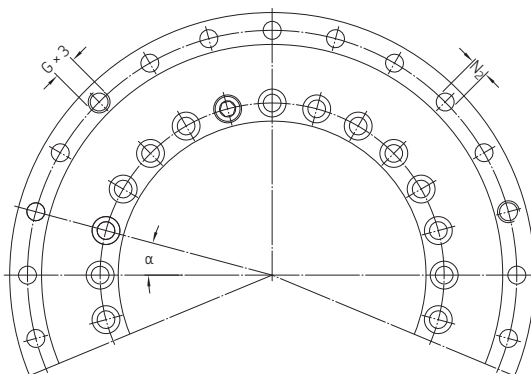
5.1 Axial-radial cylindrical roller bearings  
d 80 – 850 mm



| Principal dimensions |       |     |                |    |                | Basic load ratings     |                        |                        |                          | Attainable speeds     |                          |                            |                         | Mass | Suit-<br>able<br>rotary<br>table | Designa-<br>tion |
|----------------------|-------|-----|----------------|----|----------------|------------------------|------------------------|------------------------|--------------------------|-----------------------|--------------------------|----------------------------|-------------------------|------|----------------------------------|------------------|
| d <sup>1)</sup>      | D     | H   | H <sub>1</sub> | C  | d <sub>1</sub> | r <sub>1</sub><br>min. | r <sub>2</sub><br>min. | radial<br>dynamic<br>C | static<br>C <sub>0</sub> | axial<br>dynamic<br>C | static<br>C <sub>0</sub> | Grease<br>lubri-<br>cation | Oil<br>lubri-<br>cation | kg   | mm                               | –                |
| mm                   |       |     |                |    |                |                        |                        | kN                     |                          |                       |                          | r/min                      |                         |      |                                  |                  |
| 80                   | 146   | 35  | 23,35          | 12 | 130            | 0,3                    | 0,3                    | 55                     | 102                      | 37,5                  | 200                      | 350                        | 700                     | 2,4  | 200                              | NRT 80 B         |
| 100                  | 185   | 38  | 25             | 12 | 160            | 0,6                    | 0,3                    | 58,3                   | 116                      | 68                    | 390                      | 280                        | 560                     | 4,1  | 260                              | NRT 100 B        |
| 120                  | 210   | 40  | 26             | 12 | 184            | 0,6                    | 0,3                    | 64,4                   | 140                      | 72                    | 440                      | 230                        | 460                     | 5,3  | 315                              | NRT 120 B        |
| 150                  | 240   | 40  | 26             | 12 | 214            | 0,6                    | 0,3                    | 67,1                   | 160                      | 75                    | 480                      | 210                        | 420                     | 6,2  | 350                              | NRT 150 B        |
| 180                  | 280   | 43  | 29             | 15 | 244            | 0,6                    | 0,3                    | 89,7                   | 236                      | 80                    | 560                      | 190                        | 380                     | 7,7  | 400                              | NRT 180 B        |
| 200                  | 300   | 45  | 30             | 15 | 274            | 0,6                    | 0,3                    | 93,5                   | 270                      | 85                    | 630                      | 170                        | 340                     | 9,7  | 500                              | NRT 200 B        |
| 260                  | 385   | 55  | 36,5           | 18 | 345            | 0,6                    | 0,6                    | 108                    | 355                      | 95                    | 780                      | 130                        | 260                     | 18,5 | 630                              | NRT 260 B        |
| 325                  | 450   | 60  | 40             | 20 | 415            | 0,6                    | 0,6                    | 134                    | 450                      | 153                   | 1 660                    | 110                        | 220                     | 25   | 700                              | NRT 325 B        |
| 395                  | 525   | 65  | 42,5           | 20 | 486            | 1                      | 1                      | 147                    | 530                      | 166                   | 1 960                    | 90                         | 180                     | 33   | 800                              | NRT 395 B        |
| 460                  | 600   | 70  | 46             | 22 | 560            | 1                      | 1                      | 201                    | 765                      | 180                   | 2 240                    | 80                         | 160                     | 45   | 1 000                            | NRT 460 A        |
| 580                  | 750   | 90  | 60             | 30 | 700            | 1                      | 1                      | 229                    | 965                      | 285                   | 3 550                    | 60                         | 120                     | 89   | 1 250                            | NRT 580 A        |
| 650                  | 870   | 122 | 78             | 34 | 800            | 1                      | 1                      | 413                    | 1 600                    | 365                   | 5 000                    | 55                         | 110                     | 170  | 1 450                            | NRT 650 A        |
| 850                  | 1 095 | 124 | 80,5           | 37 | 1 018          | 1,5                    | 1,5                    | 473                    | 2 120                    | 415                   | 6 400                    | 40                         | 80                      | 253  | 1 800                            | NRT 850 A        |

<sup>1)</sup> Different shaft diameters can be supplied on request. Contact your local SKF representative.





| Attachment holes<br>Inner ring |      |                  |     |                            | Outer ring     |                |                            | Removal<br>thread<br>G | Removal<br>thread<br>nr. | Pitch<br>nr. x $\alpha$ [°] | Retaining bolts <sup>1)</sup><br>Size nr. |   |
|--------------------------------|------|------------------|-----|----------------------------|----------------|----------------|----------------------------|------------------------|--------------------------|-----------------------------|-------------------------------------------|---|
| J                              | N    | N <sub>1</sub>   | a   | Attachment<br>holes<br>nr. | J <sub>1</sub> | N <sub>2</sub> | Attachment<br>holes<br>nr. |                        |                          |                             |                                           |   |
| mm                             |      |                  |     | –                          | mm             |                | –                          |                        |                          | –                           |                                           | – |
| 92                             | 5,6  | 10 <sup>2)</sup> | 4   | 12                         | 138            | 4,6            | 12                         | M5                     | 3                        | 12x30                       | M5                                        | 3 |
| 112                            | 5,6  | 10               | 5,4 | 16                         | 170            | 5,6            | 15                         | M5                     | 3                        | 18x20                       | M5                                        | 2 |
| 135                            | 7    | 11               | 6,2 | 22                         | 195            | 7              | 21                         | M8                     | 3                        | 24x15                       | M6                                        | 2 |
| 165                            | 7    | 11               | 6,2 | 34                         | 225            | 7              | 33                         | M8                     | 3                        | 36x10                       | M6                                        | 2 |
| 194                            | 7    | 11               | 6,2 | 46                         | 260            | 7              | 45                         | M8                     | 3                        | 48x7,5                      | M6                                        | 2 |
| 215                            | 7    | 11               | 6,2 | 46                         | 285            | 7              | 45                         | M8                     | 3                        | 48x7,5                      | M6                                        | 2 |
| 280                            | 9,3  | 15               | 8,2 | 34                         | 365            | 9,3            | 33                         | M12                    | 3                        | 36x10                       | M8                                        | 2 |
| 342                            | 9,3  | 15 <sup>2)</sup> | 8,2 | 34                         | 430            | 9,3            | 33                         | M12                    | 3                        | 36x10                       | M8                                        | 2 |
| 415                            | 9,3  | 15               | 8,2 | 46                         | 505            | 9,3            | 45                         | M12                    | 3                        | 48x7,5                      | M8                                        | 2 |
| 482                            | 9,3  | 15               | 8,2 | 46                         | 580            | 9,3            | 45                         | M12                    | 3                        | 48x7,5                      | M8                                        | 2 |
| 610                            | 11,4 | 18               | 11  | 46                         | 720            | 11,4           | 42                         | M12                    | 6                        | 48x7,5                      | M10                                       | 2 |
| 680                            | 14   | 20               | 13  | 46                         | 830            | 14             | 42                         | M12                    | 6                        | 48x7,5                      | M12                                       | 2 |
| 890                            | 18   | 26               | 17  | 58                         | 1055           | 18             | 54                         | M16                    | 6                        | 60x6                        | M16                                       | 2 |

<sup>1)</sup> Retaining bolts are screwed into the loose flange.

<sup>2)</sup> Milled slots open towards bearing bore.

Super-precision bearing

SKF



# Angular contact thrust ball bearings for screw drives

|                                                                 |            |                                                                                              |            |
|-----------------------------------------------------------------|------------|----------------------------------------------------------------------------------------------|------------|
| <b>Designs and variants</b> . . . . .                           | <b>338</b> | <b>Axial load carrying capacity</b> . . . . .                                                | <b>362</b> |
| Single direction angular contact thrust ball bearings . . . . . | 340        | <b>Mounting</b> . . . . .                                                                    | <b>362</b> |
| Double direction angular contact thrust ball bearings . . . . . | 341        | <b>Attainable speeds</b> . . . . .                                                           | <b>363</b> |
| Cartridge units with a flanged housing . . . . .                | 342        | <b>Designation system</b> . . . . .                                                          | <b>364</b> |
| Customized solutions . . . . .                                  | 342        | <b>Product tables</b>                                                                        |            |
| Cages . . . . .                                                 | 344        | <b>6.1</b> Single direction angular contact thrust ball bearings . . . . .                   | 366        |
| Sealing solutions . . . . .                                     | 344        | <b>6.2</b> Double direction angular contact thrust ball bearings . . . . .                   | 368        |
| <b>Bearing arrangement design</b> . . . . .                     | <b>346</b> | <b>6.3</b> Double direction angular contact thrust ball bearings for bolt mounting . . . . . | 370        |
| Bearing arrangements . . . . .                                  | 346        | <b>6.4</b> Cartridge units with a flanged housing . . . . .                                  | 372        |
| Bearings for the non-locating position . . . . .                | 347        |                                                                                              |            |
| Associated components . . . . .                                 | 349        |                                                                                              |            |
| Application examples . . . . .                                  | 350        |                                                                                              |            |
| <b>Markings on bearings</b> . . . . .                           | <b>352</b> |                                                                                              |            |
| <b>Bearing data</b> . . . . .                                   | <b>353</b> |                                                                                              |            |
| (Boundary dimensions, tolerances)                               |            |                                                                                              |            |
| <b>Bearing preload</b> . . . . .                                | <b>355</b> |                                                                                              |            |
| <b>Axial stiffness</b> . . . . .                                | <b>358</b> |                                                                                              |            |
| <b>Frictional moment</b> . . . . .                              | <b>360</b> |                                                                                              |            |
| <b>Lifting force</b> . . . . .                                  | <b>360</b> |                                                                                              |            |
| <b>Load carrying capacity of bearing sets</b> . . . . .         | <b>361</b> |                                                                                              |            |
| <b>Equivalent bearing loads</b> . . . . .                       | <b>361</b> |                                                                                              |            |
| Equivalent dynamic bearing load . . . . .                       | 361        |                                                                                              |            |
| Equivalent static bearing load . . . . .                        | 362        |                                                                                              |            |

**More information**

Bearing life and load ratings . . . . . 337

Requisite minimum load . . . . . 337

Chamfer dimension limits . . . . . 337

Materials . . . . . 337

Design considerations . . . . . 337

Lubrication . . . . . 337

Mounting and dismounting . . . . . 337

Bearing storage . . . . . 337

Precision lock nuts . . . . . 337

Machine tools require screw drives that can position a work piece or machine component quickly, efficiently, and precisely. To meet these requirements, screw drives can be supported at both ends by SKF super-precision angular contact thrust ball bearings. The bearings provide a high degree of axial stiffness, high axial load carrying capacity, accommodate high speeds and rapid accelerations, and offer very high running accuracy.

Angular contact thrust ball bearings for screw drives are well suited for screw drive applications, but are also beneficial in other applications, where safe radial and axial support is required, together with extremely precise axial guidance of the shaft.

## Designs and variants

The SKF assortment of super-precision angular contact thrust ball bearings for screw drives can accommodate virtually any requirement placed on support bearings for screw drives. SKF supplies three types of support bearings:

- single direction bearings
- double direction bearings
- cartridge units with a flanged housing

The main criteria used when selecting bearings to support screw drives are axial stiffness and load carrying capacity, running accuracy, speed, and frictional moment. Other factors to consider can be the moment stiffness of a bearing arrangement or the ability to cope with misalignment between the shaft and housing. Mounting and seal requirements also need to be considered. **Table 1** provides an overview of the criteria and to what extent the different bearing series fulfil the requirements.

Table 1

Selection criteria for angular contact thrust ball bearings for screw drives

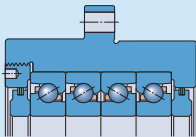
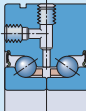
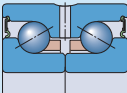
Bearing type

Single direction bearings

Double direction bearings

Double direction bearings for bolt mounting

Cartridge units



Bearing series

BSA, BSD

BEAS

BEAM

FBSA

Selection criteria

Axial stiffness

++

+

+

++

Axial load carrying capacity

++

++

++

++

Running accuracy

++

++

++

++

Speed capability

++

+

+

+

Frictional moment

++

+

+

++

Flexibility in arrangement

+

o

o

++

Easy mounting

o

+

++

++

Seals

non-contact seals (optional)

contact or non-contact seals

contact or non-contact seals

laminar rings

Symbols: ++ very good + good o suitable

### Single direction angular contact thrust ball bearings

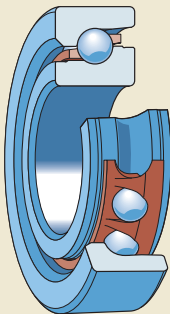
SKF supplies single direction angular contact thrust ball bearings (→ **fig. 1**) in the BSA and BSD series for shaft diameters from 12 to 75 mm. The bearings are non-separable and have a  $62^\circ$  contact angle. The transition radius between the raceway and shoulder on both rings is ground. This reduces edge stresses by approximately 30%, enabling these bearings to accommodate heavy axial loads and incidental overloading better than conventional designs.

Single direction bearings are designed to accommodate axial loads in one direction only and are therefore adjusted against a second bearing or mounted as sets. The bearings are universally matchable, as standard, and can be mounted in sets of up to four bearings for a variety of bearing arrangements, reaching the performance level of matched sets. A unique heat treatment helps to maintain a constant bearing preload over the entire service life of the bearings.

#### Matched bearing sets

Single direction bearings can be supplied as matched sets on request. However, because the standard bearings are universally matchable, SKF recommends reducing inventory by ordering single bearings only and arranging them in sets as required.

Fig. 1



## Double direction angular contact thrust ball bearings

Double direction angular contact thrust ball bearings were developed for applications where space is limited and easy mounting is required. SKF double direction bearings are greased and sealed as standard. These ready-to-mount bearings are available in two series:

- double direction bearings in the BEAS series (→ **fig. 2**), for shaft diameters from 8 to 30 mm
- double direction bearings for bolt mounting in the BEAM series (→ **fig. 3**), for shaft diameters from 12 to 60 mm

### BEAS series

Bearings in the BEAS series correspond in design to two single direction bearings arranged back-to-back. They are non-separable and have a one-piece outer ring, a two-piece inner ring, and a 60° contact angle. The bearings accommodate radial loads, and axial loads in both directions. Preload (which is preset at the factory) is applied by clamping the inner ring halves on the screw drive shaft with, for example, a precision lock nut (→ *Precision lock nuts*, **page 341**).

BEAS bearings have an annular groove and lubrication holes in the outer ring as standard to relubricate the bearing easily and reliably when necessary.

### BEAM series

Bearings in the BEAM series correspond in design to BEAS series bearings except that the outer ring is much thicker and equipped with through holes for attachment bolts. By bolting directly onto an associated component, the design and mounting process is simplified. To enable relubrication, if required, one side face and the bearing outside surface have M6 threaded holes for grease fittings. The holes are plugged on delivery with grub (set) screws. The side face with the threaded hole should be mounted opposite the machine wall. Bearings manufactured to larger tolerances (designation suffix PE) do not have a threaded hole on the outside surface of the bearing and can only be relubricated via the threaded hole in the side face.

BEAM bearings have an annular groove on their outside surface that can be used to dismount the bearing from its seat on the screw drive shaft.

Fig. 2

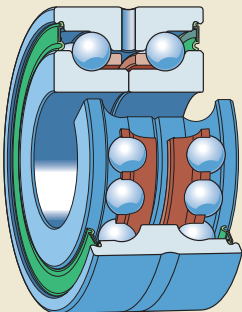
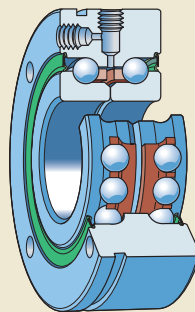


Fig. 3



### Cartridge units with a flanged housing

Cartridge units in the FBSA series (→ **fig. 4**) have a flanged housing to enable quick and easy mounting. These ready-to-mount units are available for shaft diameters ranging from 20 to 60 mm and incorporate SKF single direction angular contact thrust ball bearings (→ **page 342**). Except for the ground surfaces, the units are surface-treated with a black-oxide finish.

The units are available with different bearing arrangements (→ **fig. 5**):

- two bearings arranged back-to-back, designation suffix DB
- two bearings arranged face-to-face, designation suffix DF
- two bearing pairs arranged tandem back-to-back, designation suffix QBC
- two bearing pairs arranged tandem face-to-face, designation suffix QFC

Units with two bearing pairs are also available with the flange at the end of the cartridge (designation suffix A). Other bearing arrangements are available on request.

Cartridge units should be bolted to the machine wall and located on the screw drive shaft with an SKF precision lock nut (→ **page 342**).

### Customized solutions

The SKF assortment of support bearings covers a wide variety of application conditions. SKF can also provide customized solutions for specific applications. Advanced modelling and virtual testing services enable SKF engineers to assist in all stages of product development. For additional information, contact the SKF application engineering service.

### Greased bearings

Open, single direction bearings can be supplied greased on request, with the standard grease used for sealed bearings (designation suffix GMM, → *Sealing solutions*, **page 342**).

Customer-specific greases or fill quantities can also be applied to meet the requirements of a specific application.



Fig. 4

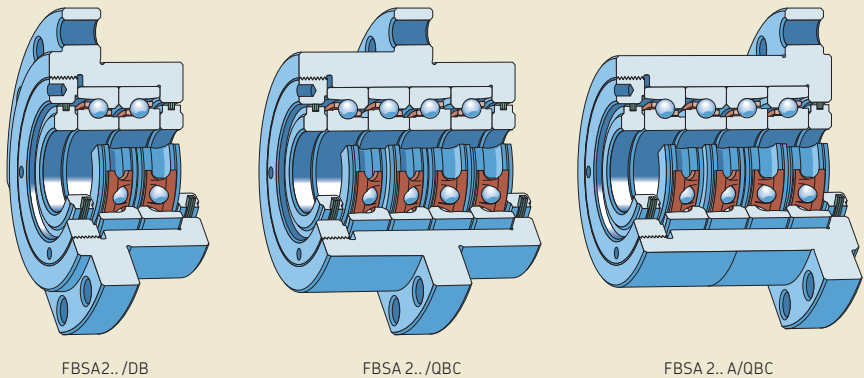
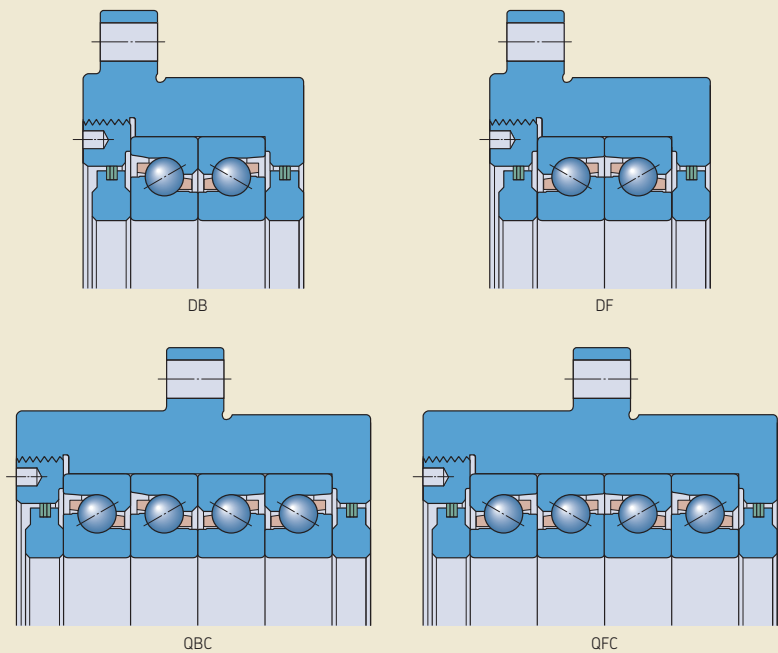


Fig. 5



### Cages

Depending on their series, angular contact thrust ball bearings for screw drives are fitted as standard with one of the following cages:

- a glass fibre reinforced PA66 cage, window-type, ball centred, no designation suffix
- a glass fibre reinforced PA66 cage, snap-type, ball centred, no designation suffix

These robust cages are extremely light to minimize centrifugal forces and accommodate rapid accelerations and decelerations.

For additional information about the materials, refer to *Cage materials* (→ **page 344**).

### Sealing solutions

Single direction angular contact thrust ball bearings can be supplied with an integral non-contact seal fitted on each side (designation suffix 2RZ, → **fig. 6**). The seals form an extremely narrow gap with the inner ring shoulder and therefore speed capability is not compromised.

Double direction angular contact thrust ball bearings are sealed as standard (→ **fig. 7**). They can be supplied with a contact seal (designation suffix 2RS) or a non-contact seal (designation suffix 2RZ) fitted on each side. Non-contact seals form an extremely narrow gap with the inner ring shoulder and therefore speed capability is not compromised.

The various seals are made of an oil- and wear-resistant NBR and are reinforced with sheet steel. The permissible operating temperature for seals made of NBR is  $-40$  to  $+100$  °C ( $-40$  to  $+210$  °F). Temperatures up to  $120$  °C ( $250$  °F) can be tolerated for brief periods. For additional information about the materials, refer to *Seal materials* (→ **page 344**).

Cartridge units are protected on both sides with laminar rings (→ **fig. 8**) to prevent both the ingress of contaminants and the egress of grease. These seals do not limit the attainable speed for the single direction angular contact thrust ball bearings within the unit.

Sealed bearings are filled as standard with a high-quality, low-viscosity grease that has a lithium soap thickener and either a mixed ester/PAO base oil (for single direction bearings and cartridge units) or an ester base oil (for double direction bearings). The quantity of grease fills ~ 25 to 35% of the free space in the bearing. The temperature range for the greases are:

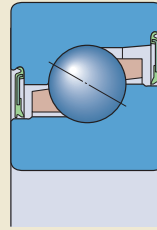
- $-40$  to  $+120$  °C ( $-40$  to  $+250$  °F) for single direction bearings
- $-55$  to  $+110$  °C ( $-65$  to  $+230$  °F) for double direction bearings

Under normal operating conditions, the service life of the initial fill will outlast the bearing. If double direction bearings have to accommodate heavy loads and run for long periods at high speeds, relubrication may be necessary. When relubricating, the grease should be applied slowly while the bearing is rotating at normal operating temperature. Excessive

pressure should be avoided as this could damage the seals.

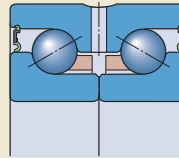
Sealed bearings should not be washed or heated to temperatures above 80 °C (175 °F). If a sealed bearing is to be heated for mounting, an induction heater must be used and the bearing should be fitted immediately.

Fig. 6

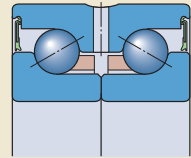


2RZ

Fig. 7

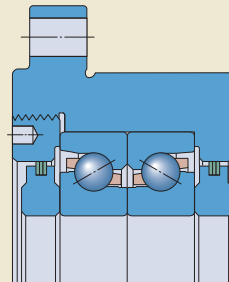


2RS



2RZ

Fig. 8



## Bearing arrangement design

Single direction angular contact thrust ball bearings for screw drives enable flexible bearing arrangement designs. As standard, they are universally matchable for mounting as sets with up to four bearings per set.

Universally matchable bearings are specifically manufactured so that when mounted in random order, but immediately adjacent to each other, preload within a predetermined range and effective load sharing will result without the use of shims or similar devices. They have very tight tolerances for the bore and outside diameter as well as for radial run-out.

## Bearing arrangements

### Back-to-back arrangement

In a back-to-back arrangement (→ **fig. 9**), the load lines diverge along the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in each direction.

Bearings mounted back-to-back provide a relatively rigid bearing arrangement. The wide span between bearing effective centres makes this arrangement particularly well suited to support moment loads.

### Face-to-face arrangement

In a face-to-face arrangement (→ **fig. 10**), the load lines converge along the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in each direction.

The shorter span between effective bearing centres makes face-to-face arrangements less suitable to support moment loads compared to bearings in a back-to-back arrangement.

### Tandem arrangement

The use of a tandem arrangement provides increased axial and radial load carrying capacity compared to a single bearing. In a tandem arrangement (→ **fig. 11**), the load lines are parallel so that radial and axial loads are shared.

The bearing set can only accommodate axial loads acting in one direction. If axial loads act in both directions, or if combined loads are present, additional bearing(s) adjusted against the tandem arrangement must be added.

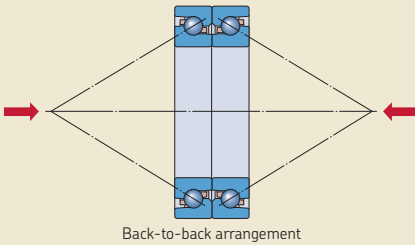
### Examples

Universally matchable single direction bearings can be arranged in various ways depending on the stiffness and load requirements of the application. The possible arrangements are shown in **fig. 12** (→ **page 346**), including the applicable designation suffixes for matched sets.

If misalignment cannot be avoided between the bearing positions, face-to-face bearing arrangements are recommended. They are less sensitive to misalignment than back-to-back bearing arrangements.

Combinations of tandem arrangements with back-to-back or face-to-face arrangements

Fig. 9



are usually selected to maximize the stiffness or load carrying capacity of a bearing set in a particular direction. This is the case, for example, when extended, preloaded, vertical or overhung screw drives must be supported.

### Bearings for the non-locating position

If temperature differences between the screw drive and machine bed require a non-locating bearing in one position, needle roller bearings are suitable, among others. In this case, only the weight of the screw drive loads the bearing. Additional information about needle roller bearings is available at [skf.com](http://skf.com).

Fig. 10

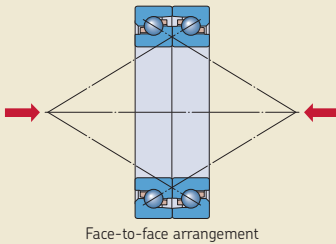


Fig. 11

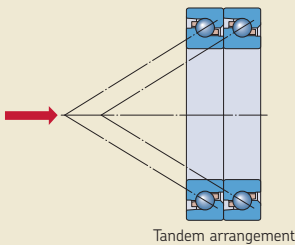
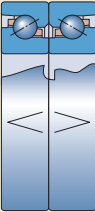
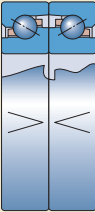


Fig. 12

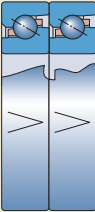
**Bearing sets with 2 bearings**



Back-to-back arrangement  
Designation suffix DB

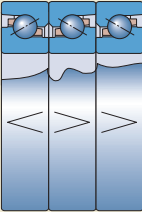


Face-to-face arrangement  
Designation suffix DF

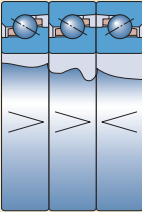


Tandem arrangement  
Designation suffix DT

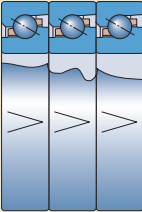
**Bearing sets with 3 bearings**



Back-to-back and tandem  
arrangement  
Designation suffix TBT

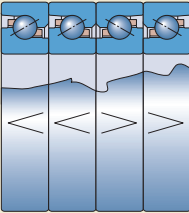


Face-to-face and tandem  
arrangement  
Designation suffix TFT

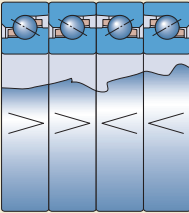


Tandem arrangement  
Designation suffix TT

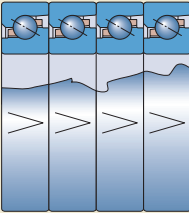
**Bearing sets with 4 bearings**



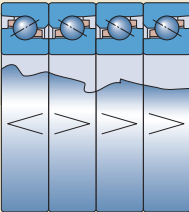
Tandem back-to-back  
arrangement  
Designation suffix QBC



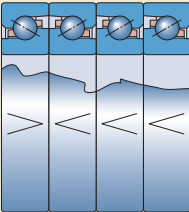
Tandem face-to-face  
arrangement  
Designation suffix QFC



Tandem arrangement  
Designation suffix QT



Back-to-back and tandem  
arrangement  
Designation suffix QBT



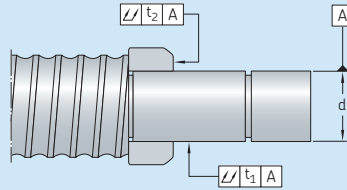
Face-to-face and tandem  
arrangement  
Designation suffix QFT

## Associated components

Associated components should be produced very precisely so that super-precision angular contact thrust ball bearings can meet the demands for high running accuracy. All dimensional and form deviations must be kept as small as possible. The bearing seats on the shaft and in the housing should follow the recommended tolerances listed in **tables 2 to 4**.

Table 2

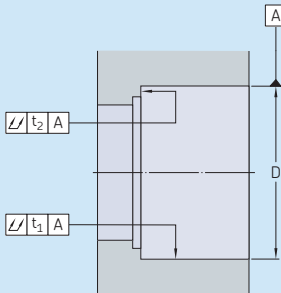
## Geometrical accuracy of bearing shaft seats



| Shaft diameter |       | Tolerance                                                                                 |     | Total radial run-out | Total axial run-out |
|----------------|-------|-------------------------------------------------------------------------------------------|-----|----------------------|---------------------|
| d over         | incl. | h4  high | low | t1 max.              | t2 max.             |
| mm             |       | µm                                                                                        |     | µm                   | µm                  |
| 10             | 18    | 0                                                                                         | -5  | 2                    | 2                   |
| 18             | 30    | 0                                                                                         | -6  | 2,5                  | 2,5                 |
| 30             | 50    | 0                                                                                         | -7  | 2,5                  | 2,5                 |
| 50             | 80    | 0                                                                                         | -8  | 3                    | 3                   |

Table 3

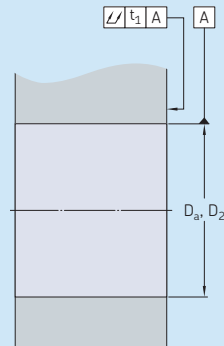
## Geometrical accuracy of bearing housing seats



| Housing diameter |       | Tolerance |     | Total radial run-out<br>t <sub>1</sub> max. | Total axial run-out<br>t <sub>2</sub> max. |
|------------------|-------|-----------|-----|---------------------------------------------|--------------------------------------------|
| D over           | incl. | H5 high   | low |                                             |                                            |
| mm               |       | µm        |     | µm                                          | µm                                         |
| –                | 50    | 11        | 0   | 2,5                                         | 4                                          |
| 50               | 80    | 13        | 0   | 3                                           | 5                                          |
| 80               | 120   | 15        | 0   | 4                                           | 6                                          |
| 120              | 150   | 18        | 0   | 5                                           | 8                                          |

Table 4

### Geometrical accuracy of the housing bore and side faces for bearings for bolt mounting and cartridge units



| Housing bore diameter                   |       | Tolerance                                                                                      |     | Total axial run-out    |
|-----------------------------------------|-------|------------------------------------------------------------------------------------------------|-----|------------------------|
| D <sub>a</sub> , D <sub>2</sub><br>over | incl. | H6 <br>high | low | t <sub>1</sub><br>max. |
| mm                                      |       | µm                                                                                             |     | µm                     |
| 50                                      | 80    | 19                                                                                             | 0   | 5                      |
| 80                                      | 120   | 22                                                                                             | 0   | 6                      |
| 120                                     | 150   | 25                                                                                             | 0   | 8                      |

### Application examples

Screw drives are typically supported at both ends with bearing sets in a back-to-back or face-to-face arrangement (→ **fig. 13**). With universally matchable single direction bearings, it is possible to adjust the arrangement to the requirements of a particular application. Sealed bearings (→ **fig. 14**) offer additional benefits. There are fewer components to install, the bearing is protected against contaminants, and no lubricant is required during mounting.

For short screw drives, an overhung support at one end is common (→ **fig. 15**). Back-to-back arrangements are best suited for overhung supports.

Double direction bearings (→ **fig. 16**) can further reduce the number of components. Bearings that are bolt mounted (→ **fig. 17**) do not require a housing and can be mounted easily.

For stretched screw drives, particularly stiff bearing arrangements can be designed if tandem arrangements, adjusted against each other, are used at both ends. Cartridge units with a flanged housing are particularly well suited for these screw drive designs (→ **fig. 18**).

Fig. 14

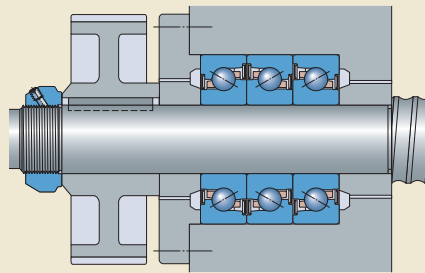


Fig. 13

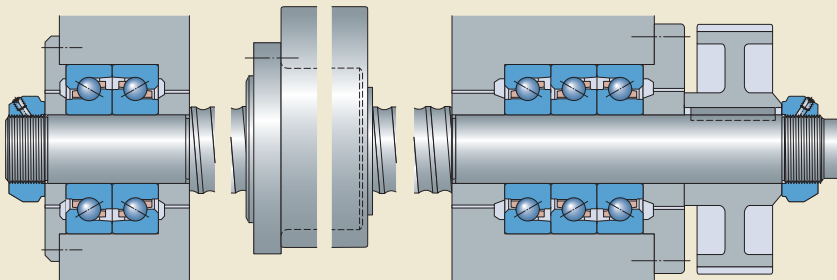




Fig. 15

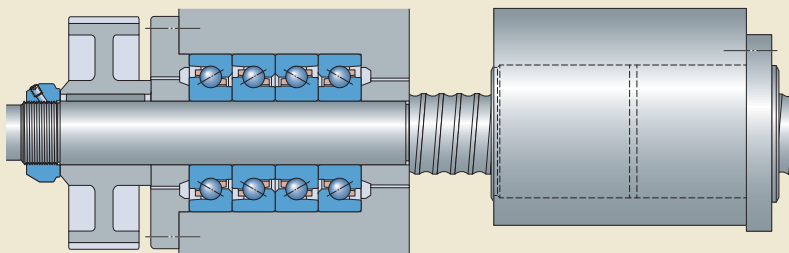


Fig. 16

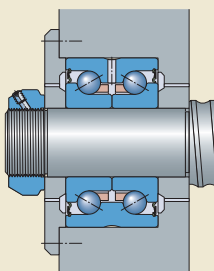


Fig. 17

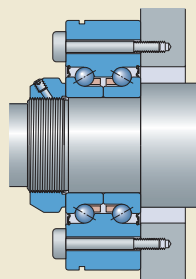
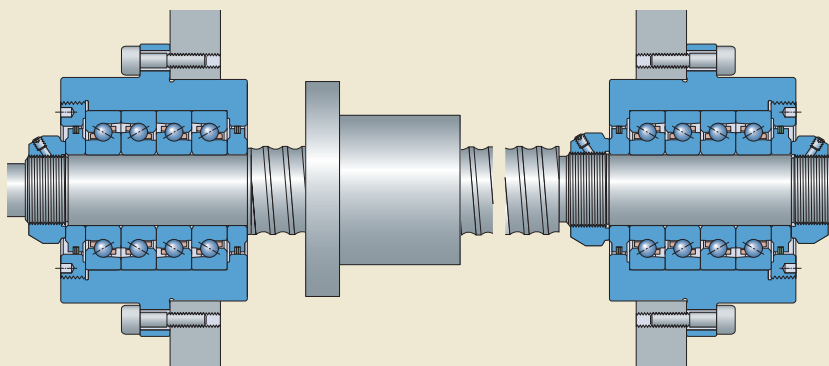


Fig. 18



## Markings on bearings

Each super-precision angular contact thrust ball bearing and cartridge unit has various markings on the outside surfaces (→ **fig. 19**):

- 1 SKF trademark
- 2 Complete designation of the bearing/unit
- 3 Country of manufacture
- 4 Date of manufacture, coded
- 5 "MATCHABLE" label (single direction bearings only)

### "V-shaped" marking

A "V-shaped" marking on the outside surface of the outer rings of universally matchable single direction bearings indicates how the bearing set should be mounted in relation to the axial load. The "V-shaped" marking points toward the side face of the inner ring that can support axial load. For sets of bearings, the large inner ring side face of the outer bearing should support axial load and should be mounted so that the "V-shaped" marking points in the direction opposite the axial load (→ **fig. 20**). In applications where there are axial loads in both directions supported by face-to-face or back-to-back arrangements, the inner ring side face of the outer bearing, to which the majority of the "V-shaped" markings point to, should support the heavier of the axial loads.

Fig. 20

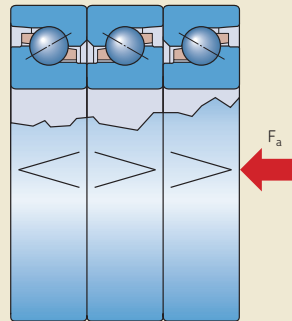
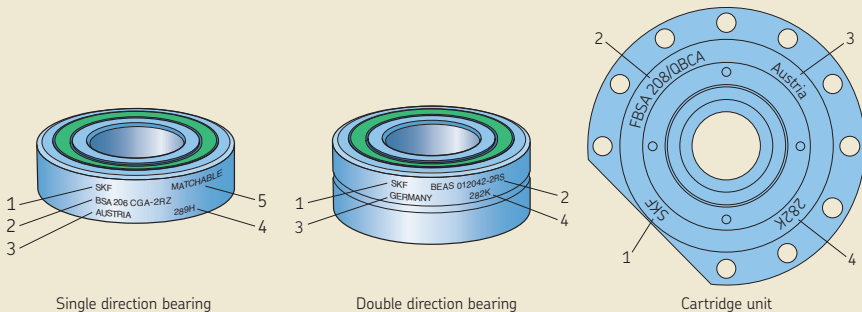


Fig. 19



## Bearing data

|                                                                  | Single direction bearings                                                                                                                                                                                                                                                                   | Double direction bearings                                                                                        | Cartridge units             |
|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>Boundary dimensions</b>                                       | ISO 15, only for BSA 2 and BSA 3 series that are in accordance with 02 and 03 ISO dimension series respectively<br>BSD series bearings partly follow ISO dimension series                                                                                                                   | Not standardized                                                                                                 | Not standardized            |
| <b>Tolerances</b><br><br>For additional information (→ page 353) | P4 dimensional accuracy<br>P2 running accuracy<br>Values: ISO 492 (→ table 5, page 353)<br>The values apply to individual bearings. For matched bearing sets, the axial run-out is usually within 2,5 µm if the bearing seats are machined precisely and the bearings are mounted properly. | P4 running accuracy<br>Values: ISO 492 (→ table 5, page 353)<br>Dimensional accuracy values: → table 5, page 353 | Values: → table 6, page 353 |

Table 5

Tolerances of single and double direction bearings

Inner ring and bearing height

| d<br>over | incl. | Single direction bearings |                       |                       |      | $S_{ia}$<br>max. | Double direction bearings |                       |                       |      | $S_{ia}$<br>max. |
|-----------|-------|---------------------------|-----------------------|-----------------------|------|------------------|---------------------------|-----------------------|-----------------------|------|------------------|
|           |       | $\Delta_{ds}$<br>high     | $\Delta_{dmp}$<br>low | $\Delta_{Ts}$<br>high | low  |                  | $\Delta_{ds}$<br>high     | $\Delta_{dmp}$<br>low | $\Delta_{Bs}$<br>high | low  |                  |
| mm        |       | $\mu m$                   |                       | $\mu m$               |      | $\mu m$          | $\mu m$                   |                       | $\mu m$               |      | $\mu m$          |
| 10        | 18    | 0                         | -4                    | 0                     | -80  | 1,5              | 0                         | -5                    | 0                     | -250 | 2                |
| 18        | 25    | 0                         | -4                    | 0                     | -120 | 2,5              | 0                         | -5                    | 0                     | -250 | 2                |
| 25        | 30    | 0                         | -4                    | 0                     | -120 | 2,5              | 0                         | -5                    | 0                     | -250 | 2,5              |
| 30        | 50    | 0                         | -5                    | 0                     | -120 | 2,5              | 0                         | -5                    | 0                     | -250 | 2,5              |
| 50        | 60    | 0                         | -5                    | 0                     | -120 | 2,5              | 0                         | -8                    | 0                     | -250 | 2,5              |
| 60        | 80    | 0                         | -5                    | 0                     | -120 | 2,5              | 0                         | -8                    | 0                     | -250 | 3                |

Outer ring

| D<br>over | incl. | Single direction bearings |                       |         | $S_{ea}$<br>max. | Double direction bearings |                       |                       |      | $S_{ea}$<br>max. |
|-----------|-------|---------------------------|-----------------------|---------|------------------|---------------------------|-----------------------|-----------------------|------|------------------|
|           |       | $\Delta_{Ds}$<br>high     | $\Delta_{Dmp}$<br>low |         |                  | $\Delta_{Ds}$<br>high     | $\Delta_{Dmp}$<br>low | $\Delta_{Cs}$<br>high | low  |                  |
| mm        |       | $\mu m$                   |                       | $\mu m$ |                  | $\mu m$                   |                       | $\mu m$               |      | $\mu m$          |
| 30        | 50    | 0                         | -5                    | 2,5     |                  | 0                         | -10                   | 0                     | -250 | 8                |
| 50        | 80    | 0                         | -6                    | 4       |                  | 0                         | -10                   | 0                     | -250 | 10               |
| 80        | 110   | 0                         | -6                    | 5       |                  | 0                         | -10                   | 0                     | -250 | 11               |
| 110       | 120   | 0                         | -6                    | 5       |                  | 0                         | -15                   | 0                     | -250 | 11               |
| 120       | 150   | 0                         | -7                    | 5       |                  | 0                         | -15                   | 0                     | -250 | 13               |

Tolerance symbols and definitions → table 4, page 354

Table 6

Tolerances of cartridge units

| d<br>over | incl. | $\Delta_{ds}$<br>high |    | $\Delta_{dp2}$<br>high |     | $\Delta_{Ts}$<br>high |      | $S_{ia}^{1)}$<br>max. |
|-----------|-------|-----------------------|----|------------------------|-----|-----------------------|------|-----------------------|
|           |       | $\Delta_{dmp}$<br>low |    | low                    |     | low                   |      |                       |
| mm        |       | $\mu m$               |    | $\mu m$                |     | mm                    |      | $\mu m$               |
| 18        | 30    | 0                     | -4 | 0                      | -13 | 0                     | -1,5 | 2,5                   |
| 30        | 50    | 0                     | -5 | 0                      | -15 | 0                     | -1,5 | 2,5                   |
| 50        | 60    | 0                     | -5 | 0                      | -18 | 0                     | -1,5 | 2,5                   |

Tolerance symbols and definitions → table 4, page 354

<sup>1)</sup> Axial run-out of a single bearing. The tolerance for the rectangularity of the flange to the housing seat diameter  $D_2$  is 5 to 10  $\mu m$  depending on the size.

# Bearing preload

## Single direction bearings

An individual single direction angular contact thrust ball bearing cannot be preloaded until a second bearing provides location in the opposite direction.

SKF single direction bearings are universally matchable as standard and are manufactured pre-set to two different preload classes:

- class A, light preload
- class B, moderate preload

The amount of preload depends on various factors and applies to bearing sets in back-to-back or face-to-face arrangements. Preload values are not standardized and are listed in **table 7 (→ page 355)**. The values do not cover influences from fits or operating conditions.

Bearing sets with a non-standard preload can be supplied on request. These bearing sets are identified by the designation suffix G followed by a number. The number is the mean preload value of the set expressed in daN.

Bearing sets consisting of three or four bearings have a heavier preload than sets with two bearings. The preload for these bearing sets is obtained by multiplying the values listed in **table 7** by a factor listed in **table 8 (→ page 355)**.

## Double direction bearings

Preload values for double direction angular contact thrust ball bearings are not standardized and are listed in **table 9 (→ page 355)**. The values do not cover influences from fits or operating conditions.

Bearings with a different preload can be supplied on request.

## Cartridge units

Cartridge units contain single direction bearings with class A or B preload values as standard (**→ table 7, page 355**). Units containing bearings with a non-standard preload can be supplied on request. Bearing sets with a non-standard preload are identified by the designation suffix G followed by a number. The number is the mean preload value of the set expressed in daN.

Table 7

Axial preload, axial stiffness, frictional moment and maximum axial load of single direction bearings

| Designation | Axial preload<br>for preload class |        | Axial stiffness<br>for preload class |       | Frictional moment<br>for preload class |       | Maximum<br>axial load |
|-------------|------------------------------------|--------|--------------------------------------|-------|----------------------------------------|-------|-----------------------|
|             | A                                  | B      | A                                    | B     | A                                      | B     |                       |
| —           | N                                  |        | N/μm                                 |       | Nm                                     |       | kN                    |
| BSA 201     | 650                                | 1 300  | 400                                  | 510   | 0,016                                  | 0,028 | 6,25                  |
| BSA 202     | 770                                | 1 540  | 460                                  | 580   | 0,022                                  | 0,038 | 8,5                   |
| BSA 203     | 1 040                              | 2 080  | 550                                  | 700   | 0,04                                   | 0,072 | 10,3                  |
| BSA 204     | 1 480                              | 2 960  | 680                                  | 860   | 0,05                                   | 0,091 | 14,5                  |
| BSA 205     | 1 580                              | 3 160  | 725                                  | 925   | 0,069                                  | 0,12  | 18                    |
| BSA 206     | 2 150                              | 4 300  | 870                                  | 1 110 | 0,12                                   | 0,21  | 22,6                  |
| BSA 207     | 2 950                              | 5 900  | 1 080                                | 1 370 | 0,18                                   | 0,32  | 29,6                  |
| BSA 208     | 3 400                              | 6 800  | 1 130                                | 1 440 | 0,212                                  | 0,46  | 37,9                  |
| BSA 209     | 3 750                              | 7 500  | 1 290                                | 1 640 | 0,23                                   | 0,52  | 40,2                  |
| BSA 210     | 4 100                              | 8 200  | 1 410                                | 1 800 | 0,31                                   | 0,68  | 42,5                  |
| BSA 212     | 6 050                              | 12 100 | 1 640                                | 2 080 | 0,54                                   | 1,05  | 65                    |
| BSA 215     | 6 850                              | 13 700 | 1 870                                | 2 380 | 0,65                                   | 1,4   | 76                    |
| BSA 305     | 2 150                              | 4 300  | 870                                  | 1 110 | 0,12                                   | 0,2   | 22,6                  |
| BSA 306     | 3 000                              | 6 000  | 1 010                                | 1 280 | 0,175                                  | 0,32  | 46                    |
| BSA 307     | 4 100                              | 8 200  | 1 120                                | 1 430 | 0,26                                   | 0,46  | 65                    |
| BSA 308     | 5 100                              | 10 200 | 1 340                                | 1 710 | 0,35                                   | 0,62  | 78,2                  |
| BSD 2047    | 1 480                              | 2 960  | 680                                  | 860   | 0,05                                   | 0,091 | 14,5                  |
| BSD 2562    | 2 150                              | 4 300  | 870                                  | 1 110 | 0,115                                  | 0,21  | 22,6                  |
| BSD 3062    | 2 150                              | 4 300  | 870                                  | 1 110 | 0,125                                  | 0,215 | 22,6                  |
| BSD 3572    | 2 950                              | 5 900  | 1 080                                | 1 370 | 0,18                                   | 0,32  | 29,6                  |
| BSD 4072    | 2 950                              | 5 900  | 1 080                                | 1 370 | 0,18                                   | 0,32  | 29,6                  |
| BSD 4090    | 5 100                              | 10 200 | 1 340                                | 1 710 | 0,35                                   | 0,61  | 78,2                  |
| BSD 4575    | 2 900                              | 5 800  | 1 180                                | 1 500 | 0,25                                   | 0,41  | 40,2                  |
| BSD 45100   | 5 850                              | 11 700 | 1 470                                | 1 870 | 0,5                                    | 0,97  | 107,4                 |
| BSD 50100   | 6 200                              | 12 400 | 1 550                                | 1 970 | 0,52                                   | 0,97  | 107,4                 |
| BSD 55100   | 6 200                              | 12 400 | 1 550                                | 1 970 | 0,52                                   | 0,97  | 107,4                 |
| BSD 55120   | 7 300                              | 14 600 | 1 800                                | 2 300 | 0,72                                   | 1,26  | 130                   |
| BSD 60120   | 7 300                              | 14 600 | 1 800                                | 2 300 | 0,72                                   | 1,26  | 130                   |

Table 8

Factors for calculating the preload and frictional moment of a bearing set

| Number of<br>bearings | Arrangement             | Designation suffix | Factor |
|-----------------------|-------------------------|--------------------|--------|
| 3                     | Back-to-back and tandem | TBT                | 1,35   |
|                       | Face-to-face and tandem | TFT                | 1,35   |
| 4                     | Back-to-back and tandem | QBT                | 1,55   |
|                       | Face-to-face and tandem | QFT                | 1,55   |
|                       | Tandem back-to-back     | QBC                | 2      |
|                       | Tandem face-to-face     | QFC                | 2      |

Table 9

Axial preload, stiffness, and frictional moment of double direction bearings

| Designation | Axial preload | Stiffness<br>Axial | Moment  | Frictional moment <sup>1)</sup> |
|-------------|---------------|--------------------|---------|---------------------------------|
| –           | N             | N/μm               | Nm/mrad | Nm                              |
| BEAS 008032 | 300           | 250                | 20      | 0,08                            |
| BEAS 012042 | 600           | 350                | 80      | 0,16                            |
| BEAS 015045 | 650           | 400                | 65      | 0,2                             |
| BEAS 017047 | 720           | 420                | 80      | 0,24                            |
| BEAS 020052 | 1 650         | 650                | 150     | 0,3                             |
| BEAS 025057 | 1 920         | 770                | 200     | 0,4                             |
| BEAS 030062 | 2 170         | 870                | 300     | 0,5                             |
| BEAM 012055 | 600           | 350                | 80      | 0,16                            |
| BEAM 017062 | 720           | 420                | 80      | 0,24                            |
| BEAM 020068 | 1 650         | 650                | 150     | 0,3                             |
| BEAM 025075 | 1 920         | 770                | 200     | 0,4                             |
| BEAM 030080 | 2 170         | 870                | 300     | 0,5                             |
| BEAM 030100 | 3 900         | 950                | 470     | 0,8                             |
| BEAM 035090 | 2 250         | 900                | 400     | 0,6                             |
| BEAM 040100 | 2 550         | 1 000              | 570     | 0,7                             |
| BEAM 040115 | 4 750         | 1 150              | 720     | 1,3                             |
| BEAM 050115 | 3 100         | 1 250              | 1 000   | 0,69                            |
| BEAM 050140 | 5 720         | 1 350              | 1 500   | 2,6                             |
| BEAM 060145 | 4 700         | 1 400              | 1 750   | 2                               |

<sup>1)</sup> The guideline values apply to bearings with contact seals (designation suffix 2RS). For bearings with non-contact seals (designation suffix 2RZ), the frictional moment is 50% of the values listed above.

## Axial stiffness

### Single direction bearings

The axial stiffness values for single direction bearings are listed in **table 7** (→ **page 358**). They apply to unmounted bearing sets with two bearings arranged back-to-back or face-to-face.

Bearing sets consisting of three or four bearings provide a higher degree of axial stiffness than sets with two bearings. The axial stiffness for these bearing sets is obtained by multiplying the values listed in **table 7** by a factor listed in **table 10**. The lower value factor applies to bearings under light axial load ( $P \leq 0,05 C$ ) and the larger value to bearings under heavy axial load ( $P > 0,1 C$ ). To determine the equivalent dynamic bearing load  $P$ , refer to **page 358**.

Bearing sets with a heavier preload provide an even higher degree of stiffness. However, this should be avoided as heavier preload substantially increases friction and heat generated by the bearing. In cases where an extremely high degree of stiffness is required, the frictional behaviour as a function of increasing preload can be estimated using the simulation tool SKF Spindle Simulator. For additional information, contact the SKF application engineering service.

### Double direction bearings

Values for axial and moment stiffness for double direction angular contact thrust ball bearings are listed in **table 9** (→ **page 358**)

and apply to the preload set at the factory. The values do not cover influences from fits or operating conditions.

### Cartridge units

For cartridge units, axial stiffness is listed in **table 11**. The values correspond to those for the included single direction bearings, multiplied by the factors provided in **table 10**.

Table 10

| Factors for calculating the axial stiffness of a bearing set |                         |                    |              |
|--------------------------------------------------------------|-------------------------|--------------------|--------------|
| Number of bearings                                           | Arrangement             | Designation suffix | Factor       |
| 3                                                            | Back-to-back and tandem | TBT                | 1,45 to 1,65 |
|                                                              | Face-to-face and tandem | TFT                | 1,45 to 1,65 |
| 4                                                            | Back-to-back and tandem | QBT                | 1,8 to 2,25  |
|                                                              | Face-to-face and tandem | QFT                | 1,8 to 2,25  |
|                                                              | Tandem back-to-back     | QBC                | 2            |
|                                                              | Tandem face-to-face     | QFC                | 2            |



Table 11

## Axial stiffness and frictional moment of cartridge units

| Designation    | Axial stiffness<br>for preload class |       | Frictional moment<br>for preload class |       |
|----------------|--------------------------------------|-------|----------------------------------------|-------|
|                | A                                    | B     | A                                      | B     |
| –              | N/μm                                 |       | Nm                                     |       |
| FBSA 204/DB    | 680                                  | 860   | 0,05                                   | 0,091 |
| FBSA 204/DF    | 680                                  | 860   | 0,05                                   | 0,091 |
| FBSA 204/QBC   | 1 360                                | 1 720 | 0,1                                    | 0,182 |
| FBSA 204/QFC   | 1 360                                | 1 720 | 0,1                                    | 0,182 |
| FBSA 205/DB    | 725                                  | 925   | 0,069                                  | 0,12  |
| FBSA 205/DF    | 725                                  | 925   | 0,069                                  | 0,12  |
| FBSA 205/QBC   | 1 450                                | 1 850 | 0,138                                  | 0,24  |
| FBSA 205/QFC   | 1 450                                | 1 850 | 0,138                                  | 0,24  |
| FBSA 206/DB    | 870                                  | 1 110 | 0,12                                   | 0,21  |
| FBSA 206/DF    | 870                                  | 1 110 | 0,12                                   | 0,21  |
| FBSA 206/QBC   | 1 740                                | 2 220 | 0,24                                   | 0,42  |
| FBSA 206/QFC   | 1 740                                | 2 220 | 0,24                                   | 0,42  |
| FBSA 206 A/QBC | 1 740                                | 2 220 | 0,24                                   | 0,42  |
| FBSA 206 A/QFC | 1 740                                | 2 220 | 0,24                                   | 0,42  |
| FBSA 207/DB    | 1 080                                | 1 370 | 0,18                                   | 0,32  |
| FBSA 207/DF    | 1 080                                | 1 370 | 0,18                                   | 0,32  |
| FBSA 207/QBC   | 2 160                                | 2 740 | 0,36                                   | 0,64  |
| FBSA 207/QFC   | 2 160                                | 2 740 | 0,36                                   | 0,64  |
| FBSA 208/DB    | 1 130                                | 1 440 | 0,212                                  | 0,46  |
| FBSA 208/DF    | 1 130                                | 1 440 | 0,212                                  | 0,46  |
| FBSA 208/QBC   | 2 260                                | 2 880 | 0,424                                  | 0,92  |
| FBSA 208/QFC   | 2 260                                | 2 880 | 0,424                                  | 0,92  |
| FBSA 208 A/QBC | 2 260                                | 2 880 | 0,424                                  | 0,92  |
| FBSA 208 A/QFC | 2 260                                | 2 880 | 0,424                                  | 0,92  |
| FBSA 209/DB    | 1 290                                | 1 640 | 0,23                                   | 0,52  |
| FBSA 209/DF    | 1 290                                | 1 640 | 0,23                                   | 0,52  |
| FBSA 209/QBC   | 2 580                                | 3 280 | 0,46                                   | 1,04  |
| FBSA 209/QFC   | 2 580                                | 3 280 | 0,46                                   | 1,04  |
| FBSA 210/DB    | 1 410                                | 1 800 | 0,31                                   | 0,68  |
| FBSA 210/DF    | 1 410                                | 1 800 | 0,31                                   | 0,68  |
| FBSA 210/QBC   | 2 820                                | 3 600 | 0,62                                   | 1,36  |
| FBSA 210/QFC   | 2 820                                | 3 600 | 0,62                                   | 1,36  |
| FBSA 210 A/QBC | 2 820                                | 3 600 | 0,62                                   | 1,36  |
| FBSA 210 A/QFC | 2 820                                | 3 600 | 0,62                                   | 1,36  |
| FBSA 212 A/QBC | 3 280                                | 4 160 | 1,08                                   | 2,1   |
| FBSA 212 A/QFC | 3 280                                | 4 160 | 1,08                                   | 2,1   |

## Frictional moment

All SKF angular contact thrust ball bearings for screw drives are designed for low friction operation. The frictional moment depends on the preload, rotational speed, seals and quantity of lubricant in the bearing set. The starting torque is typically double the frictional moment.

### Single direction bearings

Guideline values for the frictional moment of single direction bearings are listed in **table 7** (→ **page 360**) and apply to unmounted bearing sets with two bearings arranged back-to-back or face-to-face that will operate at low speeds.

Bearing sets consisting of three or four bearings have a higher frictional moment than sets with two bearings. The frictional moment for these bearing sets is obtained by multiplying the values in **table 7** by a factor provided in **table 8** (→ **page 360**).

### Double direction bearings

Guideline values for the frictional moment of double direction bearings are listed in **table 9** (→ **page 360**) and apply to unmounted bearings that will operate at low speeds.

### Cartridge units

Guideline values for the frictional moment of cartridge units are listed in **table 11** (→ **page 360**) and apply to unmounted bearings that will operate at low speeds.

## Lifting force

The external axial load on a preloaded bearing set or double direction bearing causing one ball set to become completely unloaded is called the lifting force (→ *Influence of an external load on preloaded bearing sets*, **page 360**). The lifting force for sets of single direction bearings arranged back-to-back or face-to-face and double direction bearings can be estimated using

$$K_{a1} = 2,83 F_0$$

where

$K_{a1}$  = lifting force

$F_0$  = preload on bearings before external axial load is applied (→ **table 7, page 360** and **table 9, page 360**)

For additional information, contact the SKF application engineering service.

## Load carrying capacity of bearing sets

The dynamic load rating  $C$  and the static load rating  $C_0$ , as well as the fatigue load limit  $P_u$  listed in the product tables for single direction bearings apply to axial loads for individual bearings. For bearing sets, the relevant values can be obtained by applying the factors listed in **table 12** to the ratings listed for single bearings.

## Equivalent bearing loads

### Equivalent dynamic bearing load

If individual single direction bearings, bearing sets, or double direction bearings have to accommodate both axial and radial loads, the equivalent dynamic bearing load for each direction of axial load can be determined as follows:

$$F_a/F_r \leq 2,35 \rightarrow P = X F_r + Y F_a$$

$$F_a/F_r > 2,35 \rightarrow P = 0,97 F_r + F_a$$

For bearings that accommodate axial loads only:

$$P = F_a$$

Table 12

Load ratings, fatigue load limit, and calculation factors for bearing sets with single direction bearings

| Number of bearings | Arrangement             | Designation suffix | Graphic representation | Load direction | Load rating of bearing set |         | Fatigue load limit of bearing set | Calculation factors |      |
|--------------------|-------------------------|--------------------|------------------------|----------------|----------------------------|---------|-----------------------------------|---------------------|------|
|                    |                         |                    |                        |                | dynamic                    | static  |                                   | X                   | Y    |
| 2                  | Back-to-back            | DB                 | <>                     | →              | C                          | $C_0$   | $P_u$                             | 2,04                | 0,54 |
|                    | Face-to-face            | DF                 | ><                     | →              | C                          | $C_0$   | $P_u$                             | 2,04                | 0,54 |
|                    | Tandem                  | DT                 | <<                     | →              | 1,63 C                     | 2 $C_0$ | 2 $P_u$                           | –                   | –    |
| 3                  | Back-to-back and tandem | TBT                | <>>                    | →              | C                          | $C_0$   | $P_u$                             | 1,54                | 0,75 |
|                    |                         |                    | <>>                    | ←              | 1,63 C                     | 2 $C_0$ | 2 $P_u$                           | 2,5                 | 0,33 |
|                    | Face-to-face and tandem | TFT                | ><<                    | ←              | C                          | $C_0$   | $P_u$                             | 1,54                | 0,75 |
|                    |                         |                    | ><<                    | →              | 1,63 C                     | 2 $C_0$ | 2 $P_u$                           | 2,5                 | 0,33 |
|                    | Tandem                  | TT                 | <<<                    | →              | 2,16 C                     | 3 $C_0$ | 3 $P_u$                           | –                   | –    |
| 4                  | Back-to-back and tandem | QBT                | <<<>                   | ←              | C                          | $C_0$   | $P_u$                             | 1,26                | 0,87 |
|                    |                         |                    | <<<>                   | →              | 2,16 C                     | 3 $C_0$ | 3 $P_u$                           | 2,71                | 0,25 |
|                    | Face-to-face and tandem | QFT                | >>><                   | ←              | C                          | $C_0$   | $P_u$                             | 1,26                | 0,87 |
|                    |                         |                    | >>><                   | →              | 2,16 C                     | 3 $C_0$ | 3 $P_u$                           | 2,71                | 0,25 |
|                    | Tandem back-to-back     | QBC                | <<>>                   | →              | 1,63 C                     | 2 $C_0$ | 2 $P_u$                           | 2,04                | 0,54 |
|                    | Tandem face-to-face     | QFC                | >><<                   | →              | 1,63 C                     | 2 $C_0$ | 2 $P_u$                           | 2,04                | 0,54 |
|                    | Tandem                  | QT                 | <<<<                   | →              | 2,64 C                     | 4 $C_0$ | 4 $P_u$                           | –                   | –    |

where

$P$  = equivalent dynamic load [kN]

$F_r$  = radial load [kN]

$F_a$  = axial load [kN]

$X$  = radial load factor

– for single direction bearings:

→ **table 12, page 362**

– for double direction bearings: 1,9

$Y$  = axial load factor

– for single direction bearings:

→ **table 12**

– for double direction bearings: 0,55

Preload is considered to be an axial load. For bearing sets in any arrangement, the equivalent dynamic bearing load must be calculated separately for each load direction.

### Equivalent static bearing load

If individual single direction bearings, bearing sets, or double direction bearings have to accommodate both axial and radial loads, the equivalent static bearing load for each direction of axial load can be determined as follows:

$$P_0 = F_a + 4,35 F_r$$

where

$P_0$  = equivalent static load [kN]

$F_r$  = radial load [kN]

$F_a$  = axial load [kN]

Preload is considered to be an axial load. For bearing sets, in any arrangement, the equivalent static bearing load must be calculated separately for each load direction.

The equation for equivalent static bearing load applies to individual bearings and for bearings in a tandem arrangement if the load ratio  $F_a/F_r$  is not lower than 4. When  $F_a/F_r$  is between 4 and 2,5 the equation still provides useable approximation values.

## Axial load carrying capacity

With increasing axial load, the contact conditions in the bearing change. The contact angle and especially the size of the contact ellipses increase, and there may be increased stress at the ring shoulder/raceway transitions. This stress is kept to a minimum for SKF super-precision bearings by appropriate measures, such as rounded and ground transition zones. Even so, the guideline values for the maximum axial load (→ **table 7, page 362**) should not be exceeded.

## Mounting

Mounting instructions are either printed on the inside of the bearing box or included as a leaflet. For general information about mounting and dismounting super-precision bearings, refer to *Mounting and dismounting* (→ **page 362**).

## Attainable speeds

The attainable speeds listed in the product tables are guideline values and are valid under certain conditions. For additional information, refer to *Attainable speeds* on **page 363**.

### Single direction bearings

The values listed for oil lubrication apply to the oil-air lubrication method and should be reduced if other oil lubrication methods are used.

The values listed for grease lubrication are maximum values that can be attained with sealed bearings or open bearings with an appropriate fill of a suitable, high-quality, soft consistency grease. For additional information, contact the SKF application engineering service.

If bearing sets with two or more bearings are mounted immediately adjacent to each other, the attainable speeds listed in the product table (→ **page 363**) need to be reduced. Values for the maximum rotational speeds in these cases can be obtained by multiplying the guideline value listed in the product tables by a reduction factor (→ **table 13**) dependent on the preload and number of bearings in the arrangement.

### Double direction bearings

The attainable speeds listed in the product tables (→ **pages 363 and 363**) for double direction bearings depend on the type of seal and are limited as follows:

- for bearings with contact seals (designation suffix 2RS) by the permissible sliding speed at the seal lip
- for bearings with non-contact seals (designation suffix 2RZ) by the speeds permitted for grease lubrication

### Cartridge units

The attainable speeds listed in the product table (→ **page 363**) for cartridge units apply to mounted, grease lubricated units.

Table 13

Speed reduction factors for bearing sets

| Number of bearings | Speed reduction factor for preload class |      |
|--------------------|------------------------------------------|------|
|                    | A                                        | B    |
| 2                  | 0,8                                      | 0,4  |
| 3                  | 0,65                                     | 0,3  |
| 4                  | 0,5                                      | 0,25 |

# Designation system

**Examples:** Single direction bearing – BSA 205 CGB/GMM  
Matched set of single direction bearings – BSA 208 C/TFTA  
Double direction bearing – BEAM 030080-2RS/PE  
Cartridge unit – FBSA 206 A/QBCA

|        |        |   |    |      |  |
|--------|--------|---|----|------|--|
| BSA 2  | 05     | C | GB | /    |  |
| BSA 2  | 08     | C |    | /    |  |
| BEAM   | 030080 |   |    | -2RS |  |
| FSBA 2 | 06     | A |    |      |  |

## Bearing series

**BSA 2** Single direction bearing in the 02 ISO dimension series  
**BSA 3** Single direction bearing in the 03 ISO dimension series  
**BSD** Single direction bearing  
**BEAS** Double direction bearing  
**BEAM** Double direction bearing for bolt mounting  
**FBSA 2** Cartridge unit with a flanged housing

## Bearing size

For single direction bearings in accordance with an ISO dimension series

**01** 12 mm bore diameter  
**02** 15 mm bore diameter  
**03** 17 mm bore diameter  
**04** (x5) 20 mm bore diameter  
to  
**15** (x5) 75 mm bore diameter

For single direction bearings, not standardized

**2047** 20 mm bore diameter and 47 mm outside diameter  
to  
**60120** 60 mm bore diameter and 120 mm outside diameter

For double direction bearings

**008032** 8 mm bore diameter and 32 mm outside diameter  
to  
**060145** 60 mm bore diameter and 145 mm outside diameter

## Design features

**C** Improved internal design (single direction bearings only)  
**A** Different flange position (cartridge units only)

## Single direction bearing – execution and preload

**GA** Universally matchable, light preload  
**GB** Universally matchable, moderate preload  
**G...** Universally matchable, special preload, expressed in daN e.g. G240

## Sealing solutions

**-2RS** Contact seal on both sides, NBR  
**-2RZ** Non-contact seal on both sides, NBR

|     |    |     |   |
|-----|----|-----|---|
| GMM |    |     |   |
|     |    | TFT | A |
|     | PE |     |   |
|     |    | QBC | A |

**Bearing set – preload**

- A Light preload
- B Moderate preload
- G... Special preload, expressed in daN e.g. G240

**Bearing arrangement**

- DB Set of two bearings arranged back-to-back <>
- DF Set of two bearings arranged face-to-face ><
- DT Set of two bearings arranged in tandem <<
- TBT Set of three bearings arranged back-to-back and tandem <>>
- TFT Set of three bearings arranged face-to-face and tandem ><<
- TT Set of three bearings arranged in tandem <<<
- QBC Set of four bearings arranged tandem back-to-back <>>>
- QFC Set of four bearings arranged tandem face-to-face >><<
- QBT Set of four bearings arranged back-to-back and tandem <>>>
- QFT Set of four bearings arranged face-to-face and tandem ><<<
- QT Set of four bearings arranged in tandem <<<<

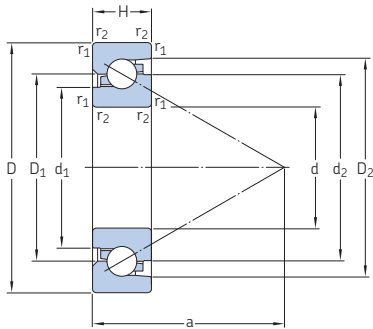
**Tolerance class**

- Dimensional accuracy to ISO tolerance class 4, running accuracy to ISO tolerance class 2
- PE Enlarged diameter tolerance and axial run-out to P5 tolerance class for radial bearing (BEAM/BEAS series only)

**Grease fill**

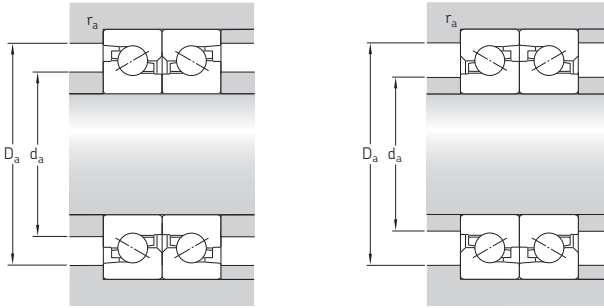
- GMM Open single direction bearing filled with standard grease

6.1 Single direction angular contact thrust ball bearings  
d 12 – 75 mm



| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speeds          |                        | Mass  | Designation |
|----------------------|-----|----|--------------------|--------------------------|--------------------|----------------------------|------------------------|-------|-------------|
| d                    | D   | H  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | Grease<br>lubrica-<br>tion | Oil-air<br>lubrication | kg    | –           |
| mm                   |     |    | kN                 |                          | kN                 | r/min                      |                        |       |             |
| 12                   | 32  | 10 | 11,8               | 21,2                     | 0,8                | 14 000                     | 17 000                 | 0,043 | BSA 201 C   |
| 15                   | 35  | 11 | 12,7               | 25,5                     | 0,95               | 12 000                     | 15 000                 | 0,054 | BSA 202 C   |
| 17                   | 40  | 12 | 16,6               | 34,5                     | 1,27               | 11 000                     | 15 000                 | 0,078 | BSA 203 C   |
| 20                   | 47  | 14 | 22                 | 49                       | 1,8                | 9 500                      | 12 000                 | 0,12  | BSA 204 C   |
|                      | 47  | 15 | 22                 | 49                       | 1,8                | 9 500                      | 12 000                 | 0,13  | BSD 2047 C  |
| 25                   | 52  | 15 | 22,4               | 52                       | 1,93               | 9 000                      | 11 000                 | 0,15  | BSA 205 C   |
|                      | 62  | 15 | 28,5               | 71                       | 2,65               | 8 000                      | 9 500                  | 0,24  | BSD 2562 C  |
|                      | 62  | 17 | 28,5               | 71                       | 2,65               | 8 000                      | 9 500                  | 0,27  | BSA 305 C   |
| 30                   | 62  | 15 | 28,5               | 71                       | 2,65               | 8 000                      | 9 500                  | 0,22  | BSD 3062 C  |
|                      | 62  | 16 | 28,5               | 71                       | 2,65               | 8 000                      | 9 500                  | 0,23  | BSA 206 C   |
|                      | 72  | 19 | 41,5               | 104                      | 3,9                | 7 000                      | 9 500                  | 0,41  | BSA 306 C   |
| 35                   | 72  | 15 | 36,5               | 98                       | 3,65               | 7 500                      | 9 000                  | 0,3   | BSD 3572 C  |
|                      | 72  | 17 | 36,5               | 98                       | 3,65               | 7 500                      | 9 000                  | 0,33  | BSA 207 C   |
|                      | 80  | 21 | 57                 | 146                      | 5,4                | 6 700                      | 9 500                  | 0,56  | BSA 307 C   |
| 40                   | 72  | 15 | 36,5               | 98                       | 3,65               | 7 500                      | 9 000                  | 0,26  | BSD 4072 C  |
|                      | 80  | 18 | 42,5               | 112                      | 4,15               | 6 300                      | 7 500                  | 0,43  | BSA 208 C   |
|                      | 90  | 20 | 64                 | 170                      | 6,3                | 6 000                      | 7 000                  | 0,68  | BSD 4090 C  |
|                      | 90  | 23 | 67                 | 180                      | 6,7                | 5 300                      | 7 000                  | 0,77  | BSA 308 C   |
| 45                   | 75  | 15 | 32,5               | 98                       | 3,65               | 7 500                      | 9 000                  | 0,26  | BSD 4575 C  |
|                      | 85  | 18 | 45                 | 134                      | 4,9                | 6 300                      | 7 500                  | 0,51  | BSA 209 C   |
|                      | 100 | 20 | 65,5               | 183                      | 6,7                | 5 600                      | 6 700                  | 0,77  | BSD 45100 C |
| 50                   | 90  | 20 | 46,5               | 146                      | 5,4                | 6 000                      | 7 000                  | 0,56  | BSA 210 C   |
|                      | 100 | 20 | 67                 | 193                      | 7,2                | 5 600                      | 6 700                  | 0,71  | BSD 50100 C |
| 55                   | 100 | 20 | 67                 | 193                      | 7,2                | 5 600                      | 6 700                  | 0,66  | BSD 55100 C |
|                      | 120 | 20 | 69,5               | 228                      | 8,5                | 5 000                      | 6 000                  | 1,15  | BSD 55120 C |
| 60                   | 110 | 22 | 69,5               | 216                      | 8                  | 5 000                      | 6 000                  | 0,95  | BSA 212 C   |
|                      | 120 | 20 | 69,5               | 228                      | 8,5                | 5 000                      | 6 000                  | 1,05  | BSD 60120 C |
| 75                   | 130 | 25 | 72                 | 245                      | 9,15               | 4 300                      | 5 000                  | 1,45  | BSA 215 C   |



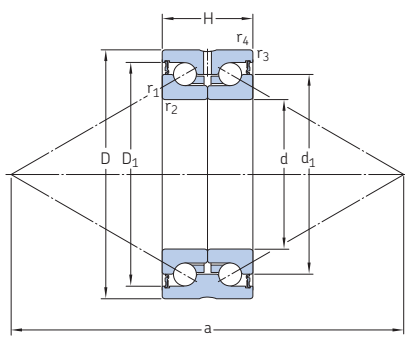


| Dimensions |                |                |                |                |                          |     | Abutment and fillet dimensions |                        |                        | Reference grease quantity <sup>1)</sup><br>$G_{ref}$ |
|------------|----------------|----------------|----------------|----------------|--------------------------|-----|--------------------------------|------------------------|------------------------|------------------------------------------------------|
| d          | d <sub>1</sub> | d <sub>2</sub> | D <sub>1</sub> | D <sub>2</sub> | r <sub>1,2</sub><br>min. | a   | d <sub>a</sub><br>min.         | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. |                                                      |
| mm         |                |                |                |                |                          |     | mm                             |                        |                        | cm <sup>3</sup>                                      |
| 12         | 17,8           | 22             | 22,1           | 26,7           | 0,6                      | 26  | 17                             | 29                     | 0,6                    | 0,4                                                  |
| 15         | 20,8           | 25             | 25,1           | 29,6           | 0,6                      | 29  | 20                             | 32                     | 0,6                    | 0,5                                                  |
| 17         | 24,1           | 29             | 29,1           | 34,4           | 0,6                      | 33  | 23                             | 37                     | 0,6                    | 0,5                                                  |
| 20         | 29,4           | 34,5           | 29,1           | 40,7           | 1                        | 40  | 24                             | 42                     | 1                      | 1,2                                                  |
|            | 29,4           | 34,5           | 34,6           | 40,7           | 1                        | 40  | 27                             | 42,5                   | 1                      | 1,4                                                  |
| 25         | 33,4           | 38,5           | 38,6           | 44,7           | 1                        | 44  | 32                             | 47,5                   | 1                      | 1,5                                                  |
|            | 39,9           | 46             | 46,1           | 53             | 1                        | 51  | 34                             | 57                     | 1                      | 2                                                    |
|            | 39,9           | 46             | 46,1           | 53             | 1                        | 52  | 34                             | 57                     | 1                      | 2,4                                                  |
| 30         | 39,9           | 46             | 46,1           | 53             | 1                        | 51  | 38                             | 57                     | 1                      | 2                                                    |
|            | 39,9           | 46             | 46,1           | 53             | 1                        | 51  | 37                             | 57                     | 1                      | 2,2                                                  |
|            | 43,9           | 51             | 51,1           | 59,5           | 1                        | 57  | 40                             | 65,5                   | 1                      | 3,5                                                  |
| 35         | 48,6           | 55             | 55,1           | 62,7           | 1,1                      | 59  | 44                             | 64,8                   | 1                      | 2,5                                                  |
|            | 48,6           | 55             | 55,1           | 62,7           | 1,1                      | 60  | 44                             | 66                     | 1                      | 3                                                    |
|            | 50,1           | 58,5           | 58,6           | 68,6           | 1                        | 66  | 47                             | 72,5                   | 1                      | 4,2                                                  |
| 40         | 48,6           | 55             | 55,1           | 62,7           | 1,1                      | 59  | 47,5                           | 65                     | 1                      | 2,5                                                  |
|            | 50,3           | 58             | 58,1           | 66,5           | 1,1                      | 64  | 48                             | 74                     | 1                      | 3,7                                                  |
|            | 57,5           | 66,5           | 66,6           | 77,3           | 1,5                      | 73  | 53                             | 81                     | 1,5                    | 5,2                                                  |
|            | 57,5           | 66,5           | 66,6           | 77,3           | 1,5                      | 74  | 53                             | 81                     | 1,5                    | 6,4                                                  |
| 45         | 54,3           | 60             | 60,1           | 66,9           | 1,1                      | 64  | 53                             | 69                     | 1                      | 2,7                                                  |
|            | 59,4           | 67             | 67,1           | 75,5           | 1,1                      | 73  | 53                             | 79,5                   | 1                      | 4,5                                                  |
|            | 61,7           | 71,5           | 71,6           | 82,3           | 1,5                      | 77  | 59                             | 90                     | 1,5                    | 5,9                                                  |
| 50         | 64,4           | 72             | 72,1           | 80,5           | 1,1                      | 78  | 59                             | 84                     | 1                      | 5,2                                                  |
|            | 66,9           | 77             | 77,1           | 87,8           | 1,5                      | 82  | 65                             | 90,5                   | 1,5                    | 6,5                                                  |
| 55         | 66,9           | 77             | 77,1           | 87,8           | 1,5                      | 82  | 67                             | 91                     | 1,5                    | 6,5                                                  |
|            | 80,9           | 91             | 91,1           | 101,8          | 1,5                      | 96  | 69                             | 110                    | 1,5                    | 7,5                                                  |
| 60         | 76,9           | 87             | 87,1           | 97,8           | 1,1                      | 93  | 71                             | 102                    | 1,5                    | 8,5                                                  |
|            | 80,9           | 91             | 91,1           | 101,8          | 1,5                      | 96  | 73                             | 111                    | 1,5                    | 7,5                                                  |
| 75         | 91,2           | 100            | 100,1          | 110,8          | 1,5                      | 107 | 85                             | 122                    | 1,5                    | 11                                                   |

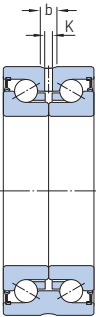
<sup>1)</sup> For calculating the initial grease fill → page 367

6.2 Double direction angular contact thrust ball bearings

d 8 – 30 mm

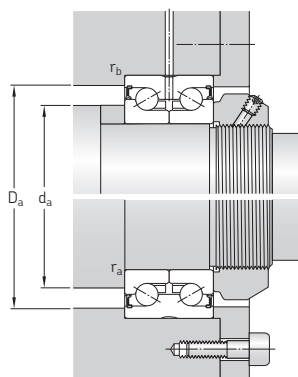


2RS



2RZ

| Principal dimensions |    |    | Basic load ratings |                | Fatigue load limit | Attainable speed | Mass | Designation        |
|----------------------|----|----|--------------------|----------------|--------------------|------------------|------|--------------------|
| d                    | D  | H  | C                  | C <sub>0</sub> | P <sub>u</sub>     |                  |      |                    |
| mm                   |    |    | kN                 |                | kN                 | r/min            | kg   | –                  |
| 8                    | 32 | 20 | 12,5               | 16,3           | 0,6                | 5 300            | 0,09 | BEAS 008032-2RS    |
|                      | 32 | 20 | 12,5               | 16,3           | 0,6                | 8 800            | 0,09 | BEAS 008032-2RZ    |
| 12                   | 42 | 25 | 16,8               | 24,5           | 0,915              | 4 000            | 0,2  | BEAS 012042-2RS    |
|                      | 42 | 25 | 16,8               | 24,5           | 0,915              | 6 700            | 0,2  | BEAS 012042-2RZ    |
| 15                   | 45 | 25 | 18                 | 28             | 1,04               | 3 900            | 0,21 | BEAS 015045-2RS    |
|                      | 45 | 25 | 18                 | 28             | 1,04               | 6 500            | 0,21 | BEAS 015045-2RZ    |
| 17                   | 47 | 25 | 18                 | 31             | 1,16               | 3 800            | 0,22 | BEAS 017047-2RS    |
|                      | 47 | 25 | 19                 | 31             | 1,16               | 6 300            | 0,22 | BEAS 017047-2RZ    |
| 20                   | 52 | 28 | 26                 | 46,5           | 1,73               | 3 400            | 0,31 | BEAS 020052-2RS    |
|                      | 52 | 28 | 26                 | 46,5           | 1,73               | 6 000            | 0,31 | BEAS 020052-2RZ    |
|                      | 52 | 28 | 26                 | 46,5           | 1,73               | 6 000            | 0,31 | BEAS 020052-2RZ/PE |
| 25                   | 57 | 28 | 27,6               | 55             | 2,04               | 3 400            | 0,34 | BEAS 025057-2RS    |
|                      | 57 | 28 | 27,6               | 55             | 2,04               | 5 600            | 0,34 | BEAS 025057-2RZ    |
| 30                   | 62 | 28 | 29                 | 64             | 2,36               | 3 200            | 0,39 | BEAS 030062-2RS    |
|                      | 62 | 28 | 29                 | 64             | 2,36               | 5 300            | 0,39 | BEAS 030062-2RZ    |

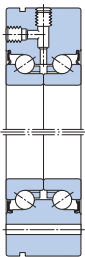
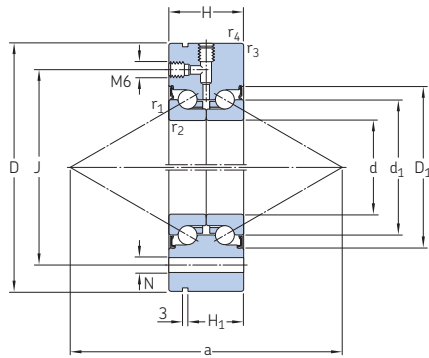


## Dimensions

## Abutment and fillet dimensions

| d  | d <sub>1</sub> | D <sub>1</sub> | b   | K   | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | a  | d <sub>a</sub><br>min. | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | r <sub>b</sub><br>max. |
|----|----------------|----------------|-----|-----|--------------------------|--------------------------|----|------------------------|------------------------|------------------------|------------------------|
| mm |                |                |     |     |                          |                          |    | mm                     |                        |                        |                        |
| 8  | 19             | 26,5           | 3,1 | 1,2 | 0,3                      | 0,6                      | 43 | 12                     | 26                     | 0,3                    | 0,6                    |
|    | 19             | 26,5           | 3,1 | 1,2 | 0,3                      | 0,6                      | 43 | 12                     | 26                     | 0,3                    | 0,6                    |
| 12 | 25             | 33,5           | 3,1 | 2,5 | 0,3                      | 0,6                      | 56 | 16                     | 35                     | 0,3                    | 0,6                    |
|    | 25             | 33,5           | 3,1 | 2,5 | 0,3                      | 0,6                      | 56 | 16                     | 35                     | 0,3                    | 0,6                    |
| 15 | 28             | 36             | 3,1 | 2,5 | 0,3                      | 0,6                      | 61 | 20                     | 35                     | 0,3                    | 0,6                    |
|    | 28             | 36             | 3,1 | 2,5 | 0,3                      | 0,6                      | 61 | 20                     | 35                     | 0,3                    | 0,6                    |
| 17 | 30             | 38             | 3,1 | 2,5 | 0,3                      | 0,6                      | 65 | 23                     | 40                     | 0,3                    | 0,6                    |
|    | 30             | 38             | 3,1 | 2,5 | 0,3                      | 0,6                      | 65 | 23                     | 40                     | 0,3                    | 0,6                    |
| 20 | 34,5           | 44             | 3,1 | 3   | 0,3                      | 0,6                      | 74 | 26                     | 45                     | 0,3                    | 0,6                    |
|    | 34,5           | 44             | 3,1 | 3   | 0,3                      | 0,6                      | 74 | 26                     | 45                     | 0,3                    | 0,6                    |
|    | 34,5           | 44             | 3,1 | 3   | 0,3                      | 0,6                      | 74 | 26                     | 45                     | 0,3                    | 0,6                    |
| 25 | 40,5           | 49             | 3,1 | 3   | 0,3                      | 0,6                      | 84 | 32                     | 50                     | 0,3                    | 0,6                    |
|    | 40,5           | 49             | 3,1 | 3   | 0,3                      | 0,6                      | 84 | 32                     | 50                     | 0,3                    | 0,6                    |
| 30 | 45,5           | 54             | 3,1 | 3   | 0,3                      | 0,6                      | 93 | 40                     | 54                     | 0,3                    | 0,6                    |
|    | 45,5           | 54             | 3,1 | 3   | 0,3                      | 0,6                      | 93 | 40                     | 54                     | 0,3                    | 0,6                    |

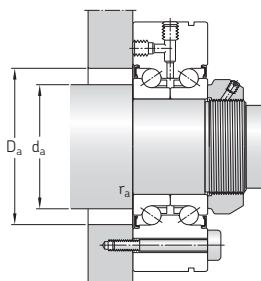
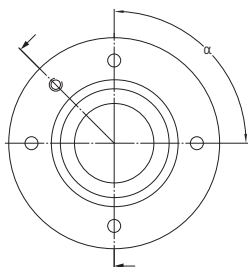
6.3 Double direction angular contact thrust ball bearings for bolt mounting  
d 12 – 60 mm



d = 60 mm

PE

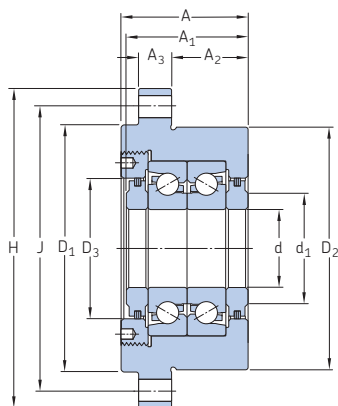
| Principal dimensions |     |    | Basic load ratings |                          | Fatigue load limit | Attainable speed | Mass | Designation        |
|----------------------|-----|----|--------------------|--------------------------|--------------------|------------------|------|--------------------|
| d                    | D   | H  | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     |                  |      |                    |
| mm                   |     |    | kN                 |                          | kN                 | r/min            | kg   | –                  |
| 12                   | 55  | 25 | 16,8               | 24,5                     | 0,915              | 4 000            | 0,37 | BEAM 012055-2RS    |
|                      | 55  | 25 | 16,8               | 24,5                     | 0,915              | 6 700            | 0,37 | BEAM 012055-2RZ    |
| 17                   | 62  | 25 | 19                 | 31                       | 1,16               | 3 800            | 0,45 | BEAM 017062-2RS    |
|                      | 62  | 25 | 19                 | 31                       | 1,16               | 3 800            | 0,45 | BEAM 017062-2RS/PE |
|                      | 62  | 25 | 19                 | 31                       | 1,16               | 6 300            | 0,45 | BEAM 017062-2RZ    |
|                      | 62  | 25 | 19                 | 31                       | 1,16               | 6 300            | 0,45 | BEAM 017062-2RZ/PE |
| 20                   | 68  | 28 | 26                 | 46,5                     | 1,73               | 3 400            | 0,61 | BEAM 020068-2RS    |
|                      | 68  | 28 | 26                 | 46,5                     | 1,73               | 3 400            | 0,61 | BEAM 020068-2RS/PE |
|                      | 68  | 28 | 26                 | 46,5                     | 1,73               | 6 000            | 0,61 | BEAM 020068-2RZ    |
|                      | 68  | 28 | 26                 | 46,5                     | 1,73               | 6 000            | 0,61 | BEAM 020068-2RZ/PE |
| 25                   | 75  | 28 | 27,6               | 55                       | 2,04               | 3 400            | 0,72 | BEAM 025075-2RS    |
|                      | 75  | 28 | 27,6               | 55                       | 2,04               | 3 400            | 0,72 | BEAM 025075-2RS/PE |
|                      | 75  | 28 | 27,6               | 55                       | 2,04               | 5 600            | 0,72 | BEAM 025075-2RZ    |
|                      | 75  | 28 | 27,6               | 55                       | 2,04               | 5 600            | 0,72 | BEAM 025075-2RZ/PE |
| 30                   | 80  | 28 | 29,1               | 64                       | 2,36               | 2 600            | 0,78 | BEAM 030080-2RS    |
|                      | 80  | 28 | 29,1               | 64                       | 2,36               | 2 600            | 0,78 | BEAM 030080-2RS/PE |
|                      | 80  | 28 | 29,1               | 64                       | 2,36               | 4 500            | 0,78 | BEAM 030080-2RZ    |
|                      | 100 | 38 | 60                 | 108                      | 4                  | 2 600            | 1,65 | BEAM 030100-2RS    |
|                      | 100 | 38 | 60                 | 108                      | 4                  | 4 300            | 1,65 | BEAM 030100-2RZ    |
| 35                   | 90  | 34 | 41                 | 88                       | 3,25               | 2 400            | 1,15 | BEAM 035090-2RS    |
|                      | 90  | 34 | 41                 | 88                       | 3,25               | 4 000            | 1,15 | BEAM 035090-2RZ    |
| 40                   | 100 | 34 | 43,6               | 102                      | 3,75               | 2 200            | 1,45 | BEAM 040100-2RS    |
|                      | 100 | 34 | 43,6               | 102                      | 3,75               | 3 800            | 1,45 | BEAM 040100-2RZ    |
|                      | 115 | 46 | 71,5               | 150                      | 5,5                | 1 800            | 2,2  | BEAM 040115-2RS    |
|                      | 115 | 46 | 71,5               | 150                      | 5,5                | 3 000            | 2,2  | BEAM 040115-2RZ    |
| 50                   | 115 | 34 | 46,8               | 127                      | 4,65               | 2 000            | 1,85 | BEAM 050115-2RS    |
|                      | 115 | 34 | 46,8               | 127                      | 4,65               | 3 600            | 1,85 | BEAM 050115-2RZ    |
|                      | 140 | 54 | 114                | 250                      | 9,3                | 1 700            | 4,7  | BEAM 050140-2RS    |
|                      | 140 | 54 | 114                | 250                      | 9,3                | 2 800            | 4,7  | BEAM 050140-2RZ    |
| 60                   | 145 | 45 | 85                 | 216                      | 8                  | 1 600            | 4,3  | BEAM 060145-2RS    |
|                      | 145 | 45 | 85                 | 216                      | 8                  | 2 600            | 4,3  | BEAM 060145-2RZ    |



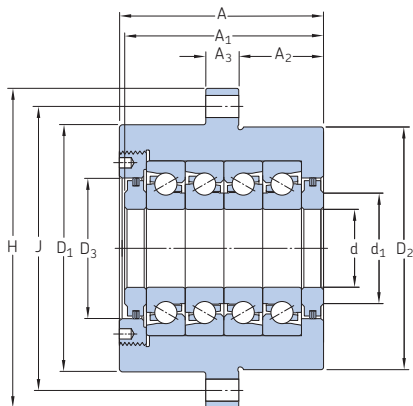
| Dimensions |                |                |                |                          |                          |     | Abutment and fillet dimensions |                        |                        | Holes for attachment bolts in accordance with DIN 912 |                   |                      |  |
|------------|----------------|----------------|----------------|--------------------------|--------------------------|-----|--------------------------------|------------------------|------------------------|-------------------------------------------------------|-------------------|----------------------|--|
| d          | d <sub>1</sub> | D <sub>1</sub> | H <sub>1</sub> | r <sub>1,2</sub><br>min. | r <sub>3,4</sub><br>min. | a   | d <sub>a</sub><br>min.         | D <sub>a</sub><br>max. | r <sub>a</sub><br>max. | Size                                                  | Dimensions<br>J N | Pitch<br>nr. x α [°] |  |
| mm         |                |                |                |                          |                          |     | mm                             |                        |                        | —                                                     | mm                | —                    |  |
| 12         | 25             | 33,5           | 17             | 0,3                      | 0,6                      | 56  | 16                             | 33                     | 0,6                    | M6                                                    | 42 6,8            | 3x120                |  |
|            | 25             | 33,5           | 17             | 0,3                      | 0,6                      | 56  | 16                             | 33                     | 0,6                    | M6                                                    | 42 6,8            | 3x120                |  |
| 17         | 30             | 38             | 17             | 0,3                      | 0,6                      | 65  | 23                             | 38                     | 0,6                    | M6                                                    | 48 6,8            | 6x60                 |  |
|            | 30             | 38             | 17             | 0,3                      | 0,6                      | 65  | 23                             | 38                     | 0,6                    | M6                                                    | 48 6,8            | 6x60                 |  |
|            | 30             | 38             | 17             | 0,3                      | 0,6                      | 65  | 23                             | 38                     | 0,6                    | M6                                                    | 48 6,8            | 6x60                 |  |
|            | 30             | 38             | 17             | 0,3                      | 0,6                      | 65  | 23                             | 38                     | 0,6                    | M6                                                    | 48 6,8            | 6x60                 |  |
| 20         | 34,5           | 44             | 19             | 0,3                      | 0,6                      | 74  | 25                             | 44                     | 0,6                    | M6                                                    | 53 6,8            | 8x45                 |  |
|            | 34,5           | 44             | 19             | 0,3                      | 0,6                      | 74  | 25                             | 44                     | 0,6                    | M6                                                    | 53 6,8            | 8x45                 |  |
|            | 34,5           | 44             | 19             | 0,3                      | 0,6                      | 74  | 25                             | 44                     | 0,6                    | M6                                                    | 53 6,8            | 8x45                 |  |
|            | 34,5           | 44             | 19             | 0,3                      | 0,6                      | 74  | 25                             | 44                     | 0,6                    | M6                                                    | 53 6,8            | 8x45                 |  |
| 25         | 40,5           | 49             | 19             | 0,3                      | 0,6                      | 84  | 32                             | 49                     | 0,6                    | M6                                                    | 58 6,8            | 8x45                 |  |
|            | 40,5           | 49             | 19             | 0,3                      | 0,6                      | 84  | 32                             | 49                     | 0,6                    | M6                                                    | 58 6,8            | 8x45                 |  |
|            | 40,5           | 49             | 19             | 0,3                      | 0,6                      | 84  | 32                             | 49                     | 0,6                    | M6                                                    | 58 6,8            | 8x45                 |  |
|            | 40,5           | 49             | 19             | 0,3                      | 0,6                      | 84  | 32                             | 49                     | 0,6                    | M6                                                    | 58 6,8            | 8x45                 |  |
| 30         | 45,5           | 54             | 19             | 0,3                      | 0,6                      | 93  | 40                             | 54                     | 0,6                    | M6                                                    | 63 6,8            | 12x30                |  |
|            | 45,5           | 54             | 19             | 0,3                      | 0,6                      | 93  | 40                             | 54                     | 0,6                    | M6                                                    | 63 6,8            | 12x30                |  |
|            | 45,5           | 54             | 19             | 0,3                      | 0,6                      | 93  | 40                             | 54                     | 0,6                    | M6                                                    | 63 6,8            | 12x30                |  |
|            | 51             | 65             | 30             | 0,3                      | 0,6                      | 106 | 47                             | 65                     | 0,6                    | M8                                                    | 80 8,8            | 8x45                 |  |
|            | 51             | 65             | 30             | 0,3                      | 0,6                      | 106 | 47                             | 65                     | 0,6                    | M8                                                    | 80 8,8            | 8x45                 |  |
|            | 51             | 65             | 30             | 0,3                      | 0,6                      | 106 | 47                             | 65                     | 0,6                    | M8                                                    | 80 8,8            | 8x45                 |  |
| 35         | 52             | 63             | 25             | 0,3                      | 0,6                      | 107 | 45                             | 63                     | 0,6                    | M8                                                    | 75 8,8            | 8x45                 |  |
|            | 52             | 63             | 25             | 0,3                      | 0,6                      | 107 | 45                             | 63                     | 0,6                    | M8                                                    | 75 8,8            | 8x45                 |  |
| 40         | 58             | 68             | 25             | 0,3                      | 0,6                      | 117 | 50                             | 68                     | 0,6                    | M8                                                    | 80 8,8            | 8x45                 |  |
|            | 58             | 68             | 25             | 0,3                      | 0,6                      | 117 | 50                             | 68                     | 0,6                    | M8                                                    | 80 8,8            | 8x45                 |  |
|            | 65             | 80             | 36             | 0,6                      | 0,6                      | 134 | 56                             | 80                     | 0,6                    | M8                                                    | 94 8,8            | 12x30                |  |
|            | 65             | 80             | 36             | 0,6                      | 0,6                      | 134 | 56                             | 80                     | 0,6                    | M8                                                    | 94 8,8            | 12x30                |  |
| 50         | 72             | 82             | 25             | 0,3                      | 0,6                      | 141 | 63                             | 82                     | 0,6                    | M8                                                    | 94 8,8            | 12x30                |  |
|            | 72             | 82             | 25             | 0,3                      | 0,6                      | 141 | 63                             | 82                     | 0,6                    | M8                                                    | 94 8,8            | 12x30                |  |
|            | 80             | 98             | 45             | 0,6                      | 0,6                      | 166 | 63                             | 98                     | 0,6                    | M10                                                   | 113 11            | 12x30                |  |
|            | 80             | 98             | 45             | 0,6                      | 0,6                      | 166 | 63                             | 98                     | 0,6                    | M10                                                   | 113 11            | 12x30                |  |
| 60         | 85             | 100            | 35             | 0,6                      | 0,6                      | 168 | 82                             | 100                    | 0,6                    | M8                                                    | 120 8,8           | 8x45                 |  |
|            | 85             | 100            | 35             | 0,6                      | 0,6                      | 168 | 82                             | 100                    | 0,6                    | M8                                                    | 120 8,8           | 8x45                 |  |

## 6.4 Cartridge units with a flanged housing

d 20 – 60 mm

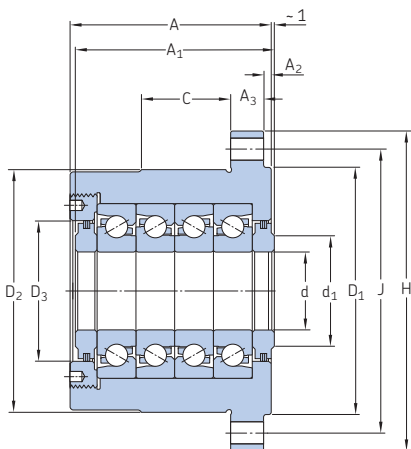


FBSA 2../DB

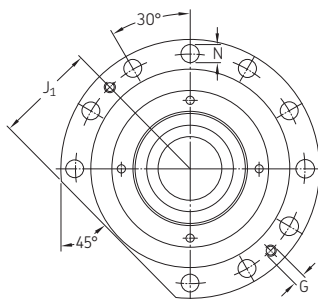


FBSA 2../QBC

| Principal dimensions |     |     | Basic load ratings |                          | Fatigue load limit | Attainable speeds<br>Preload class |       | Mass | Designation    |
|----------------------|-----|-----|--------------------|--------------------------|--------------------|------------------------------------|-------|------|----------------|
| d                    | H   | A   | dynamic<br>C       | static<br>C <sub>0</sub> | P <sub>u</sub>     | A                                  | B     |      |                |
| mm                   |     |     | kN                 |                          | kN                 | r/min                              |       | kg   | –              |
| 20                   | 90  | 47  | 22                 | 49                       | 1,8                | 7 600                              | 3 800 | 1,1  | FBSA 204/DB    |
|                      | 90  | 47  | 22                 | 49                       | 1,8                | 7 600                              | 3 800 | 1,1  | FBSA 204/DF    |
|                      | 90  | 77  | 35,9               | 98                       | 3,6                | 4 750                              | 2 375 | 1,7  | FBSA 204/QBC   |
|                      | 90  | 77  | 35,9               | 98                       | 3,6                | 4 750                              | 2 375 | 1,7  | FBSA 204/QFC   |
| 25                   | 120 | 52  | 22,4               | 52                       | 1,93               | 7 200                              | 3 600 | 2,3  | FBSA 205/DB    |
|                      | 120 | 52  | 22,4               | 52                       | 1,93               | 7 200                              | 3 600 | 2,3  | FBSA 205/DF    |
|                      | 120 | 82  | 36,5               | 104                      | 3,86               | 4 500                              | 2 250 | 3,5  | FBSA 205/QBC   |
|                      | 120 | 82  | 36,5               | 104                      | 3,86               | 4 500                              | 2 250 | 3,5  | FBSA 205/QFC   |
| 30                   | 120 | 52  | 28,5               | 71                       | 2,65               | 6 400                              | 3 200 | 2,5  | FBSA 206/DB    |
|                      | 120 | 52  | 28,5               | 71                       | 2,65               | 6 400                              | 3 200 | 2,5  | FBSA 206/DF    |
|                      | 120 | 84  | 46,5               | 142                      | 5,3                | 4 000                              | 2 000 | 3,5  | FBSA 206/QBC   |
|                      | 120 | 84  | 46,5               | 142                      | 5,3                | 4 000                              | 2 000 | 3,5  | FBSA 206/QFC   |
|                      | 120 | 86  | 46,5               | 142                      | 5,3                | 4 000                              | 2 000 | 3,7  | FBSA 206 A/QBC |
|                      | 120 | 86  | 46,5               | 142                      | 5,3                | 4 000                              | 2 000 | 3,7  | FBSA 206 A/QFC |
| 35                   | 130 | 52  | 36,5               | 98                       | 3,65               | 5 600                              | 2 800 | 3,2  | FBSA 207/DB    |
|                      | 130 | 52  | 36,5               | 98                       | 3,65               | 5 600                              | 2 800 | 3,2  | FBSA 207/DF    |
|                      | 130 | 86  | 59,5               | 196                      | 7,3                | 3 500                              | 1 750 | 4,6  | FBSA 207/QBC   |
|                      | 130 | 86  | 59,5               | 196                      | 7,3                | 3 500                              | 1 750 | 4,6  | FBSA 207/QFC   |
| 40                   | 165 | 66  | 42,5               | 112                      | 4,15               | 5 040                              | 2 520 | 6,1  | FBSA 208/DB    |
|                      | 165 | 66  | 42,5               | 112                      | 4,15               | 5 040                              | 2 520 | 6,1  | FBSA 208/DF    |
|                      | 165 | 106 | 69,3               | 224                      | 8,3                | 3 150                              | 1 575 | 9,7  | FBSA 208/QBC   |
|                      | 165 | 106 | 69,3               | 224                      | 8,3                | 3 150                              | 1 575 | 9,7  | FBSA 208/QFC   |
|                      | 165 | 106 | 69,3               | 224                      | 8,3                | 3 150                              | 1 575 | 10   | FBSA 208 A/QBC |
|                      | 165 | 106 | 69,3               | 224                      | 8,3                | 3 150                              | 1 575 | 10   | FBSA 208 A/QFC |
| 45                   | 165 | 66  | 45                 | 134                      | 4,9                | 5 040                              | 2 520 | 5,9  | FBSA 209/DB    |
|                      | 165 | 66  | 45                 | 134                      | 4,9                | 5 040                              | 2 520 | 5,9  | FBSA 209/DF    |
|                      | 165 | 106 | 73,4               | 268                      | 9,8                | 3 150                              | 1 575 | 9,4  | FBSA 209/QBC   |
|                      | 165 | 106 | 73,4               | 268                      | 9,8                | 3 150                              | 1 575 | 9,4  | FBSA 209/QFC   |
| 50                   | 165 | 66  | 46,5               | 146                      | 5,4                | 4 800                              | 2 400 | 5,7  | FBSA 210/DB    |
|                      | 165 | 66  | 46,5               | 146                      | 5,4                | 4 800                              | 2 400 | 5,7  | FBSA 210/DF    |
|                      | 165 | 106 | 75,8               | 292                      | 10,8               | 3 000                              | 1 500 | 9,1  | FBSA 210/QBC   |
|                      | 165 | 106 | 75,8               | 292                      | 10,8               | 3 000                              | 1 500 | 9,1  | FBSA 210/QFC   |
|                      | 165 | 106 | 75,8               | 292                      | 10,8               | 3 000                              | 1 500 | 9,3  | FBSA 210 A/QBC |
|                      | 165 | 106 | 75,8               | 292                      | 10,8               | 3 000                              | 1 500 | 9,3  | FBSA 210 A/QFC |
| 60                   | 185 | 114 | 113                | 432                      | 16                 | 2 500                              | 1 250 | 12,5 | FBSA 212 A/QBC |
|                      | 185 | 114 | 113                | 432                      | 16                 | 2 500                              | 1 250 | 12,5 | FBSA 212 A/QFC |



FBSA 2.. A/QBC



## Dimensions

## Holes for attachment bolts

| d  | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | C  | d <sub>1</sub> | D <sub>1</sub> | D <sub>2</sub> | D <sub>3</sub> | J   | J <sub>1</sub> | N    | G       |
|----|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|-----|----------------|------|---------|
| mm |                |                |                |    |                |                |                |                | mm  |                |      |         |
| 20 | 44,26          | 32             | 13             | —  | 26             | 64             | 60             | 36             | 76  | 32             | 6,6  | —       |
|    | 43,24          | 32             | 13             | —  | 26             | 64             | 60             | 36             | 76  | 32             | 6,6  | —       |
|    | 74,26          | 32             | 13             | —  | 26             | 64             | 60             | 36             | 76  | 32             | 6,6  | —       |
|    | 72,74          | 32             | 13             | —  | 26             | 64             | 60             | 36             | 76  | 32             | 6,6  | —       |
| 25 | 50,26          | 32             | 15             | —  | 34             | 88             | 80             | 36             | 102 | 44             | 9,2  | —       |
|    | 49,24          | 32             | 15             | —  | 34             | 88             | 80             | 36             | 102 | 44             | 9,2  | —       |
|    | 80,26          | 32             | 15             | —  | 34             | 88             | 80             | 40             | 102 | 44             | 9,2  | —       |
|    | 78,74          | 32             | 15             | —  | 34             | 88             | 80             | 40             | 102 | 44             | 9,2  | —       |
| 30 | 50,26          | 32             | 15             | —  | 41             | 88             | 80             | 50             | 102 | 44             | 9,2  | —       |
|    | 49,24          | 32             | 15             | —  | 41             | 88             | 80             | 50             | 102 | 44             | 9,2  | —       |
|    | 82,26          | 32             | 15             | —  | 41             | 88             | 80             | 50             | 102 | 44             | 9,2  | —       |
|    | 80,74          | 32             | 15             | —  | 41             | 88             | 80             | 50             | 102 | 44             | 9,2  | —       |
|    | 86,26          | 3,5            | 15             | 35 | 41             | 88             | 88             | 50             | 102 | 45             | 9,2  | M8x1,25 |
|    | 86,26          | 3,5            | 15             | 35 | 41             | 88             | 88             | 50             | 102 | 45             | 9,2  | M8x1,25 |
| 35 | 50,26          | 32             | 15             | —  | 46             | 98             | 90             | 60             | 113 | 49             | 9,2  | —       |
|    | 49,24          | 32             | 15             | —  | 46             | 98             | 90             | 60             | 113 | 49             | 9,2  | —       |
|    | 84,26          | 32             | 15             | —  | 46             | 98             | 90             | 60             | 113 | 49             | 9,2  | —       |
|    | 82,74          | 32             | 15             | —  | 46             | 98             | 90             | 60             | 113 | 49             | 9,2  | —       |
| 40 | 64,26          | 43,5           | 17             | —  | 55             | 128            | 124            | 66             | 146 | 64             | 11,4 | —       |
|    | 63,24          | 43,5           | 17             | —  | 55             | 128            | 124            | 66             | 146 | 64             | 11,4 | —       |
|    | 104,26         | 43,5           | 17             | —  | 55             | 128            | 124            | 66             | 146 | 64             | 11,4 | —       |
|    | 102,74         | 43,5           | 17             | —  | 55             | 128            | 124            | 66             | 146 | 64             | 11,4 | —       |
|    | 106,26         | 4              | 24             | 35 | 55             | 128            | 128            | 66             | 146 | 65,5           | 11,4 | M10x1,5 |
|    | 106,26         | 4              | 24             | 35 | 55             | 128            | 128            | 66             | 146 | 65,5           | 11,4 | M10x1,5 |
| 45 | 64,26          | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 63,24          | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 104,26         | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 102,74         | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
| 50 | 64,26          | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 63,24          | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 104,26         | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 102,74         | 43,5           | 17             | —  | 66             | 128            | 124            | 76             | 146 | 64             | 11,4 | —       |
|    | 106,26         | 4              | 24             | 35 | 66             | 128            | 128            | 76             | 146 | 65,5           | 11,4 | M10x1,5 |
|    | 106,26         | 4              | 24             | 35 | 66             | 128            | 128            | 76             | 146 | 65,5           | 11,4 | M10x1,5 |
| 60 | 114,26         | 20,5           | 25             | 40 | 80             | 145            | 145            | 92             | 165 | 74,5           | 11,4 | M10x1,5 |
|    | 114,26         | 20,5           | 25             | 40 | 80             | 145            | 145            | 92             | 165 | 74,5           | 11,4 | M10x1,5 |





# Precision lock nuts

|                                                                                      |            |                                                                        |     |
|--------------------------------------------------------------------------------------|------------|------------------------------------------------------------------------|-----|
| <b>Designs</b> . . . . .                                                             | <b>376</b> | <b>Product tables</b>                                                  |     |
| Precision lock nuts with locking pins . . .                                          | 376        | <b>7.1</b> KMT precision lock nuts with locking pins . . . . .         | 384 |
| Precision lock nuts with axial locking screws . . . . .                              | 377        | <b>7.2</b> KMTA precision lock nuts with locking pins . . . . .        | 386 |
| <b>Product data</b> . . . . .                                                        | <b>378</b> | <b>7.3</b> KMD precision lock nuts with axial locking screws . . . . . | 388 |
| (Dimension standards, tolerances, mating shaft threads, materials, loosening torque) |            |                                                                        |     |
| <b>Installation and removal</b> . . . . .                                            | <b>379</b> |                                                                        |     |
| KMT and KMTA precision lock nuts . . . .                                             | 380        |                                                                        |     |
| KMD precision lock nuts . . . . .                                                    | 381        |                                                                        |     |
| <b>Designation system</b> . . . . .                                                  | <b>382</b> |                                                                        |     |

**More information**  
 Design considerations . . . . . 375  
 SKF maintenance products  
 → . . . . . [skf.com/mapro](https://skf.com/mapro)

Industrial lock nuts with lock washers are not considered to be suitable for super-precision bearing applications because of the relatively wide manufacturing tolerances of the thread and abutment surfaces. As a result, SKF has developed a full line of precision lock nuts that are manufactured within very tight tolerances. These simple to mount devices, which locate bearings and other components accurately and efficiently on a shaft, meet the requirements of machine tool applications, both technically and economically.

### Designs

All SKF precision lock nuts use friction between the mating thread flanks of the spindle shaft and lock nut to hold them in place. To apply this friction, SKF manufactures two different precision lock nut designs: those with locking pins and those with axial locking screws.

### Precision lock nuts with locking pins

KMT and KMTA series precision lock nuts (→ **fig. 1**) have three locking pins, equally spaced around their circumference, with their axes parallel to the loaded thread flank (→ **fig. 2**). When tightened, the locking pins preload the threads, which provides sufficient friction to prevent the nut from loosening under normal operating conditions (→ *Loosening torque*, **page 376**).

KMT and KMTA lock nuts are intended for applications where high precision, simple assembly and reliable locking are required. The three equally-spaced locking pins enable these lock nuts to be accurately positioned at right angles to the shaft. However, they can also be adjusted to compensate for slight angular deviations of adjacent components (→ *Installation and removal*, **page 376**).

KMT and KMTA lock nuts should not be used on shafts or adapter sleeves with keyways or key slots. Damage to the locking pins can result if they align with a keyway or slot.

Both lock nut series are available standard with a thread up to 200 mm (size 40). KMT lock nuts with a thread ranging from 220 to 420 mm (sizes 44 to 84) can be supplied on request. For additional information, contact the SKF application engineering service.

KMTA lock nuts have a cylindrical outside surface and, for some sizes, a different thread pitch than KMT lock nuts. They are intended primarily for applications where space is limited and the cylindrical outside surface can be used as an element of a gap-type seal.

Fig. 1

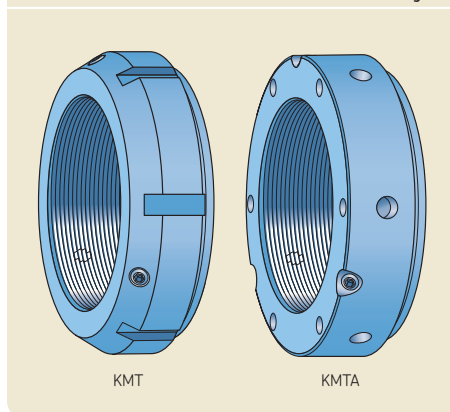
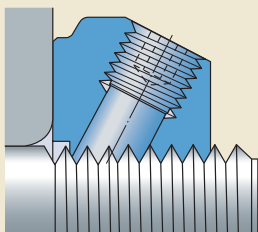


Fig. 2



## Precision lock nuts with axial locking screws

Precision lock nuts in the KMD series (→ **fig. 3**) are preloaded with axial locking screws. After the front part of the lock nut is tightened against the bearing, the axial locking screws on the rear part are tightened (→ **fig. 4**). This preloads the threads and generates sufficient friction to prevent the nut from loosening under normal operating conditions (→ *Loosening torque*, **page 377**).

Installing and removing KMD lock nuts is simple and the axial location effective and reliable. It is possible to make micro adjustments of the axial position using the locking screws (→ *Installation and removal*, **page 377**).

Fig. 3

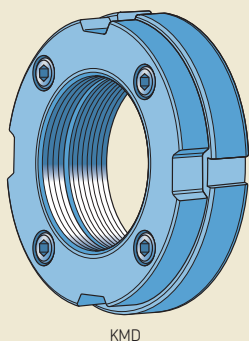
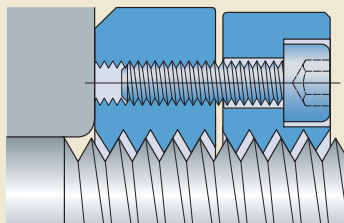


Fig. 4



Product data

|                      | KMT and KMTA series                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | KMD series                                                                                 |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Dimension standards  | ISO 965-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ISO 965-3<br>Locking screws: DIN 912-12.9                                                  |
| Tolerances           | Metric thread, 5H: ISO 965-3<br><br>Maximum axial run-out locating face / thread (for thread up to and including size 40): 0,005 mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Metric thread, 5H: ISO 965-3<br><br>Maximum axial run-out locating face / thread: 0,005 mm |
| Mating shaft threads | Metric thread, 6g: ISO 965-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                            |
| Materials            | Steel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Steel<br>For sizes 11 and 12: sintered steel (designation suffix P)                        |
| Loosening torque     | <p>KMT, KMTA and KMD lock nuts are held in place on a shaft by friction. The amount of friction can vary, depending on the amount of torque applied to the grub (set) screws or axial locking screws during installation, the surface finish of the shaft thread, the amount of lubricant on the thread, etc.</p> <p>Experience shows that the locking mechanism of KMT, KMTA and KMD lock nuts is more than adequate for typical machine tool applications, provided the lock nuts are properly installed and there is only a limited amount of lubricant on the thread.</p> <p>For additional information, contact the SKF application engineering service.</p> |                                                                                            |

## Installation and removal

KMT and KMD precision lock nuts have slots around their circumference to accommodate a hook or impact spanner (→ **figs. 5 and 6**). The designations of the appropriate spanners are listed in the product tables for KMT nuts (→ **page 379**) and KMD nuts (→ **page 379**). For additional information about SKF spanners, visit [skf.com/mapro](http://skf.com/mapro). In addition to the slots, KMT lock nuts with a thread  $\leq 75$  mm (size  $\leq 15$ ) have two opposed flats to accommodate a spanner.

KMTA precision lock nuts have holes around their circumference and in one side face (→ **fig. 7**). They can be tightened with a pin wrench, a pin-type face spanner or a tommy bar. Appropriate spanners in accordance with DIN 1810 are listed in the product tables.

All SKF precision lock nuts are designed for frequent installation and removal (provided they are not damaged).

Fig. 5

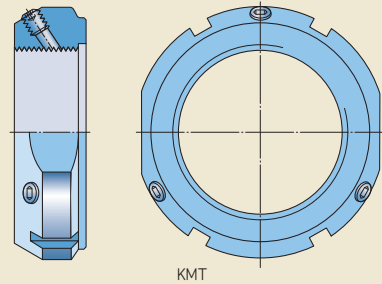


Fig. 6

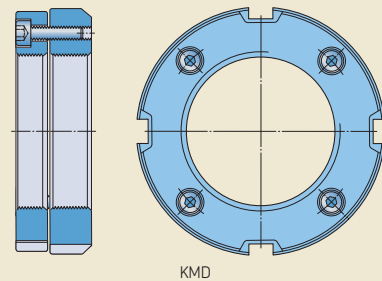
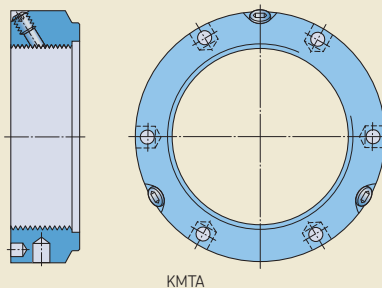


Fig. 7



### KMT and KMTA precision lock nuts

#### Locking

KMT and KMTA lock nuts should be locked in two phases:

- 1 Tighten the grub (set) screws carefully until the locking pins engage the shaft thread.
- 2 Tighten the grub screws alternately with a torque wrench until the recommended torque value is achieved (→ **product tables, pages 380 and 380**).

#### Adjustment

KMT and KMTA lock nuts are adjustable. The three equally-spaced locking pins enable these lock nuts to be accurately positioned at right angles to the shaft. However, they can also be adjusted to compensate for slight angular deviations of adjacent components. Adjustments can be made using the following procedure (→ **fig. 8**):

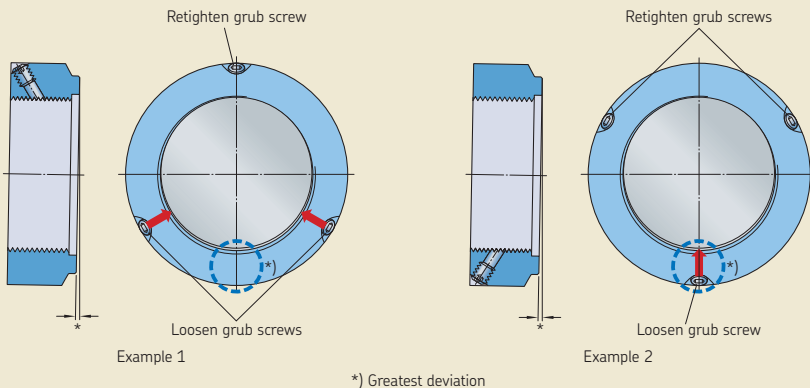
- 1 Loosen the grub screw(s) at the position showing the greatest deviation.
- 2 Tighten the remaining screw(s) equally.
- 3 Retighten the screw(s) that were loosened.
- 4 Check that the alignment of the nut, relative to the shaft, is now as required.

- 5 Repeat the procedure if the result is not adequate.

#### Removal

When removing KMT and KMTA lock nuts, the locking pins can still engage the shaft thread even after the grub screws have been loosened. Using a rubber hammer, tap the nut lightly in the vicinity of the pins to loosen them.

Fig. 8



## KMD precision lock nuts

KMD lock nuts are supplied with a protector between the front and rear part of the lock nut. The axial locking screws are “finger tight” to keep the protector in place. To install the lock nut (→ **fig. 9**):

- 1 Loosen the locking screws (1) half a turn. Do not remove them.
- 2 Remove the protector (2) between the two parts of the lock nut.
- 3 Hold the front and rear parts together and screw the lock nut onto the shaft. When the rear part grabs onto the shaft thread, a gap occurs between the two parts of approximately:
  - 0,6 mm for KMD 4 lock nuts
  - 1,0 mm for KMD 5 to KMD 15 lock nuts
  - 1,2 mm for KMD 16 to KMD 21 lock nuts

The remaining steps depend on whether adjustment to an exact position on the shaft is required.

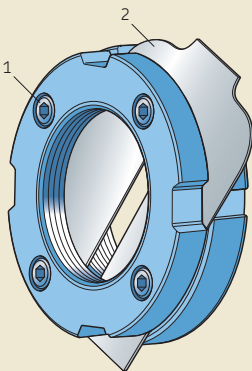
### When precise positioning is not required

- 4 Screw the lock nut to its final position on the shaft thread, engaging the spanner in the slots on the front part of the nut.
- 5 Tighten the locking screws alternately in a criss-cross pattern until the recommended torque value is obtained (→ **product table, page 381**). Screw sizes are listed in the product tables.

### When precise positioning is required

- 4 Screw the lock nut to an approximate position on the shaft thread, engaging the spanner in the slots on the front part of the nut.
- 5 Tighten the locking screws alternately in a criss-cross pattern to half the recommended torque value (→ **product table**). Screw sizes are listed in the product tables.
- 6 Adjust the nut to its final position on the shaft (placing the spanner in the slots on the front part of the nut).
- 7 Tighten the locking screws alternately in a criss-cross pattern to the full recommended torque.

Fig. 9



# Designation system

**Examples:** KMTA 24  
KMD 12 P

|      |    |   |
|------|----|---|
| KMTA | 24 |   |
| KMD  | 12 | P |

**Series**

- KMT** Precision lock nut with locking pins
- KMTA** Precision lock nut with locking pins and with cylindrical outside surface (some with different thread pitch to KMT nuts)
- KMD** Two-part precision lock nut with axial locking screws

**Nut size**

- 0** 10 mm thread diameter
- 1** 12 mm thread diameter
- 2** 15 mm thread diameter
- 3** 17 mm thread diameter
- 4** (x5) 20 mm thread diameter
- to
- 84** (x5) 420 mm thread diameter

**Material**

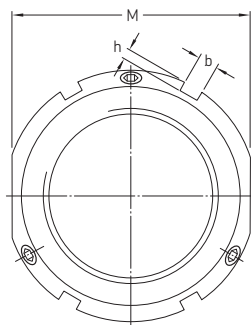
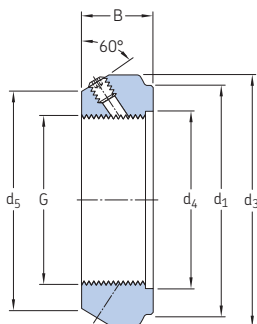
- Steel
- P** Sintered steel (For KMD 11 and KMD 12 lock nuts only)





## 7.1 KMT precision lock nuts with locking pins

### M 10x0,75 – M 200x3

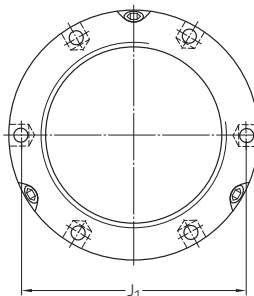
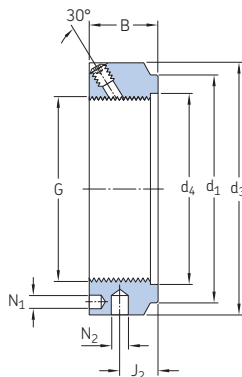


| Dimensions |                |                |                |                |    |    |     |     | Axial load<br>carrying<br>capacity<br>static | Mass  | Designations |                        | Grub (set) screw |                                     |
|------------|----------------|----------------|----------------|----------------|----|----|-----|-----|----------------------------------------------|-------|--------------|------------------------|------------------|-------------------------------------|
| G          | d <sub>1</sub> | d <sub>3</sub> | d <sub>4</sub> | d <sub>5</sub> | B  | b  | h   | M   |                                              |       | Lock<br>nut  | Appropriate<br>spanner | Size             | Recommended<br>tightening<br>torque |
| mm         |                |                |                |                |    |    |     |     | kN                                           | kg    | –            |                        | –                | Nm                                  |
| M 10x0,75  | 23             | 28             | 11             | 21             | 14 | 4  | 2   | 24  | 35                                           | 0,045 | KMT 0        | HN 2-3                 | M 5              | 4,5                                 |
| M 12x1     | 25             | 30             | 13             | 23             | 14 | 4  | 2   | 27  | 40                                           | 0,05  | KMT 1        | HN 4                   | M 5              | 4,5                                 |
| M 15x1     | 28             | 33             | 16             | 26             | 16 | 4  | 2   | 30  | 60                                           | 0,075 | KMT 2        | HN 4                   | M 5              | 4,5                                 |
| M 17x1     | 33             | 37             | 18             | 29             | 18 | 5  | 2   | 34  | 80                                           | 0,1   | KMT 3        | HN 5-6                 | M 6              | 8                                   |
| M 20x1     | 35             | 40             | 21             | 32             | 18 | 5  | 2   | 36  | 90                                           | 0,11  | KMT 4        | HN 5-6                 | M 6              | 8                                   |
| M 25x1,5   | 39             | 44             | 26             | 36             | 20 | 5  | 2   | 41  | 130                                          | 0,13  | KMT 5        | HN 5-6                 | M 6              | 8                                   |
| M 30x1,5   | 44             | 49             | 32             | 41             | 20 | 5  | 2   | 46  | 160                                          | 0,16  | KMT 6        | HN 7                   | M 6              | 8                                   |
| M 35x1,5   | 49             | 54             | 38             | 46             | 22 | 5  | 2   | 50  | 190                                          | 0,19  | KMT 7        | HN 7                   | M 6              | 8                                   |
| M 40x1,5   | 59             | 65             | 42             | 54             | 22 | 6  | 2,5 | 60  | 210                                          | 0,3   | KMT 8        | HN 8-9                 | M 8              | 18                                  |
| M 45x1,5   | 64             | 70             | 48             | 60             | 22 | 6  | 2,5 | 65  | 240                                          | 0,33  | KMT 9        | HN 10-11               | M 8              | 18                                  |
| M 50x1,5   | 68             | 75             | 52             | 64             | 25 | 7  | 3   | 70  | 300                                          | 0,4   | KMT 10       | HN 10-11               | M 8              | 18                                  |
| M 55x2     | 78             | 85             | 58             | 74             | 25 | 7  | 3   | 80  | 340                                          | 0,54  | KMT 11       | HN 12-13               | M 8              | 18                                  |
| M 60x2     | 82             | 90             | 62             | 78             | 26 | 8  | 3,5 | 85  | 380                                          | 0,61  | KMT 12       | HN 12-13               | M 8              | 18                                  |
| M 65x2     | 87             | 95             | 68             | 83             | 28 | 8  | 3,5 | 90  | 460                                          | 0,71  | KMT 13       | HN 15                  | M 8              | 18                                  |
| M 70x2     | 92             | 100            | 72             | 88             | 28 | 8  | 3,5 | 95  | 490                                          | 0,75  | KMT 14       | HN 15                  | M 8              | 18                                  |
| M 75x2     | 97             | 105            | 77             | 93             | 28 | 8  | 3,5 | 100 | 520                                          | 0,8   | KMT 15       | HN 16                  | M 8              | 18                                  |
| M 80x2     | 100            | 110            | 83             | 98             | 32 | 8  | 3,5 | –   | 620                                          | 0,9   | KMT 16       | HN 17                  | M 8              | 18                                  |
| M 85x2     | 110            | 120            | 88             | 107            | 32 | 10 | 4   | –   | 650                                          | 1,15  | KMT 17       | HN 18-20               | M 10             | 35                                  |
| M 90x2     | 115            | 125            | 93             | 112            | 32 | 10 | 4   | –   | 680                                          | 1,2   | KMT 18       | HN 18-20               | M 10             | 35                                  |
| M 95x2     | 120            | 130            | 98             | 117            | 32 | 10 | 4   | –   | 710                                          | 1,25  | KMT 19       | HN 18-20               | M 10             | 35                                  |
| M 100x2    | 125            | 135            | 103            | 122            | 32 | 10 | 4   | –   | 740                                          | 1,3   | KMT 20       | HN 21-22               | M 10             | 35                                  |

| Dimensions     |                |                |                |                |    |    |   |  | Axial load<br>carrying<br>capacity<br>static | Mass | Designations  |                        | Grub (set) screw |                                     |
|----------------|----------------|----------------|----------------|----------------|----|----|---|--|----------------------------------------------|------|---------------|------------------------|------------------|-------------------------------------|
| G              | d <sub>1</sub> | d <sub>3</sub> | d <sub>4</sub> | d <sub>5</sub> | B  | b  | h |  |                                              |      | Lock<br>nut   | Appropriate<br>spanner | Size             | Recommended<br>tightening<br>torque |
| mm             |                |                |                |                |    |    |   |  | kN                                           | kg   | –             |                        | –                | Nm                                  |
| <b>M 110x2</b> | 134            | 145            | 112            | 132            | 32 | 10 | 4 |  | 800                                          | 1,45 | <b>KMT 22</b> | HN 21-22               | M 10             | 35                                  |
| <b>M 120x2</b> | 144            | 155            | 122            | 142            | 32 | 10 | 4 |  | 860                                          | 1,6  | <b>KMT 24</b> | HN 21-22               | M 10             | 35                                  |
| <b>M 130x2</b> | 154            | 165            | 132            | 152            | 32 | 12 | 5 |  | 920                                          | 1,7  | <b>KMT 26</b> | TMFN 23-30             | M 10             | 35                                  |
| <b>M 140x2</b> | 164            | 175            | 142            | 162            | 32 | 14 | 5 |  | 980                                          | 1,8  | <b>KMT 28</b> | TMFN 23-30             | M 10             | 35                                  |
| <b>M 150x2</b> | 174            | 185            | 152            | 172            | 32 | 14 | 5 |  | 1 040                                        | 1,95 | <b>KMT 30</b> | TMFN 23-30             | M 10             | 35                                  |
| <b>M 160x3</b> | 184            | 195            | 162            | 182            | 32 | 14 | 5 |  | 1 100                                        | 2,1  | <b>KMT 32</b> | TMFN 23-30             | M 10             | 35                                  |
| <b>M 170x3</b> | 192            | 205            | 172            | 192            | 32 | 14 | 5 |  | 1 160                                        | 2,2  | <b>KMT 34</b> | TMFN 30-40             | M 10             | 35                                  |
| <b>M 180x3</b> | 204            | 215            | 182            | 202            | 32 | 16 | 5 |  | 1 220                                        | 2,3  | <b>KMT 36</b> | TMFN 30-40             | M 10             | 35                                  |
| <b>M 190x3</b> | 214            | 225            | 192            | 212            | 32 | 16 | 5 |  | 1 280                                        | 2,4  | <b>KMT 38</b> | TMFN 30-40             | M 10             | 35                                  |
| <b>M 200x3</b> | 224            | 235            | 202            | 222            | 32 | 18 | 5 |  | 1 340                                        | 2,5  | <b>KMT 40</b> | TMFN 30-40             | M 10             | 35                                  |

## 7.2 KMTA precision lock nuts with locking pins

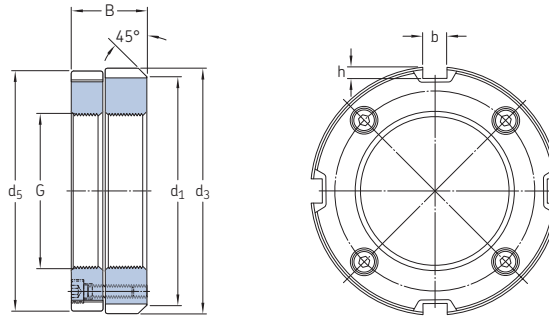
### M 25x1,5 – M 200x3



| Dimensions |                |                |                |    |                |                |                |                |          | Axial load<br>carrying<br>capacity<br>static | Mass    | Designations           |                                     | Grub<br>Size | (set) screw |  |
|------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|----------|----------------------------------------------|---------|------------------------|-------------------------------------|--------------|-------------|--|
| G          | d <sub>1</sub> | d <sub>3</sub> | d <sub>4</sub> | B  | J <sub>1</sub> | J <sub>2</sub> | N <sub>1</sub> | N <sub>2</sub> | Lock nut |                                              |         | Appropriate<br>spanner | Recommended<br>tightening<br>torque |              |             |  |
| mm         |                |                |                |    |                |                |                |                |          | kN                                           | kg      | –                      | –                                   | Nm           |             |  |
| M 25x1,5   | 35             | 42             | 26             | 20 | 32,5           | 11             | 4,3            | 4              | 130      | 0,13                                         | KMTA 5  | B 40-42                | M 6                                 | 8            |             |  |
| M 30x1,5   | 40             | 48             | 32             | 20 | 40,5           | 11             | 4,3            | 5              | 160      | 0,16                                         | KMTA 6  | B 45-50                | M 6                                 | 8            |             |  |
| M 35x1,5   | 47             | 53             | 38             | 20 | 45,5           | 11             | 4,3            | 5              | 190      | 0,19                                         | KMTA 7  | B 52-55                | M 6                                 | 8            |             |  |
| M 40x1,5   | 52             | 58             | 42             | 22 | 50,5           | 12             | 4,3            | 5              | 210      | 0,23                                         | KMTA 8  | B 58-62                | M 6                                 | 8            |             |  |
| M 45x1,5   | 58             | 68             | 48             | 22 | 58             | 12             | 4,3            | 6              | 240      | 0,33                                         | KMTA 9  | B 68-75                | M 6                                 | 8            |             |  |
| M 50x1,5   | 63             | 70             | 52             | 24 | 61,5           | 13             | 4,3            | 6              | 300      | 0,34                                         | KMTA 10 | B 68-75                | M 6                                 | 8            |             |  |
| M 55x1,5   | 70             | 75             | 58             | 24 | 66,5           | 13             | 4,3            | 6              | 340      | 0,37                                         | KMTA 11 | B 68-75                | M 6                                 | 8            |             |  |
| M 60x1,5   | 75             | 84             | 62             | 24 | 74,5           | 13             | 5,3            | 6              | 380      | 0,49                                         | KMTA 12 | B 80-90                | M 8                                 | 18           |             |  |
| M 65x1,5   | 80             | 88             | 68             | 25 | 78,5           | 13             | 5,3            | 6              | 460      | 0,52                                         | KMTA 13 | B 80-90                | M 8                                 | 18           |             |  |
| M 70x1,5   | 86             | 95             | 72             | 26 | 85             | 14             | 5,3            | 8              | 490      | 0,62                                         | KMTA 14 | B 95-100               | M 8                                 | 18           |             |  |
| M 75x1,5   | 91             | 100            | 77             | 26 | 88             | 13             | 6,4            | 8              | 520      | 0,66                                         | KMTA 15 | B 95-100               | M 8                                 | 18           |             |  |
| M 80x2     | 97             | 110            | 83             | 30 | 95             | 16             | 6,4            | 8              | 620      | 1                                            | KMTA 16 | B 110-115              | M 8                                 | 18           |             |  |
| M 85x2     | 102            | 115            | 88             | 32 | 100            | 17             | 6,4            | 8              | 650      | 1,15                                         | KMTA 17 | B 110-115              | M 10                                | 35           |             |  |
| M 90x2     | 110            | 120            | 93             | 32 | 108            | 17             | 6,4            | 8              | 680      | 1,2                                          | KMTA 18 | B 120-130              | M 10                                | 35           |             |  |
| M 95x2     | 114            | 125            | 98             | 32 | 113            | 17             | 6,4            | 8              | 710      | 1,25                                         | KMTA 19 | B 120-130              | M 10                                | 35           |             |  |
| M 100x2    | 120            | 130            | 103            | 32 | 118            | 17             | 6,4            | 8              | 740      | 1,3                                          | KMTA 20 | B 120-130              | M 10                                | 35           |             |  |
| M 110x2    | 132            | 140            | 112            | 32 | 128            | 17             | 6,4            | 8              | 800      | 1,45                                         | KMTA 22 | B 135-145              | M 10                                | 35           |             |  |
| M 120x2    | 142            | 155            | 122            | 32 | 140            | 17             | 6,4            | 8              | 860      | 1,85                                         | KMTA 24 | B 155-165              | M 10                                | 35           |             |  |
| M 130x3    | 156            | 165            | 132            | 32 | 153            | 17             | 6,4            | 8              | 920      | 2                                            | KMTA 26 | B 155-165              | M 10                                | 35           |             |  |
| M 140x3    | 166            | 180            | 142            | 32 | 165            | 17             | 6,4            | 10             | 980      | 2,45                                         | KMTA 28 | B 180-195              | M 10                                | 35           |             |  |
| M 150x3    | 180            | 190            | 152            | 32 | 175            | 17             | 6,4            | 10             | 1040     | 2,6                                          | KMTA 30 | B 180-195              | M 10                                | 35           |             |  |

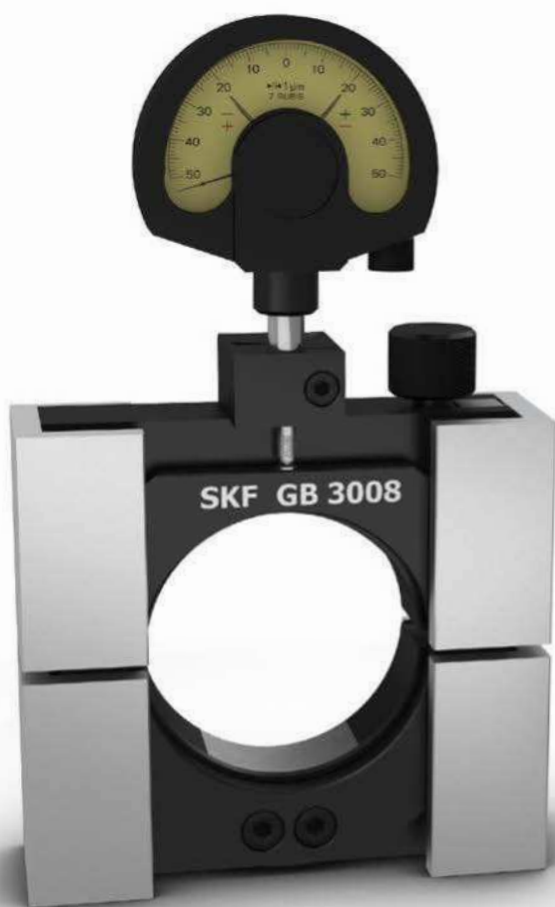
| Dimensions     |                |                |                |    |                |                |                |                |       | Axial load<br>carrying<br>capacity<br>static | Mass           | Designations |                        | Grub (set) screw |                                     |
|----------------|----------------|----------------|----------------|----|----------------|----------------|----------------|----------------|-------|----------------------------------------------|----------------|--------------|------------------------|------------------|-------------------------------------|
| G              | d <sub>1</sub> | d <sub>3</sub> | d <sub>4</sub> | B  | J <sub>1</sub> | J <sub>2</sub> | N <sub>1</sub> | N <sub>2</sub> |       |                                              |                | Lock nut     | Appropriate<br>spanner | Size             | Recommended<br>tightening<br>torque |
| mm             |                |                |                |    |                |                |                |                |       | kN                                           | kg             | –            |                        | –                | Nm                                  |
| <b>M 160x3</b> | 190            | 205            | 162            | 32 | 185            | 17             | 8,4            | 10             | 1 100 | 3,15                                         | <b>KMTA 32</b> | B 205-220    | M 10                   | 35               |                                     |
| <b>M 170x3</b> | 205            | 215            | 172            | 32 | 195            | 17             | 8,4            | 10             | 1 160 | 3,3                                          | <b>KMTA 34</b> | B 205-220    | M 10                   | 35               |                                     |
| <b>M 180x3</b> | 215            | 230            | 182            | 32 | 210            | 17             | 8,4            | 10             | 1 220 | 3,9                                          | <b>KMTA 36</b> | B 230-245    | M 10                   | 35               |                                     |
| <b>M 190x3</b> | 225            | 240            | 192            | 32 | 224            | 17             | 8,4            | 10             | 1 280 | 4,1                                          | <b>KMTA 38</b> | B 230-245    | M 10                   | 35               |                                     |
| <b>M 200x3</b> | 237            | 245            | 202            | 32 | 229            | 17             | 8,4            | 10             | 1 340 | 3,85                                         | <b>KMTA 40</b> | B 230-245    | M 10                   | 35               |                                     |

### 7.3 KMD precision lock nuts with axial locking screws M 20x1 – M 105x2



| Dimensions |                |                |                |    |    |     | Axial load<br>carrying<br>capacity<br>static | Mass | Designations |                        | Locking screws |                                     |
|------------|----------------|----------------|----------------|----|----|-----|----------------------------------------------|------|--------------|------------------------|----------------|-------------------------------------|
| G          | d <sub>1</sub> | d <sub>3</sub> | d <sub>5</sub> | B  | b  | h   |                                              |      | Lock nut     | Appropriate<br>spanner | Size           | Recommended<br>tightening<br>torque |
| mm         |                |                |                |    |    |     | kN                                           | kg   | –            |                        | –              | Nm                                  |
| M 20x1     | 38             | 40             | 39             | 18 | 5  | 2   | 70                                           | 0,11 | KMD 4        | HN 5-6                 | M 4            | 4,2                                 |
| M 25x1,5   | 43             | 45             | 44             | 20 | 5  | 2   | 95                                           | 0,14 | KMD 5        | HN 5-6                 | M 4            | 4,2                                 |
| M 30x1,5   | 48             | 50             | 49             | 20 | 5  | 2   | 105                                          | 0,2  | KMD 6        | HN 5-6                 | M 4            | 4,2                                 |
| M 35x1,5   | 53             | 58             | 57             | 22 | 6  | 2,5 | 120                                          | 0,24 | KMD 7        | HN 8-9                 | M 4            | 4,2                                 |
| M 40x1,5   | 58             | 63             | 62             | 22 | 6  | 2,5 | 130                                          | 0,27 | KMD 8        | HN 8-9                 | M 4            | 4,2                                 |
| M 45x1,5   | 66,5           | 71,5           | 70,5           | 22 | 7  | 3   | 150                                          | 0,36 | KMD 9        | HN 10-11               | M 4            | 4,2                                 |
| M 50x1,5   | 70             | 75             | 74             | 25 | 7  | 3   | 200                                          | 0,41 | KMD 10       | HN 10-11               | M 4            | 4,2                                 |
| M 55x2     | 75             | 80             | 79             | 25 | 7  | 3   | 160                                          | 0,46 | KMD 11 P     | HN 12-13               | M 4            | 4,2                                 |
| M 60x2     | 80             | 85             | 84             | 26 | 7  | 3   | 175                                          | 0,5  | KMD 12 P     | HN 12-13               | M 4            | 4,2                                 |
| M 65x2     | 85             | 90             | 89             | 28 | 8  | 3,5 | 295                                          | 0,63 | KMD 13       | HN 14                  | M 5            | 8,4                                 |
| M 70x2     | 90             | 95             | 94             | 28 | 8  | 3,5 | 320                                          | 0,67 | KMD 14       | HN 14                  | M 5            | 8,4                                 |
| M 75x2     | 95             | 100            | 99             | 28 | 8  | 3,5 | 340                                          | 0,72 | KMD 15       | HN 15                  | M 5            | 8,4                                 |
| M 80x2     | 105            | 110            | 109            | 32 | 8  | 3,5 | 445                                          | 1,05 | KMD 16       | HN 17                  | M 6            | 14,2                                |
| M 85x2     | 110            | 115            | 114            | 32 | 10 | 4   | 470                                          | 1,2  | KMD 17       | HN 17                  | M 6            | 14,2                                |
| M 90x2     | 115            | 120            | 119            | 32 | 10 | 4   | 500                                          | 1,2  | KMD 18       | HN 18-20               | M 6            | 14,2                                |
| M 95x2     | 120            | 125            | 124            | 32 | 10 | 4   | 525                                          | 1,25 | KMD 19       | HN 18-20               | M 6            | 14,2                                |
| M 100x2    | 125            | 130            | 129            | 32 | 10 | 4   | 555                                          | 1,3  | KMD 20       | HN 18-20               | M 6            | 14,2                                |
| M 105x2    | 130            | 135            | 134            | 32 | 10 | 4   | 580                                          | 1,35 | KMD 21       | HN 18-20               | M 6            | 14,2                                |







# Gauges

|                                                            |            |
|------------------------------------------------------------|------------|
| <b>GRA 30 ring gauges</b> . . . . .                        | <b>393</b> |
| Measuring options. . . . .                                 | 393        |
| Tapered seat dimensions. . . . .                           | 393        |
| <b>8.1</b> Product table. . . . .                          | 394        |
| <b>DMB taper gauges</b> . . . . .                          | <b>396</b> |
| Measuring . . . . .                                        | 396        |
| Accuracy . . . . .                                         | 396        |
| <b>8.2</b> Product table. . . . .                          | 398        |
| <b>GB 30 and GB 10 internal clearance gauges</b> . . . . . | <b>400</b> |
| Gauging . . . . .                                          | 401        |
| Accuracy . . . . .                                         | 401        |
| <b>8.3</b> Product table. . . . .                          | 402        |
| <b>GB 49 internal clearance gauges</b> . . . . .           | <b>404</b> |
| Gauging . . . . .                                          | 405        |
| Accuracy . . . . .                                         | 405        |
| <b>8.4</b> Product table. . . . .                          | 406        |

Conventional measuring methods and instruments are not always suitable for checking tapered seats or measuring the inside or outside envelope diameter of the roller set of a cylindrical roller bearing in precision applications. Therefore, SKF has developed an assortment of gauges specially designed to take the accurate measurements necessary when mounting cylindrical roller bearings with a tapered bore. These gauges are also useful for other than precision applications.

Ring gauges in the GRA 30 series and DMB taper gauges (→ **page 392**) can be used to check the most common tapered seats. A GRA ring gauge can only be used to check a tapered seat for a particular bearing size. DMB taper gauges, however, can be used for a range of diameters, as well as for tapers other than 1:12.

To precisely adjust the radial internal clearance or preload when mounting a cylindrical roller bearing with a tapered bore, it is necessary to accurately measure the inside or outside envelope diameter of the roller set(s). SKF internal clearance gauges in the GB 30 and GB 10 series (→ **page 392**), and in the GB 49 series (→ **page 392**) enable simple and accurate measuring.

For information about other SKF measuring devices, contact the SKF application engineering service.

## GRA 30 ring gauges

SKF ring gauges in the GRA 30 series (→ **fig. 1**) are typically used to check tapered shaft seats for cylindrical roller bearings in the NN 30 K series. Shaft seats for bearings in the NNU 49 BK and the N 10 K series can also be checked with a GRA 30 series gauge.

GRA 30 ring gauges are available for tapered seats with  $d \leq 200$  mm. For seats with  $d > 200$  mm, SKF recommends using a taper gauge (→ *DMB taper gauges*, **page 393**). Ring gauges for  $d > 200$  mm would be difficult to handle because of their weight.

### Measuring options

GRA 30 ring gauges are used primarily to determine the position of the tapered seat relative to a reference surface on the shaft. The reference face of a GRA 30 ring gauge is on the side of its large bore diameter. The reference surface on the shaft may be either in front of, or behind the gauging face of the ring gauge. GRA 30 ring gauges can also be used to check whether the centreline of the tapered seat is at right angles to a reference surface on the shaft. This is achieved by measuring the distance between the reference face on the ring gauge and the reference surface on the shaft at several positions around the circumference.

Taper form errors can be detected using blue dye.

### Tapered seat dimensions

SKF recommends using the tapered seat dimensions for bearings in the NN 30 K series listed in the product tables (→ **page 393**). If other dimensions or bearing series are used, the reference length  $B_c$  should always be longer than  $B_b$ , the width of the intermediate spacer ring (→ **product table**, **page 393**). This is necessary because the bearing will be driven up further on the seat than the ring gauge, depending on the bearing internal clearance or preload that should be achieved. Therefore, always make the reference length longer than the width of the intermediate ring at least by a value corresponding to the difference  $B_c - B_b$  (→ **product table**).

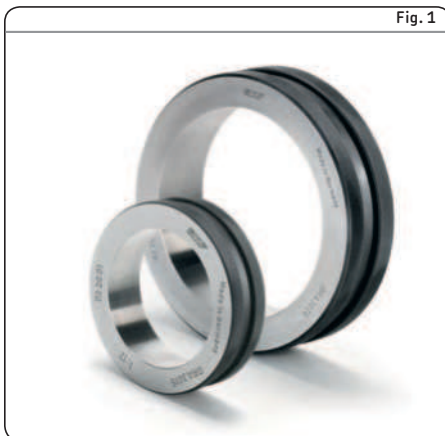
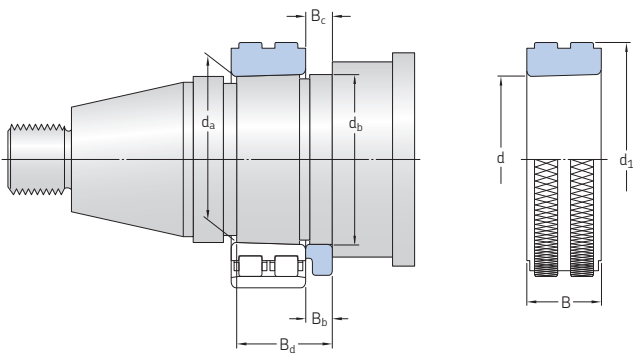


Fig. 1

8.1 GRA 30 ring gauges  
d 25 – 200 mm



| Bearing<br>Designation | Bearing seat<br>Dimensions |                |                |                                |                | B <sub>d</sub> | Ring gauge<br>Dimensions |                |    | Mass | Designation |
|------------------------|----------------------------|----------------|----------------|--------------------------------|----------------|----------------|--------------------------|----------------|----|------|-------------|
|                        | d <sub>a</sub>             | d <sub>b</sub> | B <sub>b</sub> | B <sub>c</sub><br>Nom-<br>inal | Toler-<br>ance |                | d                        | d <sub>1</sub> | B  |      |             |
| –                      | mm                         |                |                |                                |                |                | mm                       |                |    | kg   | –           |
| NN 3005 K              | 25,1                       | 27             | 4              | 4,2                            | ±0,1           | 19             | 25                       | 46             | 16 | 0,13 | GRA 3005    |
| NN 3006 KTN            | 30,1                       | 32             | 6              | 6,2                            | ±0,1           | 24             | 30                       | 52             | 19 | 0,18 | GRA 3006    |
| NN 3007 K              | 35,1                       | 37             | 6              | 6,2                            | ±0,1           | 25             | 35                       | 57             | 20 | 0,21 | GRA 3007    |
| NN 3008 KTN            | 40,1                       | 42             | 8              | 8,2                            | ±0,1           | 28             | 40                       | 62             | 21 | 0,26 | GRA 3008    |
| NN 3009 KTN            | 45,1                       | 47             | 8              | 8,2                            | ±0,1           | 30             | 45                       | 67             | 23 | 0,31 | GRA 3009    |
| NN 3010 KTN            | 50,1                       | 52             | 8              | 8,2                            | ±0,1           | 30             | 50                       | 72             | 23 | 0,34 | GRA 3010    |
| NN 3011 KTN            | 55,15                      | 57             | 8              | 8,3                            | ±0,12          | 32,5           | 55                       | 77             | 26 | 0,42 | GRA 3011    |
| NN 3012 KTN            | 60,15                      | 62             | 10             | 10,3                           | ±0,12          | 34,5           | 60                       | 82             | 26 | 0,45 | GRA 3012    |
| NN 3013 KTN            | 65,15                      | 67             | 10             | 10,3                           | ±0,12          | 34,5           | 65                       | 88             | 26 | 0,51 | GRA 3013    |
| NN 3014 KTN            | 70,15                      | 73             | 10             | 10,3                           | ±0,12          | 38,5           | 70                       | 95             | 30 | 0,69 | GRA 3014    |
| NN 3015 KTN            | 75,15                      | 78             | 10             | 10,3                           | ±0,12          | 38,5           | 75                       | 100            | 30 | 0,73 | GRA 3015    |
| NN 3016 KTN            | 80,15                      | 83             | 12             | 12,3                           | ±0,12          | 44,5           | 80                       | 105            | 34 | 0,88 | GRA 3016    |
| NN 3017 KTN9           | 85,2                       | 88             | 12             | 12,4                           | ±0,15          | 44             | 85                       | 112            | 34 | 1    | GRA 3017    |
| NN 3018 KTN9           | 90,2                       | 93             | 12             | 12,4                           | ±0,15          | 47             | 90                       | 120            | 37 | 1,3  | GRA 3018    |
| NN 3019 KTN9           | 95,2                       | 98             | 12             | 12,4                           | ±0,15          | 47             | 95                       | 128            | 37 | 1,55 | GRA 3019    |
| NN 3020 KTN9           | 100,2                      | 103            | 12             | 12,4                           | ±0,15          | 47             | 100                      | 135            | 37 | 1,7  | GRA 3020    |
| NN 3021 KTN9           | 105,2                      | 109            | 12             | 12,4                           | ±0,15          | 51             | 105                      | 142            | 41 | 2,1  | GRA 3021    |
| NN 3022 KTN9           | 110,25                     | 114            | 12             | 12,5                           | ±0,15          | 54,5           | 110                      | 150            | 45 | 2,6  | GRA 3022    |
| NN 3024 KTN9           | 120,25                     | 124            | 15             | 15,5                           | ±0,15          | 58,5           | 120                      | 162            | 46 | 3,05 | GRA 3024    |
| NN 3026 KTN9           | 130,25                     | 135            | 15             | 15,5                           | ±0,15          | 64,5           | 130                      | 175            | 52 | 3,95 | GRA 3026    |

| Bearing<br>Designation | Bearing seat<br>Dimensions |                | B <sub>b</sub> | B <sub>c</sub><br>Nom-<br>inal | Toler-<br>ance | B <sub>d</sub> | Ring gauge<br>Dimensions |                | B  | Mass | Designation |
|------------------------|----------------------------|----------------|----------------|--------------------------------|----------------|----------------|--------------------------|----------------|----|------|-------------|
|                        | d <sub>a</sub>             | d <sub>b</sub> |                |                                |                |                | d                        | d <sub>1</sub> |    |      |             |
| –                      | mm                         |                |                |                                |                |                | mm                       |                |    | kg   | –           |
| NN 3028 K              | 140,3                      | 145            | 15             | 15,6                           | ±0,15          | 65             | 140                      | 188            | 53 | 4,75 | GRA 3028    |
| NN 3030 K              | 150,3                      | 155            | 15             | 15,6                           | ±0,15          | 68             | 150                      | 200            | 56 | 5,6  | GRA 3030    |
| NN 3032 K              | 160,3                      | 165            | 15             | 15,6                           | ±0,15          | 72             | 160                      | 215            | 60 | 6,8  | GRA 3032    |
| NN 3034 K              | 170,3                      | 176            | 15             | 15,6                           | ±0,15          | 79             | 170                      | 230            | 67 | 8,8  | GRA 3034    |
| NN 3036 K              | 180,35                     | 187            | 20             | 20,7                           | ±0,15          | 90,5           | 180                      | 245            | 74 | 11,5 | GRA 3036    |
| NN 3038 K              | 190,35                     | 197            | 20             | 20,7                           | ±0,18          | 91,5           | 190                      | 260            | 75 | 13   | GRA 3038    |
| NN 3040 K              | 200,35                     | 207            | 20             | 20,7                           | ±0,18          | 98,5           | 200                      | 270            | 82 | 15   | GRA 3040    |

## DMB taper gauges

SKF taper gauges in the DMB series enable a quick and accurate check of the diameter and the angle of external tapers. They are suitable for final checks as well as for intermediate checks during machining. DMB taper gauges are available for tapered seats from  $d = 40$  to  $360$  mm.

DMB taper gauges ( $\rightarrow$  **fig. 2**) consist of:

- two saddles (**a**), firmly joined together at a fixed distance
- a gauge pin (**b**), positioned in each of the saddles
- two adjustable radial stops (**c** and **d**), in each saddle at  $90^\circ$  intervals from the gauge pin
- an axial stop (**e**) to locate the gauge axially on the taper

The gauge pins and the radial stops can be set to measure any taper angle between  $0^\circ$  and  $6^\circ$  and any diameter within the range of the gauge. Markings on the scales show the settings for 1:12 and 1:30 tapers.

As standard, DMB taper gauges are supplied together with two dial indicators. Tailored reference tapers can be supplied on request.

## Measuring

Set the radial stops and straight edges of the gauge pins to the desired diameter and taper angle, using the scales. Then, adjust the axial stop on the taper to be measured. Put the gauge on a reference taper and set the dials to zero. The gauge is now ready to take measurements.

To take a measurement, put the DMB taper gauge on the taper to be measured, making sure that it is up against the axial stop. Then take a reading. The readings on the dials are the diameter deviations. A difference in the readings between the two dials indicates a deviation in the taper angle.

While measuring, the gauge should be inclined at about  $10^\circ$  from the horizontal plane ( $\rightarrow$  **fig. 3**). In this position, the gauge is located on the taper by the radial and axial stops.

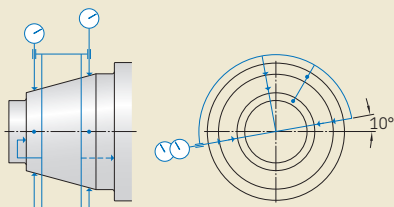
## Accuracy

The measuring accuracy of DMB taper gauges is within  $1\text{ }\mu\text{m}$  for  $d < 280$  mm and within  $1,5\text{ }\mu\text{m}$  for  $d \geq 280$  mm.

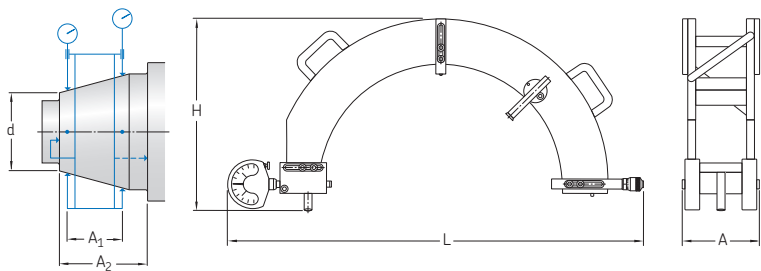
Fig. 2



Fig. 3



8.2 DMB taper gauges  
d 40 – 360 mm



| Taper Diameter |     | Taper gauge Dimensions |                |                |     |     | Mass | Designation |
|----------------|-----|------------------------|----------------|----------------|-----|-----|------|-------------|
| d from         | to  | A                      | A <sub>1</sub> | A <sub>2</sub> | H   | L   |      |             |
| mm             |     | mm                     |                |                |     |     | kg   | –           |
| 40             | 55  | 36                     | 18             | 28             | 140 | 320 | 2,5  | DMB 4/5,5   |
| 50             | 85  | 38                     | 20             | 30             | 160 | 350 | 2,5  | DMB 5/8,5   |
| 80             | 120 | 48                     | 30             | 40             | 190 | 380 | 3    | DMB 8/12    |
| 120            | 160 | 58                     | 40             | 50             | 190 | 425 | 3,5  | DMB 12/16   |
| 160            | 200 | 74                     | 50             | 64             | 190 | 465 | 4,5  | DMB 16/20   |
| 200            | 240 | 84                     | 60             | 74             | 215 | 505 | 5,5  | DMB 20/24   |
| 240            | 280 | 99                     | 75             | 89             | 240 | 540 | 7    | DMB 24/28   |
| 280            | 320 | 114                    | 90             | 104            | 265 | 590 | 8,5  | DMB 28/30   |
| 320            | 360 | 114                    | 90             | 104            | 290 | 640 | 10   | DMB 32/36   |





## GB 30 and GB 10 internal clearance gauges

SKF internal clearance gauges in the GB 30 and GB 10 series are designed for use with double row cylindrical roller bearings ranging from NN 3006 K to NN 3068 K (GB 30 gauges) and for use with single row cylindrical roller bearings ranging from N 1010 K to NN 1020 K (GB 10 gauges). In general, gauges in the GB 30 series can also be used for single row bearings in the N 10 K series. GB 30 and GB 10 internal clearance gauges are able to accurately measure the outside envelope diameter of the roller set when the rollers are in contact with the inner ring raceway.

Depending on their size, GB 30 and GB 10 internal clearance gauges consist of either a two piece or a slotted gauge body that holds two diametrically opposed ground gauging zones (→ **fig. 4**). The gauge body can be expanded by means of an adjustment screw. This enables the gauge to be pushed over the

inner ring with roller and cage assembly, without damaging the rollers or the gauging zones. The gauging zone that is connected to one half of the gauge body transmits the diameter measured by both gauging zones to a dial indicator.

Fig. 4



GB 3006 ... GB 3020  
GB 1010 ... GB 1020

GB 3021 ... GB 3068

## Gauging

The typical gauging procedure:

- 1 Set a bore gauge to the raceway diameter of the mounted outer ring and zero the dial indicator.
- 2 Place the bore gauge in the centre of the gauging zone of the GB 30 or GB 10 gauge. Adjust the GB 30 or GB 10 gauge until the bore gauge indicates zero minus the correction value listed in the GB 30 or GB 10 user instructions.
- 3 Further adjust the GB 30 or GB 10 gauge by increasing the gauge dimension by the value of the desired preload or reduce it by the desired clearance. Zero the dial indicator on the GB 30 or GB 10.
- 4 Place the bearing inner ring and roller set assembly onto the tapered shaft seat. Place the GB 30 or GB 10 gauge over the rollers and drive the inner ring up on the tapered seat until the dial indicator on the GB 30 or GB 10 reads zero.

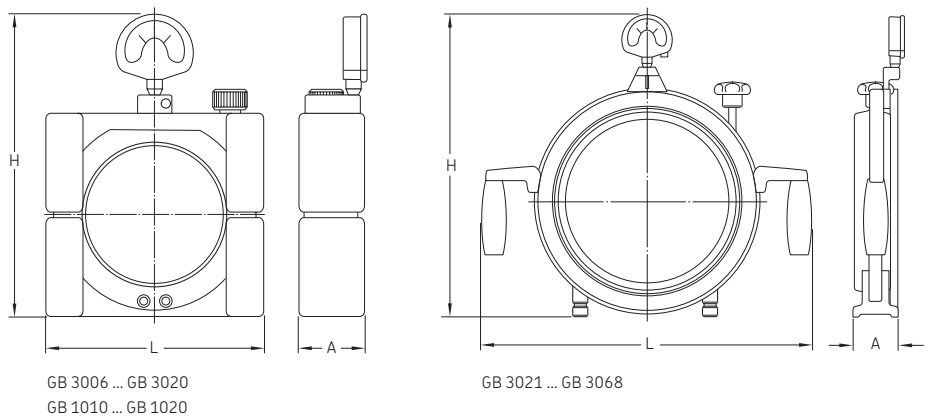
For additional information, refer to *Mounting* on **page 401**.

## Accuracy

The accuracy of GB 30 and GB 10 gauges is within 1 µm for sizes ≤ 20 (GB 3006 to GB 3020 and GB 1010 to GB 1020) and within 2 µm for sizes ≥ 21 (GB 3021 to GB 3068).

### 8.3 GB 30 and GB 10 internal clearance gauges for cylindrical roller bearings

**NN 3006 KTN – NN 3068 K**  
**N 1010 K – N 1020 K**



| Bearing<br>Designation | Internal clearance gauge<br>Dimensions |     |    | Mass | Designation |
|------------------------|----------------------------------------|-----|----|------|-------------|
|                        | L                                      | H   | A  |      |             |
| –                      | mm                                     |     |    | kg   | –           |
| NN 3006 KTN            | 107                                    | 175 | 36 | 2    | GB 3006     |
| NN 3007 K              | 112                                    | 180 | 37 | 2    | GB 3007     |
| NN 3008 KTN            | 117                                    | 185 | 39 | 2    | GB 3008     |
| NN 3009 KTN            | 129                                    | 197 | 40 | 2,5  | GB 3009     |
| NN 3010 KTN            | 134                                    | 202 | 40 | 2,5  | GB 3010     |
| N 1010 K               | 134                                    | 207 | 33 | 2    | GB 1010     |
| NN 3011 KTN            | 144                                    | 212 | 43 | 3,5  | GB 3011     |
| N 1011 K               | 144                                    | 217 | 35 | 2,3  | GB 1011     |
| NN 3012 KTN            | 152                                    | 222 | 44 | 4    | GB 3012     |
| N 1012 K               | 152                                    | 225 | 36 | 2,7  | GB 1012     |
| NN 3013 KTN            | 157                                    | 225 | 44 | 4    | GB 3013     |
| N 1013 K               | 157                                    | 230 | 36 | 3    | GB 1013     |
| NN 3014 KTN            | 164                                    | 232 | 48 | 5    | GB 3014     |
| N 1014 K               | 164                                    | 237 | 38 | 3,2  | GB 1014     |
| NN 3015 KTN            | 168                                    | 236 | 48 | 5    | GB 3015     |
| N 1015 K               | 168                                    | 241 | 38 | 3,4  | GB 1015     |
| NN 3016 KTN            | 176                                    | 244 | 52 | 6    | GB 3016     |
| N 1016 K               | 176                                    | 249 | 40 | 4    | GB 1016     |
| NN 3017 KTN9           | 185                                    | 253 | 53 | 6,5  | GB 3017     |
| N 1017 K               | 185                                    | 258 | 41 | 4,5  | GB 1017     |
| NN 3018 KTN9           | 198                                    | 266 | 56 | 8    | GB 3018     |
| N 1018 K               | 198                                    | 271 | 43 | 5,5  | GB 1018     |
| NN 3019 KTN9           | 203                                    | 271 | 56 | 9    | GB 3019     |
| N 1019 K               | 203                                    | 276 | 43 | 5,8  | GB 1019     |
| NN 3020 KTN9           | 212                                    | 280 | 56 | 9    | GB 3020     |
| N 1020 K               | 212                                    | 285 | 43 | 6,5  | GB 1020     |

| Bearing<br>Designation | Internal clearance gauge<br>Dimensions |     |     | Mass | Designation |
|------------------------|----------------------------------------|-----|-----|------|-------------|
|                        | L                                      | H   | A   |      |             |
| –                      | mm                                     |     |     | kg   | –           |
| NN 3021 KTN9           | 322                                    | 350 | 46  | 10,5 | GB 3021     |
| NN 3022 KTN9           | 332                                    | 362 | 46  | 11   | GB 3022     |
| NN 3024 KTN9           | 342                                    | 376 | 48  | 12   | GB 3024     |
| NN 3026 KTN9           | 364                                    | 396 | 54  | 13   | GB 3026     |
| NN 3028 K              | 378                                    | 410 | 54  | 14,5 | GB 3028     |
| NN 3030 K              | 391                                    | 426 | 58  | 15   | GB 3030     |
| NN 3032 K              | 414                                    | 446 | 60  | 16   | GB 3032     |
| NN 3034 K              | 430                                    | 464 | 62  | 17   | GB 3034     |
| NN 3036 K              | 454                                    | 490 | 70  | 17,5 | GB 3036     |
| NN 3038 K              | 468                                    | 504 | 70  | 18   | GB 3038     |
| NN 3040 K              | 488                                    | 520 | 74  | 19   | GB 3040     |
| NN 3044 K              | 575                                    | 514 | 85  | 26   | GB 3044     |
| NN 3048 K              | 605                                    | 534 | 87  | 28   | GB 3048     |
| NN 3052 K              | 654                                    | 580 | 104 | 41   | GB 3052     |
| NN 3056 K              | 680                                    | 607 | 106 | 45   | GB 3056     |
| NN 3064 K              | 725                                    | 640 | 122 | 60   | GB 3064     |
| NN 3068 K              | 738                                    | 665 | 122 | 64   | GB 3068     |

## GB 49 internal clearance gauges

SKF internal clearance gauges in the GB 49 series are designed for use with double row cylindrical roller bearings ranging from NNU 4920 BK to NNU 4960 BK. GB 49 series internal clearance gauges are able to accurately measure the internal envelope diameter of the roller set when the rollers are in contact with the outer ring raceway.

Depending on their size, GB 49 internal clearance gauges are available in two different designs (→ **fig. 5**). They have a slotted gauge body, so that both gauging ring halves can be brought to bear on the roller set with the appropriate pressure, as a result of the inherent resilience of the material. The outside cylindrical surface of the gauging ring has two diametrically opposed ground gauging zones. The gauge body can be compressed by means of an adjustment screw. This enables the gauge to be positioned inside the roller set

without damaging the rollers or the gauging zones.

Fig. 5



GB 4920 ... GB 4938

GB 4940 ... GB 4960

## Gauging

The typical gauging procedure:

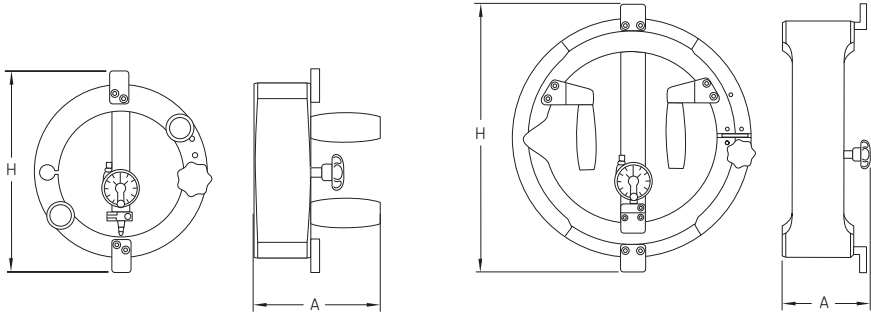
- 1** Insert the GB 49 gauge in the outer ring and roller assembly and loosen the adjustment screw until the two gauging ring halves are in contact with the roller set.
- 2** Set the dial indicator on the GB 49 gauge to zero.
- 3** Compress GB 49 using adjustment screw and remove from outer ring assembly.
- 4** Reset GB 49 so that dial indicator reads zero again using adjustment screw.
- 5** Set a stirrup gauge to GB 49 gauge diameter setting the stirrup gauge dial indicator to zero.
- 6** Drive the inner ring up onto its tapered seat monitoring the diameter expansion with the stirrup gauge until the dial indicator reads zero plus the desired preload or zero minus the desired clearance.

For additional information, refer to *Mounting* on **page 405**.

## Accuracy

The accuracy of GB 49 gauges is within 1 µm for sizes ≤ 38 (GB 4920 to GB 4938) and within 2 µm for sizes ≥ 40 (GB 4940 to GB 4960).

8.4 GB 49 internal clearance gauges for cylindrical roller bearings  
 NNU 4920 BK/SPW33 – NNU 4960 BK/SPW33



GB 4920 ... GB 4938

GB 4940 ... GB 4960

| Bearing<br>Designation | Internal clearance gauge<br>Dimensions |     | Mass | Designation |
|------------------------|----------------------------------------|-----|------|-------------|
|                        | A                                      | H   |      |             |
| –                      | mm                                     |     | kg   | –           |
| NNU 4920 BK/SPW33      | 128                                    | 138 | 2,5  | GB 4920     |
| NNU 4921 BK/SPW33      | 128                                    | 143 | 3    | GB 4921     |
| NNU 4922 BK/SPW33      | 128                                    | 148 | 3    | GB 4922     |
| NNU 4924 BK/SPW33      | 133                                    | 162 | 3,5  | GB 4924     |
| NNU 4926 BK/SPW33      | 138                                    | 176 | 4    | GB 4926     |
| NNU 4928 BK/SPW33      | 138                                    | 186 | 4,5  | GB 4928     |
| NNU 4930 BK/SPW33      | 148                                    | 204 | 6    | GB 4930     |
| NNU 4932 BK/SPW33      | 148                                    | 212 | 6,5  | GB 4932     |
| NNU 4934 BK/SPW33      | 148                                    | 224 | 8    | GB 4934     |
| NNU 4936 BK/SPW33      | 157                                    | 237 | 9,5  | GB 4936     |
| NNU 4938 BK/SPW33      | 157                                    | 248 | 10,5 | GB 4938     |
| NNU 4940 BK/SPW33      | 105                                    | 263 | 12   | GB 4940     |
| NNU 4944 BK/SPW33      | 105                                    | 283 | 13   | GB 4944     |
| NNU 4948 BK/SPW33      | 105                                    | 303 | 14   | GB 4948     |
| NNU 4952 BK/SPW33      | 120                                    | 340 | 15   | GB 4952     |
| NNU 4956 BK/SPW33      | 120                                    | 360 | 17   | GB 4956     |
| NNU 4960 BK/SPW33      | 135                                    | 387 | 19   | GB 4960     |





# Indexes

|                    |     |
|--------------------|-----|
| Text index.....    | 409 |
| Product index..... | 420 |

# Text index

## A

### A

- angular contact ball bearings 197
- axial-radial cylindrical roller bearings 333
- double direction angular contact thrust ball bearings 303, 311
- thrust bearings for screw drives 342, 364–365

**AC** 130, 196

**ACB** 196

accuracy

- of bearings 24–25
- of seats and abutments 75–77, 325–326
- of seats and abutments (for screw drives) 349
- tolerance symbol definitions 48–49

**ACD** 196

**ACE** 196

acrylonitrile-butadiene rubber (NBR) 56

adapter sleeves 126

adjusting

- angular contact ball bearings 166–172, 192
- cylindrical roller bearings 278–279, 280–283, 392
- precision lock nuts 380–381

ageing 55–56, 101, 114, 125

air flow

- effect on relubrication interval 109
- in an external sealing arrangement 96
- in an oil-air lubrication system 121

aluminium thickeners 110

ambient temperature

- considerations when selecting a grease 99
- effect on bearing speed capability 39

angular contact ball bearings 127–261

- adjustment during mounting 166–172, 192
- applications 58–64, 131–132
- assortment 128–129

axial displacement 31, 69, 91, 166

bearing arrangements 141–144

cages 134–135

contact angles 130–131

designation system 196–197

designs and variants 21, 128–141

dimension series 27, 129, 130

dimension standards 146

direct oil-air lubrication variants 120, 136–140

dismounting 124

equivalent bearing loads 190–191

fits 71–74

fitting and clamping bearing rings 183–189

high-capacity bearings 129, 131

high-speed design bearings 129, 132

hybrid bearings 133, 141, 167, 198–261

initial grease fill 101–102, 105

lifting forces 91–92

load carrying capacity 30, 189

location 183–189

lubrication (grease) 99–112, 136, 192

lubrication (oil) 113–122, 136–140, 192

markings 145, 194

matched sets 141–144

mounted with spacer rings 166–172, 192–193

mounting 123, 136, 145, 194

oil nozzle positions 118, 199–261

ordering possibilities 141

preload 50, 69, 90–93, 151–172

product table 198–261

reference grease quantities 102, 199–261

relubrication intervals 106–109

reuse 124

sealed bearings 136, 192

speeds 28–29, 38–40, 42, 192–193

spring-loaded 64, 90, 93, 165, 190

stiffness 67–69, 173–182

temperature limits 136

temperature rise as a function of speed 38

tolerance classes and tolerances 24, 146–150

universally matchable bearings 141–144, 194

with NitroMax steel rings 52–53, 141

angular contact thrust ball bearings

cartridge units (for screw drives) 342–343, 372–373

designs and variants 21–22

double direction bearings 301–317

double direction bearings (for screw drives) 341, 368–371

single direction bearings (for screw drives) 340, 366–367

angularity 76

anhydrous hydrofluorides 56

annular grooves

in angular contact ball bearings 120, 136–140

in cylindrical roller bearings 266

in double direction angular contact thrust ball bearings

303–304

in shafts 96–97

in thrust bearings for screw drives 341

applications

for angular contact ball bearings 58–64, 131–132

for axial-radial cylindrical roller bearings 320

for cylindrical roller bearings 57–59, 62

for double direction angular contact thrust ball bearings 57,

59

for thrust bearings for screw drives 350–351

machine tools 57–64

associated components 20

accuracy of seats and abutments 75–77, 325–326

accuracy of seats and abutments (for screw drives) 349

provisions for mounting and dismounting 88–89

attachment bolts

for axial-radial cylindrical roller bearings 330–332, 335

for thrust bearings for screw drives 371, 373

attainable speeds 28, 44

with grease lubrication 42–43, 45

with oil lubrication 40–41, 45

axial clamping forces 184, 186–188

axial displacement

considerations when selecting a bearing 31

considerations when selecting a fit 70, 72

in angular contact ball bearings 31, 69, 91, 166

Note: Designation prefixes and suffixes are shown in **bold**.

- in cylindrical roller bearings 31, 264, 269, 280
- axial drive-up 278–279, 280, 284
- axial fitting forces 184, 186–188
- axial location 78–87
  - with precision lock nuts 78, 375–389
  - with stepped sleeves 79, 80–87
- axial locking screws 377, 378, 381
- axial preload
  - in angular contact ball bearings 151–172
  - in axial-radial cylindrical roller bearings 322–323
  - in double direction angular contact thrust ball bearings 308
  - in thrust bearings for screw drives 355–357, 358
- axial stiffness
  - of angular contact ball bearings 173–182
  - of axial-radial cylindrical roller bearings 322–323
  - of cylindrical roller bearings 275–276
  - of double direction angular contact thrust ball bearings 309
  - of thrust bearings for screw drives 339, 356–359
  - of typical spindle bearing systems 67
- axial-radial cylindrical roller bearings 319–335
  - applications 320
  - associated components 324–326, 330
  - attachment bolts 330–332, 335
  - bearing damage 322
  - cages 320
  - designation system 333
  - designs and variants 22, 320
  - dimension standards 321
  - equivalent bearing loads 327
  - fits 324–326
  - friction 322–323, 330
  - load carrying capacity 30, 322, 327, 328–329
  - lubrication 320, 324
  - mounting 330–332
  - preload 322–323, 324
  - product table 334–335
  - retaining bolts 330, 335
  - running-in 324
  - stiffness 322–323
  - storage 330
  - temperature limits 324
  - tightening torques 332
  - tolerance classes and tolerances 24, 321
  - transport 330
  - unloading forces 322–323

## B

- angular contact ball bearings 196–197
- axial-radial cylindrical roller bearings 333
- cylindrical roller bearings 286
- double direction angular contact thrust ball bearings 303, 311
- thrust bearings for screw drives 365
- back-to-back arrangements
  - with angular contact ball bearings 142–144
  - with double direction angular contact thrust ball bearings 303
  - with thrust bearings for screw drives 341, 342–343, 346–348
- ball screw support bearings → thrust bearings for screw drives
- barium thickeners 110
- base oil viscosity → viscosity
- basic dynamic load rating 33
- basic rating life 34
- basic static load rating 36
- bearing damage
  - contamination 124
  - creep 70
  - false brinelling 100
  - fracture 52
  - skid smearing 133, 268, 304, 322
- bearing systems 57
- black-oxide 342
- blue dye 393

- boat gyrostabilizers 131
- bolt mounting
  - with cartridge units (for screw drives) 342–343, 372–373
  - with double direction bearings (for screw drives) 341, 370–371
- bolts
  - attachment bolts 330–332, 335, 371, 373
  - retaining bolts 330, 335
- bore gauges 282, 401
- boring machines 131
- brass
  - cages in angular contact ball bearings 134–135
  - cages in cylindrical roller bearings 265, 267
  - cages in double direction angular contact thrust ball bearings 304–305
- material properties 55

## C

- angular contact ball bearings 130, 196–197
- double direction angular contact thrust ball bearings 311
- thrust bearings for screw drives 364
- C2** 273, 286
- C3** 273, 286
- cages
  - function 23
  - in angular contact ball bearings 134–135
  - in axial-radial cylindrical roller bearings 320
  - in cylindrical roller bearings 264, 267, 268, 280
  - in double direction angular contact thrust ball bearings 304–305
  - in thrust bearings for screw drives 344
  - materials 51, 55
- calcium thickeners
  - compatibility 110
  - considerations when selecting a grease 99–100
- car wheels → racing car wheels
- carbon fibre reinforced cages 55
  - in angular contact ball bearings 134–135
  - in cylindrical roller bearings 264, 267
- cartridge units 342–343, 372–373
  - applications 350–351
  - compared to other bearings for screw drives 339
  - designation system 364–365
  - designs and variants 22, 342–343
  - dimension standards 353
  - frictional moment 359–360
  - location 342
  - preload 355
  - product table 372–373
  - sealing solutions 344–345
  - speeds 344, 363
  - stiffness 358–359
  - surface treatment 342
  - temperature limits 344–345
  - tolerance classes and tolerances 353–354
- CB** 196
- CD** 196
- CE** 196
- centrifugal forces
  - in angular contact ball bearings 132, 162, 166, 167
  - in hybrid bearings 34, 37
- ceramics 54
- chamfer dimensions 46–47
  - maximum chamfer dimension limits 47, 50
  - tolerance symbol definitions 48
- churning 111, 113
- circulating oil 113, 114, 121
- clay 110
- clearance
  - in housing seats 30, 74, 302
  - internal clearance 50–51
- CN** 273, 286

Note: Designation prefixes and suffixes are shown in **bold**.

CNC lathe spindles 57–58  
 coefficient of thermal expansion  
   effect on preload 162  
   of NitroMax steel 53  
   of silicon nitride versus steel 54  
 collars → spacer sleeves  
 collectors 96–97  
 consistency grades → NLGI consistency grades  
 contact angles  
   effect on lifting force 91–92  
   effect on load carrying capacity 30  
   effect on speed capability 30  
   effect on stiffness 26, 68–69  
   in angular contact ball bearings 130–131  
   in double direction angular contact thrust ball bearings 303  
   in thrust bearings for screw drives 340–341  
 contact seals  
   in external sealing arrangements 98  
   in thrust bearings for screw drives 32, 344–345  
 contamination  
   bearing damage 124  
   effect on relubrication interval 109  
   ISO oil contamination levels 122  
   protection prior to / during mounting 123, 125  
   protection with grease 99  
   protection with oil 114, 116  
   protection with seals 32, 95–98  
 coolants 23, 51, 122  
 cooling 39, 99, 113, 116  
 corrosion resistance  
   of NitroMax steel 52–53  
   protection prior to mounting 125  
   protection with grease 100–101  
 cotton fabric reinforced cages 55  
   in angular contact ball bearings 134–135  
 creep 70  
 cross-sectional height  
   considerations when selecting a bearing 27  
   effect on speed capability 38  
 cutting fluids 96, 106, 122  
 cyclic operation 35, 106  
 cylindrical roller bearings 263–299  
   adjustment during mounting 278–279, 280–283, 392  
   applications 57–59, 62  
   axial displacement 31, 264, 269, 280  
   axial drive-up 278–279, 280, 284  
   cages 264, 267, 268, 280  
   design considerations 278–280  
   designation system 286  
   designs and variants 21, 264–268  
   dimension standards 269  
   dismounting 124  
   double row bearings 265–267, 294–299  
   equivalent bearing loads 277  
   finish-grinding allowances 267  
   fits 71–72, 74  
   flanges 264  
   gauges for checking tapered seats 391–407  
   hybrid bearings 268, 288–293  
   identification numbers 273, 280  
   in combination with double direction bearings 302–303  
   initial grease fill 101, 103, 105  
   internal clearance 273–274, 275, 278–279  
   load carrying capacity 30  
   lubrication features 266, 268  
   markings 273, 280  
   mounted with spacer rings 78, 282–285  
   mounting 278–279, 280–285, 401, 405  
   oil nozzle positions 119, 266, 289–299  
   preload 50–51, 94, 275, 278  
   product tables 288–299  
   reference grease quantities 103, 289–299  
   relubrication 106–109, 266  
   reuse 124  
   single row bearings 264, 288–293  
   speeds 28, 40, 42, 264, 268, 277

stiffness 275–276  
 temperature rise as a function of speed 38  
 tolerance classes and tolerances 24, 269–272  
   with a pre-ground raceway 267  
   with a tapered bore 264–265, 272

## D

**D** 196–197

### DB

angular contact ball bearings 144, 197  
 double direction angular contact thrust ball bearings 311  
 thrust bearings for screw drives 342–343, 348, 365

**DBA** 308, 310, 311

**DBB** 308, 310, 311

deflection 66, 68

density 37, 54

designation systems

  for angular contact ball bearings 196–197  
   for axial-radial cylindrical roller bearings 333  
   for cylindrical roller bearings 286  
   for double direction angular contact thrust ball bearings 311  
   for precision lock nuts 382  
   for thrust bearings for screw drives 364–365

### DF

angular contact ball bearings 144, 197  
 thrust bearings for screw drives 342–343, 348, 365

dial indicators

  on internal clearance gauges 282–284, 400–401  
   on taper gauges 396

diameter series → ISO diameter series

dielectric strength 54

dimension series → ISO dimension series

dimension standards 46

dimensional accuracy

  of bearings 24–25  
   of seats and abutments 71–74, 325–326  
   of seats and abutments (for screw drives) 349  
   tolerance symbol definitions 48–49

dimensional stability → heat stabilization

direct oil-air lubrication 120

  bearing variants and dimensions 136–140

dismounting 123–124

  angular contact ball bearings 124

  cylindrical roller bearings 124

  design considerations 88–89

  thrust bearings for screw drives 341

dismounting fluids 87

distance rings 278

distance sleeves 86

double direction angular contact thrust ball bearings 301–317

  applications 57, 59

  basic design bearings 302–303, 312–317

  cages 304–305

  contact angles 303

  designation system 311

  designs and variants 21–22, 302–305

  dimension standards 306

  equivalent bearing loads 310

  fits 71–72, 74, 308

  high-speed design bearings 302–303, 312–317

  hybrid bearings 304, 312–317

  identification/serial numbers 305

  in combination with cylindrical roller bearings 302–303

  initial grease fill 101, 104–105

  lifting forces 94

  load carrying capacity 30

  lubrication (oil) 116–117, 119

  lubrication features 303–304

  markings 305

  mounting 123, 305, 310

  oil nozzle positions 119, 313–317

  preload 50, 94, 308

  product tables 312–317

Note: Designation prefixes and suffixes are shown in **bold**.

radial clearance in the housing 30, 74, 302  
 reference grease quantities 104, 313–317  
 relubrication intervals 106–109  
 speeds 38, 41, 43, 310  
 stiffness 67, 309  
 temperature rise as a function of speed 38  
 tolerance classes and tolerances 24, 306–307  
 double direction angular contact thrust ball bearings (for screw drives) 341, 368–371  
 compared to other bearings for screw drives 339  
 designation system 364–365  
 dimension standards 353  
 for bolt mounting 341, 370–371  
 frictional moment 357, 360  
 preload 355, 357  
 product tables 368–371  
 sealed bearings 344–345  
 speeds 344, 363  
 stiffness 357–358  
 temperature limits 344–345  
 tolerance classes and tolerances 353–354  
 double direction bearings 301–317  
 for screw drives 341, 368–371  
 double row cylindrical roller bearings 265, 294–299  
 applications 57  
 axial displacement 264, 269, 280  
 axial drive-up 278–279  
 cages 267  
 compared to single row cylindrical roller bearings 264  
 designs and variants 21, 265–267  
 dimension standards 269  
 equivalent bearing loads 277  
 finish-grinding allowances 267  
 gauges for checking tapered seats 391–407  
 hybrid bearings 268  
 initial grease fill 101, 103, 105  
 internal clearance 273–274, 275, 278  
 mounting 280–285, 401, 405  
 oil nozzle positions 119, 266, 295–299  
 preload 275, 278  
 product tables 294–299  
 reference grease quantities 103  
 speeds 264, 268, 277  
 stiffness 275–276  
 tolerance classes and tolerances 24, 269–272  
 drainage  
 for oil-air lubrication 117  
 in a multi-stage labyrinth sealing arrangement 96–97  
 drilling heads 60, 131, 132, 166  
 drive-up → axial drive-up  
**DT**  
 angular contact ball bearings 144, 197  
 thrust bearings for screw drives 348, 365  
 dust  
 effect on relubrication interval 109  
 protection prior to / during mounting 123  
 dynamometers 131

## E

**E** 196  
 eccentric loads 327  
 elastic deformation 66, 68  
 elasto-hydrodynamic lubrication (EHL) 100  
 electrical resistivity 54  
 electro-spindles  
 oil cleanliness requirements 122  
 with angular contact ball bearings 62–64, 132  
 with cylindrical roller bearings 62, 264  
 ellipse truncation 36  
 end plates 183–189  
 envelope diameters 280, 392, 400, 404  
 envelope requirement → ISO envelope requirement  
 environmental considerations

for fluoro rubber (FKM) 56  
 for oil mist lubrication 115  
 for oil-air lubrication 116  
 EP additives  
 compatibility 55, 100  
 considerations for grease lubrication 99–100  
 considerations for oil lubrication 121  
 equivalent bearing loads  
 dynamic 33  
 static 36  
 ester oils  
 compatibility 109  
 in sealed bearings 104  
 esters 56  
 ethers 56  
 external seals 95–98  
 extreme pressure additives → EP additives

## F

**F** 130, 196–197  
 face-to-face arrangements  
 with angular contact ball bearings 142–144  
 with thrust bearings for screw drives 342–343, 346–348  
 false brinelling 100  
 fatigue strength 52–53, 141  
**FB** 196  
**FE** 196  
 filtering 114, 117  
 finish-grinding allowances  
 for inner rings of cylindrical roller bearings 267  
 for spacer rings for angular contact ball bearings 166–172  
 fits  
 axial location 78–79  
 effect of surface roughness 75  
 effect on preload and internal clearance 50–51, 90, 94  
 effect on stiffness 68  
 for housings 72–74, 326  
 for shafts 71, 73–74, 325  
 radial location 70  
 FKM → fluoro rubber (FKM)  
 flanged housings 342–343, 372–373  
 fluoro rubber (FKM)  
 material properties 56  
 seals for angular contact ball bearings 136  
 fracture 52  
 friction 37  
 effect of preload and internal clearance 37  
 effect on speed capability 38–39  
 generated by seals 96, 98  
 with grease lubrication 37, 100, 111  
 with hybrid bearings 37  
 with oil lubrication 113–115  
 frictional losses 53, 99, 113  
 frictional moment  
 in axial-radial cylindrical roller bearings 322–323  
 in thrust bearings for screw drives 357, 360  
 with grease lubrication 111

## G

**G**  
 angular contact ball bearings 142, 196  
 axial-radial cylindrical roller bearings 320, 324, 333  
**G...**  
 angular contact ball bearings 151, 197  
 double direction angular contact thrust ball bearings 311  
 thrust bearings for screw drives 355, 364–365  
**GA**  
 angular contact ball bearings 196  
 thrust bearings for screw drives 364  
 gauge blocks 282–283

Note: Designation prefixes and suffixes are shown in **bold**.

gauges 391–407  
 bore gauges 282  
 for mounting cylindrical roller bearings 280–283  
 internal clearance gauges 280–283, 400–407  
 ring gauges 393–395  
 taper gauges 396–399

**GB**  
 angular contact ball bearings 196  
 thrust bearings for screw drives 364

**GC** 196

**GD** 196

geometrical accuracy  
 of seats and abutments 75–77, 325–326  
 of seats and abutments (for screw drives) 349

glass fibre reinforced cages  
 in angular contact ball bearings 134–135  
 in cylindrical roller bearings 264, 267, 268  
 material properties 55

**GMM** 342, 365

grease fills  
 effect on friction 37  
 in sealed angular contact ball bearings 136  
 in sealed thrust bearings for screw drives 344  
 initial grease fill 101–105

grease lubrication 99–112  
 attainable speeds 42–43  
 compared with oil lubrication (speed capability) 45  
 initial grease fill 101–105  
 relubrication 106–109  
 running-in 111–112  
 service life 106

greases  
 in sealed bearings 104  
 selection criteria 99–100  
 SKF greases 99  
 storage 122  
 thickener compatibility 110

grinding allowances → finish-grinding allowances

grinding machines 64, 93, 131, 132

grub (set) screws  
 in double direction angular contact thrust ball bearings 341  
 in precision lock nuts 378, 380, 384–388  
 in thrust bearings for screw drives 341

## H

**H** 120, 137–139, 197

**H1** 120, 137–139, 197

hammers 380

hardness  
 of bearing steel 51, 54  
 of NitroMax steel 53  
 of silicon nitride 54

**HC**  
 angular contact ball bearings 133, 197  
 double direction angular contact thrust ball bearings 304, 311

**HCS** 268, 286

heat stabilization 51, 53

heat treatment  
 of carbon chromium steel 51  
 of NitroMax steel 52–53

heating bearings → hot mounting

hollow shafts  
 fits 71  
 with cylindrical roller bearings 279  
 with stepped sleeves 81, 84

hot mounting 123–124  
 angular contact ball bearings 194  
 sealed bearings 136, 345

housing covers 79  
 in a multi-stage labyrinth sealing arrangement 96–97

humidity 125

hybrid bearings  
 angular contact ball bearings 133, 141, 167, 198–261

basic static load rating 36

cylindrical roller bearings 268, 288–293

double direction angular contact thrust ball bearings 304, 312–317

effect on relubrication interval 106–108

frictional behaviour 37

material properties 54

rating life 34

speeds 38, 40–43  
 with NitroMax steel rings 52–53, 141

hydraulic nuts 86

hydrocarbons 56

## I

identification numbers  
 on cylindrical roller bearings 273, 280  
 on double direction angular contact thrust ball bearings 305

immersion 106

impact toughness 52–53

indexing heads 320

induction heaters 123  
 for heating sealed bearings 136, 345  
 for mounting axial-radial cylindrical roller bearings 330

initial grease fills 101–105

injectors 116–117

installation 123–124  
 of precision lock nuts 379–381  
 of stepped sleeves 86–87, 123–124

integral seals  
 design considerations 98  
 in angular contact ball bearings 136  
 in thrust bearings for screw drives 344–345  
 types and designs 32

interference fits 71  
 axial location 78–79  
 effect on preload and internal clearance 50–51  
 for angular contact ball bearings 74  
 for cylindrical roller bearings 31, 74  
 for stepped sleeves 80–81, 84  
 radial location 70

internal clearance 50–51  
 effect on friction 37  
 in cylindrical roller bearings 273–274, 275, 278–279

internal clearance gauges 280–283, 400–407

internal grinding machines 64, 132, 165

ISO  
 diameter series 27, 46  
 dimension series 46  
 envelope requirement 71–72  
 general plans 46  
 oil contamination levels 122  
 tolerance classes 24, 73  
 tolerance grades 77  
 tolerance standards 46–47

IT tolerance grades 77

## K

**K** 264–265, 286

ketones 55, 56

key slots 376

keyways 376

kinematic lubricant starvation 52, 264

kinematic viscosity → viscosity

## L

**L** 120, 137–140, 197

**L1** 120, 139, 197

Note: Designation prefixes and suffixes are shown in **bold**.

- labyrinth seals
  - in a multi-stage sealing arrangement 96–97
  - integral to stepped sleeves 80, 84
- laminar rings 339, 344–345
- lathes 57–58, 131, 166
- life 33–35
- lifting forces
  - for angular contact ball bearings 91–92
  - for double direction angular contact thrust ball bearings 94
  - for thrust bearings for screw drives 94, 360
- linear springs → springs
- lithium thickeners
  - compatibility 110
  - considerations when selecting a grease 99–100
  - in sealed bearings 104
- live centres 59, 131
- loads
  - considerations when selecting a bearing 30
  - effect on relubrication interval 109
  - load ratings 33–36
  - requisite minimum loads 34
- locating/non-locating bearing systems 31
- location
  - axial 78–87
  - radial 70–77
  - with precision lock nuts 376–377
  - with stepped sleeves 79, 80–87
- lock nuts → precision lock nuts
- lock washers 376
- locking pins 376
- loose fits 71
  - effect on stiffness 31, 68
  - for non-locating bearings 31
  - radial location 70
- loosening torques 378
- lubricants
  - greases 99–101, 104, 110
  - oils 121
  - storage 122
- lubricating oils → oils
- lubrication
  - grease 99–112
  - oil 113–122
- lubrication holes
  - in angular contact ball bearings 120, 136–140
  - in axial-radial cylindrical roller bearings 324
  - in cylindrical roller bearings 266
  - in double direction angular contact thrust ball bearings 304
  - in thrust bearings for screw drives 341
- lubrication intervals 117
- of thrust bearings for screw drives 340, 346–348
- materials 51–56
  - for bearings 51–54
  - for cages 55
  - for precision lock nuts 378
  - for seals 56
- measuring systems 131
- medical equipment 131
- metal cutting machines 57–63, 132
- metal-to-metal contact 113
- microturbines 131
- milling machines 59, 62–63, 131–132, 141, 166
- mineral acids 56
- mineral oils 56, 99
  - compatibility 109
- minimum load 34
- minimum quantity lubrication (MQL)
  - with oil-air lubrication 116
  - with SKF Mircrodosage system 121
- misalignment 75
  - in thrust bearings for screw drives 346
- miscibility 109–110
- modulus of elasticity 54
- moisture
  - effect on lubricant properties 122
  - effect on relubrication interval 109
  - protection prior to / during mounting 123
  - protection with grease 99
  - protection with seals 95
- moment loads
  - on angular contact ball bearings 142, 167
  - on axial-radial cylindrical roller bearings 327, 328–329
  - on thrust bearings for screw drives 346
- moment stiffness 323
- motorized spindles → electro-spindles
- mounting 123–124
  - angular contact ball bearings 136, 145, 194
  - axial-radial cylindrical roller bearings 330–332
  - cylindrical roller bearings 280–285
  - design considerations 88–89
  - double direction angular contact thrust ball bearings 305, 310
  - precision lock nuts 379–381
  - stepped sleeves 86–87
  - thrust bearings for screw drives 339, 345, 352, 362
- mounting fluids 87
- multi-spindle heads 320

## N

- NBR → acrylonitrile-butadiene rubber (NBR)
- needle roller bearings 347
- NitroMax steel 52–53
  - in hybrid angular contact ball bearings 141
- NLGI consistency grades 99
- non-contact seals
  - in angular contact ball bearings 32, 136
  - in external sealing arrangements 96–97
  - in thrust bearings for screw drives 32, 344–345

## O

- oil bath 114
  - attainable speeds 44
- oil change intervals 121
- oil distribution grooves 89
- oil drop 115
- oil flow rates 113–114
- oil injection method
  - dimensions for ducts, grooves and holes 88–89
  - equipment and pressure media 87
  - for cylindrical roller bearings 285
  - for stepped sleeves 80, 86–87

Note: Designation prefixes and suffixes are shown in **bold**.



- oil jet 115
    - attainable speeds 44
    - lubricating oils 121
  - oil lubrication 113–122
    - compared with grease lubrication (speed capability) 45
    - contamination levels 122
    - effect on temperature and frictional losses 113
    - lubricating oils 121
  - oil mist 115
    - attainable speeds 44
    - lubricating oils 121
  - oil nozzles 116–117
    - for angular contact ball bearings 118, 199–261
    - for cylindrical roller bearings 119, 266, 289–299
    - for double direction angular contact thrust ball bearings 119, 313–317
  - oil supply ducts 89
  - oil-air 116–121
    - attainable speeds 40–41, 44
    - direct oil-air lubrication 120, 136–140
    - effect on bearing temperature and frictional losses 113
    - lubricating oils 121
  - oils 121
  - oil-spot → oil-air
  - open bearings
    - initial grease fill 101–105
    - shelf life 125
  - open flames 56
  - operating temperatures 37
    - as a function of oil quantity 113
    - as a function of speed 38
    - during running-in 112, 124
    - effect on preload and internal clearance 37
    - effect on relubrication interval 109
    - of cage materials 55
    - of seal materials 56
  - O-rings
    - in stepped sleeves 81, 83
    - on angular contact ball bearings 120, 136–140
  - oscillations
    - considerations when selecting a grease 99
    - with axial-radial cylindrical roller bearings 328
  - osculation 26, 131, 132
  - overhung shafts 346–347, 350–351
  - ozone 56
- P**
- P** 378, 382
  - P2** 197
  - P4** 197
  - PA4** 197
  - PA4C** 311
  - PA66 → polyamide 66 (PA66)
  - PA9A** 197
  - PAO 104
  - Parallel Kinematic Machines (PKM) 131
  - PBC** 197
  - PBT** 197
  - PCB drilling machines 132
  - PE** 341, 365
  - PEEK → polyetheretherketone (PEEK)
  - permissible speeds 39
  - PFC** 197
  - PFT** 197
  - PG** 197
  - PHA** 264, 267, 268, 286
  - phenolic resin
    - cages in angular contact ball bearings 134–135
    - material properties 55
  - pin wrenches 379
  - polishing machines 131
  - polyamide 66 (PA66)
    - cages in cylindrical roller bearings 264, 267
    - material properties 55
  - polyetheretherketone (PEEK)
    - cages in angular contact ball bearings 134–135
    - material properties 55
  - polyglycol 109
  - polymers
    - cages in angular contact ball bearings 134–135
    - cages in cylindrical roller bearings 264, 267, 268, 280
    - material properties 55–56
  - polyphenylether 109
  - polyurea 110
  - precision
    - of bearings 24–25
    - of seats and abutments 75–77, 325–326
    - of seats and abutments (for screw drives) 349
  - precision lock nuts 78, 375–389
    - adjustment during mounting 380–381
    - compared with stepped sleeves 79
    - designation system 382
    - designs 376–377
    - dimension standards 378
    - installation 379–381
    - loosening torques 378
    - lubrication 378
    - materials 378
    - preload 376–377
    - product tables 384–389
    - removal 379–380
    - spanners 379, 384–388
    - thread standards 378
    - tolerances 378
    - with axial locking screws 377, 388–389
    - with locking pins 376, 384–387
  - pre-ground raceways 267
  - preload 90–94
    - effect on friction 37
    - effect on relubrication interval 108
    - effect on speed capability 64
    - in angular contact ball bearings 50, 69, 90–93, 151–172
    - in axial-radial cylindrical roller bearings 322–323, 324
    - in cylindrical roller bearings 50–51, 94, 275, 278
    - in double direction angular contact thrust ball bearings 50, 94, 308
    - in precision lock nuts 376–377
    - in thrust bearings for screw drives 50, 94, 341, 355–357, 358
  - preservatives 125
  - printing machines 131
  - protectors 381
  - PT** 197
  - PTFE 109
  - pumping effects 96
- Q**
- QBC**
    - angular contact ball bearings 144, 197
    - thrust bearings for screw drives 342–343, 348, 365
  - QBT**
    - angular contact ball bearings 144, 197
    - thrust bearings for screw drives 348, 365
  - QFC**
    - angular contact ball bearings 144, 197
    - thrust bearings for screw drives 342–343, 348, 365
  - QFT**
    - angular contact ball bearings 144, 197
    - thrust bearings for screw drives 348, 365
  - QT**
    - angular contact ball bearings 144, 197
    - thrust bearings for screw drives 348, 365

Note: Designation prefixes and suffixes are shown in **bold**.

## R

racing car wheels 131  
 radial clearance 30, 74, 288  
 radial internal clearance 50–51  
     in cylindrical roller bearings 273–274, 275, 278–279  
 radial location 70–77  
 radial stiffness 68–69  
     of axial-radial cylindrical roller bearings 322–323  
     of cylindrical roller bearings 275–276  
     of typical spindle bearing systems 67  
 reconditioning 125  
 reference grease quantities 101  
     for angular contact ball bearings 102, 199–261  
     for cylindrical roller bearings 103, 289–299  
     for double direction angular contact thrust ball bearings 104, 313–317  
     for thrust bearings for screw drives 104, 367  
 reliability 34–35  
     effect on relubrication interval 109  
 relubrication  
     effect on frictional moment 37  
     intervals and adjustments 106–109  
     of sealed bearings 32, 101  
 relubrication-free 101  
 removal  
     of precision lock nuts 380  
     of stepped sleeves 80–81, 87  
 retaining bolts 330, 335  
 reusing bearings 124  
 rigidity 66–69  
     considerations when selecting a bearing 26, 27  
 ring gauges 393–395  
 robotics 131  
 roller and cage thrust assemblies 320  
 rotary tables 320, 324  
 rotating outer ring loads 71–72  
**RS** 344–345, 363, 364  
 running accuracy  
     of bearings 24–25  
     of seats and abutments 75–76, 325–326  
     of seats and abutments (for screw drives) 349  
     tolerance symbol definitions 49  
 running-in 111–112  
     effect of grease fill on friction 37, 101, 124  
     of axial-radial cylindrical roller bearings 324  
 run-out → running accuracy  
 rust protection 100–101, 125  
**RZ** 344–345, 363, 364

## S

**S** 136, 196  
 safety factors → static safety factors  
 screw drive bearings → thrust bearings for screw drives  
 screw drives 338, 350–351  
 sealed bearings  
     angular contact ball bearings 136, 192  
     grease specifications 104  
     shelf life 125  
     thrust bearings for screw drives 344–345  
     washing 136, 345  
 sealing solutions 32, 95–98  
     materials 56  
 seats  
     accuracy 75–77, 324–326  
     accuracy (for screw drives) 349  
     fits 70–74, 324–326  
     fits (for screw drives) 349  
 selection criteria 20–32  
 semiconductor industry 61, 131  
 serial numbers  
     on angular contact ball bearings 145

    on double direction angular contact thrust ball bearings 305  
 service life  
     of bearings with NitroMax steel rings 52  
     of grease 99, 106  
     of hybrid bearings 34, 37, 52  
 set screws → grub (set) screws  
 sets  
     of angular contact ball bearings 141–144  
     of thrust bearings for screw drives 340, 346–348  
 shaft orientation  
     considerations for oil-air lubrication 117  
     considerations when selecting a grease 99–100  
     effect on relubrication interval 109  
 shaft systems 20  
 shelf life 125  
 shock loads  
     considerations for life calculations 35  
     considerations when selecting a grease 98–99  
     permissible static loads 36  
     suitability of preloading with springs 93  
 silicon nitride ( $\text{Si}_3\text{N}_4$ )  
     in hybrid angular contact ball bearings 133  
     in hybrid cylindrical roller bearings 268  
     in hybrid double direction angular contact thrust ball bearings 304  
         material properties 54  
 silicon wafer chips 61  
 silicone-methyl 109  
 silicone-phenyl 109  
 single direction angular contact thrust ball bearings (for screw drives) 340, 366–367  
     applications 350–351  
     bearing arrangements 346–348  
     compared to other bearings for screw drives 339  
     designation system 364–365  
     designs and variants 22, 340  
     dimension standards 353  
     frictional moment 356, 360  
     in cartridge units 342–343, 372–373  
     load carrying capacity 356, 361  
     preload 355–356  
     product table 366–367  
     reference grease quantities 104, 367  
     sealed bearings 344–345  
     sets 340, 346–348  
     speeds 344, 363  
     stiffness 356, 358  
     temperature limits 344–345  
     tolerance classes and tolerances 24, 353–354  
 single direction bearings 340, 366–367  
     in cartridge units 342–343, 372–373  
 single row cylindrical roller bearings 264, 288–293  
     axial displacement 264, 269, 280  
     axial drive-up 278–279  
     basic design bearings 264  
     cages 264, 267  
     compared to double row cylindrical roller bearings 264  
     designs and variants 264  
     dimension standards 269  
     equivalent bearing loads 277  
     gauges for checking tapered seats 391–407  
     high-speed design bearings 264  
     hybrid bearings 268  
     initial grease fill 101, 103, 105  
     internal clearance 273–274, 275, 278–279  
     lubrication features 268  
     mounting 278–279, 401  
     preload 275, 278  
     product tables 288–293  
     speeds 264, 268, 277  
     stiffness 275–276  
     tolerance classes and tolerances 24, 269–272  
 sintered steel 378, 382  
 SKF LubeSelect 100  
 SKF Microdosage system 121  
 SKF Spindle Service Centres 125, 166

Note: Designation prefixes and suffixes are shown in **bold**.

SKF Spindle Simulator 33, 358  
 skidding 90–91, 322  
   benefits of hybrid bearings 133, 268, 304  
 sleeves  
   spacer sleeves 78  
   stepped sleeves 79, 80–87  
 smearing 133, 268, 304  
 soaps 110  
 sodium thickeners 110  
**SP**  
   cylindrical roller bearings 273, 286  
   double direction angular contact thrust ball bearings 311  
 spacer rings  
   effect on running-in of bearings 111  
   for angular contact ball bearings 166–172, 192–193  
   for cylindrical roller bearings 78, 282–285  
   for oil-air lubrication 116  
 spacer sleeves 78  
 spacers → spacer rings  
 spanners 379, 384–388  
**SPC2** 273, 286  
 speed factor 33  
 speeds 38–45  
   attainable speeds 44  
   considerations when selecting a bearing 28  
   for typical spindle bearing systems 45  
   permissible speeds 39  
   with grease lubrication 42–45  
   with oil lubrication 40–41, 44–45  
 Spindle Service Centres → SKF Spindle Service Centres  
 Spindle Simulator → SKF Spindle Simulator  
 spindles  
   applications 57–64  
   service 125, 166  
 splash guards 96–97  
 spring curves 91  
 springs 64, 90, 93, 165  
 stainless steels → NitroMax steel  
 standalone bearings 141  
 start-up  
   benefits of hybrid bearings 133, 268, 304  
   benefits of preload 90  
   considerations when selecting a grease 100  
   effect of grease fill 37  
   when running in 111–112, 124  
 static loads 36  
 static safety factors 36  
 steels 51–54  
 stepped sleeves 79, 80–87  
   designs 80, 84  
   dimensions 81–83  
   fits 80, 84  
   installation 86–87, 123–124  
   load carrying capacity 84–85  
   material 84  
   removal 87  
   with O-ring 80, 81, 83  
   without O-ring 80, 81–82  
 stiffness 66–69  
   of angular contact ball bearings 173–182  
   of axial-radial cylindrical roller bearings 322–323  
   of cylindrical roller bearings 275–276  
   of double direction angular contact thrust ball bearings 309  
   of thrust bearings for screw drives 339, 356–359  
 stirrup gauges 405  
 storage  
   of bearings 125, 330  
   of lubricants 122  
 super-precision bearings  
   selection criteria 20–32  
   types and designs 21–22  
 surface roughness 75, 77, 325–326  
 surface treatments 342  
 synthetic oils  
   compatibility 109  
   considerations when selecting a grease 99

  effect on cage materials 55  
 system rigidity → rigidity

## T

tandem arrangements  
   with angular contact ball bearings 142–144  
   with thrust bearings for screw drives 346–348  
 taper gauges 396–399  
 tapered bores 264–265, 272  
 tapered seats  
   checking the accuracy with a ring gauge 393  
   checking the accuracy with a taper gauge 396–397  
**TBT**  
   angular contact ball bearings 144, 197  
   thrust bearings for screw drives 348, 365  
 telescopes 131  
 temperatures  
   ambient 39  
   operating 37  
 test running 124  
**TFT**  
   angular contact ball bearings 144, 197  
   thrust bearings for screw drives 348, 365  
 thermal contraction 31  
 thermal expansion 31  
   effect on preload and internal clearance 50–51, 93  
   of silicon nitride versus steel 54  
 thickeners 110  
 thin-walled rings 75, 81, 123  
 threaded holes  
   in double direction angular contact thrust ball bearings 355  
   in housings 88  
   in shafts 89  
 thrust bearings  
   axial-radial cylindrical roller bearings 319–335  
   cartridge units (for screw drives) 342–343, 372–373  
   double direction bearings 301–317  
   double direction bearings (for screw drives) 341, 368–371  
   single direction bearings (for screw drives) 340, 366–367  
 thrust bearings for screw drives 337–373  
   applications 350–351  
   associated components 349  
   bearing arrangements 346–348  
   cages 344  
   cartridge units 342–343, 372–373  
   contact angles 340, 341  
   designation system 364–365  
   designs and variants 22, 338–345  
   dimension standards 353  
   dismounting 341  
   double direction bearings 341, 368–372  
   equivalent bearing loads 361–362  
   frictional moment 339, 346–360  
   initial grease fill 101, 104–105  
   lifting forces 94, 360  
   load carrying capacity 30, 339, 346, 361  
   lubrication 99, 106, 342, 344  
   markings 352  
   matched sets 340, 346–348  
   misalignment 346  
   moment stiffness 357  
   mounting 123, 339, 345, 352, 362  
   non-locating bearings 347  
   preload 50, 94, 355–357, 358  
   reference grease quantities 104, 367  
   relubrication 106–109, 341, 344  
   sealed bearings 339, 344–345  
   selection criteria 339  
   single direction bearings 340, 366–367  
   speeds 41, 43, 339, 344, 363  
   stiffness 339, 356–359  
   temperature limits 344–345  
   tolerance classes and tolerances 24, 353–354

Note: Designation prefixes and suffixes are shown in **bold**.

## Indexes

universally matchable bearings 340, 346–348, 352  
washing 345  
tightening torques  
  for locating angular contact ball bearings 183–189  
  for precision lock nuts 384–388  
**TN** 264, 267, 286  
**TN9**  
  cylindrical roller bearings 264, 267, 286  
  double direction angular contact thrust ball bearings 304–305, 311  
**TNHA**  
  angular contact ball bearings 134, 196  
  cylindrical roller bearings 264, 267, 268, 286  
tolerance classes  
  for bearings 24–25  
  for seats 71–74, 325–326  
  for seats (for screw drives) 349  
tolerance grades → IT tolerance grades  
tolerances 47  
  symbols and definitions 48–50  
tommy bars 379  
torque wrenches 380  
toughness → impact toughness  
transition fits 71  
trial mounting 282–285  
troubleshooting 124  
**TT**  
  angular contact ball bearings 144, 197  
  thrust bearings for screw drives 348, 365  
turbochargers 131

## U

unit conversion table 10  
universally matchable bearings  
  angular contact ball bearings 141–144, 194  
  thrust bearings for screw drives 340, 346–348, 352  
unloading forces 322–323  
**UP**  
  cylindrical roller bearings 286  
  double direction angular contact thrust ball bearings 311

## V

**V** 141, 196  
vertical shaft arrangements  
  applications 61, 131–132  
  effect on relubrication interval 109  
  with grease lubrication 99  
  with oil-air lubrication 117  
  with thrust bearings for screw drives 346–347  
vibrations  
  considerations when selecting a grease 99–100  
  troubleshooting 124  
viscosity  
  considerations when selecting a grease 99–100  
  of grease in sealed bearings 104  
  of lubricating oils 121  
  of mounting and dismantling fluids 87  
**VR521** 286  
V-shaped markings  
  on angular contact ball bearings 145  
  on double direction angular contact thrust ball bearings 305  
  on thrust bearings for screw drives 352  
**VU001** 267, 286

## W

**W33**

cylindrical roller bearings 266, 286  
double direction angular contact thrust ball bearings 311  
**W33X** 286  
washing  
  bearings before regreasing 109  
  sealed bearings 32, 136, 345  
water  
  considerations when selecting a grease 99–100  
  effect on lubricant shelf life 122  
  resistance of NBR 56  
  wash-out 100  
wear  
  resistance of hybrid bearings 34  
  resistance of NitroMax steel 52  
width series 46  
woodworking machines 132

---

Note: Designation prefixes and suffixes are shown in **bold**.



# Product index

| Designation              | Product                                                                           | Product tables |                    |
|--------------------------|-----------------------------------------------------------------------------------|----------------|--------------------|
|                          |                                                                                   | No.            | Page <sup>1)</sup> |
| <b>70..</b>              | Angular contact ball bearings . . . . .                                           | 2.1            | 198                |
| <b>70../..H</b>          | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>70../..H1</b>         | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>70../..L</b>          | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>70../..L1</b>         | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>70../..HC</b>         | Hybrid angular contact ball bearings . . . . .                                    | 2.1            | 198                |
| <b>70../..HC..H</b>      | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>70../..HC..H1</b>     | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>70../..HC..L</b>      | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>70../..HC..L1</b>     | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>718..</b>             | Angular contact ball bearings . . . . .                                           | 2.1            | 198                |
| <b>718../..HC</b>        | Hybrid angular contact ball bearings . . . . .                                    | 2.1            | 198                |
| <b>719..</b>             | Angular contact ball bearings . . . . .                                           | 2.1            | 198                |
| <b>719../..H</b>         | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>719../..H1</b>        | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>719../..L</b>         | Angular contact ball bearings for direct oil-air lubrication . . . . .            | 2.1            | 198                |
| <b>719../..HC</b>        | Hybrid angular contact ball bearings . . . . .                                    | 2.1            | 198                |
| <b>719../..HC..H</b>     | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>719../..HC..H1</b>    | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>719../..HC..L</b>     | Hybrid angular contact ball bearings for direct oil-air lubrication . . . . .     | 2.1            | 198                |
| <b>72..</b>              | Angular contact ball bearings . . . . .                                           | 2.1            | 198                |
| <b>72../..HC</b>         | Hybrid angular contact ball bearings . . . . .                                    | 2.1            | 198                |
| <b>BEAM ..</b>           | Double direction angular contact thrust ball bearings for bolt mounting . . . . . | 6.3            | 370                |
| <b>BEAS ..</b>           | Double direction angular contact thrust ball bearings . . . . .                   | 6.2            | 368                |
| <b>BSA 2..</b>           | Single direction angular contact thrust ball bearings . . . . .                   | 6.1            | 366                |
| <b>BSA 3..</b>           | Single direction angular contact thrust ball bearings . . . . .                   | 6.1            | 366                |
| <b>BSD ..</b>            | Single direction angular contact thrust ball bearings . . . . .                   | 6.1            | 366                |
| <b>BTM ..</b>            | Double direction angular contact thrust ball bearings . . . . .                   | 4.1            | 312                |
| <b>BTM ../..HC</b>       | Hybrid double direction angular contact thrust ball bearings . . . . .            | 4.1            | 312                |
| <b>BTW ..</b>            | Double direction angular contact thrust ball bearings . . . . .                   | 4.1            | 312                |
| <b>DMB ..</b>            | Taper gauges . . . . .                                                            | 8.2            | 398                |
| <b>FBSA 2..</b>          | Cartridge units with a flanged housing . . . . .                                  | 6.4            | 372                |
| <b>GB 10..</b>           | Internal clearance gauges for cylindrical roller bearings . . . . .               | 8.3            | 402                |
| <b>GB 30..</b>           | Internal clearance gauges for cylindrical roller bearings . . . . .               | 8.3            | 402                |
| <b>GB 49..</b>           | Internal clearance gauges for cylindrical roller bearings . . . . .               | 8.4            | 406                |
| <b>GRA 30..</b>          | Ring gauges . . . . .                                                             | 8.1            | 394                |
| <b>KMD ..</b>            | Precision lock nuts with axial locking screws . . . . .                           | 7.3            | 388                |
| <b>KMT ..</b>            | Precision lock nuts with locking pins . . . . .                                   | 7.1            | 384                |
| <b>KMTA ..</b>           | Precision lock nuts with locking pins . . . . .                                   | 7.2            | 386                |
| <b>N 10..</b>            | Single row cylindrical roller bearings . . . . .                                  | 3.1            | 288                |
| <b>N 10../..HC5</b>      | Hybrid single row cylindrical roller bearings . . . . .                           | 3.1            | 288                |
| <b>NN 30..</b>           | Double row cylindrical roller bearings . . . . .                                  | 3.2            | 294                |
| <b>NN 30../..W33(X)</b>  | Double row cylindrical roller bearings with relubrication features . . . . .      | 3.2            | 294                |
| <b>NNU 49..</b>          | Double row cylindrical roller bearings . . . . .                                  | 3.2            | 294                |
| <b>NNU 49../..W33(X)</b> | Double row cylindrical roller bearings with relubrication features . . . . .      | 3.2            | 294                |
| <b>NRT ..</b>            | Axial-radial cylindrical roller bearings . . . . .                                | 5.1            | 334                |

<sup>1)</sup> Starting page of the product table

| Designation      | Product                                               | Product tables |                    |
|------------------|-------------------------------------------------------|----------------|--------------------|
|                  |                                                       | No.            | Page <sup>1)</sup> |
| <b>S70..</b>     | Sealed angular contact ball bearings . . . . .        | 2.1            | 198                |
| <b>S70../HC</b>  | Sealed hybrid angular contact ball bearings . . . . . | 2.1            | 198                |
| <b>S719..</b>    | Sealed angular contact ball bearings . . . . .        | 2.1            | 198                |
| <b>S719../HC</b> | Sealed hybrid angular contact ball bearings . . . . . | 2.1            | 198                |
| <b>S72..</b>     | Sealed angular contact ball bearings . . . . .        | 2.1            | 198                |
| <b>S72../HC</b>  | Sealed hybrid angular contact ball bearings . . . . . | 2.1            | 198                |

<sup>1)</sup> Starting page of the product table

