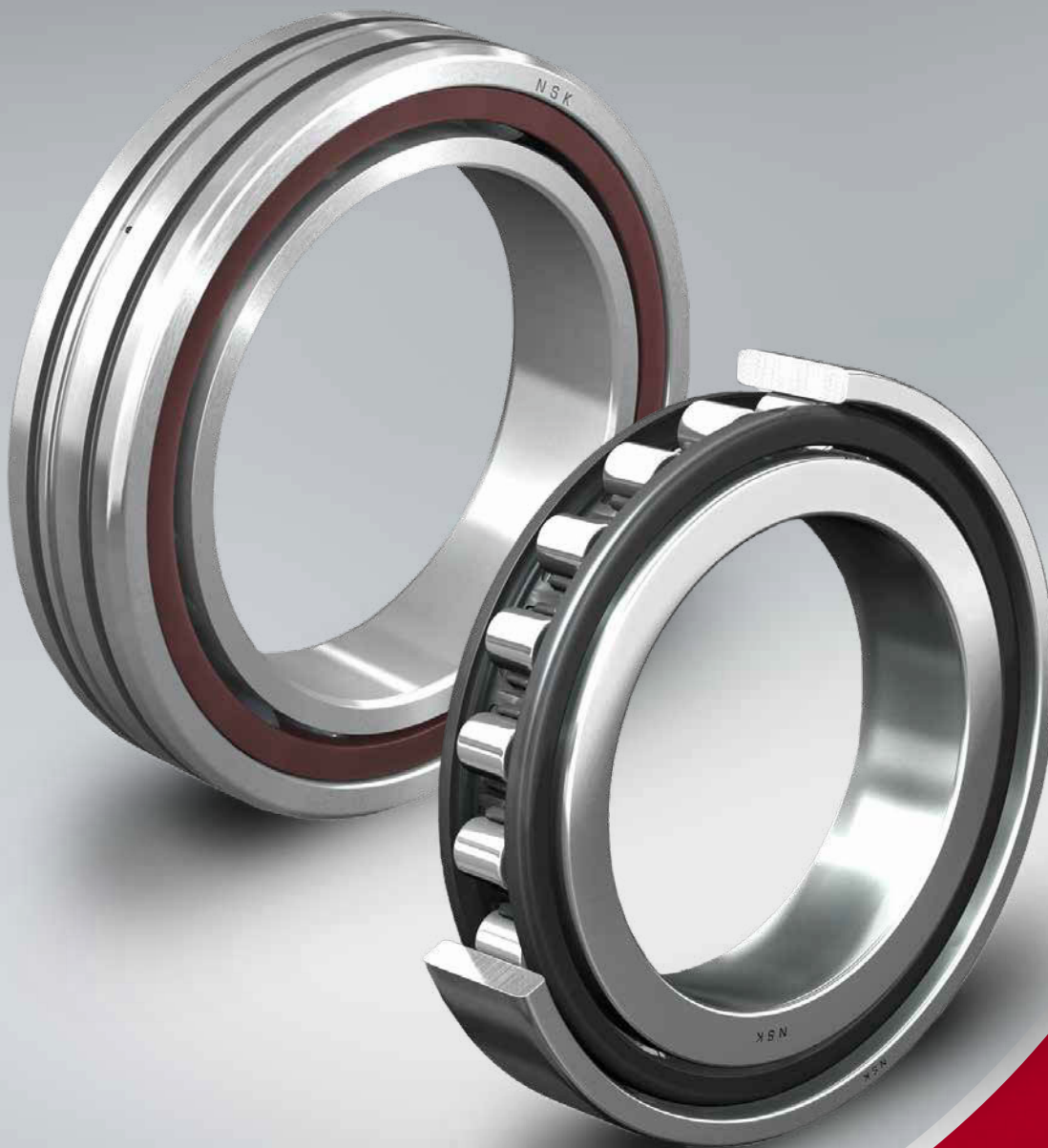


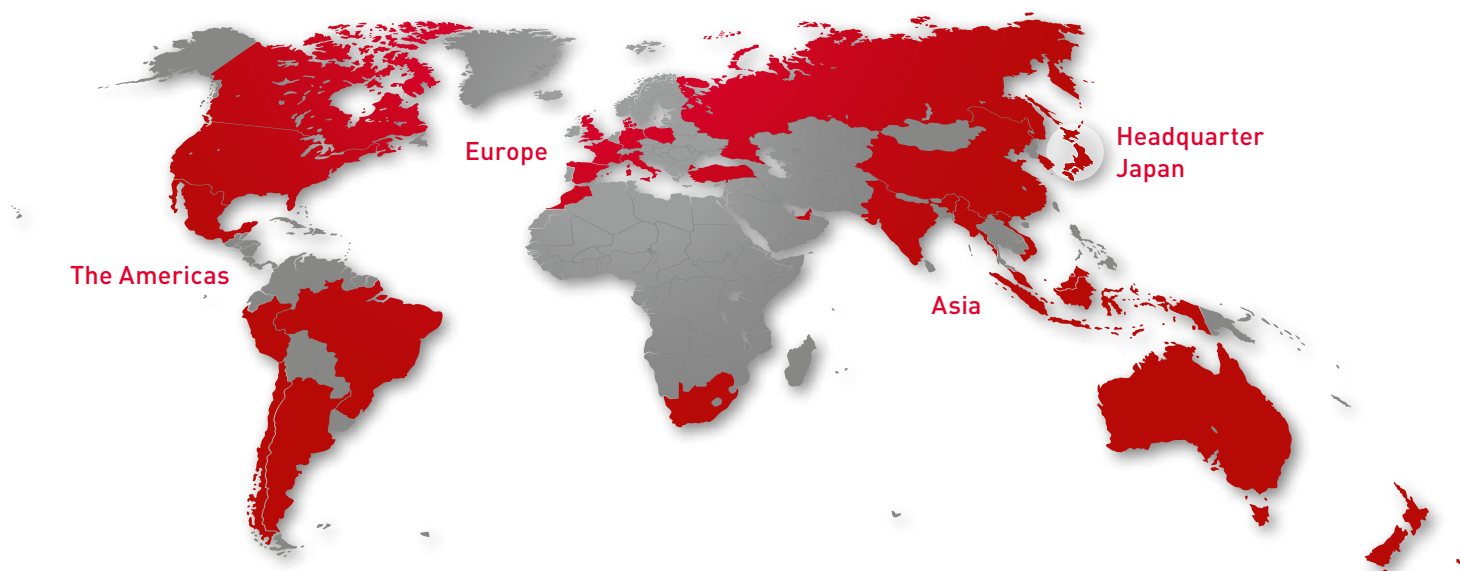
+ SUPER PRECISION BEARINGS



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SETTING THE FUTURE IN MOTION

We are among the leading manufacturers for rolling bearings, linear technology components and steering systems worldwide. We can be found on almost every continent – with production facilities, sales offices and technology centres – because our customers appreciate short decision-making channels, prompt deliveries and local service.



The NSK company

NSK commenced operations as the first Japanese manufacturer of rolling bearings back in 1916. Ever since, we have been continuously expanding and improving not only our product portfolio but also our range of services for various industrial sectors. In this context our worldwide research and production facilities are linked together in a global network. Here we concentrate not only on the

development of new technologies, but also on the continuous optimisation of quality – at every process stage. Among other things, our research activities include product design, simulation applications using a variety of analytical systems and the development of different steels and lubricants for rolling bearings.

Trademarks: All NSK product and service names listed in this catalogue are trademarks or registered trademarks of NSK Ltd.

OUR MOST IMPORTANT PRODUCT: OUR CUSTOMERS' SATISFACTION

One thing keeps us moving: we want to help you increase the reliability of your vehicles and equipment, not only with excellent products, but above all with excellent service. Our experienced engineers have a deep understanding of systems – together with you, they work to optimise products and processes and develop solutions for the future. The goal that we are dedicated to every day is ensuring that you remain competitive over the long run.

More about NSK on www.nsk europe.com



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SUPER PRECISION BEARINGS



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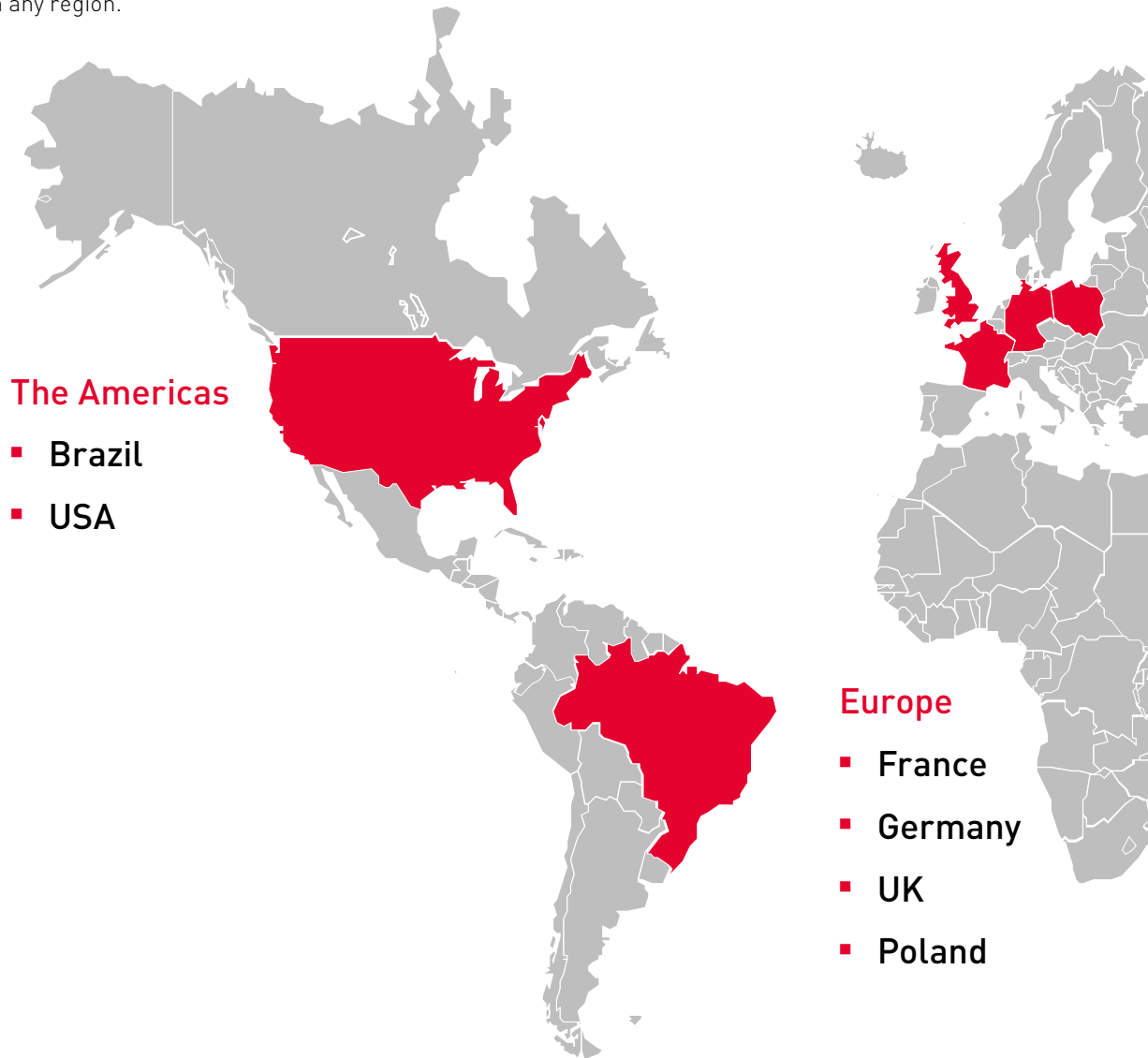


Global Support Capabilities

Uniform support system all over the world

NSK is committed to manufacturing and selling products all over the world with a consistently high quality under the leadership of our Technology Centers in the four major global markets. Staffed with experts that constantly endeavor to understand our customers' evolving needs NSK's sales offices promote global network management that encompasses our Technology Centers and production sites.

NSK is able to respond quickly and effectively to the various needs of customers and supports their business development efforts in any region.



The Americas

- Brazil
- USA

Europe

- France
- Germany
- UK
- Poland

Global Network

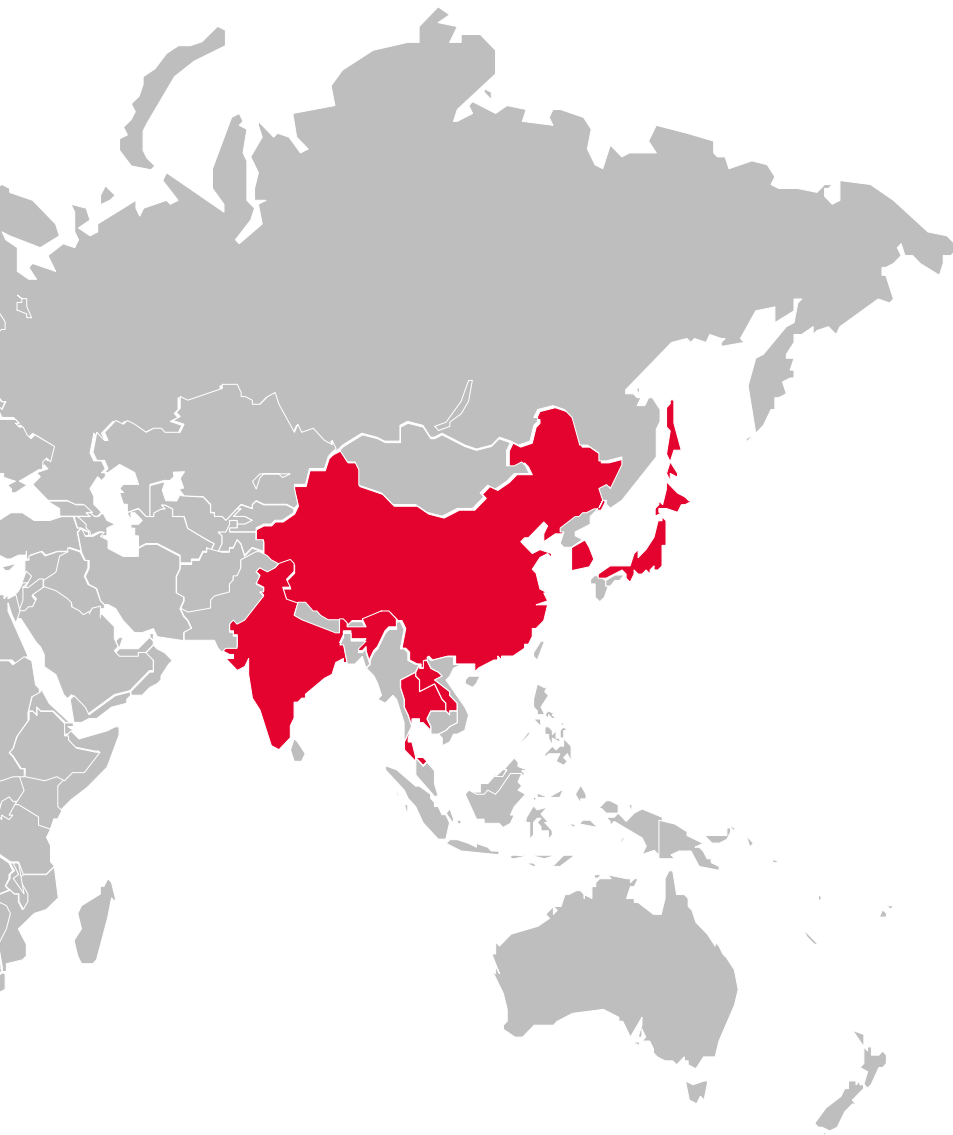
NSK has established a highly developed information network centered on Technology Centers located in the four major markets of the world – Europe, the United States, Asia and Japan. With this network, we are able to gather information, in real time, related to the changes and trends in any market in the world. As a result, we are able to react quickly to meet changing customer needs to supply optimal, high-quality products.



Technology Centres

Our 20 Technology Centres are located in 10 countries around the world; they offer technical support and provide the information that enables our customers to use NSK's products under ideal conditions and achieve the best possible performance.





Asia

- China
- India
- Japan
- South Korea
- Thailand

Customised Products

Because of our superior development and machining capabilities, NSK's products deliver impressive performance in terms of both quality and cost.

Our product supply system enables us to provide customized solutions for highly-specialized customer needs.

Global Support Network

Our extensive global network is able to receive orders and supply products anywhere in the world. NSK's distributors cover the globe and maintain an inventory of all critical products in every major market and location, making it possible to supply products to customers without delay. NSK also provides technical support worldwide to help customers determine the best bearing for each application, respond quickly to any questions, and immediately address any problems our customers may encounter.



Development Capabilities

In the service of our customers and society

Since our forebears at NSK manufactured the first bearing in Japan in 1916, we have developed a wide range of bearing types.

Building on the technological know-how we achieved, we have expanded into precision components and automotive parts. NSK relentlessly pursues innovative technologies and ongoing improvement in the quality of its products to contribute to a safer, more smoothly running society and to protect the global environment, in line with its corporate philosophy.

NSK leads the world in the areas of bearings, automotive components and precision machinery and parts.

NSK started its European activities in the early 1960s and today encompasses a network of production plants, sales offices and Technology Centers across 30 countries; this enables us to respond quickly to customer requests and regional requirements anywhere in the world with specially designed and regionally manufactured products.

The foundation of these product fields consists of tribology, materials, numerical simulation and mechatronics – NSK’s Four Core Technologies.

These are complemented and additionally shaped by manufacturing engineering, another important strength of NSK. The systems and products that we have created on the basis of our Four Core Technologies and the ‘plus One’ of manufacturing engineering contribute to the development of industry and to people’s prosperity around the world.

We call it +1. This means a plus in efficiency, safety and sustainability in our production processes.

In the years to come, NSK will continue its work in advanced technology, providing highly functional, premium products in response to the needs of the market.

NSK’s technological foundation

Four Core plus One Technologies

Tribology

Tribology is the science of lubrication, friction, wear. Good lubrication is vital to bearings that have to withstand linear and rotational loads. Thanks to improved grease formulations and surface processing methods, we’re in a position to develop faster, quieter and more durable bearings capable of sustaining the heaviest of loads

Areas

- Lubricant (oil, grease, additives)
- Friction Control
- Creation of Functional Surfaces

Numerical Simulation

As part of our product development, computer simulations play an essential role in the process. Through them, we can not only assess our products under extreme conditions, but also gain valuable insights into product design and finishing processes.

Areas

- Motion and Friction Analysis
- Macro/Nano Lubrication Analysis
- Machine System Simulation

Materials

Materials are continually being developed in order to improve the functionality and durability of rolling bearings. And NSK is right there at the leading edge. Our research focuses mainly on the areas of material design, heat treatment, performance evaluation and analytical evaluation. The results of this research go straight back into our products.

Areas

- High-strength Materials (Steel, Resin, Ceramics)
- Heat Treatment, Material Fatigue

Mechatronics

Through the combination of mechanics and electronics, key advances in high-performance motors, control technology, highly precise sensing technology and biomedical microelectromechanical systems become possible. Mechatronics also play an important role in assembly technology applications that demand high temperatures, power density and reliability.

Areas

- Motor, Circuit and Control Technology
- Sensor Technology
- Packaging Technology
- Biomedical Microelectromechanical System (Bio-MEMS) Technology

Manufacturing Engineering

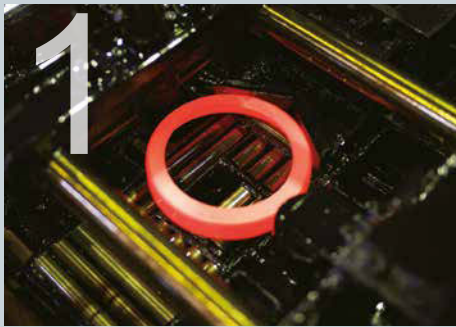
Contributing to the environment and enhancing safety & security through our Four Core Technologies requires something to breathe life into these technologies. NSK applies AI to its equipment, utilizing IoT, and optimising its overall production framework while it works to realise the creation of smart factories that save on space & energy, and reduce manpower requirements.

Quality Control and Production Capabilities

Leadership in quality

NSK Super Precision Bearings deliver the highest level of accuracy, supported by our production lines featuring state-of-the-art equipment and our unique production technology, as well as our commitment to applying the same rigorous quality control procedures at each stage of the production process in every NSK facility.

At our global production sites in Japan and England we at NSK focus our efforts on offering highly accurate products to quickly meet the diverse needs of customers worldwide.



Heat treatment



Grinding

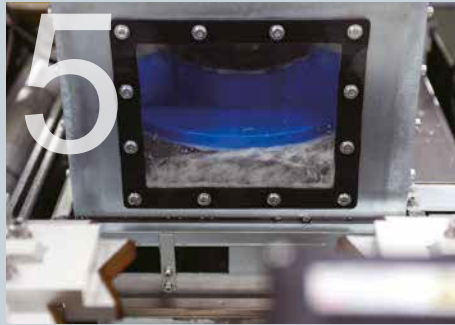
Manufacturing to Highest Accuracy

NSK Super Precision Bearings are checked to nanometer accuracy. Our extraordinary level of manufacturing technology enables us to supply products with the highest degree of accuracy in the world.



Global Production Sites in England and Japan

NSK Super Precision Bearings are made in both England and Japan. The combined expertise and locations of these manufacturing facilities enable us to quickly respond to customer requests.



Cleaning



Assembly



Packaging

Quality Control and Environmental Responsibility

As members of an ISO 9001-certified enterprise, all NSK plants adhere to strict international standards for quality control. NSK is also making an all-out, company wide effort to address environmental concerns as a top priority.

NSK Packaging

NSK's golden box guarantees the highest level of accuracy.



High Performance in the Next Generation

NSK continually challenges the status quo to explore new possibilities.

As our design philosophy does not allow us to compromise quality in manufacturing, we are driven to develop total solution technologies.

By using the latest material and analysis technologies we are able to design and manufacture exceptional, high performance precision bearings.

NSK will always strive to achieve the quality and performance that will be required in the next generation of bearings.



Features of Precision Bearings

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Metallurgical Technologies to Extend Bearing Life

Two types of steel assure the long life and high performance of NSK Super Precision Bearings

NSK has established groundbreaking techniques for the evaluation of inclusions in steel and for steel-making. We have developed materials that extend the life and enhance the performance of rolling bearings. Two types of materials are used for NSK Super Precision Bearings—SHX Steel that endures ultra high-speed rotation, and Z Steel that achieves an extended operation life under normal conditions for a wide range of applications.



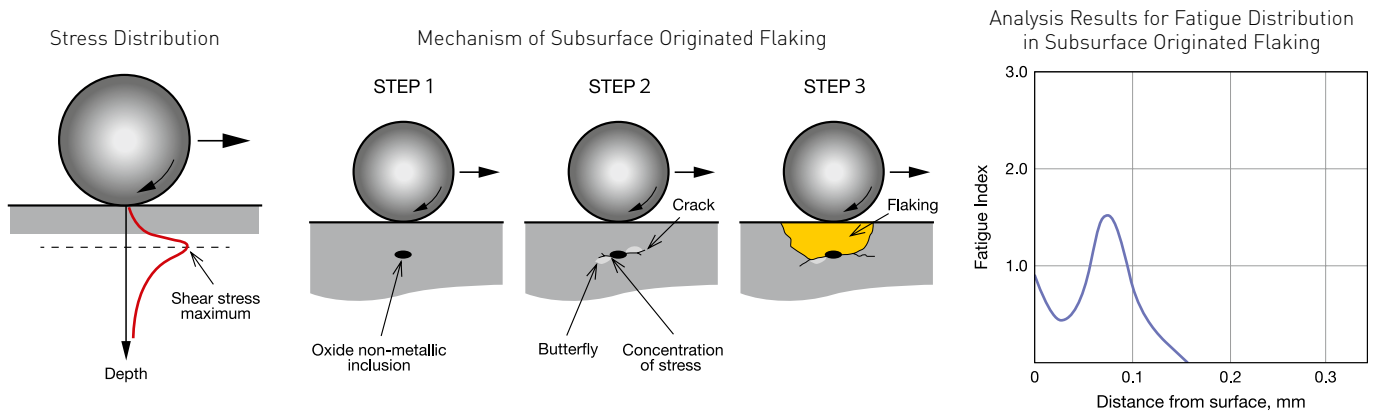
Z-Steel is our standard material for NSK Super Precision Bearings

Z-Steel Standard Long Life Material
Long Life Steel with Minimized Oxide Non-metallic Inclusion

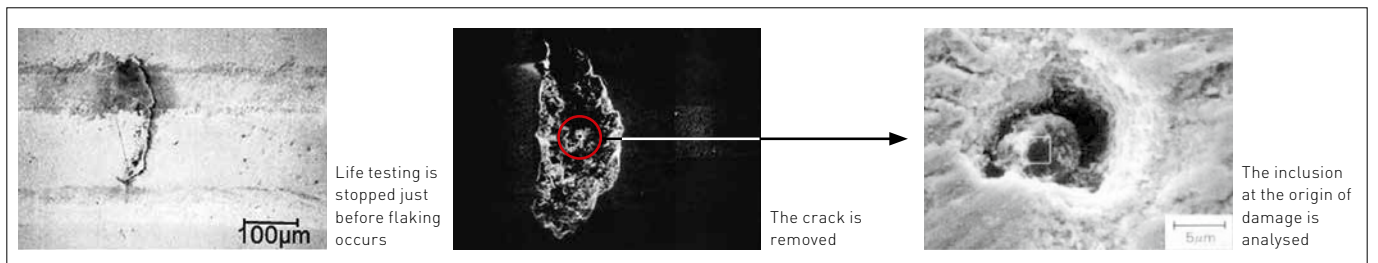
Rolling fatigue life of rolling bearings is significantly affected by non-metallic inclusions. Oxide non-metallic inclusions have a particularly adverse effect. Z-Steel is the bearing material that solves this issue.

• Features of Z-Steel

In the type of clean environment in which super precision bearings are used, it is possible to extend bearing life for applications in which subsurface originated flaking occurs by reducing oxide non-metallic inclusions in the steel. NSK's technology for evaluating the purity of steel material minimizes oxygen content and lowers the amount of impurities like Ti or S substantially, as a result, their life increases.



Identification of Flaking Origin



• Products made of Z-Steel



NSK uses Z-Steel as a standard material

SHX-Steel Endures Ultra High-Speed Rotation Environments

SHX-Steel Seizure Resistant SHX-Steel for High Temperature and High Speed Applications
4 Times Longer Fatigue Life and 20% Higher Speed than SUJ2 Z-steel

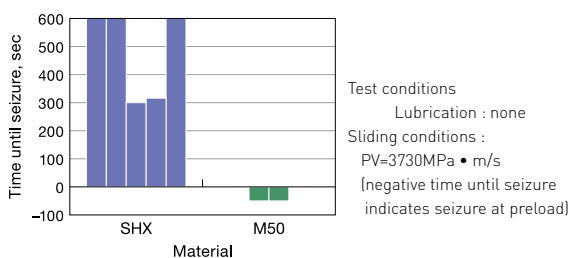
SHX is a heat resistant steel created from NSK's special heat treatment technology.

• Features of SHX-Steel

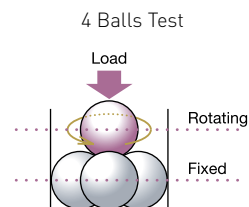
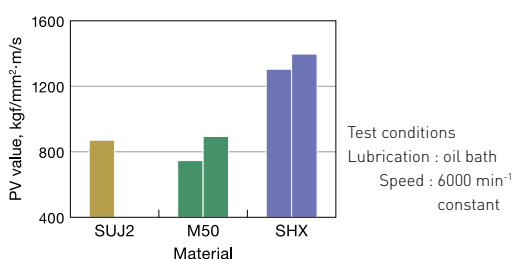
Seizure resistance of SHX-Steel exceeds that of Heat resistant M50-Steel, which is used for bearings on the main shaft of aircraft jet engines. SHX-Steel exhibits superior wear resistance and rolling fatigue life. Thus, SHX-Steel has broadened the application range of rolling bearings. Patent Number 2961768JP

• Seizure Resistance

Dry Seizure Limit Test (4 Balls Test)

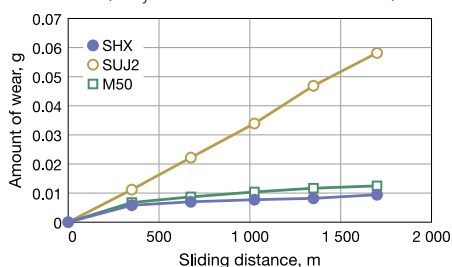


Oil Bath Seizure Limit Test (4 Balls Test)

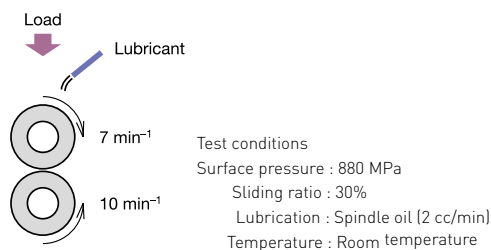


• Wear Resistance

Wear Resistance of Each Material (2 Cylindrical Rollers Wear Test)

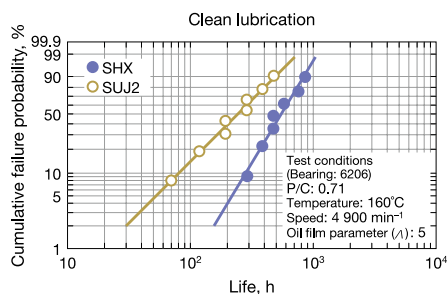


2 Cylindrical Rollers Wear Test

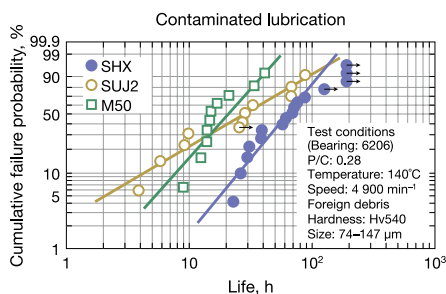


• Fatigue Life

Subsurface Originated Flaking Test



Surface Originated Flaking Test



• Products made of SHX-Steel



Ultra High Speed NSKROBUST Series
 for Ultra High Speed Machine Tool Spindles

Ceramic Balls

High speed, low heat generation, high rigidity and high reliability

Ceramic hybrid bearings have many excellent performance characteristics such as heat resistance, durability, light weight, lower thermal expansion, electrically non-conductivity and thus can be used in a nearly infinite number of applications as a new generation material.

Applying our extensive experience in bearing manufacturing at NSK, we introduced silicon nitride (Si_3N_4), a ceramic with outstanding characteristics, to rolling elements. Ceramic ball bearings have earned a good reputation in ultra high speed applications combined with ultra high accuracy, a performance combination that cannot be achieved with steel ball bearings.



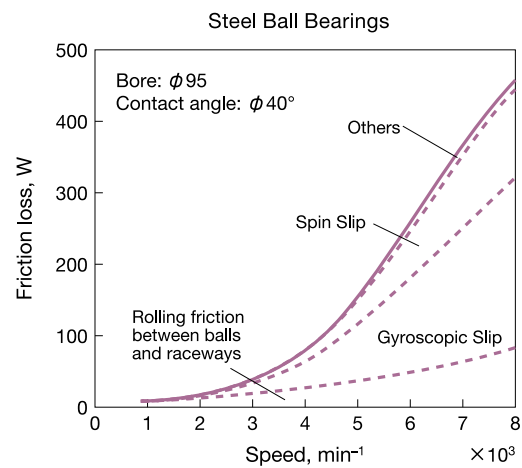
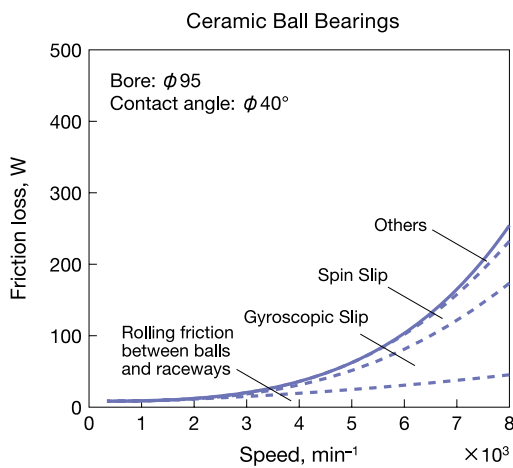
Low Heat Generation

- **Light weight**
As the weight is 60% lower than that of steel, the centrifugal force acting on the rolling elements is smaller, resulting in lower heat generation.
- **Low linear expansion coefficient**
Due to low thermal expansion, preload increase with position preload is minimized.
- **Low friction**
Low heat generation because of low sliding friction in high-speed applications.

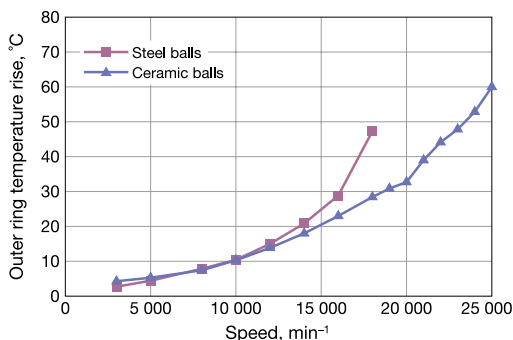


Less heat is generated, making ultra high-speed operation possible

Calculated Results of Friction Loss



The Outer Ring Temperature Rise in High Speed Operation



NSK Spindle that achieved 4 million d_m using ceramic ball bearings

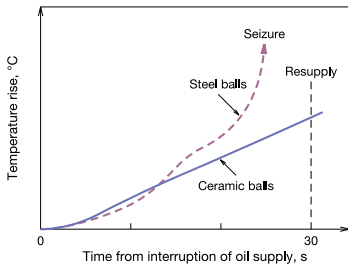


Ceramic Ball Bearing



Seizure Resistance

Ceramic balls exhibit a higher seizure resistance than steel balls



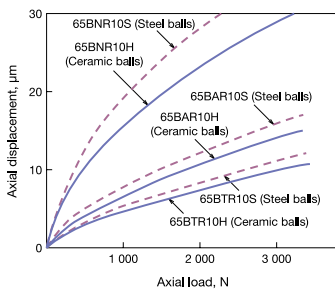
Cutting with NSK spindle using ceramic ball bearing



End Mill: Ø16
Work Material: A5052
Speed: 20 000 min⁻¹
2 500 cc/min

High Rigidity

The Young's Modulus of ceramic balls is 50% higher than that of steel. This results in high rigidity bearings ideally suited for use in machine tool spindles.



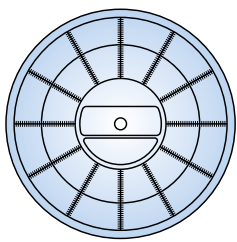
Cutting with NSK spindle using ceramic ball bearing



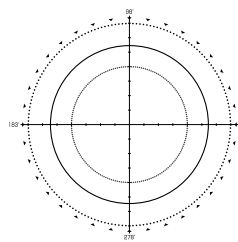
Face Mill: Ø80
Work Material: C50
Speed: 1 200 min⁻¹
504 cc/min

High Accuracy

NSK's expertise in the manufacturing of balls over the years, along with improvements in the sintering process and the grade of materials used enables NSK to produce ceramic balls that feature a higher level of accuracy than steel materials. Bearings using these high-accuracy ceramic balls facilitate high-accuracy machining.



Size: 9/32"
Magnification: 50 000 times
Roundness of ceramics ball



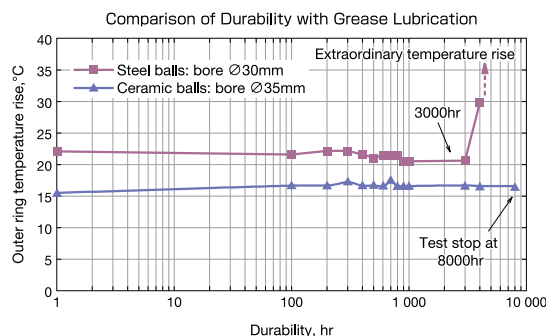
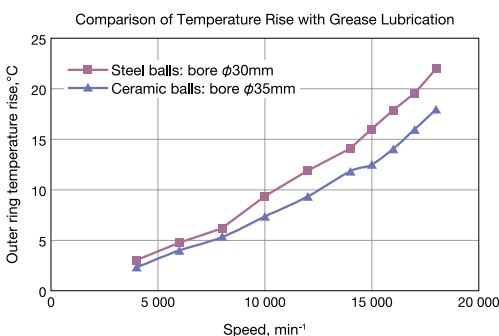
Roundness of material being ground 0.14 µm
1 µm/div



High magnification (200 000 times)
Sphericity measuring equipment

Extended Grease Life

Low heat generation and seizure resistance result in extended bearing life with grease lubrication.



Preload: 147N (spring)
Grease used: ISOFLEX NBU15
Maximum speed: n=18 000 min⁻¹

Cages

Engineered polymer cages offer higher speed capability and less wear

Engineered polymer cages are lighter (1/6 of the weight of cages made of brass), self-lubricating and have a low friction coefficient. Bearings fitted with such cages generate less heat at high-speed rotation, making them excellently suited for high-speed operation. Polymers can be engineered for low wear, thus extending grease life. Engineered polymer cages are used in super precision bearings for machine tool spindles.

Cage for Angular Contact Ball Bearings

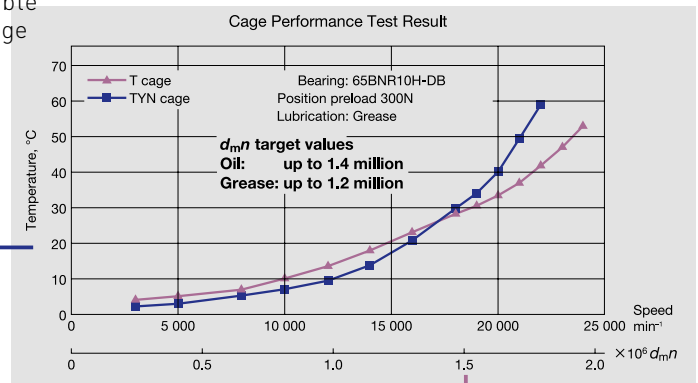
Ball Guided Polyamide Cage — (TYN) Engineered Polymer

Low Noise

- This special design developed by NSK produces lower friction and lower noise, especially effective with grease lubrication
- Ball guided design means more space at the outer ring, allowing more grease to be held inside the bearing
- Grease running-in period is shortened, with more stable temperature rise compared to outer ring guided phenolic cage



Products: High Accuracy Angular Contact Ball Bearings Standard Series
Ultra High Speed Angular Contact Ball Bearings NSKROBUST Series



Outer Ring Guided Phenolic Cage — (T, TR, TA)

Ultra High-Speed



- The outer ring guided cage offers excellent high-speed operation capability and exhibits stable temperature rise

Products:
High Accuracy Angular Contact Ball Bearings Standard Series
Ultra High Speed Angular Contact Ball Bearings NSKROBUST Series



Outer Ring Guided PPS Cage — (TSR) Engineered Polymer

Ultra High-Speed



- Specifically designed for oil-air lubrication, achieving 3.0 million $d_m n$ at high speed
- High performance cage that reduces NRRO (Non-repeatable Runout) and features low temperature rise

Products:
Ultra High Speed Angular Contact Ball Bearings NSKROBUST Series



Ball Guided Brass Cage — (MY)

General Purpose



- This cage demonstrates high temperature resistance, high strength and high rigidity
- Specifically for large bearings

Products:
High Accuracy Angular Contact Ball Bearings Standard Series
Ultra High Speed Angular Contact Ball Bearings NSKROBUST Series



Cage for Cylindrical Roller Bearings

Cage for Single Row Cylindrical Roller Bearings

Outer Ring Guided PEEK Cage — (TP) Engineered Polymer

Ultra High-Speed

- Minimizes cage deformation to permit stable high-speed rotation
- Excellent wear-resistant performance, ideally suitable for minimal lubrication



Products:

Ultra High Speed Single Row Cylindrical Roller Bearings
NSK ROBUST Series



Roller Guided Brass Cage — (MR)

General Purpose

- This cage demonstrates high temperature resistance, high strength and high rigidity

Products:

Single Row Cylindrical Roller Bearings Standard Series

Cage for Double Row Cylindrical Roller Bearings

Roller Guided PPS Cage — (TB) Engineered Polymer

High Rigidity

- Optimal roller-guided cage design with consideration for strength and friction
- Light weight reduces deformation caused by centrifugal force at high speed, resulting in a low temperature rise.



Products:

Double Row Cylindrical Roller Bearings
High Rigidity Series



Roller Guided Brass Cage — (MB)

General Purpose

- This cage demonstrates high temperature resistance, high strength and high rigidity



Products:

Double Row Cylindrical Roller Bearings
High Rigidity Series



Product Range

Several types of Super Precision Bearings are available from NSK, including the NSKROBUST series high performance bearings, the special series of bearings for unique and specialized applications, and the standard series bearings.



NSKHPS High Accuracy Angular Contact Ball Bearings (7xxx)

NSKHPS

High dynamic load rating, optimal for applications with low to medium speed and high external load.

- 79, 70, and 72 Series
- Three types of contact angle: 15°(C), 25°(A5), 30°(A)
- Three types of cage: Select either Outer Ring Guided Phenolic Cage (TR), Ball Guided Polyamide Cage (TYN), or Ball Guided Brass Cage (MY) depending on required application and size
- Also available as non-contact sealed bearing



Ultra High Speed Angular Contact Ball Bearings (BNR, BER)

NSKROBUST

High performance bearings developed for high-speed operation with low temperature rise. Suitable for ultra high precision machining applications and ultra high-speed applications.

- 19, 10, 29, and 20 Series
- Two types of contact angle: 18°(BNR), 25°(BER)
- Three types of ball material: Steel Balls (S), Ultra Long Life Bearing Rolling Elements (E), and Ceramic Balls (H, X)
- Four types of cage: Select either Outer Ring Guided Phenolic Cage (T), Ball Guided Polyamide Cage (TYN), Ball Guided Brass Cage (MY) or Outer Ring Guided PPS Cage (TSR), depending on application requirements
- Also available as non-contact sealed bearing



High Speed Angular Contact Thrust Ball Bearings

NSKROBUST

High performance bearings developed for lathes and other applications requiring high speed and high axial rigidity

NSKROBUST Series (BAR, BTR)

- Two types of contact angle: 30°(BAR), 40°(BTR)
- Three types of ball material: Steel Balls (S), Ultra Long Life Bearing Rolling Elements (E), and Ceramic Balls (H)

NSKTAC Series (TAC2xF, TAC2xD)

- Contact angles: 50°(TAC-F), 60°(TAC-D)



Ultra High Speed Angular Contact Ball Bearings (BSR)

NSKROBUST

High performance bearings developed for high frequency spindles, small high-speed spindles and similar applications.

- 19, 10, and 02 Series
- Bore size range: $\varnothing 6$ -25mm, contact angle: 15°
- Two types of ball material: Steel Balls (S) and Ceramic Balls (H, X)
- Non separable type
- Also available as non-contact sealed bearing



Ultra High Speed Single Row Cylindrical Roller Bearings (N10xx)

NSKROBUST

High performance bearings developed for high-speed applications such as machining center spindles.

- Optimized shape of inner ring ribs increases robustness
- High temperature resistant PEEK resin cage stabilizes roller dynamics during high-speed operation
- Two types of roller material: Steel and SHX-Steel



NSKHPS High Accuracy High Performance Cylindrical Roller Bearings

APTSURF

NSKHPS

High accuracy cylindrical roller bearings have been relaunched as NSKHPS Series. Optimized internal design of the bearings and improved fabrication technology have extended bearing life by 60% compared to conventional bearings. Bearings with an accuracy rating of P4 and higher reduce rotational vibration (APTSURF).

Single Row Cylindrical Roller Bearings (N10xx)

Longer life and high rigidity in a compact design

Double Row Cylindrical Roller Bearings (NN30xx)

Double Row Cylindrical Roller Bearings developed for high-speed high-rigidity applications such as lathe spindles

- Two types of cage: Brass (MB) or PPS resin (TB)
- Also available for E44 specification with outer ring lubrication hole / lubrication groove placed in the center of outer ring



NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support (NSKTACxxC)

NSKHPS

High rigidity thrust bearings designed specifically for ball screw support applications in machine tools.

- Contact angle: 60°
- Universal combination: can be universally matched to any rigidity specification or operation life requirement
- Highly dustproof contact sealed bearings is available
- Also available as non-contact sealed bearing



NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support (NSKTAC0xD, NSKTACxx-3)

NSKHPS

Thrust bearings optimal for injection molding machines and electric press machines. Optimized internal bearing design yields higher axial load carrying capacity and longer life.

- Contact angle: 55°
- Suitable for ball screw support in large machine tools
- Easier handling than tapered roller bearings or spherical thrust roller bearings as a result of non separable configuration
- Universal combination: can be universally matched to any required load conditions



High Accuracy Low Profile Angular Contact Ball Bearings ROBUSTSLIM (BRSA)

Special Series

Specially designed angular contact ball bearings for swiveling (rotary/tilt) spindle heads and rotary/tilt tables used in machine tools.

- Lower torque than roller bearings
- NRRO (Non-Repeatable Runout) less than 0.5 μm was archived with BRSA130.
- Delivers the same high moment rigidity as crossed roller bearings
- Bearing width reduced by 35% or more compared to standard bearings

Ultra High Speed Angular Contact Ball Bearings

NSKROBUST

High performance angular contact ball bearings delivering high speed and low heat generation—NSKROBUST Series

Benefits

- 1 Low Heat Generation
- 2 Higher Seizure Resistance
- 3 Improved Thermal Robustness
- 4 Stable during High-Speed Operation

High performance

ROBUSTSHOT

High performance bearings combining highly reliable lubricant supply in oil-air lubrication and space-saving design

- Material of inner/outer rings: SUJ2 bearing steel
- Ceramic balls



Spinshot II XE Type

Suitable for silent operation due to reduced air-noise achieved through oil-air lubrication design

- Material of inner/outer rings: heat resistant SHX steel for high-speed operation
- Ceramic balls

NSKROBUST Series X Type

High performance bearings delivering excellent wear and seizure resistance during ultra high-speed operation

- Material of inner/outer rings: heat resistant SHX Steel for high-speed operation
- Ceramic balls



NSKROBUST Series H Type

High performance bearings that combine high-speed operation with low heat generation

- Material of inner/outer rings: SUJ2 bearing steel
- Ceramic balls



NSKROBUST Series E Type

Steel ball bearing with improved seizure resistance and extended life

- Material of inner/outer rings: SUJ2 bearing steel
- Ultra long life bearing rolling elements



NSKROBUST Series S Type

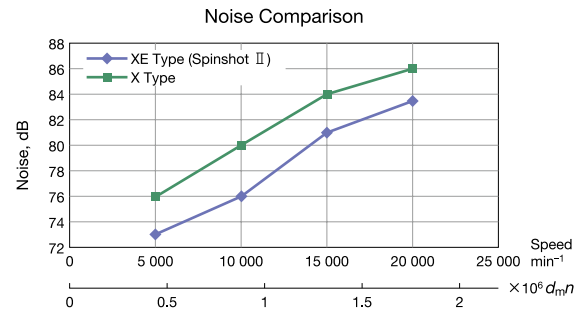
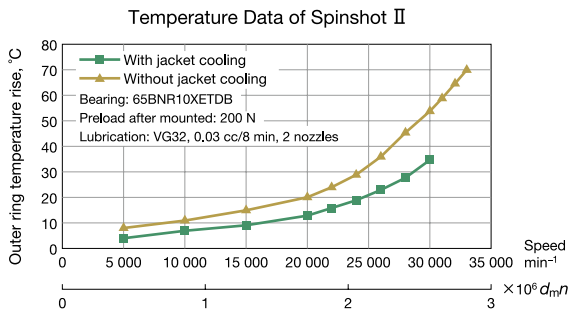
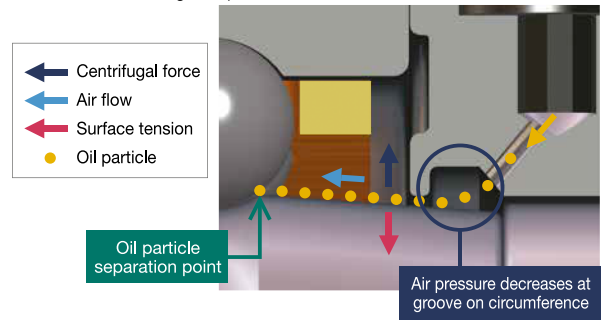
- Material of inner/outer rings: SUJ2 bearing steel
- Steel balls

High speed

Features of Spinshot II XE Type

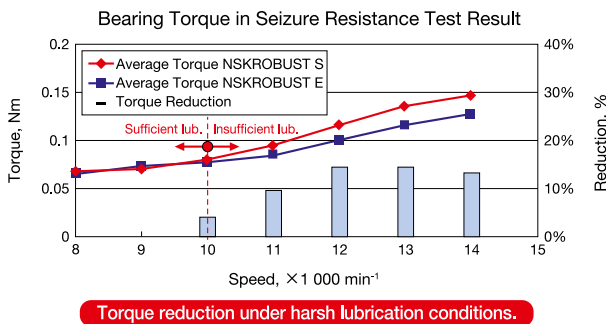
- **High-Speed Performance**
High-speed performance in position preload up to 2.5 million $d_m n$ with jacket cooling (maximum 2.7 million $d_m n$ without jacket cooling).
- **Silent Operation**
3-5 dB quieter than conventional oil-air lubrication.
- **Orientation**
Remains stable in either vertical or horizontal spindle orientation.
- **Reduced Air Consumption**
Air consumption may be reduced to as low as 1/3 of that in conventional oil-air lubrication.

Structural Drawing of Spinshot II

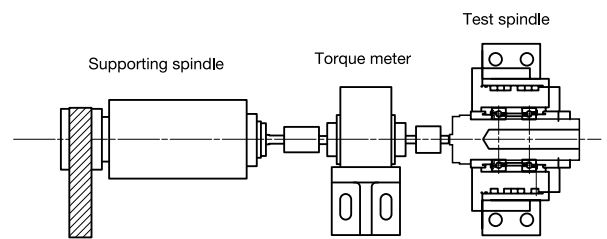


Features of NSKROBUST Series E Type

Higher seizure resistance and extended life due to strengthened material.

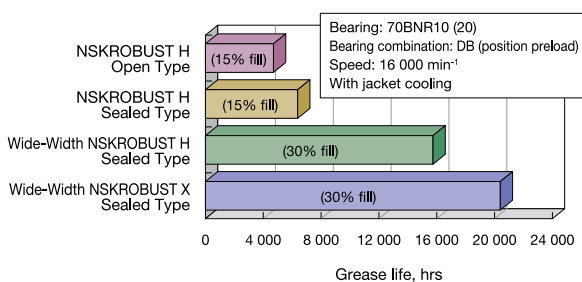


Test Bench Structure

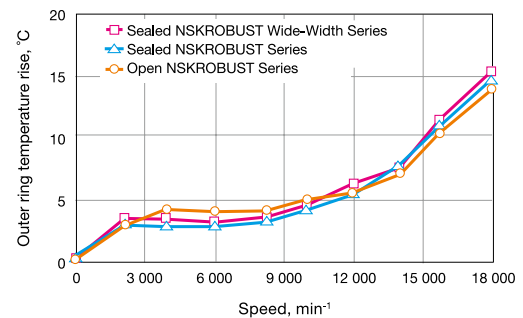


Features of Sealed Angular Contact Ball Bearings

Comparison of Grease Life in Various Types of Bearings



Comparison of Temperature Rise in Open vs. Sealed Bearings



High Performance Cylindrical Roller Bearings

NSKROBUST APTSURF NSKHPS

Designed to achieve high-speed performance combined with high rigidity

Benefits

- 1 Low Heat Generation
- 2 Higher Seizure Resistance
- 3 Stable during High-Speed Operation
- 4 Lower Vibration

High performance

NSKROBUST



**Ultra High Speed Single Row Cylindrical Roller Bearings
NSKROBUST Series RX Type**
High performance series with excellent heat and wear resistance during ultra high speed operation

- Material of inner/outer rings and rollers: SHX Steel for high speed and heat resistance
- Outer Ring Guided PEEK Cage



**Ultra High Speed Single Row Cylindrical Roller Bearings
NSKROBUST Series RS Type**
High speed series with excellent cost performance

- Material of inner/outer rings and rollers: SUJ2 bearing steel
- Outer Ring Guided PEEK Cage



**Double Row Cylindrical Roller Bearings
High Rigidity MB Series**

- Material of inner/outer rings and rollers: SUJ2 bearing steel
- Roller Guided Brass Cage



**Double Row Cylindrical Roller Bearings
High Rigidity TB Series**
High performance series with polymer cages

- Material of inner/outer rings and rollers: SUJ2 bearing steel
- Roller Guided PPS Cage



**High Performance Double Row Cylindrical Roller Bearings
Low Heat Generation NN-Z Series**
Low heat generation series specifically for free-end bearings

- Material of inner/outer rings and rollers: SUJ2 bearing steel
- Roller Guided PPS Cage



**Single Row Cylindrical Roller Bearings
Standard Series**
Standard type bearing with brass cage

- Material of inner/outer rings and rollers: SUJ2 bearing steel
- Roller Guided Brass Cage

Long Life and Low Vibration APTSURF

Long Life
NSKHPS

High speed

Features of High Accuracy High Performance Cylindrical Roller Bearings APTSURF

- Low Vibration (APTSURF)

By increasing the accuracy of bearing parts we have reduced vibration during rotation. Available for bearings with an accuracy rating of P4 or higher and an outer diameter of up to 360mm.

- Extended Life (NSKHPS)

Optimized internal design of the bearings and improved fabrication technology have extended bearing life by 60% compared to conventional bearings. Available for bearings with an accuracy rating of P5 or higher and an outer diameter of up to 360mm.

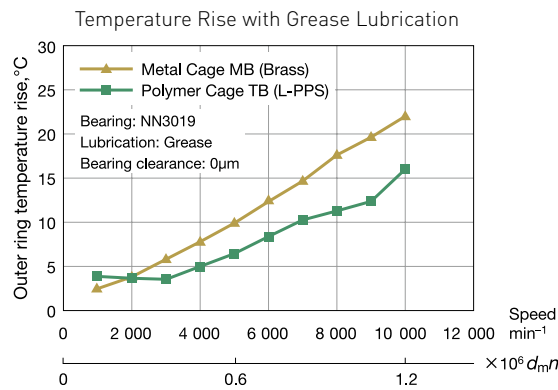
Features of Double Row Cylindrical Roller Bearings High Rigidity Series

- Extended Life

The high rigidity PPS (engineered polymer) cage demonstrates excellent wear resistance, resulting in lower amount of wear during initial operation and thus longer grease life.

- Available for High-Speed Applications

NSK offers the Low Heat Generation NN-Z series specifically for free-end bearings.



NN-Z Series

Features of Ultra High Speed Single Row Cylindrical Roller Bearings NSKROBUST Series

- Low Heat Generation

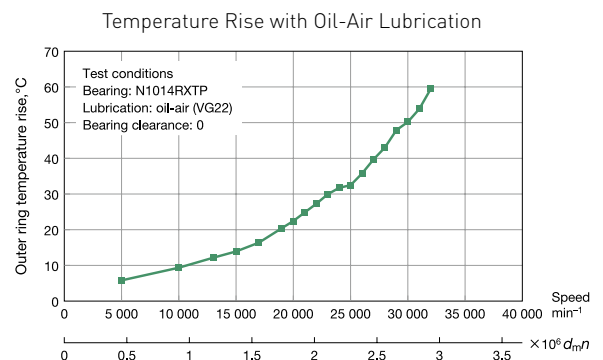
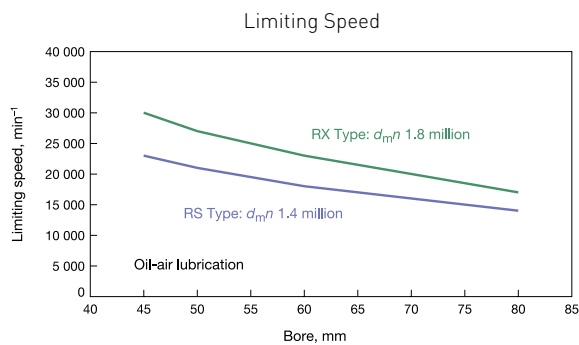
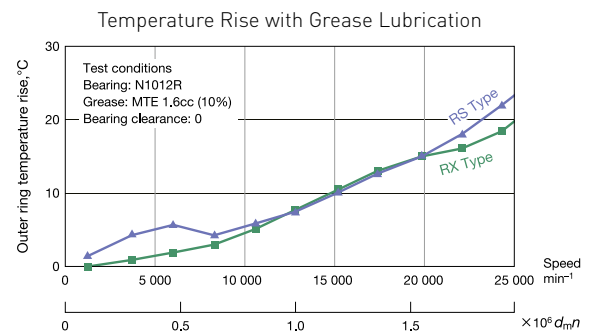
Internal design and advanced cage material result in low heat generation.

- Seizure Resistance

RX Type is made with SHX Steel resulting in improved seizure resistance.

- High-Speed Capability

All types feature cages made of heat resistant and highly rigid PEEK for high-speed operation



High Speed Angular Contact Thrust Ball Bearings

NSK ROBUST

High performance bearings that combine high-speed capability with high rigidity

Benefits

- 1 High Rigidity
- 2 Low Heat Generation



High Speed Angular Contact Thrust Ball Bearings BTR10 Series
40° contact angle, combining high rigidity and low heat generation.



High Speed Angular Contact Thrust Ball Bearings BAR10 Series
30° contact angle delivers higher speed capability.



Double Row Angular Contact Thrust Ball Bearings NSKTAC F Series
50° contact angle with higher axial rigidity.

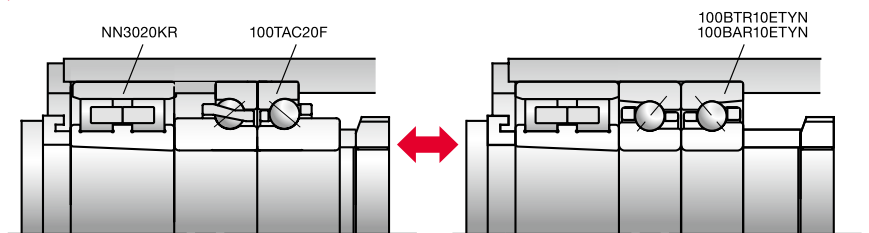


Double Row Angular Contact Thrust Ball Bearings NSKTAC D Series
60° contact angle with the highest axial rigidity. Separable type.

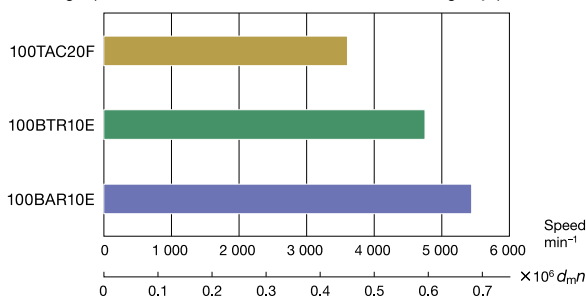
Features of Angular Contact Thrust Ball Bearings for Lathe Spindles

- Interchangeability between NSKTAC ⇔ BAR, BTR

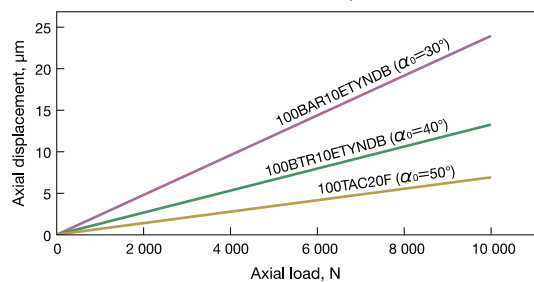
BAR and BTR have special width dimensions. By replacing NSKTAC with BAR or BTR, it is possible to achieve lower heat generation and higher speeds. Correspondingly, replacing BAR or BTR with NSKTAC will provide higher rigidity. (see figure on the right).



Limiting Speeds with Grease Lubrication (when lightly preloaded)



Axial Load and Axial Displacement



Ultra High Speed Small-size Angular Contact Ball Bearings

NSK ROBUST

Combining low heat generation and high rigidity, for use with ultra high speed spindles—NSK ROBUST Series (BSR)

Benefits

- 1 Optimal for Constant Pressure Preload
- 2 Easy Handling Due to Non Separable Structure
- 3 Available as Sealed Bearing



Features of NSK ROBUST Series (BSR) Ultra High Speed Small-size Angular Contact Ball Bearings

- Optimal Design

Rigidity remains high even during high-speed operation with constant pressure preload, minimizing the need for reduction of maximum spindle speeds. A counter bore in the inner ring enlarges the opening for oil-air or oil mist to enter into the bearing, thus ensuring a stable oil supply.

- Extended Life

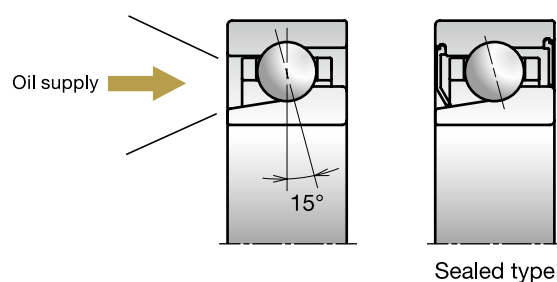
Heat resistant SHX-Steel for high-speed operation.

- Easy Handling

Non separable structure makes handling easy.

- Low Maintenance

Available as sealed bearing, reducing maintenance.



Angular Contact Thrust Ball Bearings for Ball Screw Support (High Rigidity)

NSKHPS

Specialized high performance bearings with high rigidity—NSKTAC C Series

Benefits

- 1 Long Life
- 2 Low Torque
- 3 Easier Handling
- 4 High Accuracy



Features of NSKHPS NSKTAC C Series

Applications: ball screw support in machine tool feed drives, transport ball screws etc.

- Designed for High Performance in the Above Applications

60° contact angle and more balls ensure high rigidity.

- Contact Seal for High Reliability and High Dust Resistance as Standard

Bearings from this series are fitted with contact seals as standard; this achieves high dust-resistance and prevents grease leakage.

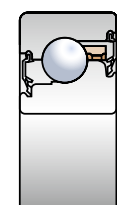
Light seal contact for low torque and low heat generation.

Seal color is different on front and back face, for easy identification of bearing direction.

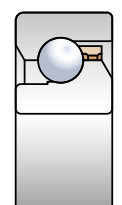
Non-contact seal is available for some bearings from this series.

- You choose the bearing arrangement

Universal combination is standard for this series, allowing free choice of arrangement in 2, 3 or 4 rows.



NSKTAC C
Sealed type



NSKTAC C

Angular Contact Thrust Ball Bearings for Ball Screw Support (Double Row)

Special Series

Specialized high performance bearings with single outer ring and mounting holes—BSBD Series

Benefits

- 1 Easier Handling
- 2 Higher Reliability
- 3 Simplified Mounting Process



Features of NSKHPS BSBD Series

- Easier Handling

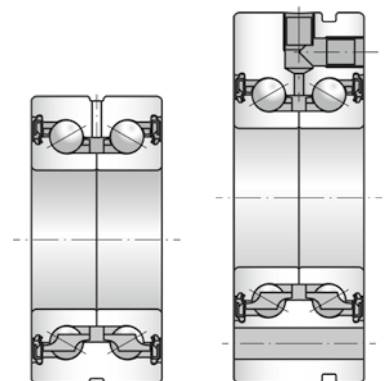
Double row angular contact thrust ball bearings in back-to-back arrangement(DB) with a single outer ring. The bearings from this series are contact sealed and pre-greased for easy handling.

- Higher Reliability

Fitted with a contact seal with minimized effect on frictional loss and heat generation.

- Simplified Mounting Process (BSF Type)

BSF Type bearings feature mounting holes for mounting directly into the housing. The outer ring is equipped with an extraction groove for easier removal from the housing.



Angular Contact Thrust Ball Bearings for Ball Screw Support (for High-Load Drive Applications)

NSKHPS

Specialized high performance bearings simplify machine design and reduce costs—NSKTAC 03 Series

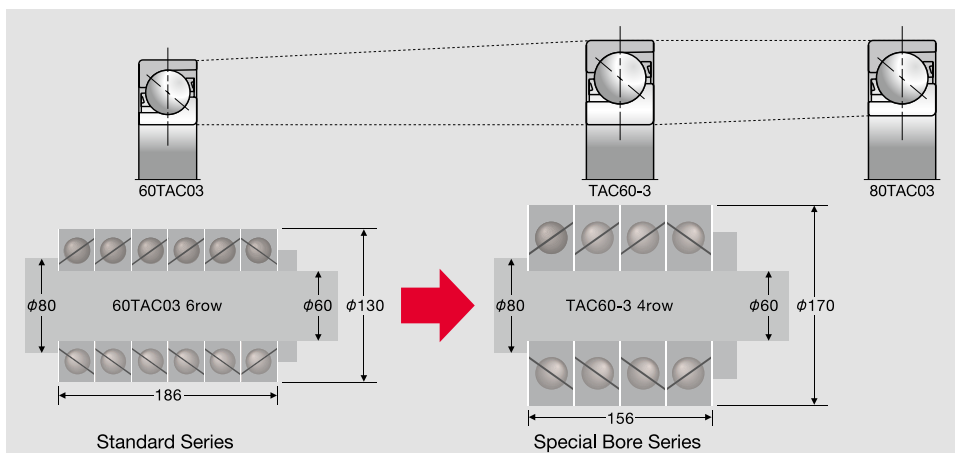
Benefits

- 1 Long Life
- 2 Higher Axial Load Maximum
- 3 Easier Handling



Features of NSKHPS NSKTAC 03 Series

- **Longer Bearing Life**
Larger size balls and a 55° contact angle for extended bearing life.
- **Higher Axial Load Maximum**
Optimized internal design of the bearings yields higher axial load capacity.
- **Special Bore Series for Higher Load Capacity with Unchanged Shaft Diameter**
The Special Bore Series are Standard Series bearings of the next larger size with only their bore reduced in size, permitting higher load capacity with the same shaft diameter as well as more compact screw shaft ends.



High Accuracy Low Profile Angular Contact Ball Bearings ROBUSTSLIM

Special Series

Specially designed angular contact ball bearings reduce energy loss with swiveling (rotary/tilt) spindle heads and rotary/tilt tables

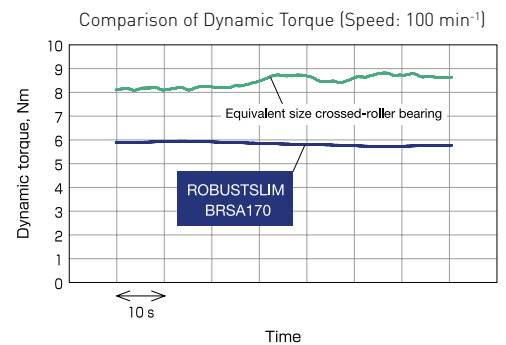
Benefits

- 1 Low Torque
- 2 Achieved NRRO Accuracy of 0.5 μm or Lower
- 3 High Moment Rigidity
- 4 Space-saving

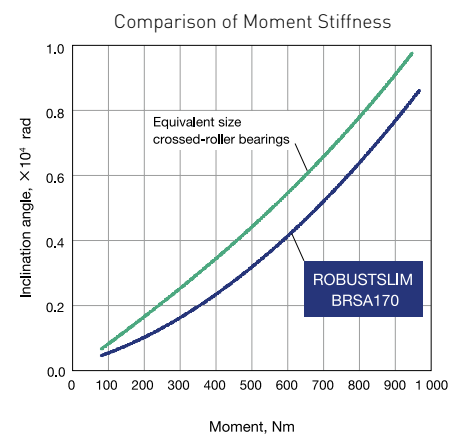


Features of High Accuracy Low Profile Angular Contact Ball Bearings ROBUSTSLIM

- **Low Torque**
Lower torque is achieved with ball bearings
- **High Accuracy**
NRRO (Non-Repeatable Runout) less than 0.5 μm was archived with BRS130.
- **High Rigidity**
High moment stiffness on a par with crossed-roller bearings
- **Space-saving**
At least 35% thinner profile than a standard angular contact ball bearing



Rotational Runout Measurement



High Performance Greases for Machine Tool Spindles

Special Series

MTS, MTE

Features of Greases for Machine Tool Spindles

MTS Contains urea thickener and delivers higher heat resistance. Recommended for use with ultra high speed machine tool spindles

MTE Formulated to handle higher load capacities. Recommended for use in high speed machine tool spindles.



Characteristics of each grease

| Items | Condition | MTS | MTE | Test Method |
|--|---------------|----------------------|----------------------|----------------------|
| Thickener | — | Urea | Barium Complex | — |
| Base Oil | — | Ester Oil | Ester Oil | — |
| Kinematic Viscosity of Base Oil (mm ² /S) | 40 °C | 22 | 23 | JIS K2283 |
| Worked Penetration | 25 °C, 60 W | 2-3 | 2 | JIS K2220 (Clause7) |
| Dropping Point (°C) | — | > 220 | >260 | JIS K2220 (Clause8) |
| Evaporation (mass%) | 99 °C × 22 H | 0.3 | 0.2 | JIS K2220 (Clause10) |
| Oil Separation (mass%) | 100 °C × 24 H | 0.4 | 1.0 | JIS K2220 (Clause11) |
| Package Sizes (Mass) | — | 100g tube 1kg can | 100g tube 1kg can | — |

Our Support for Your Bearing Selection

NSK supports customers to select the right bearings to meet their needs and ensure NSK Super Precision Bearings provide superior performance and the highest efficiency. The technical information mentioned in this catalog is to let you know how to select and use precision bearings for machine tools. NSK has knowledge and experience of this and other applications, so don't hesitate to contact us for technical assistance. You will also find information on our latest technologies on our website to assist your selection.

NSK Web Site

<http://www.nskeurope.com>



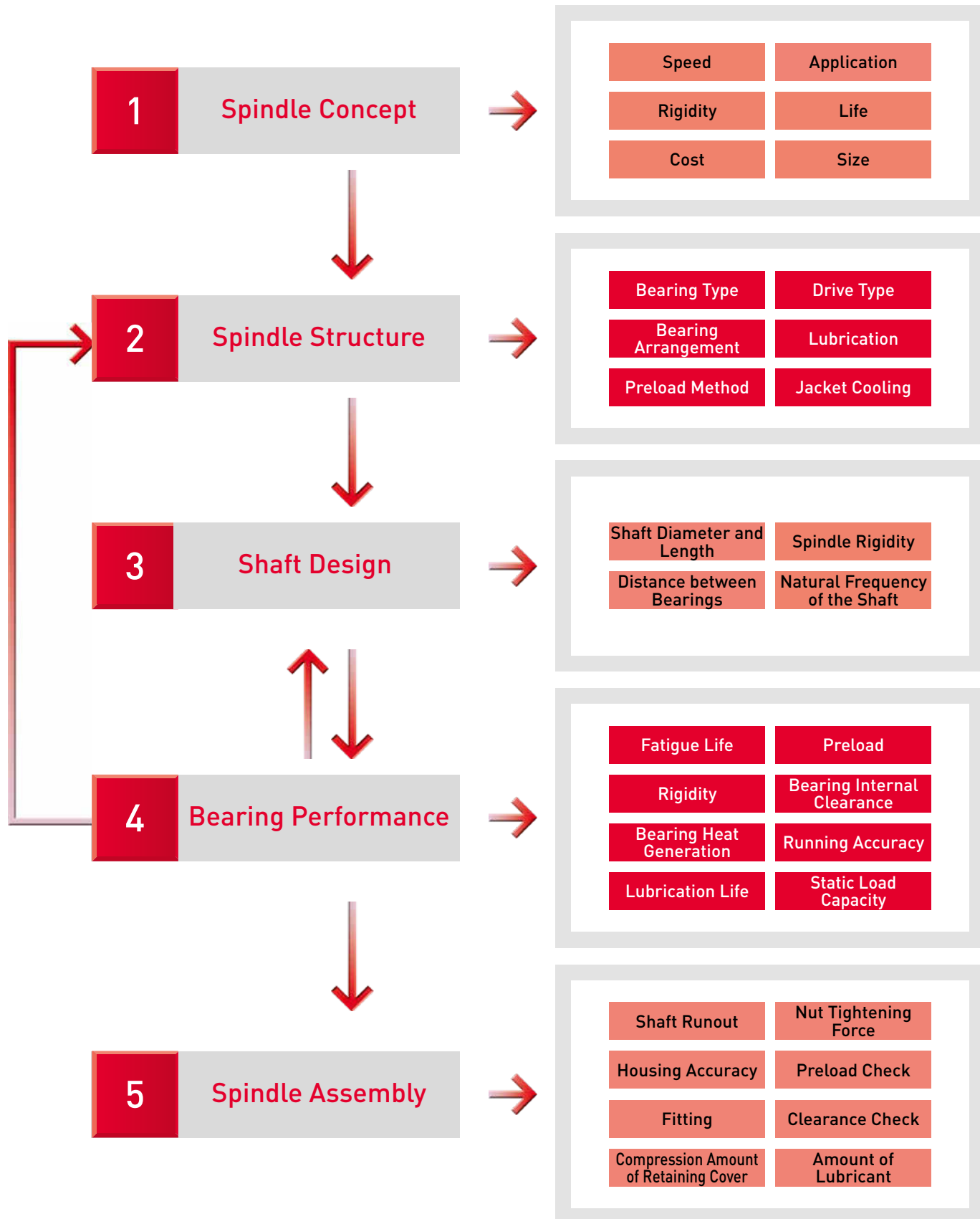
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Guidelines for Bearing Selection

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Selection Flow

The chart below outlines the correct five step procedure to follow to select the right bearing for a typical high-speed spindle application, including the factors to be considered during each stage of the selection process.



Remember, NSK technical support is always at your disposal when designing a new spindle, an ultra high-speed spindle or a spindle for a unique application. We offer customers our comprehensive experience and our expertise in advanced technology for spindle bearings.



When designing a new spindle, we recommend a thorough analysis of the desired spindle performance before selecting the bearings. In designing the spindle, it is necessary to determine which performance factors are the most important. For example, deciding if operational speed is more important than rigidity, or vice versa. Once the performance factors are prioritized proceed to the next step.



After the spindle performance analysis has been completed, the next step is to determine the structure of the spindle. Bearing type (ball bearing or roller bearing), combination (number of rows), type of drive (belt, gear, coupling or built-in motor), lubrication (grease, oil-air, oil-mist or jet) etc. need to be selected in accordance with the spindle concept. Please refer to the chart on pages 40-41 which shows the relationship between the spindle structure and its rigidity and speed.



Part 3



The decision regarding the spindle structure is followed by the design of the shaft (shaft diameter and length, distance between the bearings, etc.). Shaft dimension is determined with the consideration of spindle rigidity, the dimensions of related components, and its critical speed. The radial rigidity required of the bearings is chosen based on the spindle rigidity and calculated critical speed.



Part 5



After the required bearing size and type have been identified, the detailed bearing specifications are determined in the next step. Fatigue life, rigidity, heat generation etc. need to be taken into consideration in the selection of the optimal bearing and preload. Bearing preload is the most critical factor influencing bearing performance and must be considered with more care the higher the application speed. Premature failure or seizure may be the consequence of a wrong preload. Sometimes it is necessary to repeat step 3 or even steps 2 and 3 to achieve an optimal spindle design.



Part 4

Part 5



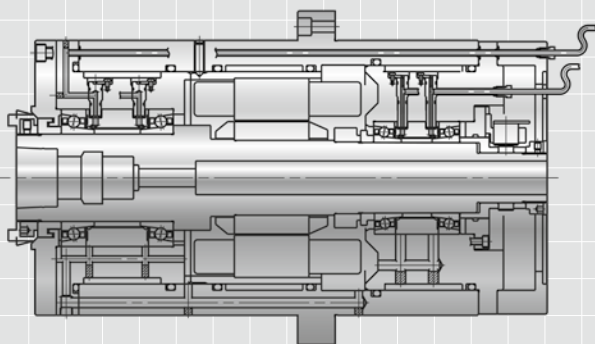
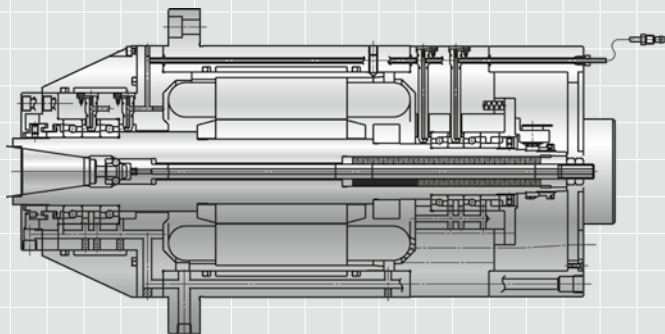
After the specification of the main shaft is complete, the final stage is the specification of the assembly method. Accuracy of the shaft and housing at the bearing seats is important. Specify the fit and clearance of the bearings to the shaft and housing. Use the correct nut tightening force to fix the bearings. And double check that the preload, or clearance, after the bearing has been mounted is correct.



Part 6

Typical High-Speed Spindle Structures

Speed ($d_m n$)



Bearing Arrangement II

Front side: Ultra high-speed angular contact ball bearing duplex set (DB)

Rear side: Ultra high-speed angular contact ball bearing duplex set (DB)

(Constant pressure preload is applicable with angular contact ball bearings)

Spindles with this arrangement achieve high speeds with position preload and deliver higher radial and axial rigidity than Bearing Arrangement I. Rigidity is lower than in Bearing Arrangement III, but this arrangement is suitable for high speed operation and light cutting, and mounting is relatively easy.

Applications:
Machining Centers, etc.

Oil-air lubrication
 $d_m n \nearrow 2.5M$

Grease lubrication
 $d_m n \nearrow 1.5M$

Bearing Arrangement IV

Front side: Ultra high-speed angular contact ball bearing quad set (DBB)

Rear side: Ultra high-speed single-row cylindrical roller bearing

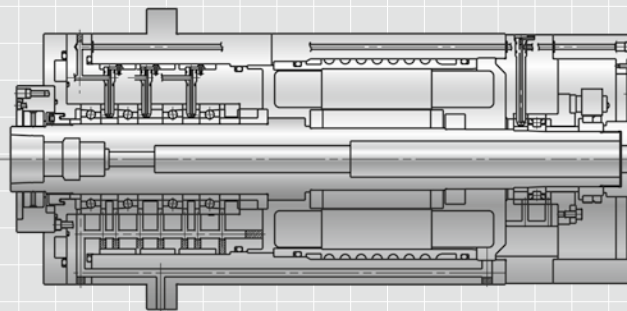
(Either constant pressure or position preload is applicable with angular contact ball bearings)

Spindles with this arrangement achieve lower operating speeds than Bearing Arrangement II but deliver higher radial and axial rigidity.

Applications: NC Lathes, NC Milling Machines, Machining Centers, etc.

Oil-air lubrication
 $d_m n \nearrow 2.2M$

Grease lubrication
 $d_m n \nearrow 1.3M$



Bearing Arrangement VI

Front side: Ultra high-speed angular contact ball bearing triplex set (DBD)

Rear side: Ultra high-speed single-row cylindrical roller bearing

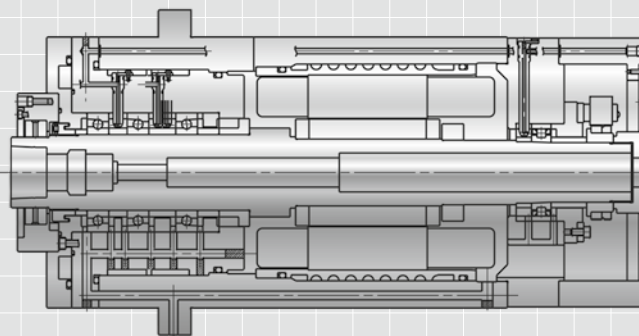
(Either constant pressure or position preload is applicable with angular contact ball bearings)

Spindles with this arrangement achieve lower operating speeds than Bearing Arrangement II but deliver higher radial and axial rigidity. Compared to Bearing Arrangements III and IV, this arrangement achieves both lower speed and lower rigidity.

Applications: NC Lathes, NC Milling Machines, Machining Centers, etc.

Oil-air lubrication
 $d_m n \nearrow 1.8M$

Grease lubrication
 $d_m n \nearrow 1.2M$



(Speeds higher than 0.7 million $d_m n$)

Bearing Arrangement I

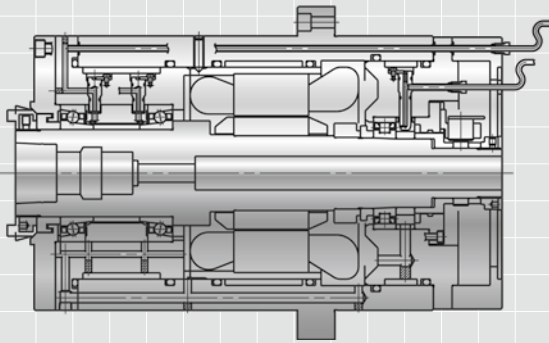
Front side: Ultra high-speed angular contact ball bearing duplex set (DT)

Rear side: Ultra high-speed angular contact ball bearing duplex set (DT)

Spindles with this arrangement are suited for ultra high-speed operation and commonly make use of constant pressure preload. Compared to position preload, the rigidity is lower, but higher speed capability and lower temperature rise are achieved.

Applications: Machining Centers, Grinding Machines, High Frequency Spindles, etc.

| | |
|--|---|
| Oil-air lubrication $d_m n \nearrow 3.5M$ | Grease lubrication $d_m n \nearrow 2.0M$ |
|--|---|



Bearing Arrangement III

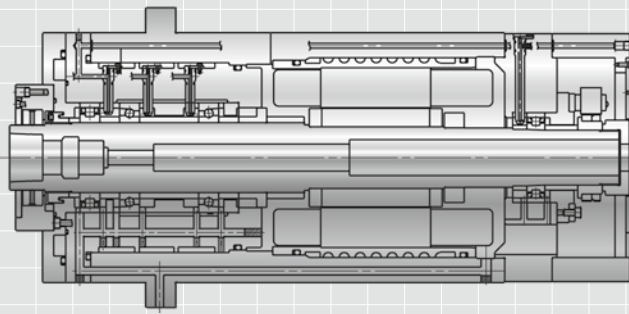
Front side: Ultra high-speed angular contact ball bearing duplex set (DB)

Rear side: Ultra high-speed single-row cylindrical roller bearing

Spindles with this arrangement achieve high speeds with position preload and deliver higher radial and axial rigidity than Bearing Arrangement I. Considering thermal expansion of the shaft, a cylindrical roller bearing may be used on the rear side for better slide performance.

Applications: Machining Centers, etc.

| | |
|--|---|
| Oil-air lubrication $d_m n \nearrow 2.5M$ | Grease lubrication $d_m n \nearrow 1.5M$ |
|--|---|



Bearing Arrangement V

Front side: Ultra high-speed single-row cylindrical roller bearing, Angular contact ball bearing duplex set (DB)

Rear side: Ultra high-speed single-row cylindrical roller bearing (Either constant pressure or position preload is applicable with angular contact ball bearings)

Spindles with this arrangement achieve similar operating speeds as Bearing Arrangement III. The cylindrical roller bearing in front delivers high radial rigidity, making this structure suitable for high speed and heavy cutting.

Applications: NC Lathes, NC Milling Machines, Machining Centers, etc.

| | |
|--|---|
| Oil-air lubrication $d_m n \nearrow 2.2M$ | Grease lubrication $d_m n \nearrow 1.3M$ |
|--|---|

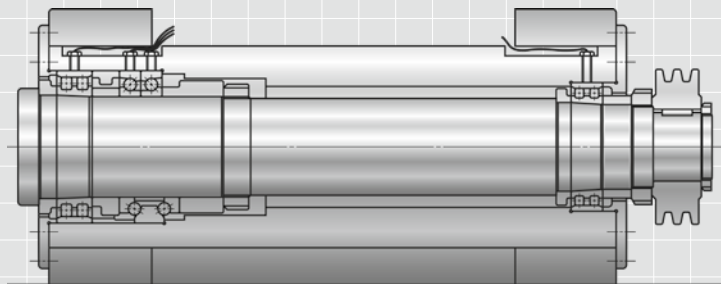
Bearing Arrangement VII

Front side: High-rigidity double-row cylindrical roller bearing, High-rigidity angular contact thrust ball bearings (DB)

Rear side: High-rigidity double-row cylindrical roller bearing
Spindles with this arrangement achieve lower operating speeds but deliver the highest level of radial and axial rigidity.

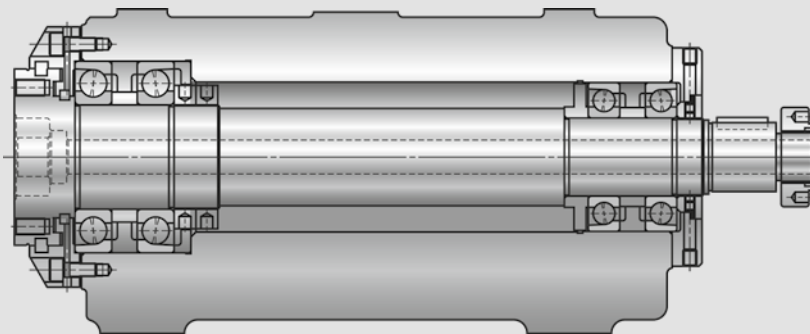
Applications: NC Lathes, NC Milling Machines, Boring Machines, Machining Centers, etc.

| | |
|--|---|
| Oil-air lubrication $d_m n \nearrow 1.0M$ | Grease lubrication $d_m n \nearrow 0.8M$ |
|--|---|

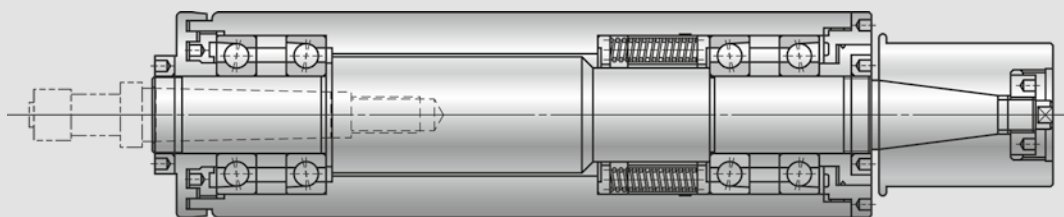


Other Spindle Structures

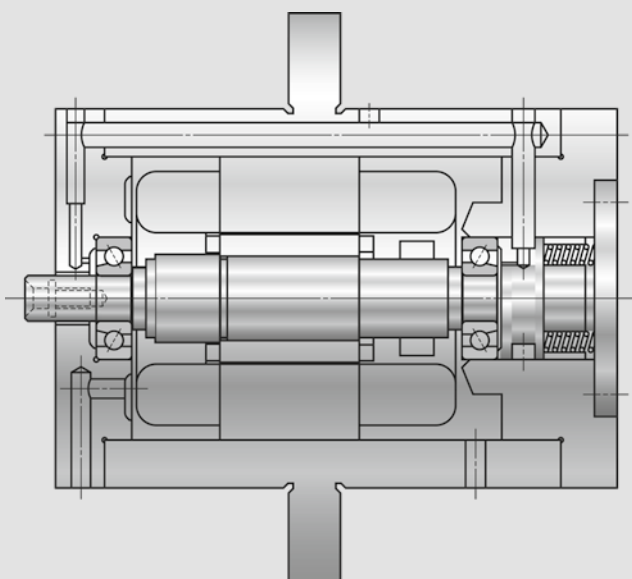
Boring Head



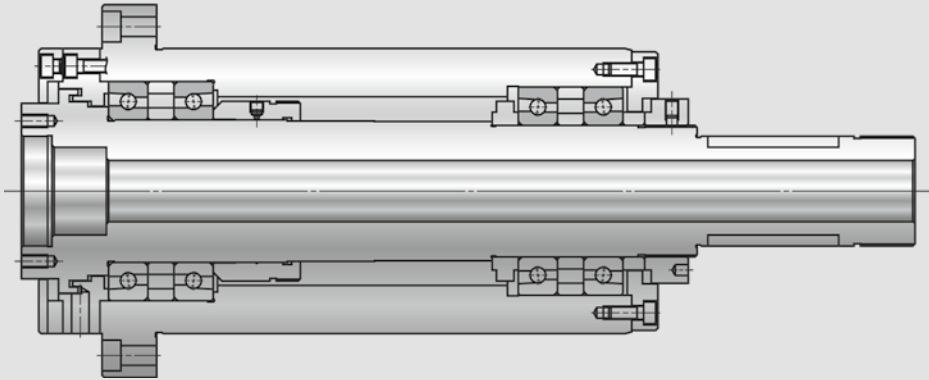
Grinding Spindle



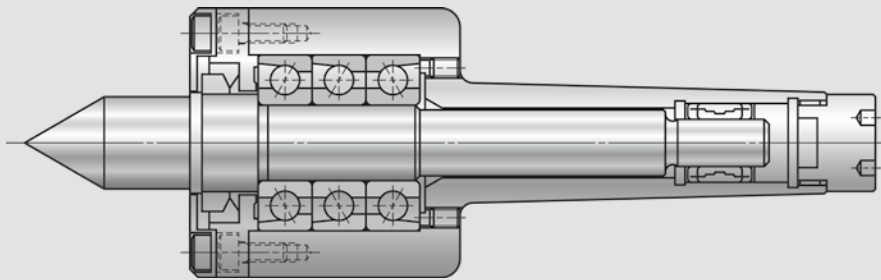
High Frequency Spindle



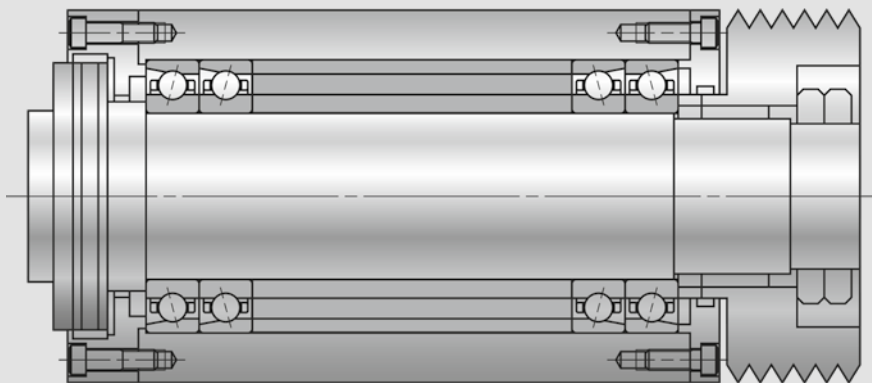
High Precision Spindle for Lathe



Live Center

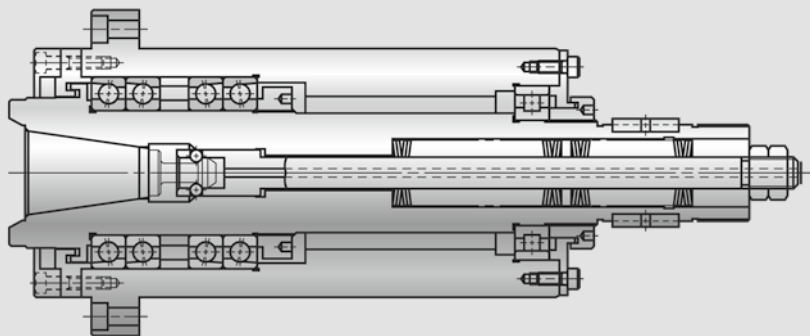


Work Head Spindle

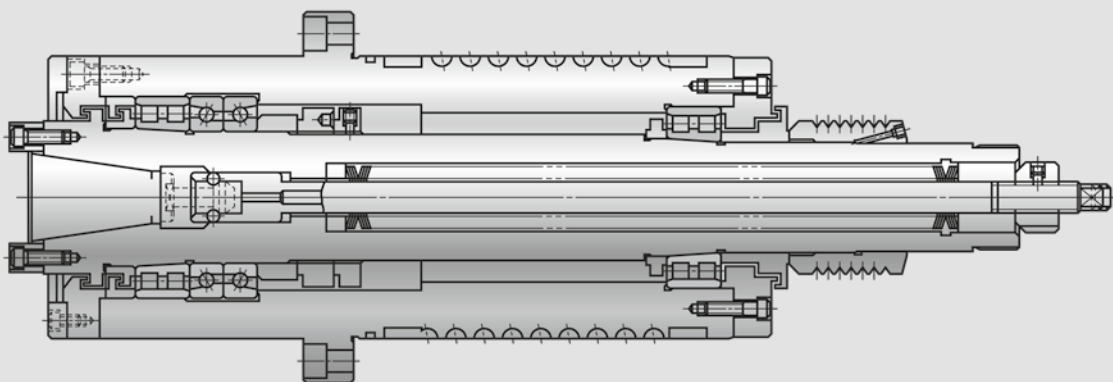


Other Spindle Structures

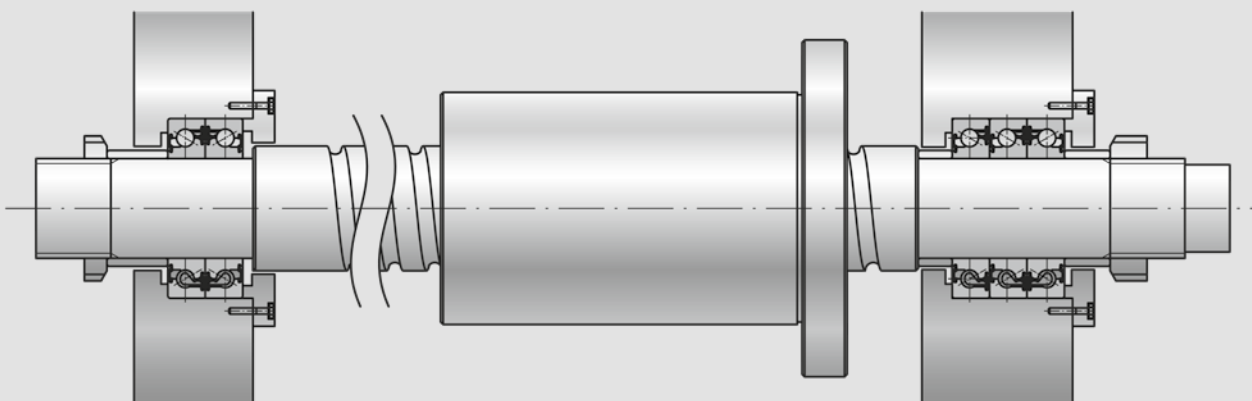
Cutting Spindle



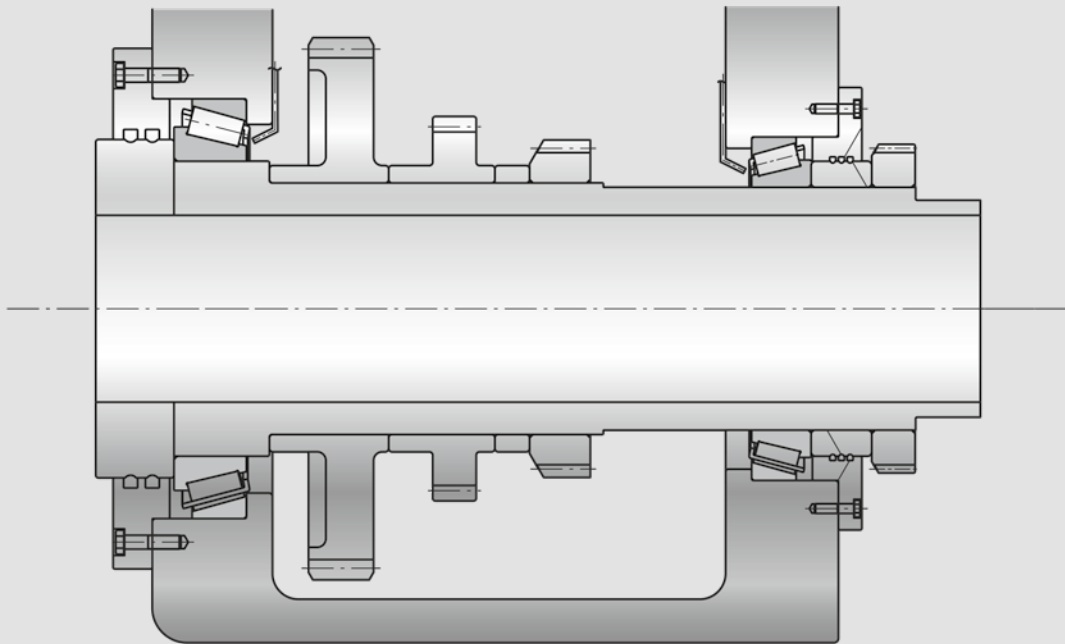
High Rigidity Spindle



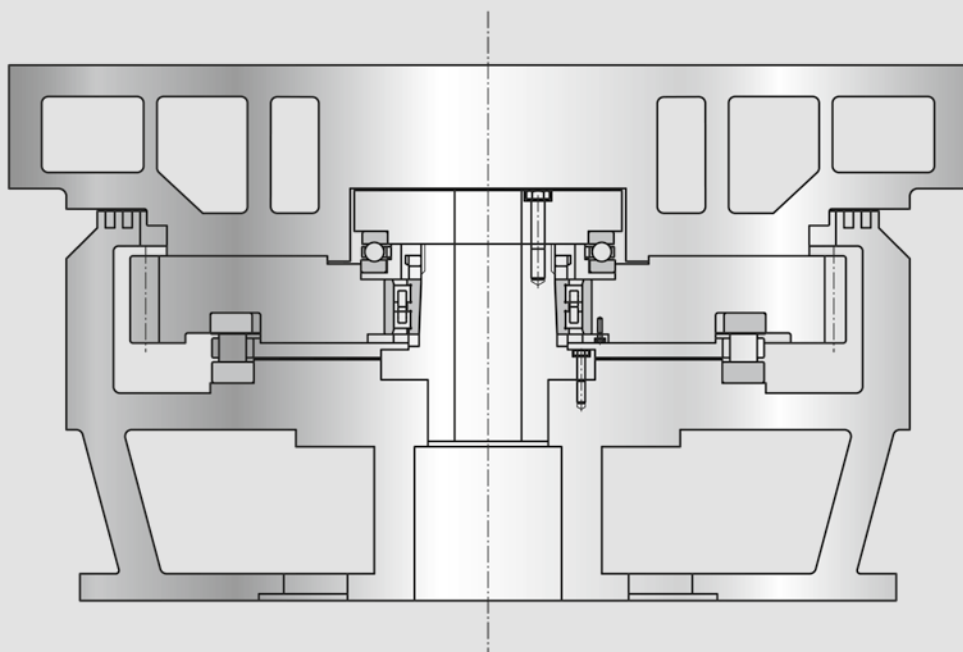
Ball Screw Support



Large Lathe



Rotary Table for Vertical Lathe



Features of Angular Contact Ball Bearings

The main features of the Angular Contact Ball Bearing (ACBB)

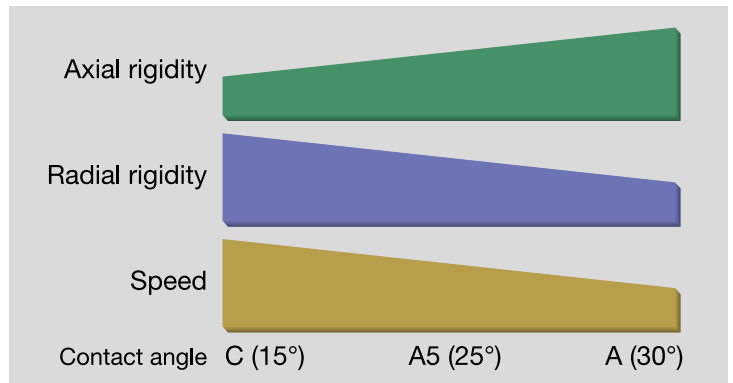
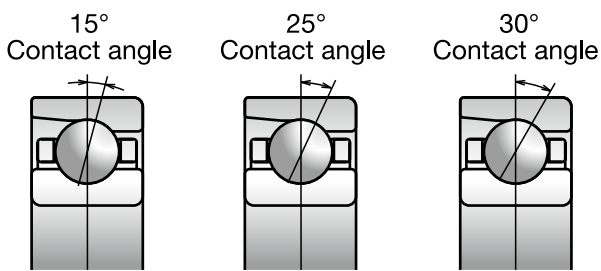
- Predefined contact angle
- Choice of preload level
- Several combinations of bearings in rows are possible

The three properties on the left need to be taken into consideration when choosing angular contact ball bearings.

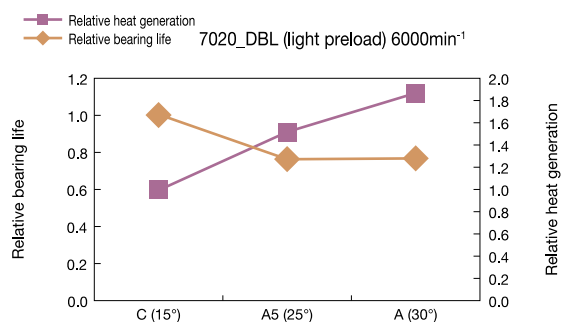
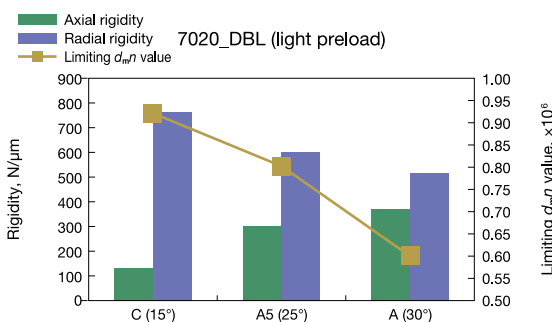
To enable our customers to choose the optimal bearing for their applications, this section provides basic information on contact angle, preload and bearing arrangement.

The Effect of Contact Angle

A larger contact angle means that the bearing can support higher axial loads. Smaller contact angles, while supporting less axial load, are better suited for high speed and high radial load applications.

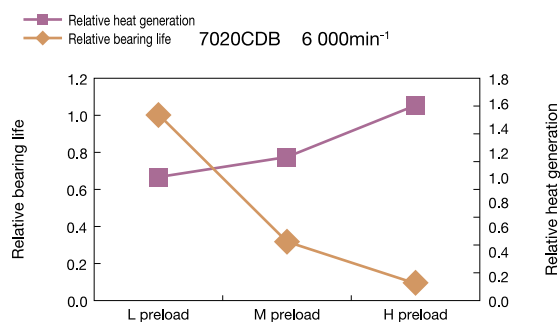
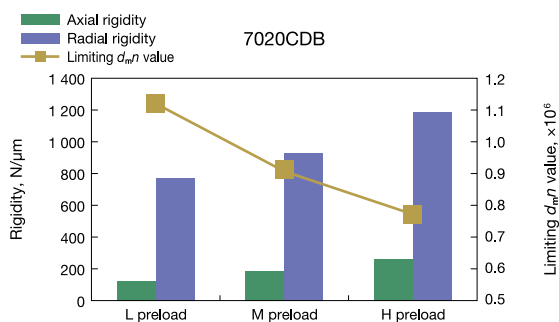
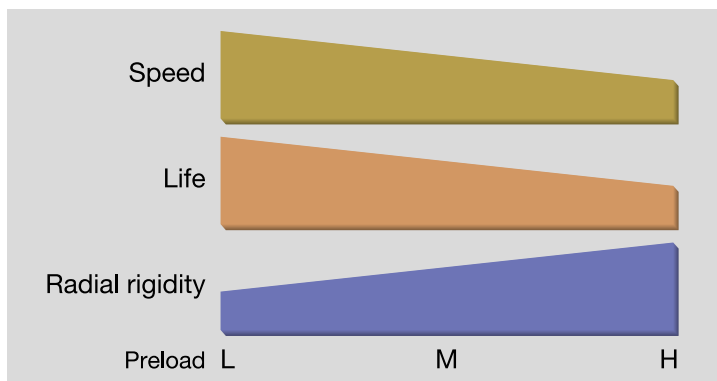
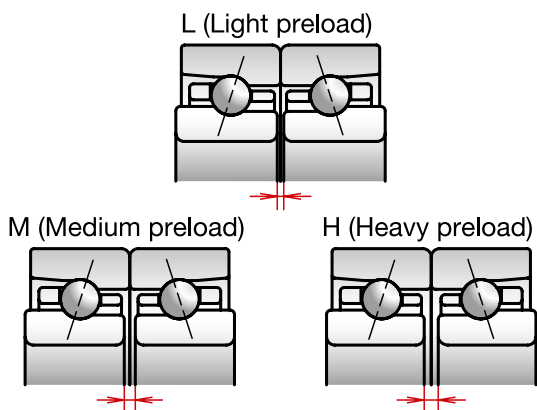


The graphs below show rigidity, limiting speed and heat generation of a 7020 angular contact ball bearing with different contact angles: C (15°), A5 (25°) and A (30°). Under the same light preload level (L), the bearing with A angle delivers the highest axial rigidity, roughly three times the axial rigidity of the bearing with C angle, but at a lower limiting speed. The bearing with C angle surpasses the bearing with A angle in terms of radial rigidity and heat generation performance.



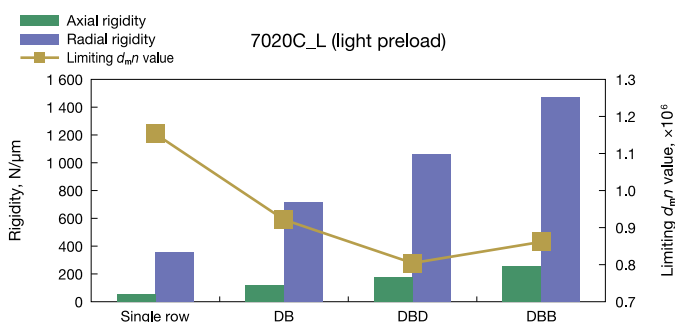
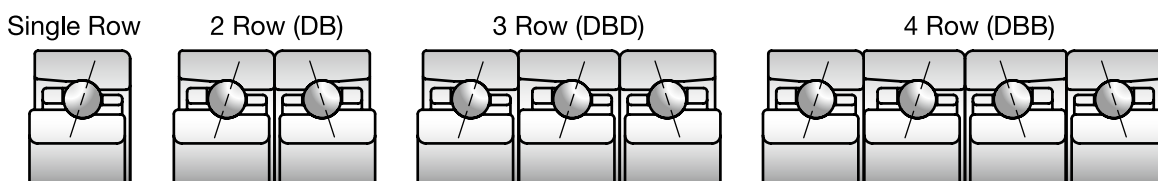
The Effect of Preload

Preload affects the performance of ACBBs in much the same way that the contact angle does. NSK has defined standard preload levels as Extra Light (EL), Light (L), Medium (M) and Heavy (H). The figures show the performance of a 7020CDB bearing combination at different preload levels. For any given contact angle, both radial and axial rigidity can be increased by increasing preload, but at the same time, heat generation will rise, while bearing life and limiting speed will decline. Higher rigidity can be achieved by sacrificing speed, and higher speed can be achieved by sacrificing rigidity to a certain degree. Caution must be exercised, as high speeds combined with too high a preload risk seizure.



The Effect of Combination

ACBBs can be used either as single bearings or as combinations of two or more ACBBs. There are three types of combinations: Back-to-back (DB), Face-to-face (DF) or Tandem (DT). There is no limit to the number of rows. Two row, three row and four row are the most commonly used multiple bearing sets. When the combination is held constant (back-to-back in this example), rigidity and load capacity increase with the number of rows, but limiting speed decreases.



Features of Cylindrical Roller Bearings

Cylindrical roller bearings (CRB) support only radial loads, but have the advantage of a larger radial load capacity than ACBBs. Double row cylindrical roller bearings (NN and NNU types) and single row cylindrical roller bearings (N type) are available.

In general, double row cylindrical roller bearings are used for high rigidity applications such as lathes, while single row cylindrical roller bearings are used in high-speed applications such as machining centers. The following graphs display the effect of internal radial clearance on the performance of cylindrical roller bearings.

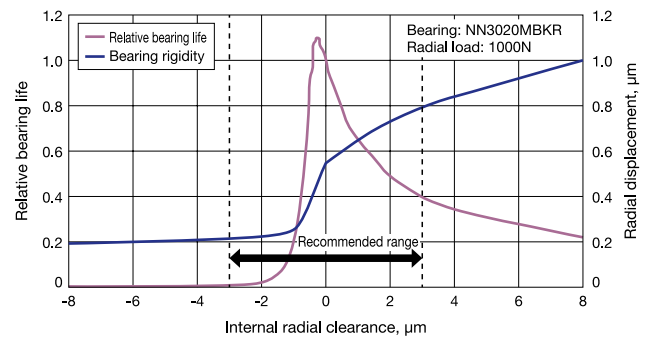
The Effect of Internal Radial Clearance

The performance of cylindrical roller bearings is affected by internal radial clearance after mounting. The graph shows that $0\mu\text{m}$ to slightly negative clearance is optimal in terms of both rigidity and bearing life.

In order to achieve rigidity for fixed-end bearings, radial clearance is set to slightly below zero, but a radial clearance below $-3\mu\text{m}$ will practically not increase rigidity at all, while bearing life will fall sharply.

Positive clearance of about $+3\mu\text{m}$ is commonly used in free-end bearings. However, depending on bearing size and speed a more detailed examination may be required.

Internal radial clearance decreases during operation. This must be taken into account when setting internal radial clearance during mounting, especially with high-speed applications.



The Relationship between Internal Radial Clearance and Temperature Rise

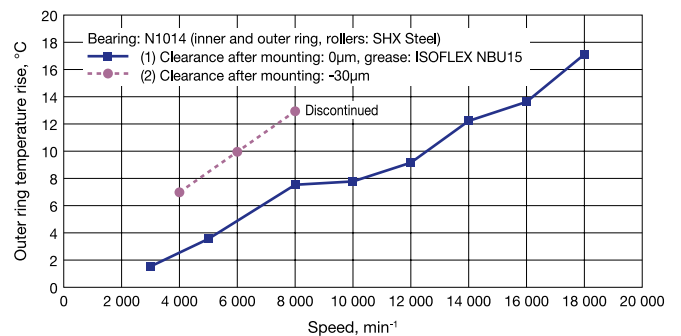
The figure on the right shows test results of the temperature rise in cylindrical roller bearings.

Internal radial clearance after mounting:

Bearing (1): $0\mu\text{m}$

Bearing (2): $-30\mu\text{m}$

The bearing (2) with $-30\mu\text{m}$ internal radial clearance after mounting displays a strong temperature rise and a drop in limiting speed. This illustrates that mounting a bearing with an excessively negative internal radial clearance will not allow that bearing to perform to its potential.



Adjusting Internal Radial Clearance After Mounting

Difference in clearance control for cylindrical bore and tapered bore

With cylindrical bore bearings it is necessary to match the shaft and housing with the actual bore and outer diameter of the bearing, to achieve the target radial clearance.

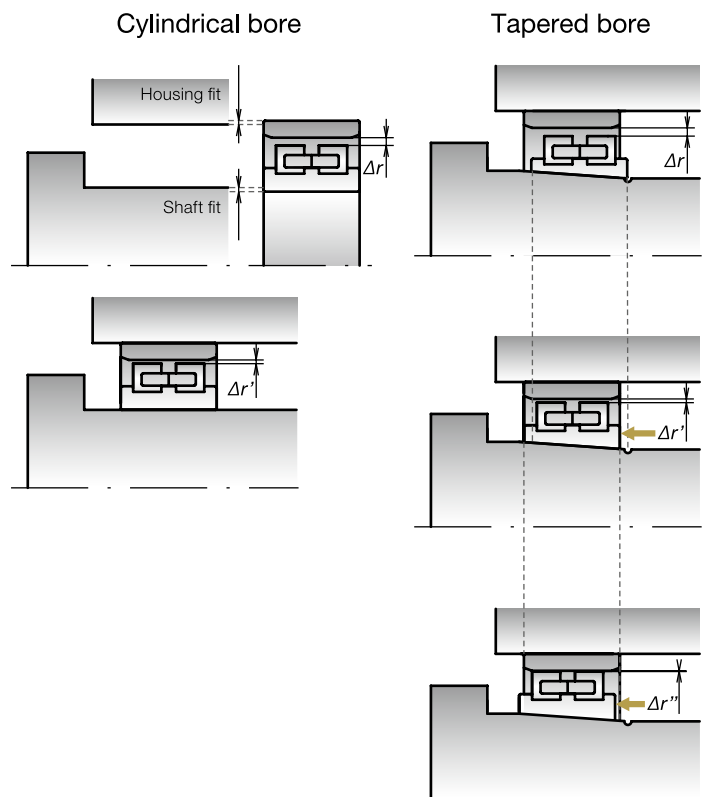
With tapered bore bearings, how far the bearing is driven onto the shaft determines the amount of inner ring expansion. That way internal radial clearance after mounting is easily adjusted.

Cylindrical bore

As a result of the shaft fit and housing fit, internal radial clearance will change from Δr to $\Delta r'$. Further adjustment of internal radial clearance is not possible.

Tapered bore

By pushing the inner ring onto the shaft, internal radial clearance will change from Δr to $\Delta r'$ to $\Delta r''$. Thereby the desired internal radial clearance may easily be achieved.



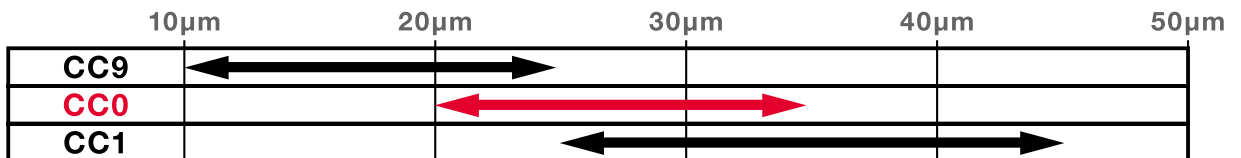
- The ISO standards for 1:12 tapered bores have a rather wide tolerance range for the taper angle. Therefore, for precision cylindrical roller bearings, NSK has established its own narrower tolerances:

- 1) KR tolerance has a very narrow range that is positioned towards the lower limit of the standard ISO range. The narrow tolerance of KR tapered bores supports easier clearance control during mounting. NSK applies KR tolerance as standard to bore diameters up to 400mm.
- 2) K tolerance is positioned midrange of the ISO standard. Bore dimensional tolerances are identical with those of ISO. NSK applies K tolerance to bore diameters of more than 400mm.

Please refer to page 228 for taper angle tolerances.

Internal Radial Clearance Classes

Three classes of internal radial clearance for tapered bore bearings are commonly in use: CC9, CC0 and CC1. It depends on the operating conditions which class is most suitable. NSK has chosen to make CC0, a well-balanced clearance, its standard internal radial clearance class because of its advantages in terms of ease of mounting and spindle accuracy.



Internal clearance example (bearing: NN3020TBKR)

NSK's recommended clearance

- CC0

With the upper limit of CC1 and the lower limit of CC9 omitted, this class offers medium radial clearance. Its range is also smaller than that of CC1. As it is the easiest-to-use for customers who target this range, it is the recommended clearance offered for CRB with tapered bore.

- CC9 clearance

The bearings of this class are produced with the lowest internal clearance of the three classes. Therefore, the bearing needs to be pushed onto the shaft only a short distance, which helps to avoid the negative influence of interference on bearing accuracy or deformation of the shaft bore. However, in the case of the bearing's internal clearance after manufacture being at the lower end of the range, only a small movement is required to drive the bearing onto the tapered shaft to achieve the required clearance. Depending on the load and especially in high-speed operation, pushing the bearing too short a distance onto the shaft may cause creep damage between the shaft and the inner ring of the bearing.

- CC1 clearance

Traditionally, this internal clearance class has been the most popular. There is no danger of creep damage, because the bearing will necessarily be pushed onto the shaft by a certain amount. However, in the case of the bearing's internal clearance after manufacture being at the high end of the range, the bearing will be pushed further onto the tapered shaft. This may be detrimental to bearing accuracy or cause deformation of the inside shaft bore. Especially when a thin hollow shaft has a large bore diameter, this bore diameter may easily shrink.

1. Angular Contact Ball Bearings



High-Accuracy Angular Contact Ball Bearings

Standard Series



Ultra High-Speed Angular Contact Ball Bearings

NSKROBUST Series

Spinshot II

ROBUSTSHOT

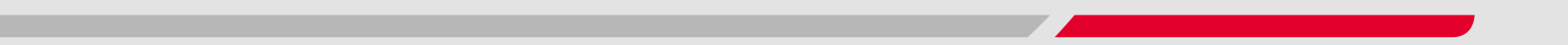
NSKROBUST BSR Series

Angular Contact Ball Bearings

Part 4

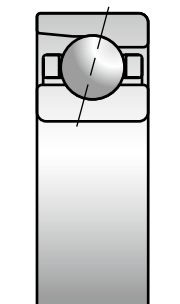
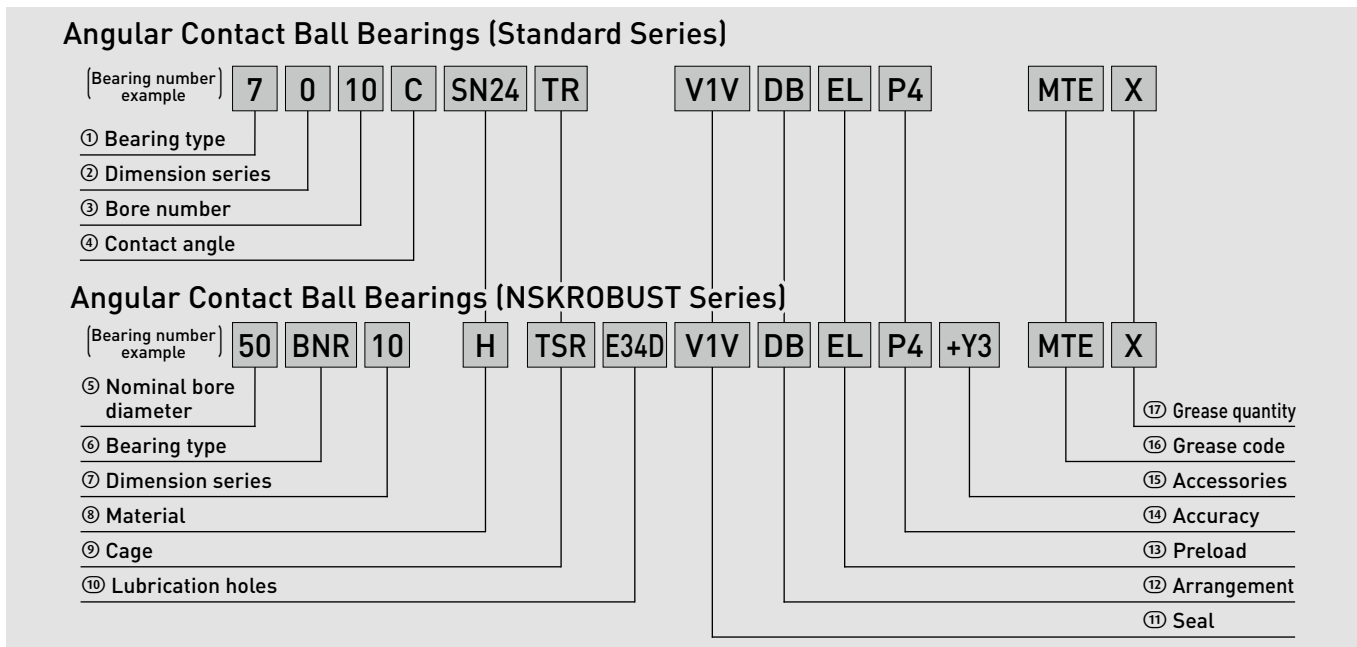
Angular Contact Ball Bearings52-109

- Designation System
- Bearing Tables
 - High Accuracy Angular Contact Ball Bearings (Standard Series)
 - Ultra High Speed Angular Contact Ball Bearings (NSKROBUST Series)



1. Angular Contact Ball Bearings

Designation System



①⑥ Bearing Type

① 7: High-Accuracy Angular Contact Ball Bearings (Standard Series)

The high performance standard NSK HPS Series features a high basic dynamic load rating and is suitable for low to medium speed operation and high-load applications. NSK's original material evaluation technology ensures only high purity materials are used in their manufacture, which has the most influence on bearing life. Superior steel materials have led to a 15% extension of rolling fatigue life.

⑥ BNR, BER, BSR: High-Speed Angular Contact Ball Bearings (NSKROBUST Series)

High performance ACBBs with high rigidity and low heat generation. The results of temperature rise simulations undertaken to evaluate rolling element slip were used to optimize the design of this series.

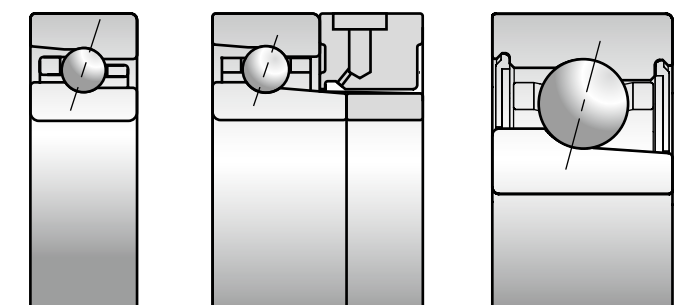
NSKROBUST bearings are available as S, E, H or X type with different combinations of materials such as high-accuracy ceramic balls and heat-resistant high-speed SHX Steel, enabling our customers to choose the most suitable bearing for each application.

Sealed bearings are available mainly up to 120mm bore diameter. Optimization of the space between seal and cage and minimization of the seal labyrinth prevent grease leakage. The wide-width series (29, 20 series) has been designed to allow more grease to be held inside the bearing. This helps keep temperature rise down and prolongs grease life.

The Spinshot type has been designed for noise reduction and greater reliability of oil-air lubrication during ultra high-speed operation.

The BSR series bearings retain high radial rigidity even in high-speed operation with constant pressure preload. This makes them ideal for grinders and similar applications.

BNR: 18° contact angle BER: 25° contact angle BSR: 15° contact angle



BNR, BER

Spinshot II

BSR

Available sizes

| | BNR, BER | BSR |
|-----------|--------------------|-------------------|
| 19 Series | 30BxR19 ~ 200BxR19 | 10BSR19 ~ 25BSR19 |
| 10 Series | 30BxR10 ~ 160BxR10 | 6BSR10 ~ 25BSR10 |
| 02 Series | — | 10BSR02 ~ 25BSR02 |

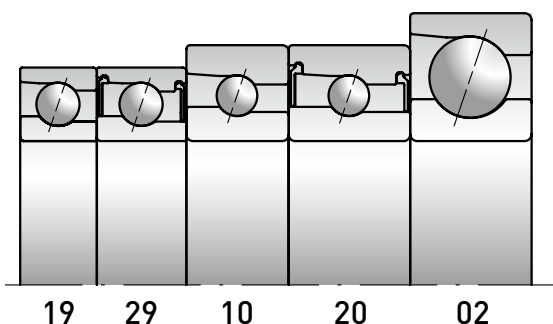
②⑦ Dimension series

② Standard Series

9: 19 Series, 0: 10 Series, 2: 02 Series

⑦ NSKROBUST Series

19: 19 Series, 29: 29 Series, 10: 10 Series, 20: 20 Series, 02: 02 Series



As shown in the figure above, for identical bore diameters, the bearings' outside diameter and width increase in the order 19– 29– 10– 20– 02 Series as expressed by the dimension series codes.

Please note the 29 and 20 Series are only available as NSKROBUST Series sealed ultra high-speed angular contact ball bearings.

③ Bore Number ⑤ Nominal Bore Diameter

③ Standard Series

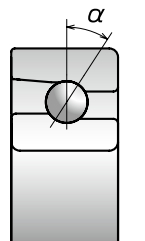
Up to 3: Bore diameter 00: 10mm, 01: 12mm, 02: 15mm, 03: 17mm
4 and above: Bore diameter = Bore number x 5 (mm)

⑤ NSKROBUST Series

Nominal bore diameter = Bore dimension (mm)

④ Contact Angle ⑥ Bearing Type

Page 46-47



④ Standard Series

C: 15° A5: 25° A: 30°

⑥ NSKROBUST Series

BNR: 18° BER: 25° BSR: 15°

⑧ Material

Page 16-19, 24

Standard Series

No symbol: steel ball SN24: ceramic ball

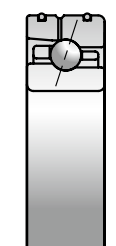
NSKROBUST Series

| Type | Material | |
|------------------|---|---|
| | Inner and outer ring | Balls |
| S | Bearing steel (SUJ2) | Bearing steel (SUJ2) |
| E | Bearing steel (SUJ2) | Ultra long life rolling elements (EQTF) |
| H | Bearing steel (SUJ2) | Ceramic (Si ₃ N ₄) |
| X | Heat resistant steel for high-speed operation (SHX) | Ceramic (Si ₃ N ₄) |
| XE (Spinshot II) | Heat resistant steel for high-speed operation (SHX) | Ceramic (Si ₃ N ₄) |

⑩ Lubrication holes

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No symbol: No lubrication holes E34: Direct lubricating bearing



⑩ NSKROBUST Series

E34, E34D: Direct lubricating bearing
Space-saving bearings designed specifically for oil-air lubrication, equipped with lubrication groove, lubrication holes and O-ring groove on outer ring.
Available for NSKROBUST Series only.

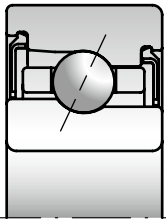
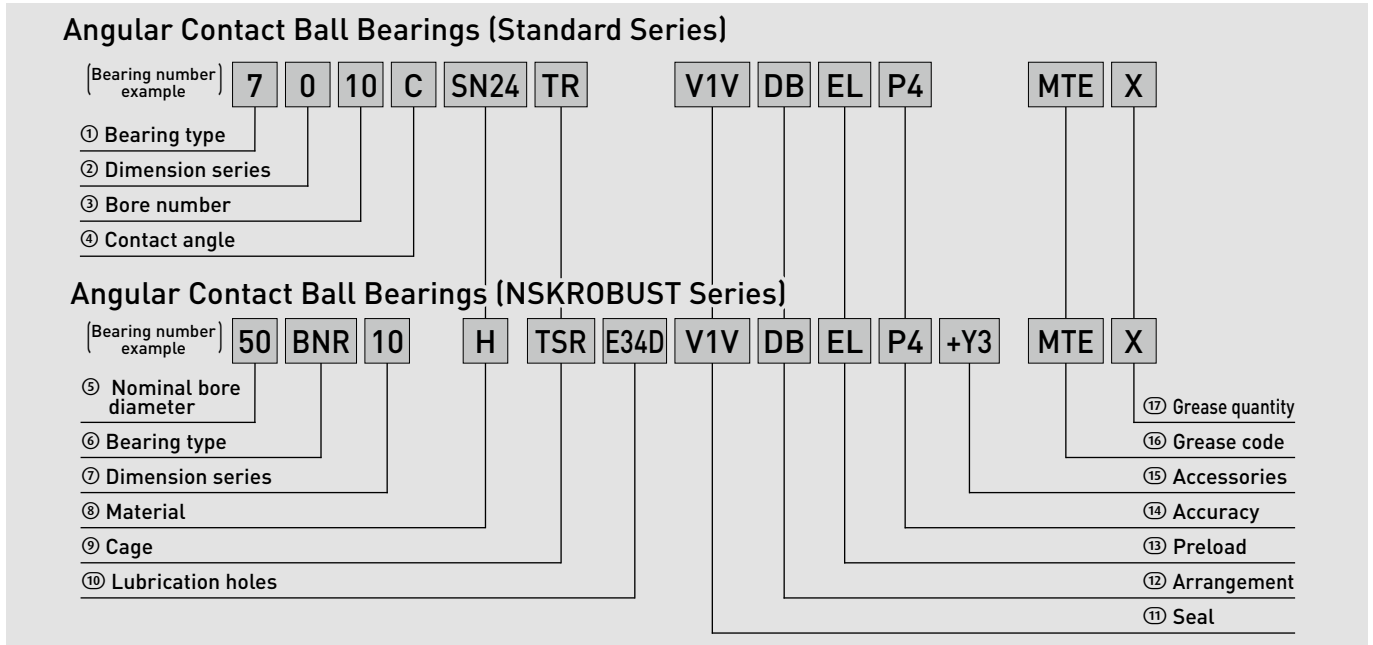
⑨ Cage

Page 20

| | Symbol | Material | Guiding | Features | Limiting Speed (d _m n value) | Available for |
|--|--------|-----------------|-------------------|---|---|--|
| | TYN | Polyamide resin | Ball guided | Excellent wear and noise characteristics, especially effective with grease lubrication | Oil: 1.4 million Grease: 1.2 million | · Standard Series · NSKROBUST Series (not available for 19 Series sealed type) |
| | T | Phenolic resin | Outer ring guided | Stable cage rotation in high-speed operation | 2.8 million | TR: Standard Series T: NSKROBUST Series TA: BSR series (sealed type) |
| | TSR | PPS resin | Outer ring guided | Reduction of non-repeatable run-out (NRRO). Low temperature rise in ultra high-speed operation due to unique design with enhanced oil drain | 3.0 million | · NSKROBUST Series |
| | MY | Brass | Ball guided | Excellent noise and temperature rise characteristics. Extended grease life. | Oil: 0.8 million Grease: 0.7 million | · Standard Series · NSKROBUST Series only for large bearings that are not equipped with TYN cages |

1. Angular Contact Ball Bearings

Designation System



⑪ Seal No symbol: Open type V1V: Non-contact rubber seal

Page 25

Non-contact rubber seals on both sides of the bearing prevent entry of foreign matter and grease expulsion, thereby ensuring high reliability and longer grease life.

⑫ Arrangement

Page 207

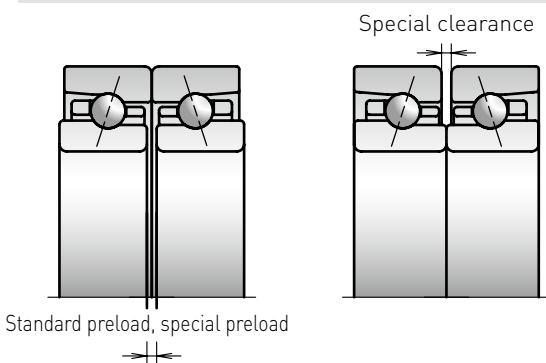
| Universal combination | Arrangement example |
|-----------------------|--|
| SU Single row | |
| DU 2 row | DB DF DT |
| DUD 3 row | DBD DFD DTD |
| QU 4 row | DBB DFB DTB DBT DFT |

Universal combination bearings SU, DU, DUD and QU are controlled during production to ensure front face stand out is the same as back face stand out.

In addition, if the bearing number indicates two or more rows (DU, DUD and QU), the tolerance variation of bore and outer diameter is controlled within each set of bearings.

⑬ Preload

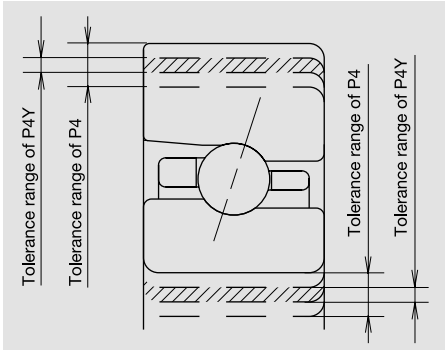
Page 208-214



EL: Extra Light Preload L: Light Preload
 M: Medium Preload H: Heavy Preload

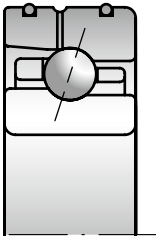
CP: Special preload CA: Special clearance

⑭ Accuracy



P2: ISO Class 2 P4: ISO Class 4 P5: ISO Class 5
 P3: special class (dimensional accuracy ISO Class 4, rotation accuracy ISO Class 2)
 P4Y: special class (dimensional accuracy of bore and outer ring are exclusive for NSK, all others are ISO Class 4 – see figure on the left)

⑮ Accessories



+Y3: O-ring on bearing outside surface
 Available for NSKROBUST direct lubricating bearings (E34, E34D) only.

⑯ Grease brand

Grease typically used in machine tool spindles:
 MTE: MTE grease MTS: MTS grease

⑰ Grease quantity

X: 15% of internal space
 K: 20% of internal space
 L: 30% of internal space

Which specification is available for which bearing?

Standard Series

| | ① Bearing type | ② Material | ③ Cage | | ④ Seal |
|-----------|----------------|-------------|----------------------------|-------------|-----------------------------|
| | NSKHPS | SN24 | TYN | TR | V1V |
| 19 Series | 7900 ~ 7952 | 7900 ~ 7948 | 7900 ~ 7928, 7932, 7938 | 7903 ~ 7960 | 7906 ~ 7920 |
| 10 Series | 7000 ~ 7040 | 7000 ~ 7032 | 7000 ~ 7028 | 7000 ~ 7048 | 7006 ~ 7018, 7020 ~ 7021 |
| 02 Series | 7200 ~ 7230 | 7200 ~ 7219 | 7200 ~ 7224 | 7200 ~ 7230 | — |

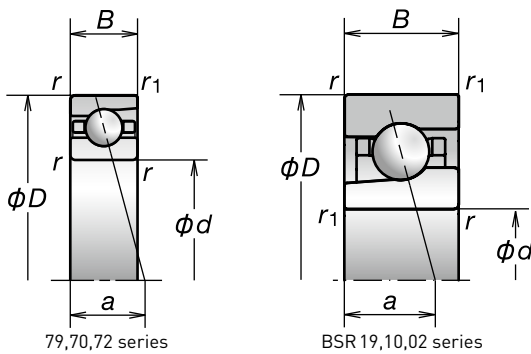
NSKROBUST Series

| | ② Material | | ③ Cage | | | | ④ Seal |
|-----------|----------------------|---|--|----------------------|---------------------------------------|---------------------------------|--|
| | Ceramic balls | Ultra long life rolling elements | TYN | T | TSR | TA | V1V |
| 19 Series | 10BxR19 ~200BxR19 | 55BxR19~140BxR19 (excluding 120mm bore diameter) | 30BxR19~140BxR19 160BxR19, 190BxR19 | 10BxR19 ~160BxR19 | — | 10BSR19 (V1V) ~25BSR19 (V1V) | 10BxR19~90BxR19, 100BxR19, 110BxR19 |
| 10 Series | 6BxR10 ~160BxR10 | 45BxR10~140BxR10 | 30BxR10~160BxR10 | 6BxR10 ~160BxR10 | 30BxR10~90BxR10 100BxR10, 110BxR10 | 6BSR10 (V1V) ~25BSR10 (V1V) | 6BxR10~90BxR10, 100BxR10, 120BxR10 |
| 02 Series | 10BSR02 ~25BSR02 | — | — | 10BSR02 ~25BSR02 | — | 10BSR02 (V1V) ~25BSR02 (V1V) | 10BSR02~25BSR02 |

For bearing numbers not listed in the tables, please contact NSK for details.

1. Angular Contact Ball Bearings

Bore Diameter 5-10 mm



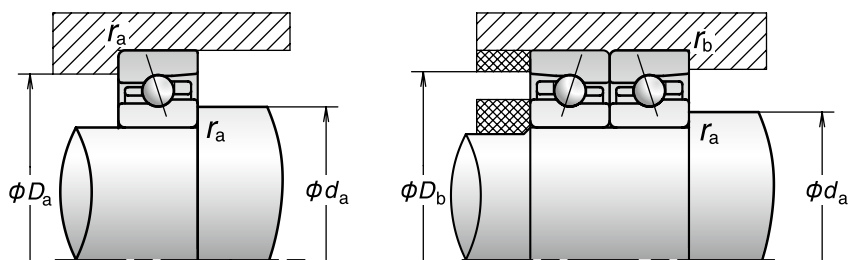
| Bearing Designation (1) | Boundary Dimensions (mm) | | | | | Basic Load Ratings (2) (kN) | | Permissible Axial Load (3) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (4) (min ⁻¹) | |
|-------------------------|--------------------------|----|---|----------|-----------------------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|---------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 725C | 5 | 16 | 5 | 0.3 | 0.15 | 1.70 | 0.660 | 0.545 | 15 | 12.6 | 3.9 | 110 000 | 167 000 |
| 725A | 5 | 16 | 5 | 0.3 | 0.15 | 1.61 | 0.620 | 0.665 | 30 | — | 5.5 | 72 000 | 96 000 |
| 706C | 6 | 17 | 6 | 0.3 | 0.15 | 2.15 | 0.845 | 0.765 | 15 | 12.4 | 4.5 | 100 000 | 153 000 |
| 706A | 6 | 17 | 6 | 0.3 | 0.15 | 2.03 | 0.795 | 0.725 | 30 | — | 6.3 | 66 000 | 87 000 |
| * 6BSR10S | 6 | 17 | 6 | 0.3 | 0.15 | 1.35 | 0.445 | 0.525 | 15 | 6.6 | 4.5 | 140 000 | 192 000 |
| * 6BSR10H | 6 | 17 | 6 | 0.3 | 0.15 | [1.35] | [0.445] | 0.345 | 15 | 6.6 | 4.5 | 166 000 | 244 000 |
| * 6BSR10X | 6 | 17 | 6 | 0.3 | 0.15 | [1.35] | [0.445] | 0.345 | 15 | 6.6 | 4.5 | 192 000 | 261 000 |
| 726C | 6 | 19 | 6 | 0.3 | 0.15 | 2.39 | 1.00 | 0.835 | 15 | 12.8 | 4.7 | 92 000 | 140 000 |
| 726A | 6 | 19 | 6 | 0.3 | 0.15 | 2.24 | 0.940 | 0.395 | 30 | — | 6.6 | 60 000 | 80 000 |
| 707C | 7 | 19 | 6 | 0.3 | 0.15 | 2.39 | 1.00 | 0.835 | 15 | 12.8 | 4.7 | 89 000 | 135 000 |
| 707A | 7 | 19 | 6 | 0.3 | 0.15 | 2.24 | 0.940 | 0.375 | 30 | — | 6.6 | 58 000 | 77 000 |
| * 7BSR10S | 7 | 19 | 6 | 0.3 | 0.15 | 1.57 | 0.570 | 0.675 | 15 | 7.1 | 4.7 | 124 000 | 170 000 |
| * 7BSR10H | 7 | 19 | 6 | 0.3 | 0.15 | [1.57] | [0.570] | 0.440 | 15 | 7.1 | 4.7 | 147 000 | 216 000 |
| * 7BSR10X | 7 | 19 | 6 | 0.3 | 0.15 | [1.57] | [0.570] | 0.440 | 15 | 7.1 | 4.7 | 170 000 | 231 000 |
| 708C | 8 | 22 | 7 | 0.3 | 0.15 | 3.55 | 1.54 | 1.30 | 15 | 12.7 | 5.5 | 77 000 | 117 000 |
| 708A | 8 | 22 | 7 | 0.3 | 0.15 | 3.35 | 1.45 | 1.02 | 30 | — | 7.8 | 50 000 | 67 000 |
| * 8BSR10S | 8 | 22 | 7 | 0.3 | 0.15 | 2.31 | 0.835 | 1.01 | 15 | 7.0 | 5.5 | 107 000 | 147 000 |
| * 8BSR10H | 8 | 22 | 7 | 0.3 | 0.15 | [2.31] | [0.835] | 0.660 | 15 | 7.0 | 5.5 | 127 000 | 187 000 |
| * 8BSR10X | 8 | 22 | 7 | 0.3 | 0.15 | [2.31] | [0.835] | 0.660 | 15 | 7.0 | 5.5 | 147 000 | 200 000 |
| 728C | 8 | 24 | 8 | 0.3 | 0.15 | 3.60 | 1.58 | 1.33 | 15 | 13.1 | 6.1 | 72 000 | 110 000 |
| 728A | 8 | 24 | 8 | 0.3 | 0.15 | 3.35 | 1.48 | 0.610 | 30 | — | 8.6 | 47 000 | 63 000 |
| 7900C | 10 | 22 | 6 | 0.3 | 0.15 | 3.15 | 1.52 | 1.23 | 15 | 14.1 | 5.1 | 71 900 | 109 000 |
| 7900CSN24 | 10 | 22 | 6 | 0.3 | 0.15 | [3.15] | [1.52] | 1.42 | 15 | 14.1 | 5.1 | 93 800 | 143 000 |
| 7900A5 | 10 | 22 | 6 | 0.3 | 0.15 | 3.00 | 1.45 | 1.44 | 25 | — | 6.7 | 62 500 | 93 800 |
| 7900A5SN24 | 10 | 22 | 6 | 0.3 | 0.15 | [3.00] | [1.45] | 1.71 | 25 | — | 6.7 | 81 300 | 122 000 |
| * 10BSR19S | 10 | 22 | 6 | 0.3 | 0.15 | 1.78 | 0.715 | 0.855 | 15 | 7.4 | 5.1 | 100 000 | 138 000 |
| * 10BSR19H | 10 | 22 | 6 | 0.3 | 0.15 | [1.78] | [0.715] | 0.560 | 15 | 7.4 | 5.1 | 119 000 | 175 000 |
| * 10BSR19X | 10 | 22 | 6 | 0.3 | 0.15 | [1.78] | [0.715] | 0.560 | 15 | 7.4 | 5.1 | 138 000 | 188 000 |
| 7000C | 10 | 26 | 8 | 0.3 | 0.15 | 5.60 | 2.49 | 2.16 | 15 | 12.6 | 6.4 | 63 900 | 97 300 |
| 7000CSN24 | 10 | 26 | 8 | 0.3 | 0.15 | [5.60] | [2.49] | 2.36 | 15 | 12.6 | 6.4 | 83 400 | 127 000 |
| 7000A5 | 10 | 26 | 8 | 0.3 | 0.15 | 5.40 | 2.41 | 2.48 | 25 | — | 8.2 | 55 600 | 83 400 |
| 7000A5SN24 | 10 | 26 | 8 | 0.3 | 0.15 | [5.40] | [2.41] | 2.94 | 25 | — | 8.2 | 72 300 | 108 000 |
| 7000A | 10 | 26 | 8 | 0.3 | 0.15 | 5.25 | 2.34 | 1.91 | 30 | — | 9.2 | 41 700 | 55 600 |
| * 10BSR10S | 10 | 26 | 8 | 0.3 | 0.15 | 3.00 | 1.18 | 1.44 | 15 | 7.1 | 6.4 | 88 900 | 123 000 |
| * 10BSR10H | 10 | 26 | 8 | 0.3 | 0.15 | [3.00] | [1.18] | 0.94 | 15 | 7.1 | 6.4 | 106 000 | 156 000 |
| * 10BSR10X | 10 | 26 | 8 | 0.3 | 0.15 | [3.00] | [1.18] | 0.94 | 15 | 7.1 | 6.4 | 123 000 | 167 000 |
| 7200C | 10 | 30 | 9 | 0.6 | 0.3 | 5.65 | 2.61 | 2.16 | 15 | 13.2 | 7.2 | 57 500 | 87 500 |
| 7200CSN24 | 10 | 30 | 9 | 0.6 | 0.3 | [5.65] | [2.61] | 2.48 | 15 | 13.2 | 7.2 | 75 000 | 114 000 |
| 7200A5 | 10 | 30 | 9 | 0.6 | 0.3 | 5.45 | 2.51 | 2.49 | 25 | — | 9.2 | 50 000 | 75 000 |
| 7200A5SN24 | 10 | 30 | 9 | 0.6 | 0.3 | [5.45] | [2.51] | 2.96 | 25 | — | 9.2 | 65 000 | 97 500 |
| 7200A | 10 | 30 | 9 | 0.6 | 0.3 | 5.30 | 2.44 | 1.92 | 30 | — | 10.3 | 37 500 | 50 000 |
| * 10BSR02S | 10 | 30 | 9 | 0.6 | 0.3 | 3.85 | 1.48 | 1.81 | 15 | 6.7 | 7.2 | 80 000 | 110 000 |
| * 10BSR02H | 10 | 30 | 9 | 0.6 | 0.3 | [3.85] | [1.48] | 1.18 | 15 | 6.7 | 7.2 | 95 000 | 140 000 |
| * 10BSR02X | 10 | 30 | 9 | 0.6 | 0.3 | [3.85] | [1.48] | 1.18 | 15 | 6.7 | 7.2 | 110 000 | 150 000 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available.

(2) Basic load rating values are reference values for ceramic ball bearings.

(3) For permissible axial load, please refer to Page 201.

(4) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-----|-----|-----|---|-----|----|-----|--------------------------------------|----|-----|-----|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 7.5 | 13.5 | — | 0.3 | — | 1.2 | 5.5 | 12 | 25 | 4.0 | 7.3 | 10 | 14 | 10 | 7 | 4 | 0 | 0.005 |
| 7.5 | 13.5 | — | 0.3 | — | 5 | 10 | 25 | 53 | 19 | 24 | 33 | 43 | 3 | 2 | 0 | -3 | 0.005 |
| 8.5 | 14.5 | — | 0.3 | — | 1.5 | 7.9 | 15 | 32 | 4.3 | 8.3 | 11 | 15 | 10 | 6 | 3 | -2 | 0.006 |
| 8.5 | 14.5 | — | 0.3 | — | 4.9 | 17 | 25 | 53 | 19 | 29 | 33 | 42 | 3 | 1 | 0 | -3 | 0.006 |
| 8.5 | 14.5 | — | 0.3 | — | 3.4 | 6.7 | 16 | — | 5.7 | 7.5 | 11 | — | 9 | 7 | 3 | — | 0.007 |
| 8.5 | 14.5 | — | 0.3 | — | 2.1 | 5.4 | 15 | — | 5.4 | 7.6 | 11 | — | 9 | 7 | 3 | — | 0.006 |
| 8.5 | 14.5 | — | 0.3 | — | 2.1 | 5.4 | 15 | — | 5.4 | 7.6 | 11 | — | 9 | 7 | 3 | — | 0.006 |
| 8.5 | 16.5 | — | 0.3 | — | 1.8 | 9.2 | 18 | 37 | 5 | 10 | 13 | 28 | 9 | 5 | 2 | -3 | 0.008 |
| 8.5 | 16.5 | — | 0.3 | — | 3.7 | 16 | 34 | 69 | 18 | 31 | 40 | 52 | 3 | 1 | -1 | -4 | 0.008 |
| 9.5 | 16.5 | — | 0.3 | — | 1.8 | 9.2 | 18 | 37 | 5.1 | 10 | 13 | 18 | 9 | 5 | 2 | -3 | 0.007 |
| 9.5 | 16.5 | — | 0.3 | — | 3.7 | 16 | 34 | 69 | 18 | 31 | 40 | 52 | 3 | 1 | -1 | -4 | 0.007 |
| 9.5 | 16.5 | — | 0.3 | — | 5.2 | 9.5 | 18 | — | 7.7 | 9.7 | 12 | — | 7 | 5 | 2 | — | 0.009 |
| 9.5 | 16.5 | — | 0.3 | — | 3.8 | 8.2 | 17 | — | 7.6 | 10 | 14 | — | 7 | 5 | 2 | — | 0.008 |
| 9.5 | 16.5 | — | 0.3 | — | 3.8 | 8.2 | 17 | — | 7.6 | 10 | 14 | — | 7 | 5 | 2 | — | 0.008 |
| 10.5 | 19.5 | — | 0.3 | — | 4.2 | 14 | 29 | 59 | 7.5 | 12 | 17 | 23 | 7 | 3 | -1 | -7 | 0.012 |
| 10.5 | 19.5 | — | 0.3 | — | 8.1 | 25 | 46 | 88 | 26 | 39 | 49 | 63 | 2 | 0 | -2 | -5 | 0.012 |
| 10.5 | 19.5 | — | 0.3 | — | 7.3 | 12 | 21 | — | 8.7 | 11 | 13 | — | 6 | 4 | 1 | — | 0.013 |
| 10.5 | 19.5 | — | 0.3 | — | 5.9 | 11 | 21 | — | 9.0 | 11 | 15 | — | 6 | 4 | 1 | — | 0.012 |
| 10.5 | 19.5 | — | 0.3 | — | 5.9 | 11 | 21 | — | 9.0 | 11 | 15 | — | 6 | 4 | 1 | — | 0.012 |
| 10.5 | 21.5 | — | 0.3 | — | 4.2 | 14 | 29 | 59 | 7.5 | 12 | 17 | 23 | 7 | 3 | -1 | -7 | 0.016 |
| 10.5 | 21.5 | — | 0.3 | — | 8.1 | 25 | 46 | 88 | 26 | 39 | 49 | 63 | 2 | 0 | -2 | -5 | 0.016 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 7.0 | 16 | 29 | 58 | 10 | 15 | 19 | 27 | 5 | 2 | -1 | -6 | 0.009 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 5.7 | 16 | 30 | 62 | 11 | 16 | 21 | 30 | 5 | 2 | -1 | -6 | 0.008 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 9.8 | 17 | 55 | 94 | 24 | 29 | 46 | 58 | 2 | 1 | -3 | -6 | 0.009 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 8.5 | 16 | 59 | 103 | 26 | 32 | 53 | 66 | 2 | 1 | -3 | -6 | 0.008 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 5.9 | 14 | 21 | — | 8.9 | 12 | 15 | — | 6 | 3 | 1 | — | 0.011 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 4.5 | 13 | 20 | — | 9.0 | 13 | 16 | — | 6 | 3 | 1 | — | 0.010 |
| 12.5 | 19.5 | 20.8 | 0.3 | 0.15 | 4.5 | 13 | 20 | — | 9.0 | 13 | 16 | — | 6 | 3 | 1 | — | 0.010 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 13 | 25 | 49 | 96 | 13 | 17 | 23 | 31 | 3 | 0 | -5 | -12 | 0.019 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 12 | 25 | 52 | 106 | 14 | 19 | 26 | 36 | 3 | 0 | -5 | -12 | 0.017 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 17 | 43 | 78 | 153 | 29 | 41 | 52 | 68 | 1 | -2 | -5 | -10 | 0.019 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 16 | 46 | 86 | 172 | 32 | 47 | 59 | 78 | 1 | -2 | -5 | -10 | 0.017 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 25 | 97 | 202 | 333 | 44 | 72 | 94 | 115 | 0 | -5 | -10 | -15 | 0.019 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 8.4 | 17 | 37 | — | 10 | 13 | 18 | — | 5 | 2 | -3 | — | 0.021 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 7.1 | 17 | 39 | — | 11 | 15 | 21 | — | 5 | 2 | -3 | — | 0.019 |
| 12.5 | 23.5 | 24.8 | 0.3 | 0.15 | 7.1 | 17 | 39 | — | 11 | 15 | 21 | — | 5 | 2 | -3 | — | 0.019 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 13 | 29 | 68 | 150 | 13 | 18 | 26 | 39 | 3 | -1 | -8 | -18 | 0.032 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 12 | 29 | 73 | 167 | 14 | 20 | 30 | 45 | 3 | -1 | -8 | -18 | 0.030 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 17 | 43 | 106 | 188 | 29 | 41 | 58 | 74 | 1 | -2 | -7 | -12 | 0.031 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 16 | 46 | 117 | 213 | 32 | 47 | 67 | 86 | 1 | -2 | -7 | -12 | 0.029 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 25 | 97 | 202 | — | 44 | 72 | 95 | — | 0 | -5 | -10 | — | 0.032 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 11 | 25 | 51 | — | 11 | 15 | 20 | — | 4 | 0 | -6 | — | 0.032 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 10 | 25 | 54 | — | 12 | 17 | 23 | — | 4 | 0 | -6 | — | 0.030 |
| 15 | 25 | 27.5 | 0.6 | 0.3 | 10 | 25 | 54 | — | 12 | 17 | 23 | — | 4 | 0 | -6 | — | 0.030 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

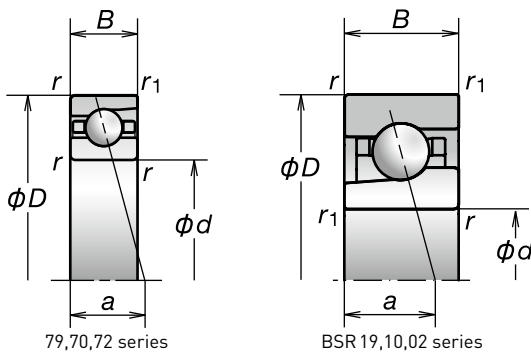
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 12, 15 mm



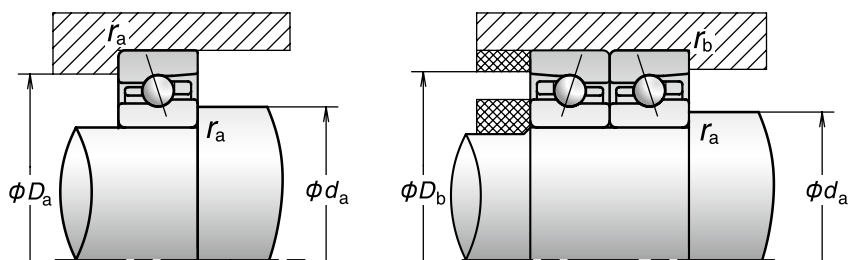
| Bearing Designation (1) | Boundary Dimensions (mm) | | | | | Basic Load Ratings (2) (kN) | | Permissible Axial Load (3) (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds (4) (min ⁻¹) | |
|-------------------------|--------------------------|----|----|----------|-----------------------|-----------------------------|--------------------------|---------------------------------|------------------------|--------------|------------------------------|--|---------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7901C | 12 | 24 | 6 | 0.3 | 0.15 | 3.55 | 1.86 | 1.45 | 15 | 14.7 | 5.4 | 63 900 | 97 300 |
| 7901CSN24 | 12 | 24 | 6 | 0.3 | 0.15 | [3.55] | [1.86] | 1.72 | 15 | 14.7 | 5.4 | 83 300 | 127 000 |
| 7901A5 | 12 | 24 | 6 | 0.3 | 0.15 | 3.35 | 1.77 | 1.71 | 25 | — | 7.2 | 55 600 | 83 400 |
| 7901A5SN24 | 12 | 24 | 6 | 0.3 | 0.15 | [3.35] | [1.77] | 2.04 | 25 | — | 7.2 | 72 200 | 108 000 |
| * 12BSR19S | 12 | 24 | 6 | 0.3 | 0.15 | 1.95 | 0.85 | 1.02 | 15 | 7.7 | 5.4 | 88 900 | 123 000 |
| * 12BSR19H | 12 | 24 | 6 | 0.3 | 0.15 | [1.95] | [0.85] | 0.665 | 15 | 7.7 | 5.4 | 106 000 | 156 000 |
| * 12BSR19X | 12 | 24 | 6 | 0.3 | 0.15 | [1.95] | [0.85] | 0.665 | 15 | 7.7 | 5.4 | 123 000 | 167 000 |
| 7001C | 12 | 28 | 8 | 0.3 | 0.15 | 6.10 | 2.90 | 2.4 | 15 | 13.2 | 6.7 | 57 500 | 87 500 |
| 7001CSN24 | 12 | 28 | 8 | 0.3 | 0.15 | [6.10] | [2.90] | 2.75 | 15 | 13.2 | 6.7 | 75 000 | 114 000 |
| 7001A5 | 12 | 28 | 8 | 0.3 | 0.15 | 5.85 | 2.79 | 2.82 | 25 | — | 8.7 | 50 000 | 75 000 |
| 7001A5SN24 | 12 | 28 | 8 | 0.3 | 0.15 | [5.85] | [2.79] | 3.44 | 25 | — | 8.7 | 65 000 | 97 500 |
| 7001A | 12 | 28 | 8 | 0.3 | 0.15 | 5.70 | 2.71 | 2.13 | 30 | — | 9.8 | 37 500 | 50 000 |
| * 12BSR10S | 12 | 28 | 8 | 0.3 | 0.15 | 3.25 | 1.33 | 1.63 | 15 | 7.4 | 6.7 | 80 000 | 110 000 |
| * 12BSR10H | 12 | 28 | 8 | 0.3 | 0.15 | [3.25] | [1.33] | 1.06 | 15 | 7.4 | 6.7 | 95 000 | 140 000 |
| * 12BSR10X | 12 | 28 | 8 | 0.3 | 0.15 | [3.25] | [1.33] | 1.06 | 15 | 7.4 | 6.7 | 110 000 | 150 000 |
| 7201C | 12 | 32 | 10 | 0.6 | 0.3 | 8.30 | 3.85 | 3.45 | 15 | 12.5 | 7.9 | 52 300 | 79 600 |
| 7201CSN24 | 12 | 32 | 10 | 0.6 | 0.3 | [8.30] | [3.85] | 3.75 | 15 | 12.5 | 7.9 | 68 200 | 104 000 |
| 7201A5 | 12 | 32 | 10 | 0.6 | 0.3 | 8.05 | 3.70 | 3.55 | 25 | — | 10.1 | 45 500 | 68 200 |
| 7201A5SN24 | 12 | 32 | 10 | 0.6 | 0.3 | [8.05] | [3.70] | 4.23 | 25 | — | 10.1 | 59 100 | 88 700 |
| 7201A | 12 | 32 | 10 | 0.6 | 0.3 | 7.85 | 3.65 | 2.72 | 30 | — | 11.4 | 34 100 | 45 500 |
| * 12BSR02S | 12 | 32 | 10 | 0.6 | 0.3 | 5.05 | 1.98 | 2.45 | 15 | 6.6 | 7.9 | 72 800 | 100 000 |
| * 12BSR02H | 12 | 32 | 10 | 0.6 | 0.3 | [5.05] | [1.98] | 1.59 | 15 | 6.6 | 7.9 | 86 400 | 128 000 |
| * 12BSR02X | 12 | 32 | 10 | 0.6 | 0.3 | [5.05] | [1.98] | 1.59 | 15 | 6.6 | 7.9 | 100 000 | 137 000 |
| 7902C | 15 | 28 | 7 | 0.3 | 0.15 | 5.00 | 2.64 | 1.93 | 15 | 14.5 | 6.4 | 53 500 | 81 400 |
| 7902CSN24 | 15 | 28 | 7 | 0.3 | 0.15 | [5.00] | [2.64] | 2.30 | 15 | 14.5 | 6.4 | 69 800 | 106 000 |
| 7902A5 | 15 | 28 | 7 | 0.3 | 0.15 | 4.75 | 2.53 | 2.22 | 25 | — | 8.5 | 46 600 | 69 800 |
| 7902A5SN24 | 15 | 28 | 7 | 0.3 | 0.15 | [4.75] | [2.53] | 2.63 | 25 | — | 8.5 | 60 500 | 90 700 |
| * 15BSR19S | 15 | 28 | 7 | 0.3 | 0.15 | 2.96 | 1.31 | 1.60 | 15 | 7.7 | 6.4 | 74 500 | 103 000 |
| * 15BSR19H | 15 | 28 | 7 | 0.3 | 0.15 | [2.96] | [1.31] | 1.04 | 15 | 7.7 | 6.4 | 88 400 | 131 000 |
| * 15BSR19X | 15 | 28 | 7 | 0.3 | 0.15 | [2.96] | [1.31] | 1.04 | 15 | 7.7 | 6.4 | 103 000 | 140 000 |
| 7002C | 15 | 32 | 9 | 0.3 | 0.15 | 6.55 | 3.40 | 2.63 | 15 | 14.1 | 7.6 | 49 000 | 74 500 |
| 7002CSN24 | 15 | 32 | 9 | 0.3 | 0.15 | [6.55] | [3.40] | 3.12 | 15 | 14.1 | 7.6 | 63 900 | 97 100 |
| 7002A5 | 15 | 32 | 9 | 0.3 | 0.15 | 6.25 | 3.25 | 3.05 | 25 | — | 10 | 42 600 | 63 900 |
| 7002A5SN24 | 15 | 32 | 9 | 0.3 | 0.15 | [6.25] | [3.25] | 3.64 | 25 | — | 10 | 55 400 | 83 000 |
| 7002A | 15 | 32 | 9 | 0.3 | 0.15 | 6.05 | 3.15 | 2.36 | 30 | — | 11.3 | 32 000 | 42 600 |
| * 15BSR10S | 15 | 32 | 9 | 0.3 | 0.15 | 4.20 | 1.72 | 2.12 | 15 | 7.2 | 7.6 | 68 100 | 93 700 |
| * 15BSR10H | 15 | 32 | 9 | 0.3 | 0.15 | [4.20] | [1.72] | 1.38 | 15 | 7.2 | 7.6 | 80 900 | 120 000 |
| * 15BSR10X | 15 | 32 | 9 | 0.3 | 0.15 | [4.20] | [1.72] | 1.38 | 15 | 7.2 | 7.6 | 93 700 | 128 000 |
| 7202C | 15 | 35 | 11 | 0.6 | 0.3 | 9.10 | 4.55 | 3.85 | 15 | 13.2 | 8.8 | 46 000 | 70 000 |
| 7202CSN24 | 15 | 35 | 11 | 0.6 | 0.3 | [9.10] | [4.55] | 4.55 | 15 | 13.2 | 8.8 | 60 000 | 91 200 |
| 7202A5 | 15 | 35 | 11 | 0.6 | 0.3 | 8.75 | 4.35 | 3.95 | 25 | — | 11.3 | 40 000 | 60 000 |
| 7202A5SN24 | 15 | 35 | 11 | 0.6 | 0.3 | [8.75] | [4.35] | 5.50 | 25 | — | 11.3 | 52 000 | 78 000 |
| 7202A | 15 | 35 | 11 | 0.6 | 0.3 | 8.50 | 4.25 | 3.00 | 30 | — | 12.7 | 30 000 | 40 000 |
| * 15BSR02S | 15 | 35 | 11 | 0.6 | 0.3 | 5.80 | 2.34 | 2.90 | 15 | 6.8 | 8.8 | 64 000 | 88 000 |
| * 15BSR02H | 15 | 35 | 11 | 0.6 | 0.3 | [5.80] | [2.34] | 1.89 | 15 | 6.8 | 8.8 | 76 000 | 112 000 |
| * 15BSR02X | 15 | 35 | 11 | 0.6 | 0.3 | [5.80] | [2.34] | 1.89 | 15 | 6.8 | 8.8 | 88 000 | 120 000 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available.

(2) Basic load rating values are reference values for ceramic ball bearings.

(3) For permissible axial load, please refer to Page 201.

(4) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-----|-----|-----|---|----|-----|-----|-------------------------------|----|-----|-----|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 8.6 | 16 | 41 | 77 | 12 | 16 | 25 | 34 | 4 | 2 | -3 | -8 | 0.011 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 7.3 | 15 | 43 | 84 | 13 | 17 | 27 | 38 | 4 | 2 | -3 | -8 | 0.010 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 16 | 25 | 59 | 120 | 32 | 38 | 53 | 70 | 1 | 0 | -3 | -7 | 0.011 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 15 | 25 | 63 | 134 | 35 | 43 | 60 | 81 | 1 | 0 | -3 | -7 | 0.010 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 4.7 | 13 | 25 | — | 9.0 | 13 | 17 | — | 6 | 3 | 0 | — | 0.012 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 3.3 | 12 | 25 | — | 8.8 | 14 | 19 | — | 6 | 3 | 0 | — | 0.011 |
| 14.5 | 21.5 | 22.8 | 0.3 | 0.15 | 3.3 | 12 | 25 | — | 8.8 | 14 | 19 | — | 6 | 3 | 0 | — | 0.011 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 13 | 25 | 57 | 120 | 14 | 18 | 26 | 37 | 3 | 0 | -6 | -14 | 0.021 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 12 | 25 | 61 | 133 | 15 | 20 | 29 | 42 | 3 | 0 | -6 | -14 | 0.019 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 16 | 45 | 97 | 203 | 31 | 45 | 60 | 81 | 1 | -2 | -6 | -12 | 0.021 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 15 | 47 | 108 | 230 | 34 | 51 | 69 | 94 | 1 | -2 | -6 | -12 | 0.019 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 25 | 104 | 218 | 363 | 48 | 78 | 104 | 127 | 0 | -5 | -10 | -15 | 0.021 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 10 | 21 | 43 | — | 12 | 15 | 20 | — | 4 | 1 | -4 | — | 0.023 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 9.2 | 20 | 45 | — | 12 | 17 | 23 | — | 4 | 1 | -4 | — | 0.021 |
| 14.5 | 25.5 | 26.8 | 0.3 | 0.15 | 9.2 | 20 | 45 | — | 12 | 17 | 23 | — | 4 | 1 | -4 | — | 0.021 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 20 | 39 | 99 | 197 | 16 | 21 | 32 | 46 | 1 | -3 | -12 | -22 | 0.036 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 20 | 41 | 109 | 221 | 18 | 24 | 37 | 52 | 1 | -3 | -12 | -22 | 0.031 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 34 | 56 | 146 | 287 | 40 | 49 | 70 | 92 | -1 | -3 | -9 | -16 | 0.036 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 35 | 61 | 164 | 329 | 46 | 56 | 81 | 107 | -1 | -3 | -9 | -16 | 0.031 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 25 | 104 | 218 | 361 | 48 | 78 | 103 | 126 | 0 | -5 | -10 | -15 | 0.030 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 14 | 33 | 63 | — | 13 | 18 | 23 | — | 3 | -2 | -8 | — | 0.039 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 13 | 34 | 68 | — | 14 | 20 | 26 | — | 3 | -2 | -8 | — | 0.035 |
| 17 | 27 | 29.5 | 0.6 | 0.3 | 13 | 34 | 68 | — | 14 | 20 | 26 | — | 3 | -2 | -8 | — | 0.035 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 12 | 25 | 47 | 104 | 14 | 20 | 26 | 39 | 3 | 0 | -4 | -11 | 0.016 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 11 | 25 | 50 | 114 | 15 | 22 | 29 | 44 | 3 | 0 | -4 | -11 | 0.014 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 16 | 35 | 74 | 141 | 33 | 44 | 59 | 76 | 1 | -1 | -4 | -8 | 0.016 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 15 | 36 | 80 | 158 | 36 | 50 | 67 | 88 | 1 | -1 | -4 | -8 | 0.014 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 9.8 | 20 | 39 | — | 12 | 16 | 21 | — | 4 | 1 | -3 | — | 0.017 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 8.5 | 20 | 40 | — | 13 | 18 | 23 | — | 4 | 1 | -3 | — | 0.015 |
| 17.5 | 25.5 | 26.8 | 0.3 | 0.15 | 8.5 | 20 | 40 | — | 13 | 18 | 23 | — | 4 | 1 | -3 | — | 0.015 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 12 | 29 | 66 | 147 | 14 | 20 | 29 | 43 | 3 | -1 | -7 | -16 | 0.030 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 11 | 30 | 72 | 164 | 15 | 23 | 33 | 50 | 3 | -1 | -7 | -16 | 0.027 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 16 | 35 | 103 | 197 | 33 | 43 | 65 | 84 | 1 | -1 | -6 | -11 | 0.030 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 15 | 36 | 114 | 223 | 36 | 49 | 75 | 98 | 1 | -1 | -6 | -11 | 0.027 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 25 | 110 | 234 | 392 | 51 | 85 | 113 | 139 | 0 | -5 | -10 | -15 | 0.030 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 14 | 25 | 53 | — | 13 | 16 | 22 | — | 3 | 0 | -6 | — | 0.030 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 13 | 25 | 56 | — | 14 | 18 | 25 | — | 3 | 0 | -6 | — | 0.027 |
| 17.5 | 29.5 | 30.8 | 0.3 | 0.15 | 13 | 25 | 56 | — | 14 | 18 | 25 | — | 3 | 0 | -6 | — | 0.027 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 20 | 40 | 97 | 199 | 17 | 23 | 34 | 48 | 1 | -3 | -11 | -21 | 0.045 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 20 | 42 | 106 | 224 | 19 | 26 | 39 | 56 | 1 | -3 | -11 | -21 | 0.040 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 35 | 73 | 197 | 392 | 44 | 57 | 84 | 112 | -1 | -4 | -11 | -19 | 0.044 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 36 | 79 | 223 | 452 | 49 | 66 | 98 | 131 | -1 | -4 | -11 | -19 | 0.039 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 25 | 111 | 236 | 394 | 51 | 86 | 114 | 139 | 0 | -5 | -10 | -15 | 0.045 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 21 | 38 | 76 | — | 15 | 19 | 25 | — | 1 | -3 | -10 | — | 0.045 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 20 | 39 | 83 | — | 16 | 21 | 29 | — | 1 | -3 | -10 | — | 0.040 |
| 20 | 30 | 32.5 | 0.6 | 0.3 | 20 | 39 | 83 | — | 16 | 21 | 29 | — | 1 | -3 | -10 | — | 0.040 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

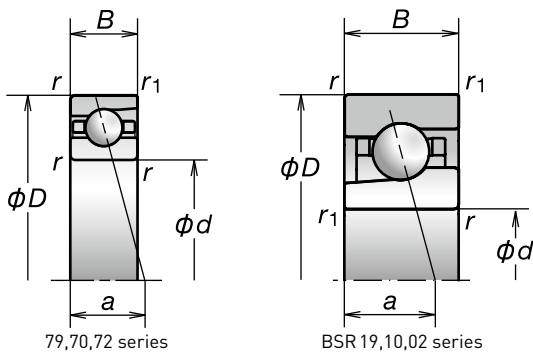
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 17, 20 mm



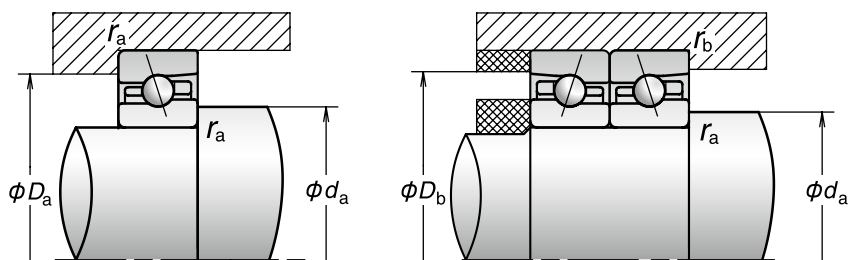
| Bearing Designation (1) | Boundary Dimensions (mm) | | | | | Basic Load Ratings (2) (kN) | | Permissible Axial Load (3) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (4) (min ⁻¹) | |
|-------------------------|--------------------------|----|----|----------|-----------------------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|---------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7903C | 17 | 30 | 7 | 0.3 | 0.15 | 5.25 | 2.94 | 2.09 | 15 | 14.8 | 6.6 | 49 000 | 74 500 |
| 7903CSN24 | 17 | 30 | 7 | 0.3 | 0.15 | [5.25] | [2.94] | 2.46 | 15 | 14.8 | 6.6 | 63 900 | 97 100 |
| 7903A5 | 17 | 30 | 7 | 0.3 | 0.15 | 5.00 | 2.80 | 2.21 | 25 | — | 9 | 42 600 | 63 900 |
| 7903A5SN24 | 17 | 30 | 7 | 0.3 | 0.15 | [5.00] | [2.80] | 2.63 | 25 | — | 9 | 55 400 | 83 000 |
| * 17BSR19S | 17 | 30 | 7 | 0.3 | 0.15 | 3.25 | 1.53 | 1.76 | 15 | 7.8 | 6.6 | 68 100 | 93 700 |
| * 17BSR19H | 17 | 30 | 7 | 0.3 | 0.15 | [3.25] | [1.53] | 1.22 | 15 | 7.8 | 6.6 | 80 900 | 120 000 |
| * 17BSR19X | 17 | 30 | 7 | 0.3 | 0.15 | [3.25] | [1.53] | 1.22 | 15 | 7.8 | 6.6 | 93 700 | 128 000 |
| 7003C | 17 | 35 | 10 | 0.3 | 0.15 | 6.95 | 3.80 | 2.85 | 15 | 14.5 | 8.5 | 44 300 | 67 400 |
| 7003CSN24 | 17 | 35 | 10 | 0.3 | 0.15 | [6.95] | [3.80] | 3.38 | 15 | 14.5 | 8.5 | 57 700 | 87 700 |
| 7003A5 | 17 | 35 | 10 | 0.3 | 0.15 | 6.60 | 3.65 | 3.35 | 25 | — | 11.1 | 38 500 | 57 700 |
| 7003A5SN24 | 17 | 35 | 10 | 0.3 | 0.15 | [6.60] | [3.65] | 4.00 | 25 | — | 11.1 | 50 000 | 75 000 |
| 7003A | 17 | 35 | 10 | 0.3 | 0.15 | 6.40 | 3.50 | 2.59 | 30 | — | 12.5 | 28 900 | 38 500 |
| * 17BSR10S | 17 | 35 | 10 | 0.3 | 0.15 | 4.45 | 1.93 | 2.39 | 15 | 7.4 | 8.5 | 61 600 | 84 700 |
| * 17BSR10H | 17 | 35 | 10 | 0.3 | 0.15 | [4.45] | [1.93] | 1.56 | 15 | 7.4 | 8.5 | 73 100 | 108 000 |
| * 17BSR10X | 17 | 35 | 10 | 0.3 | 0.15 | [4.45] | [1.93] | 1.56 | 15 | 7.4 | 8.5 | 84 700 | 116 000 |
| 7203C | 17 | 40 | 12 | 0.6 | 0.3 | 11.4 | 5.85 | 4.85 | 15 | 13.3 | 9.8 | 40 400 | 61 500 |
| 7203CSN24 | 17 | 40 | 12 | 0.6 | 0.3 | [11.4] | [5.85] | 5.70 | 15 | 13.3 | 9.8 | 52 700 | 80 000 |
| 7203A5 | 17 | 40 | 12 | 0.6 | 0.3 | 11.0 | 5.60 | 5.30 | 25 | — | 12.6 | 35 100 | 52 700 |
| 7203A5SN24 | 17 | 40 | 12 | 0.6 | 0.3 | [11.0] | [5.60] | 6.28 | 25 | — | 12.6 | 45 700 | 68 500 |
| 7203A | 17 | 40 | 12 | 0.6 | 0.3 | 10.7 | 5.45 | 4.05 | 30 | — | 14.2 | 26 400 | 35 100 |
| * 17BSR02S | 17 | 40 | 12 | 0.6 | 0.3 | 7.25 | 2.98 | 3.65 | 15 | 6.8 | 9.8 | 56 200 | 77 200 |
| * 17BSR02H | 17 | 40 | 12 | 0.6 | 0.3 | [7.25] | [2.98] | 2.39 | 15 | 6.8 | 9.8 | 66 700 | 98 300 |
| * 17BSR02X | 17 | 40 | 12 | 0.6 | 0.3 | [7.25] | [2.98] | 2.39 | 15 | 6.8 | 9.8 | 77 200 | 106 000 |
| 7904C | 20 | 37 | 9 | 0.3 | 0.15 | 7.30 | 4.25 | 3.20 | 15 | 14.9 | 8.3 | 40 400 | 61 500 |
| 7904CSN24 | 20 | 37 | 9 | 0.3 | 0.15 | [7.30] | [4.25] | 3.78 | 15 | 14.9 | 8.3 | 52 700 | 80 000 |
| 7904A5 | 20 | 37 | 9 | 0.3 | 0.15 | 6.95 | 4.05 | 3.55 | 25 | — | 11.1 | 35 100 | 52 700 |
| 7904A5SN24 | 20 | 37 | 9 | 0.3 | 0.15 | [6.95] | [4.05] | 4.20 | 25 | — | 11.1 | 45 700 | 68 500 |
| * 20BSR19S | 20 | 37 | 9 | 0.3 | 0.15 | 4.70 | 2.15 | 2.66 | 15 | 7.7 | 8.3 | 56 200 | 77 200 |
| * 20BSR19H | 20 | 37 | 9 | 0.3 | 0.15 | [4.70] | [2.15] | 1.73 | 15 | 7.7 | 8.3 | 66 700 | 98 300 |
| * 20BSR19X | 20 | 37 | 9 | 0.3 | 0.15 | [4.70] | [2.15] | 1.73 | 15 | 7.7 | 8.3 | 77 200 | 106 000 |
| 7004C | 20 | 42 | 12 | 0.6 | 0.3 | 11.7 | 6.55 | 4.80 | 15 | 14.0 | 10.1 | 37 100 | 56 500 |
| 7004CSN24 | 20 | 42 | 12 | 0.6 | 0.3 | [11.7] | [6.55] | 5.72 | 15 | 14.0 | 10.1 | 48 400 | 73 600 |
| 7004A5 | 20 | 42 | 12 | 0.6 | 0.3 | 11.2 | 6.25 | 5.45 | 25 | — | 13.2 | 32 300 | 48 400 |
| 7004A5SN24 | 20 | 42 | 12 | 0.6 | 0.3 | [11.2] | [6.25] | 6.48 | 25 | — | 13.2 | 42 000 | 63 000 |
| 7004A | 20 | 42 | 12 | 0.6 | 0.3 | 10.8 | 6.10 | 4.20 | 30 | — | 14.9 | 24 200 | 32 300 |
| * 20BSR10S | 20 | 42 | 12 | 0.6 | 0.3 | 7.45 | 3.35 | 4.10 | 15 | 7.2 | 10.1 | 51 700 | 71 000 |
| * 20BSR10H | 20 | 42 | 12 | 0.6 | 0.3 | [7.45] | [3.35] | 2.67 | 15 | 7.2 | 10.1 | 61 300 | 90 400 |
| * 20BSR10X | 20 | 42 | 12 | 0.6 | 0.3 | [7.45] | [3.35] | 2.67 | 15 | 7.2 | 10.1 | 71 000 | 96 800 |
| 7204C | 20 | 47 | 14 | 1 | 0.6 | 15.3 | 8.05 | 6.30 | 15 | 13.3 | 11.5 | 34 400 | 52 300 |
| 7204CSN24 | 20 | 47 | 14 | 1 | 0.6 | [15.3] | [8.05] | 7.46 | 15 | 13.3 | 11.5 | 44 800 | 68 100 |
| 7204A5 | 20 | 47 | 14 | 1 | 0.6 | 14.7 | 7.75 | 7.40 | 25 | — | 14.8 | 29 900 | 44 800 |
| 7204A5SN24 | 20 | 47 | 14 | 1 | 0.6 | [14.7] | [7.75] | 8.88 | 25 | — | 14.8 | 38 900 | 58 300 |
| 7204A | 20 | 47 | 14 | 1 | 0.6 | 14.3 | 7.55 | 5.75 | 30 | — | 16.7 | 22 400 | 29 900 |
| * 20BSR02S | 20 | 47 | 14 | 1 | 0.6 | 9.70 | 4.10 | 5.10 | 15 | 6.8 | 11.5 | 47 800 | 65 700 |
| * 20BSR02H | 20 | 47 | 14 | 1 | 0.6 | [9.70] | [4.10] | 3.30 | 15 | 6.8 | 11.5 | 56 800 | 83 600 |
| * 20BSR02X | 20 | 47 | 14 | 1 | 0.6 | [9.70] | [4.10] | 3.30 | 15 | 6.8 | 11.5 | 65 700 | 89 600 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available.

(2) Basic load rating values are reference values for ceramic ball bearings.

(3) For permissible axial load, please refer to Page 201.

(4) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-----|-----|-----|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 11 | 25 | 56 | 119 | 15 | 21 | 30 | 43 | 3 | 0 | -5 | -12 | 0.017 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 10 | 25 | 59 | 131 | 16 | 23 | 33 | 49 | 3 | 0 | -5 | -12 | 0.015 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 15 | 35 | 77 | 149 | 34 | 47 | 63 | 82 | 1 | -1 | -4 | -8 | 0.017 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 14 | 37 | 84 | 167 | 37 | 53 | 72 | 95 | 1 | -1 | -4 | -8 | 0.015 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 12 | 25 | 46 | — | 14 | 19 | 24 | — | 3 | 0 | -4 | — | 0.018 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 11 | 25 | 49 | — | 13 | 21 | 27 | — | 3 | 0 | -4 | — | 0.016 |
| 19.5 | 27.5 | 28.8 | 0.3 | 0.15 | 11 | 25 | 49 | — | 13 | 21 | 27 | — | 3 | 0 | -4 | — | 0.016 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 15 | 30 | 69 | 156 | 16 | 21 | 31 | 46 | 2 | -1 | -7 | -16 | 0.039 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 15 | 30 | 75 | 174 | 18 | 24 | 35 | 53 | 2 | -1 | -7 | -16 | 0.036 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 25 | 47 | 127 | 257 | 41 | 51 | 74 | 99 | 0 | -2 | -7 | -13 | 0.040 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 25 | 50 | 142 | 293 | 46 | 58 | 86 | 116 | 0 | -2 | -7 | -13 | 0.037 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 25 | 116 | 251 | 422 | 54 | 92 | 123 | 151 | 0 | -5 | -10 | -15 | 0.040 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 13 | 29 | 60 | — | 13 | 18 | 24 | — | 3 | -1 | -7 | — | 0.039 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 12 | 29 | 65 | — | 14 | 20 | 28 | — | 3 | -1 | -7 | — | 0.036 |
| 19.5 | 32.5 | 33.8 | 0.3 | 0.15 | 12 | 29 | 65 | — | 14 | 20 | 28 | — | 3 | -1 | -7 | — | 0.036 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 46 | 146 | 296 | 19 | 25 | 41 | 59 | 0 | -4 | -16 | -28 | 0.065 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 49 | 163 | 337 | 21 | 28 | 48 | 69 | 0 | -4 | -16 | -28 | 0.058 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 35 | 75 | 204 | 408 | 45 | 60 | 87 | 116 | -1 | -4 | -11 | -19 | 0.064 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 37 | 82 | 232 | 470 | 51 | 69 | 102 | 136 | -1 | -4 | -11 | -19 | 0.057 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 115 | 247 | 412 | 53 | 90 | 119 | 145 | 0 | -5 | -10 | -15 | 0.065 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 48 | 97 | — | 16 | 21 | 28 | — | 0 | -5 | -13 | — | 0.065 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 51 | 107 | — | 18 | 24 | 32 | — | 0 | -5 | -13 | — | 0.057 |
| 22 | 35 | 37.5 | 0.6 | 0.3 | 25 | 51 | 107 | — | 18 | 24 | 32 | — | 0 | -5 | -13 | — | 0.057 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 20 | 42 | 80 | 152 | 19 | 26 | 35 | 48 | 1 | -3 | -8 | -15 | 0.036 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 19 | 44 | 87 | 169 | 21 | 29 | 40 | 55 | 1 | -3 | -8 | -15 | 0.033 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 25 | 63 | 114 | 247 | 43 | 60 | 75 | 102 | 0 | -3 | -6 | -12 | 0.037 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 25 | 68 | 127 | 282 | 48 | 69 | 87 | 119 | 0 | -3 | -6 | -12 | 0.034 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 16 | 29 | 63 | — | 15 | 19 | 26 | — | 2 | -1 | -7 | — | 0.036 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 15 | 30 | 67 | — | 17 | 21 | 29 | — | 2 | -1 | -7 | — | 0.033 |
| 22.5 | 34.5 | 35.8 | 0.3 | 0.15 | 15 | 30 | 67 | — | 17 | 21 | 29 | — | 2 | -1 | -7 | — | 0.033 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 49 | 119 | 244 | 21 | 28 | 42 | 59 | 0 | -4 | -12 | -22 | 0.067 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 52 | 132 | 277 | 24 | 32 | 48 | 68 | 0 | -4 | -12 | -22 | 0.060 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 36 | 81 | 206 | 403 | 51 | 68 | 97 | 127 | -1 | -4 | -10 | -17 | 0.067 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 38 | 90 | 234 | 465 | 58 | 79 | 113 | 149 | -1 | -4 | -10 | -17 | 0.060 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 128 | 280 | 473 | 59 | 104 | 139 | 170 | 0 | -5 | -10 | -15 | 0.068 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 51 | 107 | — | 18 | 24 | 32 | — | 0 | -5 | -13 | — | 0.068 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 54 | 119 | — | 20 | 27 | 37 | — | 0 | -5 | -13 | — | 0.061 |
| 25 | 37 | 39.5 | 0.6 | 0.3 | 25 | 54 | 119 | — | 20 | 27 | 37 | — | 0 | -5 | -13 | — | 0.061 |
| 26 | 41 | 42 | 1 | 0.5 | 35 | 68 | 196 | 384 | 23 | 30 | 48 | 68 | -2 | -7 | -20 | -33 | 0.103 |
| 26 | 41 | 42 | 1 | 0.5 | 37 | 74 | 221 | 440 | 26 | 34 | 56 | 79 | -2 | -7 | -20 | -33 | 0.091 |
| 26 | 41 | 42 | 1 | 0.5 | 63 | 112 | 290 | 596 | 59 | 73 | 104 | 140 | -3 | -6 | -14 | -24 | 0.102 |
| 26 | 41 | 42 | 1 | 0.5 | 68 | 125 | 332 | 691 | 67 | 84 | 122 | 165 | -3 | -6 | -14 | -24 | 0.090 |
| 26 | 41 | 42 | 1 | 0.5 | 25 | 262 | 439 | 649 | 56 | 128 | 155 | 181 | 0 | -10 | -15 | -20 | 0.104 |
| 26 | 41 | 42 | 1 | 0.5 | 34 | 67 | 140 | — | 19 | 25 | 34 | — | -2 | -8 | -18 | — | 0.103 |
| 26 | 41 | 42 | 1 | 0.5 | 35 | 72 | 157 | — | 22 | 29 | 39 | — | -2 | -8 | -18 | — | 0.091 |
| 26 | 41 | 42 | 1 | 0.5 | 35 | 72 | 157 | — | 22 | 29 | 39 | — | -2 | -8 | -18 | — | 0.091 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

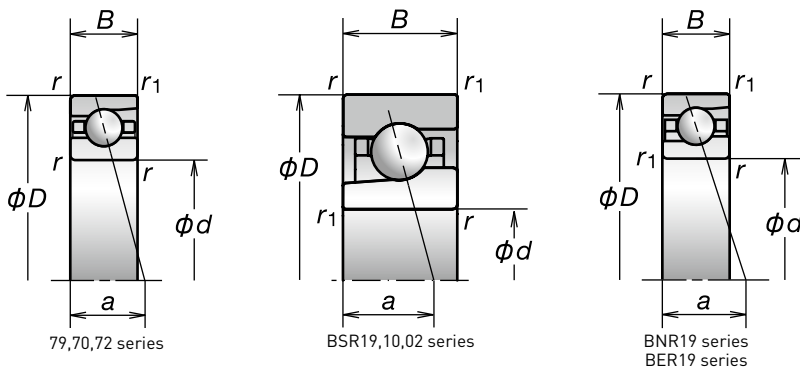
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 25 mm



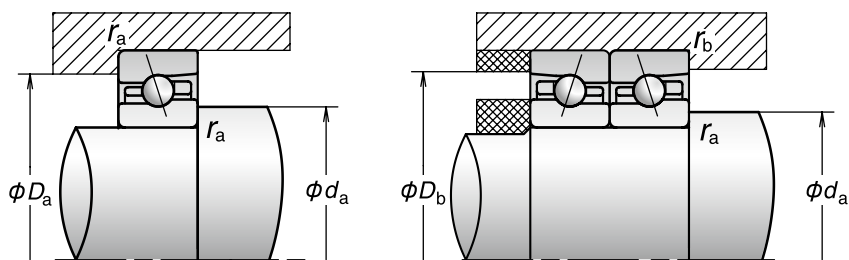
| Bearing Designation (1) | Boundary Dimensions (mm) | | | | | Basic Load Ratings (2) (kN) | | Permissible Axial Load (3) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (4) (min ⁻¹) | |
|-------------------------|--------------------------|----|----|----------|-----------------------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7905C | 25 | 42 | 9 | 0.3 | 0.15 | 8.25 | 5.40 | 3.90 | 15 | 15.5 | 9.0 | 34 400 | 52 300 |
| 7905CSN24 | 25 | 42 | 9 | 0.3 | 0.15 | [8.25] | [5.40] | 4.63 | 15 | 15.5 | 9.0 | 44 800 | 68 100 |
| 7905A5 | 25 | 42 | 9 | 0.3 | 0.15 | 7.80 | 5.15 | 4.40 | 25 | — | 12.3 | 29 900 | 44 800 |
| 7905A5SN24 | 25 | 42 | 9 | 0.3 | 0.15 | [7.80] | [5.15] | 5.20 | 25 | — | 12.3 | 38 900 | 58 300 |
| * 25BSR19S | 25 | 42 | 9 | 0.3 | 0.15 | 5.30 | 2.71 | 3.40 | 15 | 7.8 | 9.0 | 47 800 | 65 700 |
| * 25BSR19H | 25 | 42 | 9 | 0.3 | 0.15 | [5.30] | [2.71] | 2.22 | 15 | 7.8 | 9.0 | 56 800 | 83 600 |
| * 25BSR19X | 25 | 42 | 9 | 0.3 | 0.15 | [5.30] | [2.71] | 2.22 | 15 | 7.8 | 9.0 | 65 700 | 89 600 |
| 7005C | 25 | 47 | 12 | 0.6 | 0.3 | 12.3 | 7.40 | 5.20 | 15 | 14.7 | 10.8 | 32 000 | 48 700 |
| 7005CSN24 | 25 | 47 | 12 | 0.6 | 0.3 | [12.3] | [7.40] | 6.16 | 15 | 14.7 | 10.8 | 41 700 | 63 400 |
| 7005A5 | 25 | 47 | 12 | 0.6 | 0.3 | 11.7 | 7.10 | 5.95 | 25 | — | 14.4 | 27 800 | 41 700 |
| 7005A5SN24 | 25 | 47 | 12 | 0.6 | 0.3 | [11.7] | [7.10] | 7.08 | 25 | — | 14.4 | 36 200 | 54 200 |
| 7005A | 25 | 47 | 12 | 0.6 | 0.3 | 11.3 | 6.85 | 4.55 | 30 | — | 16.4 | 20 900 | 27 800 |
| * 25BSR10S | 25 | 47 | 12 | 0.6 | 0.3 | 7.90 | 3.75 | 4.65 | 15 | 7.6 | 10.8 | 44 500 | 61 200 |
| * 25BSR10H | 25 | 47 | 12 | 0.6 | 0.3 | [7.90] | [3.75] | 3.05 | 15 | 7.6 | 10.8 | 52 800 | 77 800 |
| * 25BSR10X | 25 | 47 | 12 | 0.6 | 0.3 | [7.90] | [3.75] | 3.05 | 15 | 7.6 | 10.8 | 61 200 | 83 400 |
| 7205C | 25 | 52 | 15 | 1 | 0.6 | 17.4 | 10.2 | 7.50 | 15 | 14.0 | 12.7 | 29 900 | 45 500 |
| 7205CSN24 | 25 | 52 | 15 | 1 | 0.6 | [17.4] | [10.2] | 8.91 | 15 | 14.0 | 12.7 | 39 000 | 59 300 |
| 7205A5 | 25 | 52 | 15 | 1 | 0.6 | 16.7 | 9.80 | 9.05 | 25 | — | 16.5 | 26 000 | 39 000 |
| 7205A5SN24 | 25 | 52 | 15 | 1 | 0.6 | [16.7] | [9.80] | 10.7 | 25 | — | 16.5 | 33 800 | 50 700 |
| 7205A | 25 | 52 | 15 | 1 | 0.6 | 16.1 | 9.45 | 6.95 | 30 | — | 18.6 | 19 500 | 26 000 |
| * 25BSR02S | 25 | 52 | 15 | 1 | 0.6 | 11.0 | 5.20 | 6.45 | 15 | 7.1 | 12.7 | 41 600 | 57 200 |
| * 25BSR02H | 25 | 52 | 15 | 1 | 0.6 | [11.0] | [5.20] | 4.20 | 15 | 7.1 | 12.7 | 49 400 | 72 800 |
| * 25BSR02X | 25 | 52 | 15 | 1 | 0.6 | [11.0] | [5.20] | 4.20 | 15 | 7.1 | 12.7 | 57 200 | 78 000 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available.

(2) Basic load rating values are reference values for ceramic ball bearings.

(3) For permissible axial load, please refer to Page 201.

(4) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-----|-----|-----|---|-----|-----|-----|--------------------------------------|-----|-----|-----|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 19 | 37 | 99 | 203 | 21 | 28 | 43 | 61 | 1 | -2 | -9 | -17 | 0.043 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 18 | 39 | 109 | 229 | 23 | 31 | 49 | 70 | 1 | -2 | -9 | -17 | 0.039 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 38 | 70 | 153 | 290 | 57 | 71 | 96 | 124 | -1 | -3 | -7 | -12 | 0.043 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 39 | 76 | 172 | 332 | 64 | 81 | 111 | 144 | -1 | -3 | -7 | -12 | 0.039 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 20 | 41 | 76 | — | 18 | 25 | 32 | — | 1 | -3 | -8 | — | 0.043 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 19 | 43 | 83 | — | 20 | 28 | 36 | — | 1 | -3 | -8 | — | 0.039 |
| 27.5 | 39.5 | 40.8 | 0.3 | 0.15 | 19 | 43 | 83 | — | 20 | 28 | 36 | — | 1 | -3 | -8 | — | 0.039 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 30 | 58 | 148 | 292 | 24 | 32 | 48 | 67 | -1 | -5 | -14 | -24 | 0.078 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 31 | 62 | 165 | 332 | 27 | 36 | 55 | 78 | -1 | -5 | -14 | -24 | 0.070 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 52 | 104 | 193 | 397 | 61 | 79 | 100 | 133 | -2 | -5 | -9 | -16 | 0.077 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 55 | 116 | 220 | 458 | 70 | 91 | 116 | 156 | -2 | -5 | -9 | -16 | 0.069 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 25 | 135 | 299 | 507 | 63 | 112 | 149 | 183 | 0 | -5 | -10 | -15 | 0.079 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 25 | 52 | 112 | — | 20 | 25 | 35 | — | 0 | -5 | -13 | — | 0.078 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 25 | 56 | 125 | — | 22 | 29 | 40 | — | 0 | -5 | -13 | — | 0.070 |
| 30 | 42 | 44.5 | 0.6 | 0.3 | 25 | 56 | 125 | — | 22 | 29 | 40 | — | 0 | -5 | -13 | — | 0.070 |
| 31 | 46 | 47 | 1 | 0.5 | 42 | 82 | 193 | 402 | 27 | 36 | 53 | 76 | 1 | -4 | -14 | -27 | 0.127 |
| 31 | 46 | 47 | 1 | 0.5 | 41 | 86 | 212 | 452 | 30 | 41 | 61 | 88 | 1 | -4 | -14 | -27 | 0.112 |
| 31 | 46 | 47 | 1 | 0.5 | 82 | 143 | 330 | 691 | 73 | 89 | 123 | 166 | -2 | -5 | -12 | -22 | 0.130 |
| 31 | 46 | 47 | 1 | 0.5 | 87 | 156 | 372 | 793 | 83 | 103 | 143 | 194 | -2 | -5 | -12 | -22 | 0.115 |
| 31 | 46 | 47 | 1 | 0.5 | 49 | 357 | 578 | 839 | 80 | 161 | 193 | 223 | 0 | -10 | -15 | -20 | 0.129 |
| 31 | 46 | 47 | 1 | 0.5 | 37 | 84 | 163 | — | 22 | 31 | 40 | — | 2 | -5 | -14 | — | 0.127 |
| 31 | 46 | 47 | 1 | 0.5 | 36 | 88 | 179 | — | 25 | 35 | 46 | — | 2 | -5 | -14 | — | 0.112 |
| 31 | 46 | 47 | 1 | 0.5 | 36 | 88 | 179 | — | 25 | 35 | 46 | — | 2 | -5 | -14 | — | 0.112 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

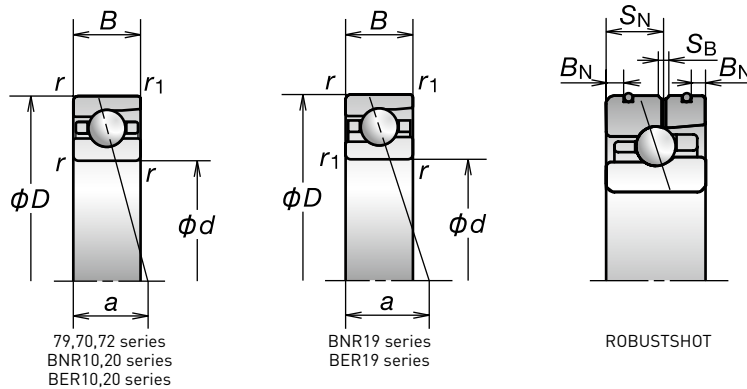
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 30 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7906C | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 8.70 | 6.25 | 4.40 | 15 | 15.9 | 9.7 | 29 900 | 45 500 |
| * 7906CSN24 | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | (8.70) | (6.25) | 5.20 | 15 | 15.9 | 9.7 | 39 000 | 59 300 |
| * 7906A5 | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 8.25 | 5.95 | 4.95 | 25 | — | 13.5 | 26 000 | 39 000 |
| * 7906A5SN24 | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | (8.25) | (5.95) | 5.86 | 25 | — | 13.5 | 33 800 | 50 700 |
| * 30BN19BV1V | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 5.00 | 3.60 | 5.05 | 18 | 10.9 | 10.8 | 36 400 | — |
| * 30BN19BSN24V1V | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | (5.00) | (3.60) | 3.30 | 18 | 10.9 | 10.8 | 46 800 | — |
| * 30BA19BV1V | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 4.80 | 3.45 | 5.90 | 25 | — | 13.5 | 31 200 | — |
| * 30BA19BSN24V1V | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | (4.80) | (3.45) | 4.00 | 25 | — | 13.5 | 41 600 | — |
| 30BNR19S | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 6.30 | 4.05 | 5.75 | 18 | 10.5 | 10.8 | 36 400 | 52 000 |
| 30BNR19H | 30 | 47 | 9 | 1.1 | 5.6 | 1.4 | 0.3 | 0.15 | (6.30) | (4.05) | 3.80 | 18 | 10.5 | 10.8 | 46 800 | 72 800 |
| 30BNR19X | 30 | 47 | 9 | 1.1 | 5.6 | 1.4 | 0.3 | 0.15 | (6.30) | (4.05) | 3.80 | 18 | 10.5 | 10.8 | 54 600 | 85 800 |
| 30BER19S | 30 | 47 | 9 | — | — | — | 0.3 | 0.15 | 6.00 | 3.90 | 6.80 | 25 | — | 13.5 | 31 200 | 44 200 |
| 30BER19H | 30 | 47 | 9 | 1.1 | 5.6 | 1.4 | 0.3 | 0.15 | (6.00) | (3.90) | 4.60 | 25 | — | 13.5 | 41 600 | 65 000 |
| 30BER19X | 30 | 47 | 9 | 1.1 | 5.6 | 1.4 | 0.3 | 0.15 | (6.00) | (3.90) | 4.60 | 25 | — | 13.5 | 49 400 | 78 000 |
| * 7006C | 30 | 55 | 13 | — | — | — | 1 | 0.6 | 15.9 | 10.3 | 6.85 | 15 | 14.9 | 12.2 | 27 100 | 41 200 |
| * 7006CSN24 | 30 | 55 | 13 | — | — | — | 1 | 0.6 | (15.9) | (10.3) | 8.12 | 15 | 14.9 | 12.2 | 35 300 | 53 700 |
| * 7006A5 | 30 | 55 | 13 | — | — | — | 1 | 0.6 | 15.1 | 9.80 | 8.05 | 25 | — | 16.4 | 23 600 | 35 300 |
| * 7006A5SN24 | 30 | 55 | 13 | — | — | — | 1 | 0.6 | (15.1) | (9.80) | 9.56 | 25 | — | 16.4 | 30 600 | 45 900 |
| * 7006A | 30 | 55 | 13 | — | — | — | 1 | 0.6 | 14.6 | 9.45 | 6.20 | 30 | — | 18.8 | 17 700 | 23 600 |
| * 30BNR10S | 30 | 55 | 13 | — | — | — | 1 | 0.6 | 8.65 | 5.75 | 8.20 | 18 | 10.3 | 13.3 | 33 000 | 47 100 |
| * 30BNR10H | 30 | 55 | 13 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (8.65) | (5.75) | 5.35 | 18 | 10.3 | 13.3 | 42 400 | 65 900 |
| * 30BNR10X | 30 | 55 | 13 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (8.65) | (5.75) | 5.35 | 18 | 10.3 | 13.3 | 49 500 | 77 700 |
| * 30BER10S | 30 | 55 | 13 | — | — | — | 1 | 0.6 | 8.30 | 5.50 | 9.65 | 25 | — | 16.3 | 28 300 | 40 000 |
| * 30BER10H | 30 | 55 | 13 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (8.30) | (5.50) | 6.50 | 25 | — | 16.3 | 37 700 | 58 900 |
| * 30BER10X | 30 | 55 | 13 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (8.30) | (5.50) | 6.50 | 25 | — | 16.3 | 44 800 | 70 600 |
| * 30BNR20SV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | 8.65 | 5.75 | 8.20 | 18 | 10.3 | 14.8 | 33 000 | — |
| * 30BNR20HV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | (8.65) | (5.75) | 5.35 | 18 | 10.3 | 14.8 | 42 400 | — |
| * 30BNR20XV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | (8.65) | (5.75) | 5.35 | 18 | 10.3 | 14.8 | 49 500 | — |
| * 30BER20SV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | 8.30 | 5.50 | 9.65 | 25 | — | 17.8 | 28 300 | — |
| * 30BER20HV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | (8.30) | (5.50) | 6.50 | 25 | — | 17.8 | 37 700 | — |
| * 30BER20XV1V | 30 | 55 | 16 | — | — | — | 1 | 0.6 | (8.30) | (5.50) | 6.50 | 25 | — | 17.8 | 44 800 | — |
| 7206C | 30 | 62 | 16 | — | — | — | 1 | 0.6 | 24.2 | 14.7 | 10.3 | 15 | 13.9 | 14.2 | 25 000 | 38 100 |
| 7206CSN24 | 30 | 62 | 16 | — | — | — | 1 | 0.6 | (24.2) | (14.7) | 12.2 | 15 | 13.9 | 14.2 | 32 700 | 49 600 |
| 7206A5 | 30 | 62 | 16 | — | — | — | 1 | 0.6 | 23.2 | 14.1 | 12.0 | 25 | — | 18.7 | 21 800 | 32 700 |
| 7206A5SN24 | 30 | 62 | 16 | — | — | — | 1 | 0.6 | (23.2) | (14.1) | 14.2 | 25 | — | 18.7 | 28 300 | 42 400 |
| 7206A | 30 | 62 | 16 | — | — | — | 1 | 0.6 | 22.4 | 13.6 | 9.20 | 30 | — | 21.3 | 16 400 | 21 800 |

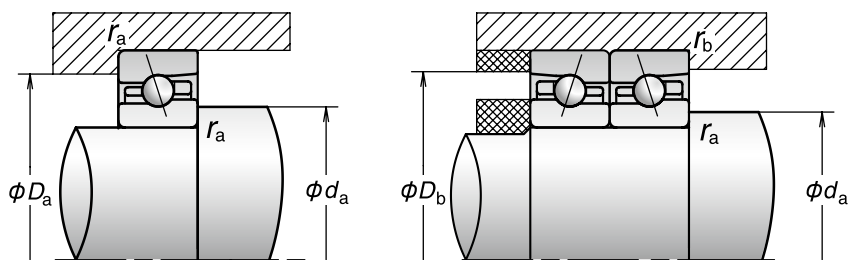
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 is exclusively for sealed bearings.

(2) A bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-----|-----|-------|---|-----|-----|-----|-------------------------------------|-----|-----|-----|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 46 | 95 | 204 | 25 | 33 | 45 | 65 | 0 | -3 | -8 | -16 | 0.049 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 49 | 104 | 230 | 28 | 37 | 51 | 75 | 0 | -3 | -8 | -16 | 0.044 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 39 | 74 | 141 | 285 | 62 | 78 | 99 | 131 | -1 | -3 | -6 | -11 | 0.050 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 41 | 81 | 158 | 326 | 70 | 90 | 115 | 154 | -1 | -3 | -6 | -11 | 0.045 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 109 | 218 | — | 30 | 53 | 71 | — | 0 | -8 | -15 | — | 0.050 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 121 | 248 | — | 34 | 62 | 83 | — | 0 | -8 | -15 | — | 0.047 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 178 | 352 | — | 50 | 100 | 131 | — | 0 | -8 | -14 | — | 0.050 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 202 | 405 | — | 56 | 117 | 153 | — | 0 | -8 | -14 | — | 0.047 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 101 | 197 | — | 28 | 48 | 63 | — | 0 | -8 | -15 | — | 0.048 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 112 | 224 | — | 31 | 55 | 73 | — | 0 | -8 | -15 | — | 0.043 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 112 | 224 | — | 31 | 55 | 73 | — | 0 | -8 | -15 | — | 0.043 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 164 | 318 | — | 47 | 90 | 116 | — | 0 | -8 | -14 | — | 0.048 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 185 | 366 | — | 52 | 105 | 136 | — | 0 | -8 | -14 | — | 0.043 |
| 32.5 | 44.5 | 45.8 | 0.3 | 0.15 | 25 | 185 | 366 | — | 52 | 105 | 136 | — | 0 | -8 | -14 | — | 0.043 |
| 36 | 49 | 50 | 1 | 0.5 | 41 | 75 | 195 | 386 | 30 | 38 | 58 | 81 | 1 | -3 | -13 | -24 | 0.114 |
| 36 | 49 | 50 | 1 | 0.5 | 41 | 78 | 214 | 434 | 33 | 42 | 66 | 94 | 1 | -3 | -13 | -24 | 0.102 |
| 36 | 49 | 50 | 1 | 0.5 | 66 | 129 | 294 | 590 | 73 | 93 | 127 | 169 | -1 | -4 | -10 | -18 | 0.114 |
| 36 | 49 | 50 | 1 | 0.5 | 68 | 139 | 331 | 676 | 82 | 106 | 148 | 197 | -1 | -4 | -10 | -18 | 0.102 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 191 | 390 | 638 | 87 | 138 | 180 | 217 | 0 | -5 | -10 | -15 | 0.116 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 106 | 229 | — | 39 | 52 | 71 | — | 0 | -5 | -13 | — | 0.124 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 113 | 254 | — | 44 | 59 | 82 | — | 0 | -5 | -13 | — | 0.116 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 113 | 254 | — | 44 | 59 | 82 | — | 0 | -5 | -13 | — | 0.116 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 224 | 443 | — | 64 | 109 | 141 | — | 0 | -8 | -15 | — | 0.124 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 250 | 505 | — | 72 | 126 | 165 | — | 0 | -8 | -15 | — | 0.116 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 250 | 505 | — | 72 | 126 | 165 | — | 0 | -8 | -15 | — | 0.116 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 106 | 229 | — | 39 | 52 | 71 | — | 0 | -5 | -13 | — | 0.150 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 113 | 254 | — | 44 | 59 | 82 | — | 0 | -5 | -13 | — | 0.142 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 113 | 254 | — | 44 | 59 | 82 | — | 0 | -5 | -13 | — | 0.142 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 224 | 443 | — | 64 | 109 | 141 | — | 0 | -8 | -15 | — | 0.150 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 250 | 505 | — | 72 | 126 | 165 | — | 0 | -8 | -15 | — | 0.142 |
| 36 | 49 | 50 | 1 | 0.5 | 49 | 250 | 505 | — | 72 | 126 | 165 | — | 0 | -8 | -15 | — | 0.142 |
| 36 | 56 | 57 | 1 | 0.5 | 57 | 114 | 292 | 591 | 33 | 43 | 66 | 94 | -1 | -7 | -20 | -35 | 0.194 |
| 36 | 56 | 57 | 1 | 0.5 | 58 | 122 | 326 | 673 | 36 | 49 | 76 | 109 | -1 | -7 | -20 | -35 | 0.169 |
| 36 | 56 | 57 | 1 | 0.5 | 105 | 202 | 457 | 881 | 85 | 108 | 147 | 192 | -3 | -7 | -15 | -25 | 0.194 |
| 36 | 56 | 57 | 1 | 0.5 | 113 | 224 | 521 | 1 018 | 97 | 124 | 172 | 225 | -3 | -7 | -15 | -25 | 0.169 |
| 36 | 56 | 57 | 1 | 0.5 | 49 | 384 | 625 | 908 | 86 | 175 | 210 | 243 | 0 | -10 | -15 | -20 | 0.197 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

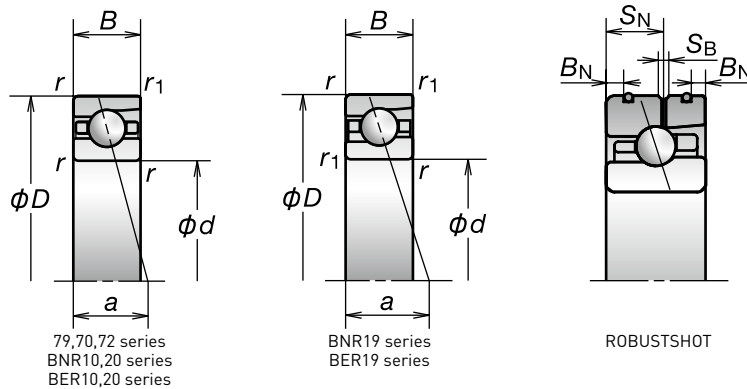
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 35 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7907C | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 12.7 | 9.15 | 6.60 | 15 | 15.7 | 11.0 | 25 600 | 38 900 |
| * 7907CSN24 | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | [12.7] | [9.15] | 7.82 | 15 | 15.7 | 11.0 | 33 400 | 50 700 |
| * 7907A5 | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 12.0 | 8.70 | 7.20 | 25 | — | 15.5 | 22 300 | 33 400 |
| * 7907A5SN24 | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | [12.0] | [8.70] | 8.52 | 25 | — | 15.5 | 28 900 | 43 400 |
| * 35BN19AV1V | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 6.95 | 5.10 | 7.20 | 18 | 10.8 | 12.3 | 31 200 | — |
| * 35BN19ASN24V1V | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | [6.95] | [5.10] | 4.75 | 18 | 10.8 | 12.3 | 40 000 | — |
| * 35BA19BV1V | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 6.65 | 4.90 | 8.50 | 25 | — | 15.5 | 26 700 | — |
| * 35BA19BSN24V1V | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | [6.65] | [4.90] | 5.75 | 25 | — | 15.5 | 35 600 | — |
| 35BNR19S | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 9.20 | 6.00 | 8.55 | 18 | 10.4 | 12.3 | 31 200 | 44 500 |
| 35BNR19H | 35 | 55 | 10 | 1.6 | 6.1 | 1.4 | 0.6 | 0.3 | [9.20] | [6.00] | 5.60 | 18 | 10.4 | 12.3 | 40 000 | 62 300 |
| 35BNR19X | 35 | 55 | 10 | 1.6 | 6.1 | 1.4 | 0.6 | 0.3 | [9.20] | [6.00] | 5.60 | 18 | 10.4 | 12.3 | 46 700 | 73 400 |
| 35BER19S | 35 | 55 | 10 | — | — | — | 0.6 | 0.3 | 8.80 | 5.75 | 10.0 | 25 | — | 15.5 | 26 700 | 37 800 |
| 35BER19H | 35 | 55 | 10 | 1.6 | 6.1 | 1.4 | 0.6 | 0.3 | [8.80] | [5.75] | 6.80 | 25 | — | 15.5 | 35 600 | 55 600 |
| 35BER19X | 35 | 55 | 10 | 1.6 | 6.1 | 1.4 | 0.6 | 0.3 | [8.80] | [5.75] | 6.80 | 25 | — | 15.5 | 42 300 | 66 700 |
| * 7007C | 35 | 62 | 14 | — | — | — | 1 | 0.6 | 20.1 | 13.7 | 9.35 | 15 | 15.0 | 13.5 | 23 800 | 36 100 |
| * 7007CSN24 | 35 | 62 | 14 | — | — | — | 1 | 0.6 | [20.1] | [13.7] | 11.1 | 15 | 15.0 | 13.5 | 29 700 | 45 200 |
| * 7007A5 | 35 | 62 | 14 | — | — | — | 1 | 0.6 | 19.1 | 13.0 | 11.4 | 25 | — | 18.3 | 20 700 | 31 000 |
| * 7007A5SN24 | 35 | 62 | 14 | — | — | — | 1 | 0.6 | [19.1] | [13.0] | 13.5 | 25 | — | 18.3 | 25 800 | 38 800 |
| * 7007A | 35 | 62 | 14 | — | — | — | 1 | 0.6 | 18.4 | 12.6 | 8.75 | 30 | — | 21.0 | 15 500 | 20 700 |
| * 35BNR10S | 35 | 62 | 14 | — | — | — | 1 | 0.6 | 10.1 | 7.10 | 10.2 | 18 | 10.6 | 14.8 | 28 900 | 41 300 |
| * 35BNR10H | 35 | 62 | 14 | 2.8 | 8.3 | 1.4 | 1 | 0.6 | [10.1] | [7.10] | 6.70 | 18 | 10.6 | 14.8 | 37 200 | 57 800 |
| * 35BNR10X | 35 | 62 | 14 | 2.8 | 8.3 | 1.4 | 1 | 0.6 | [10.1] | [7.10] | 6.70 | 18 | 10.6 | 14.8 | 43 300 | 68 100 |
| * 35BER10S | 35 | 62 | 14 | — | — | — | 1 | 0.6 | 9.70 | 6.85 | 12.0 | 25 | — | 18.2 | 24 800 | 35 100 |
| * 35BER10H | 35 | 62 | 14 | 2.8 | 8.3 | 1.4 | 1 | 0.6 | [9.70] | [6.85] | 8.10 | 25 | — | 18.2 | 33 000 | 51 600 |
| * 35BER10X | 35 | 62 | 14 | 2.8 | 8.3 | 1.4 | 1 | 0.6 | [9.70] | [6.85] | 8.10 | 25 | — | 18.2 | 39 200 | 61 900 |
| * 35BNR20SV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | 10.1 | 7.10 | 10.2 | 18 | 10.6 | 16.3 | 28 900 | — |
| * 35BNR20HV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | [10.1] | [7.10] | 6.70 | 18 | 10.6 | 16.3 | 37 200 | — |
| * 35BNR20XV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | [10.1] | [7.10] | 6.70 | 18 | 10.6 | 16.3 | 43 300 | — |
| * 35BER20SV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | 9.70 | 6.85 | 12.0 | 25 | — | 19.7 | 24 800 | — |
| * 35BER20HV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | [9.70] | [6.85] | 8.10 | 25 | — | 19.7 | 33 000 | — |
| * 35BER20XV1V | 35 | 62 | 17 | — | — | — | 1 | 0.6 | [9.70] | [6.85] | 8.10 | 25 | — | 19.7 | 39 200 | — |
| 7207C | 35 | 72 | 17 | — | — | — | 1.1 | 0.6 | 32.0 | 19.9 | 14.4 | 15 | 13.9 | 15.7 | 21 500 | 32 800 |
| 7207CSN24 | 35 | 72 | 17 | — | — | — | 1.1 | 0.6 | [32.0] | [19.9] | 17.1 | 15 | 13.9 | 15.7 | 28 100 | 42 700 |
| 7207A5 | 35 | 72 | 17 | — | — | — | 1.1 | 0.6 | 30.5 | 19.1 | 16.6 | 25 | — | 21.0 | 18 700 | 28 100 |
| 7207A5SN24 | 35 | 72 | 17 | — | — | — | 1.1 | 0.6 | [30.5] | [19.1] | 19.7 | 25 | — | 21.0 | 24 300 | 36 500 |
| 7207A | 35 | 72 | 17 | — | — | — | 1.1 | 0.6 | 29.6 | 18.5 | 12.7 | 30 | — | 23.9 | 14 100 | 18 700 |

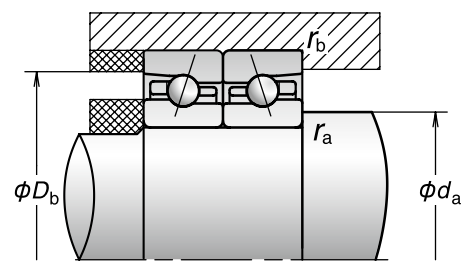
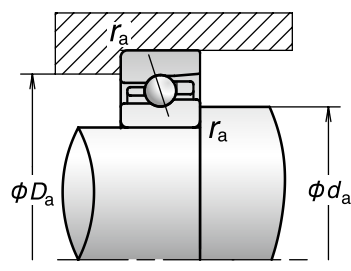
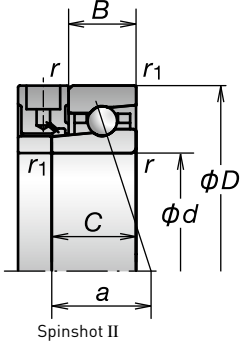
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 is exclusively for sealed bearings.

(2) A bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|-----|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 33 | 67 | 149 | 297 | 29 | 39 | 55 | 77 | 2 | -2 | -9 | -18 | 0.074 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 32 | 69 | 162 | 332 | 32 | 43 | 63 | 89 | 2 | -2 | -9 | -18 | 0.065 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 110 | 248 | 508 | 70 | 93 | 127 | 169 | 0 | -3 | -8 | -15 | 0.075 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 119 | 278 | 580 | 79 | 107 | 147 | 198 | 0 | -3 | -8 | -15 | 0.066 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 154 | 324 | — | 41 | 64 | 87 | — | 0 | -8 | -17 | — | 0.080 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 168 | 364 | — | 46 | 73 | 101 | — | 0 | -8 | -17 | — | 0.074 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 235 | 472 | — | 67 | 117 | 153 | — | 0 | -8 | -15 | — | 0.080 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 263 | 538 | — | 75 | 135 | 178 | — | 0 | -8 | -15 | — | 0.074 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 142 | 288 | — | 37 | 56 | 74 | — | 0 | -8 | -17 | — | 0.072 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 155 | 323 | — | 42 | 64 | 86 | — | 0 | -8 | -17 | — | 0.063 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 155 | 323 | — | 42 | 64 | 86 | — | 0 | -8 | -17 | — | 0.063 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 214 | 419 | — | 61 | 102 | 132 | — | 0 | -8 | -15 | — | 0.072 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 238 | 477 | — | 68 | 118 | 154 | — | 0 | -8 | -15 | — | 0.063 |
| 40 | 50 | 52.5 | 0.6 | 0.3 | 49 | 238 | 477 | — | 68 | 118 | 154 | — | 0 | -8 | -15 | — | 0.063 |
| 41 | 56 | 57 | 1 | 0.5 | 58 | 121 | 251 | 493 | 36 | 49 | 67 | 94 | -1 | -7 | -16 | -28 | 0.151 |
| 41 | 56 | 57 | 1 | 0.5 | 59 | 130 | 279 | 558 | 40 | 55 | 78 | 109 | -1 | -7 | -16 | -28 | 0.133 |
| 41 | 56 | 57 | 1 | 0.5 | 68 | 161 | 387 | 779 | 78 | 107 | 150 | 199 | -1 | -5 | -12 | -21 | 0.151 |
| 41 | 56 | 57 | 1 | 0.5 | 70 | 177 | 439 | 897 | 89 | 124 | 174 | 233 | -1 | -5 | -12 | -21 | 0.133 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 203 | 421 | 693 | 93 | 151 | 197 | 237 | 0 | -5 | -10 | -15 | 0.153 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 110 | 222 | — | 41 | 55 | 73 | — | 0 | -5 | -12 | — | 0.164 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 117 | 247 | — | 46 | 63 | 85 | — | 0 | -5 | -12 | — | 0.154 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 117 | 247 | — | 46 | 63 | 85 | — | 0 | -5 | -12 | — | 0.154 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 237 | 474 | — | 68 | 118 | 153 | — | 0 | -8 | -15 | — | 0.164 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 265 | 541 | — | 76 | 136 | 178 | — | 0 | -8 | -15 | — | 0.154 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 265 | 541 | — | 76 | 136 | 178 | — | 0 | -8 | -15 | — | 0.154 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 110 | 222 | — | 41 | 55 | 73 | — | 0 | -5 | -12 | — | 0.197 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 117 | 247 | — | 46 | 63 | 85 | — | 0 | -5 | -12 | — | 0.187 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 117 | 247 | — | 46 | 63 | 85 | — | 0 | -5 | -12 | — | 0.187 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 237 | 474 | — | 68 | 118 | 153 | — | 0 | -8 | -15 | — | 0.197 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 265 | 541 | — | 76 | 136 | 178 | — | 0 | -8 | -15 | — | 0.187 |
| 41 | 56 | 57 | 1 | 0.5 | 49 | 265 | 541 | — | 76 | 136 | 178 | — | 0 | -8 | -15 | — | 0.187 |
| 42 | 65 | 67 | 1 | 0.6 | 75 | 151 | 385 | 794 | 37 | 50 | 75 | 107 | -3 | -10 | -25 | -43 | 0.280 |
| 42 | 65 | 67 | 1 | 0.6 | 78 | 164 | 434 | 911 | 42 | 57 | 87 | 125 | -3 | -10 | -25 | -43 | 0.240 |
| 42 | 65 | 67 | 1 | 0.6 | 131 | 238 | 596 | 1 178 | 95 | 118 | 167 | 220 | -4 | -8 | -18 | -30 | 0.277 |
| 42 | 65 | 67 | 1 | 0.6 | 142 | 266 | 683 | 1 366 | 109 | 137 | 196 | 259 | -4 | -8 | -18 | -30 | 0.237 |
| 42 | 65 | 67 | 1 | 0.6 | 49 | 401 | 654 | 1 288 | 90 | 184 | 221 | 286 | 0 | -10 | -15 | -25 | 0.284 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

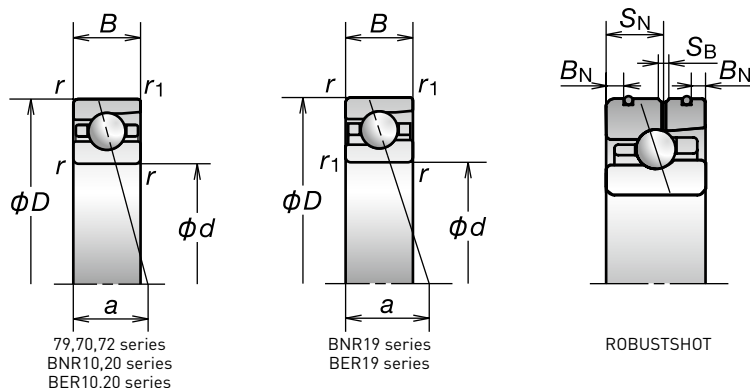
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 40 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7908C | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | 15.9 | 11.7 | 8.40 | 15 | 15.7 | 12.8 | 22 600 | 34 400 |
| * 7908CSN24 | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | [15.9] | [11.7] | 9.97 | 15 | 15.7 | 12.8 | 29 500 | 44 800 |
| * 7908A5 | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | 15.0 | 11.2 | 8.90 | 25 | — | 17.9 | 19 700 | 29 500 |
| * 7908A5SN24 | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | [15.0] | [11.2] | 10.5 | 25 | — | 17.9 | 25 500 | 38 300 |
| * 40BNR19S | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | 11.5 | 7.65 | 10.8 | 18 | 10.4 | 14.3 | 27 500 | 39 300 |
| * 40BNR19H | 40 | 62 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.5] | [7.65] | 7.10 | 18 | 10.4 | 14.3 | 35 300 | 55 000 |
| * 40BNR19X | 40 | 62 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.5] | [7.65] | 7.10 | 18 | 10.4 | 14.3 | 41 200 | 64 800 |
| * 40BER19S | 40 | 62 | 12 | — | — | — | — | 0.6 | 0.3 | 11.0 | 7.35 | 12.8 | 25 | — | 17.9 | 23 600 | 33 400 |
| * 40BER19H | 40 | 62 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.0] | [7.35] | 8.65 | 25 | — | 17.9 | 31 400 | 49 100 |
| * 40BER19X | 40 | 62 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.0] | [7.35] | 8.65 | 25 | — | 17.9 | 37 300 | 58 900 |
| * 40BNR29SV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | 11.5 | 7.65 | 10.8 | 18 | 10.4 | 15.3 | 27 500 | — |
| * 40BNR29HV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | [11.5] | [7.65] | 7.10 | 18 | 10.4 | 15.3 | 35 300 | — |
| * 40BNR29XV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | [11.5] | [7.65] | 7.10 | 18 | 10.4 | 15.3 | 41 200 | — |
| * 40BER29SV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | 11.0 | 7.35 | 12.8 | 25 | — | 18.9 | 23 600 | — |
| * 40BER29HV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | [11.0] | [7.35] | 8.65 | 25 | — | 18.9 | 31 400 | — |
| * 40BER29XV1V | 40 | 62 | 14 | — | — | — | — | 0.6 | 0.3 | [11.0] | [7.35] | 8.65 | 25 | — | 18.9 | 37 300 | — |
| * 7008C | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | 21.6 | 15.9 | 10.6 | 15 | 15.4 | 14.7 | 21 300 | 32 500 |
| * 7008CSN24 | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | [21.6] | [15.9] | 12.5 | 15 | 15.4 | 14.7 | 27 800 | 42 300 |
| * 7008A5 | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | 20.5 | 15.1 | 12.0 | 25 | — | 20.1 | 18 600 | 27 800 |
| * 7008A5SN24 | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | [20.5] | [15.1] | 14.2 | 25 | — | 20.1 | 24 100 | 36 200 |
| * 7008A | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | 19.7 | 14.6 | 9.15 | 30 | — | 23.1 | 13 900 | 18 600 |
| * 40BNR10S | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | 10.6 | 7.95 | 11.5 | 18 | 10.7 | 16.2 | 26 000 | 37 100 |
| * 40BNR10H | 40 | 68 | 15 | — | 2.8 | 8.8 | 1.4 | 1 | 0.6 | [10.6] | [7.95] | 7.50 | 18 | 10.7 | 16.2 | 33 400 | 51 900 |
| * 40BNR10X | 40 | 68 | 15 | 20 | 2.8 | 8.8 | 1.4 | 1 | 0.6 | [10.6] | [7.95] | 7.50 | 18 | 10.7 | 16.2 | 38 900 | 61 200 |
| * 40BER10S | 40 | 68 | 15 | — | — | — | — | 1 | 0.6 | 10.1 | 7.65 | 13.5 | 25 | — | 19.9 | 22 300 | 31 500 |
| * 40BER10H | 40 | 68 | 15 | — | 2.8 | 8.8 | 1.4 | 1 | 0.6 | [10.1] | [7.65] | 9.10 | 25 | — | 19.9 | 29 700 | 46 300 |
| * 40BER10X | 40 | 68 | 15 | 20 | 2.8 | 8.8 | 1.4 | 1 | 0.6 | [10.1] | [7.65] | 9.10 | 25 | — | 19.9 | 35 200 | 55 600 |
| * 40BNR20SV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | 10.6 | 7.95 | 11.5 | 18 | 10.7 | 17.7 | 26 000 | — |
| * 40BNR20HV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | [10.6] | [7.95] | 7.50 | 18 | 10.7 | 17.7 | 33 400 | — |
| * 40BNR20XV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | [10.6] | [7.95] | 7.50 | 18 | 10.7 | 17.7 | 38 900 | — |
| * 40BER20SV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | 10.1 | 7.65 | 13.5 | 25 | — | 21.4 | 22 300 | — |
| * 40BER20HV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | [10.1] | [7.65] | 9.10 | 25 | — | 21.4 | 29 700 | — |
| * 40BER20XV1V | 40 | 68 | 18 | — | — | — | — | 1 | 0.6 | [10.1] | [7.65] | 9.10 | 25 | — | 21.4 | 35 200 | — |
| 7208C | 40 | 80 | 18 | — | — | — | — | 1.1 | 0.6 | 38.0 | 25.2 | 17.6 | 15 | 14.1 | 17.0 | 19 200 | 29 200 |
| 7208CSN24 | 40 | 80 | 18 | — | — | — | — | 1.1 | 0.6 | [38.0] | [25.2] | 20.9 | 15 | 14.1 | 17.0 | 25 000 | 38 000 |
| 7208A5 | 40 | 80 | 18 | — | — | — | — | 1.1 | 0.6 | 36.5 | 24.1 | 20.6 | 25 | — | 23.0 | 16 700 | 25 000 |
| 7208A5SN24 | 40 | 80 | 18 | — | — | — | — | 1.1 | 0.6 | [36.5] | [24.1] | 24.4 | 25 | — | 23.0 | 21 700 | 32 500 |
| 7208A | 40 | 80 | 18 | — | — | — | — | 1.1 | 0.6 | 35.5 | 23.3 | 15.8 | 30 | — | 26.3 | 12 500 | 16 700 |

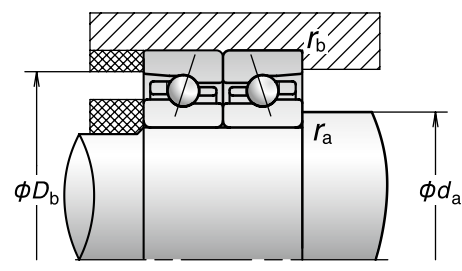
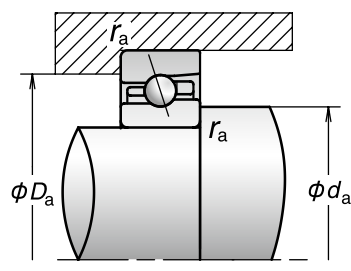
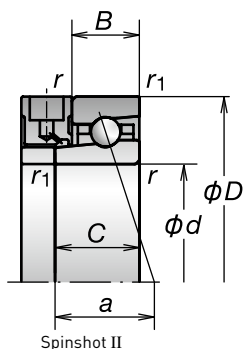
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|-----|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 41 | 78 | 196 | 384 | 32 | 42 | 63 | 88 | 1 | -3 | -12 | -22 | 0.109 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 40 | 81 | 215 | 432 | 35 | 47 | 72 | 101 | 1 | -3 | -12 | -22 | 0.096 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 68 | 113 | 291 | 572 | 81 | 97 | 139 | 182 | -1 | -3 | -9 | -16 | 0.110 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 71 | 121 | 327 | 655 | 92 | 111 | 161 | 213 | -1 | -3 | -9 | -16 | 0.097 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 145 | 277 | — | 38 | 57 | 74 | — | 0 | -8 | -16 | — | 0.105 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 158 | 310 | — | 43 | 66 | 86 | — | 0 | -8 | -16 | — | 0.092 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 158 | 310 | — | 43 | 66 | 86 | — | 0 | -8 | -16 | — | 0.092 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 221 | 434 | — | 63 | 106 | 137 | — | 0 | -8 | -15 | — | 0.105 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 246 | 494 | — | 71 | 123 | 160 | — | 0 | -8 | -15 | — | 0.092 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 246 | 494 | — | 71 | 123 | 160 | — | 0 | -8 | -15 | — | 0.092 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 145 | 277 | — | 38 | 57 | 74 | — | 0 | -8 | -16 | — | 0.120 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 158 | 310 | — | 43 | 66 | 86 | — | 0 | -8 | -16 | — | 0.107 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 158 | 310 | — | 43 | 66 | 86 | — | 0 | -8 | -16 | — | 0.107 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 221 | 434 | — | 63 | 106 | 137 | — | 0 | -8 | -15 | — | 0.120 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 246 | 494 | — | 71 | 123 | 160 | — | 0 | -8 | -15 | — | 0.107 |
| 45 | 57 | 59.5 | 0.6 | 0.3 | 49 | 246 | 494 | — | 71 | 123 | 160 | — | 0 | -8 | -15 | — | 0.107 |
| 46 | 62 | 63 | 1 | 0.5 | 58 | 114 | 291 | 594 | 39 | 51 | 77 | 110 | -1 | -6 | -17 | -30 | 0.189 |
| 46 | 62 | 63 | 1 | 0.5 | 59 | 123 | 325 | 676 | 43 | 58 | 89 | 128 | -1 | -6 | -17 | -30 | 0.168 |
| 46 | 62 | 63 | 1 | 0.5 | 92 | 203 | 424 | 864 | 95 | 127 | 167 | 223 | -2 | -6 | -12 | -21 | 0.188 |
| 46 | 62 | 63 | 1 | 0.5 | 98 | 225 | 483 | 998 | 108 | 147 | 195 | 262 | -2 | -6 | -12 | -21 | 0.167 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 219 | 463 | 768 | 101 | 168 | 221 | 267 | 0 | -5 | -10 | -15 | 0.191 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 114 | 216 | — | 44 | 60 | 77 | — | 0 | -5 | -11 | — | 0.204 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 122 | 240 | — | 49 | 68 | 89 | — | 0 | -5 | -11 | — | 0.193 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 122 | 240 | — | 49 | 68 | 89 | — | 0 | -5 | -11 | — | 0.193 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 252 | 510 | — | 72 | 128 | 167 | — | 0 | -8 | -15 | — | 0.204 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 282 | 583 | — | 81 | 148 | 195 | — | 0 | -8 | -15 | — | 0.193 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 282 | 583 | — | 81 | 148 | 195 | — | 0 | -8 | -15 | — | 0.193 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 114 | 216 | — | 44 | 60 | 77 | — | 0 | -5 | -11 | — | 0.242 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 122 | 240 | — | 49 | 68 | 89 | — | 0 | -5 | -11 | — | 0.231 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 122 | 240 | — | 49 | 68 | 89 | — | 0 | -5 | -11 | — | 0.231 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 252 | 510 | — | 72 | 128 | 167 | — | 0 | -8 | -15 | — | 0.242 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 282 | 583 | — | 81 | 148 | 195 | — | 0 | -8 | -15 | — | 0.231 |
| 46 | 62 | 63 | 1 | 0.5 | 49 | 282 | 583 | — | 81 | 148 | 195 | — | 0 | -8 | -15 | — | 0.231 |
| 47 | 73 | 75 | 1 | 0.6 | 98 | 202 | 501 | 985 | 44 | 60 | 90 | 125 | -5 | -13 | -29 | -47 | 0.366 |
| 47 | 73 | 75 | 1 | 0.6 | 104 | 223 | 570 | 1 133 | 50 | 69 | 104 | 147 | -5 | -13 | -29 | -47 | 0.313 |
| 47 | 73 | 75 | 1 | 0.6 | 138 | 290 | 750 | 1 490 | 105 | 137 | 196 | 259 | -4 | -9 | -20 | -33 | 0.362 |
| 47 | 73 | 75 | 1 | 0.6 | 151 | 326 | 864 | 1 734 | 121 | 159 | 230 | 305 | -4 | -9 | -20 | -33 | 0.309 |
| 47 | 73 | 75 | 1 | 0.6 | 49 | 438 | 721 | 1 428 | 97 | 205 | 246 | 318 | 0 | -10 | -15 | -25 | 0.370 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

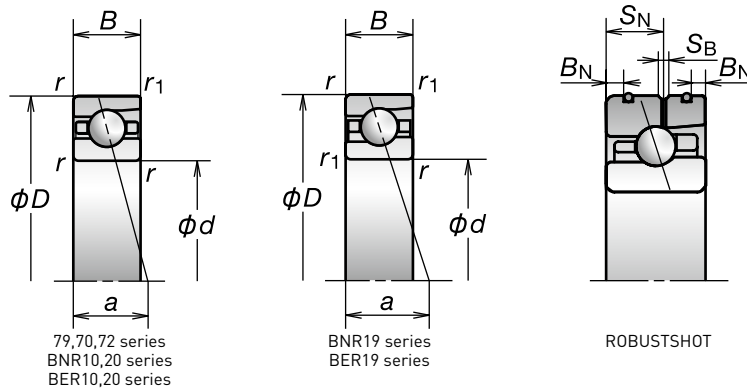
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 45 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7909C | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | 16.8 | 13.4 | 8.55 | 15 | 16.0 | 13.6 | 20 400 | 31 000 |
| * 7909CSN24 | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | [16.8] | [13.4] | 10.1 | 15 | 16.0 | 13.6 | 26 600 | 40 400 |
| * 7909A5 | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | 15.9 | 12.7 | 9.95 | 25 | — | 19.2 | 17 700 | 26 600 |
| * 7909A5SN24 | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | [15.9] | [12.7] | 11.8 | 25 | — | 19.2 | 23 100 | 34 600 |
| * 45BNR19S | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | 12.1 | 8.70 | 12.4 | 18 | 10.6 | 15.2 | 24 800 | 35 400 |
| * 45BNR19H | 45 | 68 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.1] | [8.70] | 8.10 | 18 | 10.6 | 15.2 | 31 900 | 49 600 |
| * 45BNR19X | 45 | 68 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.1] | [8.70] | 8.10 | 18 | 10.6 | 15.2 | 37 200 | 58 500 |
| * 45BER19S | 45 | 68 | 12 | — | — | — | — | 0.6 | 0.3 | 11.6 | 8.35 | 14.6 | 25 | — | 19.2 | 21 300 | 30 100 |
| * 45BER19H | 45 | 68 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.6] | [8.35] | 9.85 | 25 | — | 19.2 | 28 400 | 44 300 |
| * 45BER19X | 45 | 68 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [11.6] | [8.35] | 9.85 | 25 | — | 19.2 | 33 700 | 53 100 |
| * 45BNR29SV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | 12.1 | 8.70 | 12.4 | 18 | 10.6 | 16.2 | 24 800 | — |
| * 45BNR29HV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | [12.1] | [8.70] | 8.10 | 18 | 10.6 | 16.2 | 31 900 | — |
| * 45BNR29XV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | [12.1] | [8.70] | 8.10 | 18 | 10.6 | 16.2 | 37 200 | — |
| * 45BER29SV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | 11.6 | 8.35 | 14.6 | 25 | — | 20.2 | 21 300 | — |
| * 45BER29HV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | [11.6] | [8.35] | 9.85 | 25 | — | 20.2 | 28 400 | — |
| * 45BER29XV1V | 45 | 68 | 14 | — | — | — | — | 0.6 | 0.3 | [11.6] | [8.35] | 9.85 | 25 | — | 20.2 | 33 700 | — |
| * 7009C | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 25.6 | 19.3 | 12.4 | 15 | 15.4 | 16.0 | 19 200 | 29 200 |
| * 7009CSN24 | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | [25.6] | [19.3] | 14.7 | 15 | 15.4 | 16.0 | 25 000 | 38 000 |
| * 7009A5 | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 24.3 | 18.3 | 14.5 | 25 | — | 22.0 | 16 700 | 25 000 |
| * 7009A5SN24 | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | [24.3] | [18.3] | 17.2 | 25 | — | 22.0 | 21 700 | 32 500 |
| * 7009A | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 23.4 | 17.7 | 11.1 | 30 | — | 25.3 | 12 500 | 16 700 |
| * 45BNR10S | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 11.7 | 9.00 | 12.7 | 18 | 10.6 | 17.6 | 23 400 | 33 400 |
| * 45BNR10E | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 11.7 | 9.00 | 12.7 | 18 | 10.6 | 17.6 | 25 000 | 35 700 |
| * 45BNR10H | 45 | 75 | 16 | — | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.7] | [9.00] | 8.35 | 18 | 10.6 | 17.6 | 30 000 | 46 700 |
| * 45BNR10X | 45 | 75 | 16 | 21 | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.7] | [9.00] | 8.35 | 18 | 10.6 | 17.6 | 35 000 | 55 000 |
| * 45BER10S | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 11.2 | 8.60 | 15.0 | 25 | — | 21.8 | 20 000 | 28 400 |
| * 45BER10E | 45 | 75 | 16 | — | — | — | — | 1 | 0.6 | 11.2 | 8.60 | 15.0 | 25 | — | 21.8 | 21 500 | 30 400 |
| * 45BER10H | 45 | 75 | 16 | — | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.2] | [8.60] | 10.1 | 25 | — | 21.8 | 26 700 | 41 700 |
| * 45BER10X | 45 | 75 | 16 | 21 | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.2] | [8.60] | 10.1 | 25 | — | 21.8 | 31 700 | 50 000 |
| * 45BNR20EV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | 11.7 | 9.00 | 12.7 | 18 | 10.6 | 19.1 | 25 000 | — |
| * 45BNR20HV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | [11.7] | [9.00] | 8.35 | 18 | 10.6 | 19.1 | 30 000 | — |
| * 45BNR20XV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | [11.7] | [9.00] | 8.35 | 18 | 10.6 | 19.1 | 35 000 | — |
| * 45BER20EV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | 11.2 | 8.60 | 15.0 | 25 | — | 23.3 | 21 500 | — |
| * 45BER20HV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | [11.2] | [8.60] | 10.1 | 25 | — | 23.3 | 26 700 | — |
| * 45BER20XV1V | 45 | 75 | 19 | — | — | — | — | 1 | 0.6 | [11.2] | [8.60] | 10.1 | 25 | — | 23.3 | 31 700 | — |
| 7209C | 45 | 85 | 19 | — | — | — | — | 1.1 | 0.6 | 43.0 | 28.8 | 19.6 | 15 | 14.2 | 18.2 | 17 700 | 27 000 |
| 7209CSN24 | 45 | 85 | 19 | — | — | — | — | 1.1 | 0.6 | [43.0] | [28.8] | 23.3 | 15 | 14.2 | 18.2 | 23 100 | 35 100 |
| 7209A5 | 45 | 85 | 19 | — | — | — | — | 1.1 | 0.6 | 41.0 | 27.6 | 23.3 | 25 | — | 24.7 | 15 400 | 23 100 |
| 7209A5SN24 | 45 | 85 | 19 | — | — | — | — | 1.1 | 0.6 | [41.0] | [27.6] | 27.7 | 25 | — | 24.7 | 20 000 | 30 000 |
| 7209A | 45 | 85 | 19 | — | — | — | — | 1.1 | 0.6 | 39.5 | 26.7 | 18.0 | 30 | — | 28.3 | 11 600 | 15 400 |

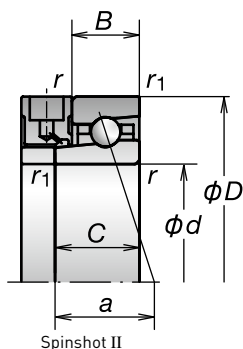
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

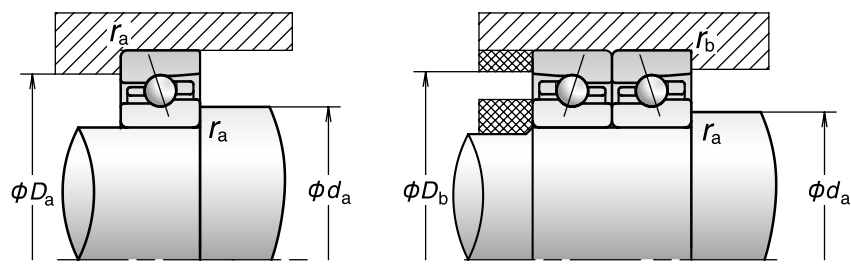
(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



Spinshot II



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 104 | 192 | 391 | 37 | 51 | 66 | 93 | 0 | -5 | -11 | -21 | 0.129 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 111 | 211 | 440 | 41 | 57 | 76 | 108 | 0 | -5 | -11 | -21 | 0.115 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 70 | 146 | 353 | 676 | 88 | 115 | 160 | 208 | -1 | -4 | -10 | -17 | 0.130 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 72 | 159 | 399 | 776 | 99 | 132 | 187 | 243 | -1 | -4 | -10 | -17 | 0.116 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 153 | 298 | — | 41 | 63 | 82 | — | 0 | -8 | -16 | — | 0.125 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 168 | 335 | — | 46 | 72 | 95 | — | 0 | -8 | -16 | — | 0.111 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 168 | 335 | — | 46 | 72 | 95 | — | 0 | -8 | -16 | — | 0.111 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 237 | 473 | — | 68 | 117 | 151 | — | 0 | -8 | -15 | — | 0.125 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 265 | 539 | — | 76 | 136 | 177 | — | 0 | -8 | -15 | — | 0.111 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 265 | 539 | — | 76 | 136 | 177 | — | 0 | -8 | -15 | — | 0.111 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 153 | 298 | — | 41 | 63 | 82 | — | 0 | -8 | -16 | — | 0.143 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 168 | 335 | — | 46 | 72 | 95 | — | 0 | -8 | -16 | — | 0.128 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 168 | 335 | — | 46 | 72 | 95 | — | 0 | -8 | -16 | — | 0.128 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 237 | 473 | — | 68 | 117 | 151 | — | 0 | -8 | -15 | — | 0.143 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 265 | 539 | — | 76 | 136 | 177 | — | 0 | -8 | -15 | — | 0.128 |
| 50 | 63 | 65.5 | 0.6 | 0.3 | 49 | 265 | 539 | — | 76 | 136 | 177 | — | 0 | -8 | -15 | — | 0.128 |
| 51 | 69 | 70 | 1 | 0.5 | 80 | 144 | 338 | 695 | 45 | 57 | 84 | 120 | -3 | -8 | -19 | -33 | 0.238 |
| 51 | 69 | 70 | 1 | 0.5 | 84 | 156 | 380 | 794 | 51 | 66 | 97 | 140 | -3 | -8 | -19 | -33 | 0.211 |
| 51 | 69 | 70 | 1 | 0.5 | 94 | 210 | 485 | 958 | 99 | 132 | 181 | 238 | -2 | -6 | -13 | -22 | 0.250 |
| 51 | 69 | 70 | 1 | 0.5 | 99 | 233 | 553 | 1 107 | 113 | 153 | 212 | 280 | -2 | -6 | -13 | -22 | 0.223 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 227 | 482 | 1 178 | 105 | 176 | 231 | 324 | 0 | -5 | -10 | -20 | 0.241 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 114 | 218 | — | 44 | 60 | 77 | — | 0 | -5 | -11 | — | 0.259 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 114 | 218 | — | 44 | 60 | 77 | — | 0 | -5 | -11 | — | 0.259 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 123 | 242 | — | 50 | 69 | 89 | — | 0 | -5 | -11 | — | 0.246 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 123 | 242 | — | 50 | 69 | 89 | — | 0 | -5 | -11 | — | 0.246 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 255 | 516 | — | 73 | 129 | 168 | — | 0 | -8 | -15 | — | 0.259 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 255 | 516 | — | 73 | 129 | 168 | — | 0 | -8 | -15 | — | 0.259 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 285 | 590 | — | 82 | 150 | 197 | — | 0 | -8 | -15 | — | 0.246 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 285 | 590 | — | 82 | 150 | 197 | — | 0 | -8 | -15 | — | 0.246 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 114 | 218 | — | 44 | 60 | 77 | — | 0 | -5 | -11 | — | 0.305 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 123 | 242 | — | 50 | 69 | 89 | — | 0 | -5 | -11 | — | 0.291 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 123 | 242 | — | 50 | 69 | 89 | — | 0 | -5 | -11 | — | 0.291 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 255 | 516 | — | 73 | 129 | 168 | — | 0 | -8 | -15 | — | 0.305 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 285 | 590 | — | 82 | 150 | 197 | — | 0 | -8 | -15 | — | 0.291 |
| 51 | 69 | 70 | 1 | 0.5 | 49 | 285 | 590 | — | 82 | 150 | 197 | — | 0 | -8 | -15 | — | 0.291 |
| 52 | 78 | 80 | 1 | 0.6 | 123 | 254 | 534 | 1 067 | 49 | 67 | 94 | 131 | -7 | -16 | -30 | -49 | 0.406 |
| 52 | 78 | 80 | 1 | 0.6 | 132 | 283 | 608 | 1 230 | 56 | 77 | 109 | 154 | -7 | -16 | -30 | -49 | 0.341 |
| 52 | 78 | 80 | 1 | 0.6 | 169 | 333 | 875 | 1 738 | 115 | 147 | 212 | 281 | -5 | -10 | -22 | -36 | 0.402 |
| 52 | 78 | 80 | 1 | 0.6 | 186 | 377 | 1 011 | 2 026 | 133 | 171 | 249 | 330 | -5 | -10 | -22 | -36 | 0.337 |
| 52 | 78 | 80 | 1 | 0.6 | 49 | 450 | 1 084 | 1 905 | 100 | 212 | 292 | 363 | 0 | -10 | -20 | -30 | 0.410 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

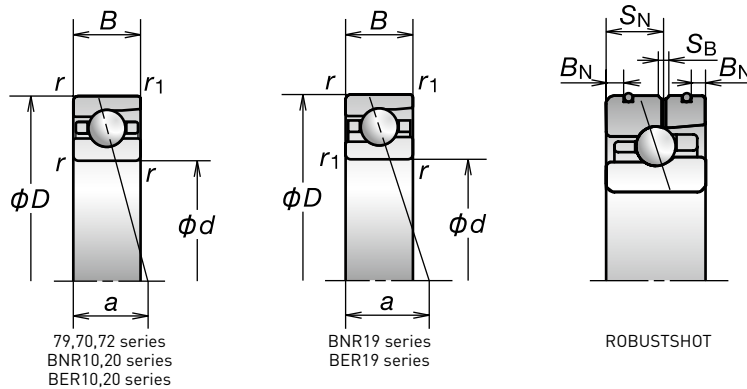
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 50 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7910C | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | 17.7 | 15.0 | 9.45 | 15 | 16.2 | 14.2 | 18 900 | 28 700 |
| * 7910CSN24 | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | [17.7] | [15.0] | 11.2 | 15 | 16.2 | 14.2 | 24 600 | 37 400 |
| * 7910A5 | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | 16.7 | 14.2 | 11.0 | 25 | — | 20.2 | 16 400 | 24 600 |
| * 7910A5SN24 | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | [16.7] | [14.2] | 13.1 | 25 | — | 20.2 | 21 400 | 32 000 |
| * 50BNR19S | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | 12.8 | 9.75 | 13.9 | 18 | 10.7 | 15.9 | 23 000 | 32 800 |
| * 50BNR19H | 50 | 72 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.8] | [9.75] | 9.10 | 18 | 10.7 | 15.9 | 29 600 | 46 000 |
| * 50BNR19X | 50 | 72 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.8] | [9.75] | 9.10 | 18 | 10.7 | 15.9 | 34 500 | 54 100 |
| * 50BER19S | 50 | 72 | 12 | — | — | — | — | 0.6 | 0.3 | 12.2 | 9.35 | 16.3 | 25 | — | 20.2 | 19 700 | 27 900 |
| * 50BER19H | 50 | 72 | 12 | — | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.2] | [9.35] | 11.0 | 25 | — | 20.2 | 26 300 | 41 000 |
| * 50BER19X | 50 | 72 | 12 | 17 | 2.2 | 7.0 | 1.4 | 0.6 | 0.3 | [12.2] | [9.35] | 11.0 | 25 | — | 20.2 | 31 200 | 49 200 |
| * 50BNR29SV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | 12.8 | 9.75 | 13.9 | 18 | 10.7 | 16.9 | 23 000 | — |
| * 50BNR29HV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | [12.8] | [9.75] | 9.10 | 18 | 10.7 | 16.9 | 29 600 | — |
| * 50BNR29XV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | [12.8] | [9.75] | 9.10 | 18 | 10.7 | 16.9 | 34 500 | — |
| * 50BER29SV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | 12.2 | 9.35 | 16.3 | 25 | — | 21.2 | 19 700 | — |
| * 50BER29HV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | [12.2] | [9.35] | 11.0 | 25 | — | 21.2 | 26 300 | — |
| * 50BER29XV1V | 50 | 72 | 14 | — | — | — | — | 0.6 | 0.3 | [12.2] | [9.35] | 11.0 | 25 | — | 21.2 | 31 200 | — |
| * 7010C | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 27.3 | 21.9 | 13.9 | 15 | 15.7 | 16.7 | 17 700 | 27 000 |
| * 7010CSN24 | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | [27.3] | [21.9] | 16.5 | 15 | 15.7 | 16.7 | 23 100 | 35 100 |
| * 7010A5 | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 25.8 | 20.8 | 16.2 | 25 | — | 23.2 | 15 400 | 23 100 |
| * 7010A5SN24 | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | [25.8] | [20.8] | 19.3 | 25 | — | 23.2 | 20 000 | 30 000 |
| * 7010A | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 24.8 | 20.1 | 12.5 | 30 | — | 26.8 | 11 600 | 15 400 |
| * 50BNR10S | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 12.2 | 9.90 | 14.0 | 18 | 10.8 | 18.4 | 21 600 | 30 800 |
| * 50BNR10E | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 12.2 | 9.90 | 14.0 | 18 | 10.8 | 18.4 | 23 100 | 33 000 |
| * 50BNR10H | 50 | 80 | 16 | — | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [12.2] | [9.90] | 9.20 | 18 | 10.8 | 18.4 | 27 700 | 43 100 |
| * 50BNR10X | 50 | 80 | 16 | 21 | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [12.2] | [9.90] | 9.20 | 18 | 10.8 | 18.4 | 32 400 | 50 800 |
| * 50BER10S | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 11.6 | 9.50 | 16.5 | 25 | — | 23.0 | 18 500 | 26 200 |
| * 50BER10E | 50 | 80 | 16 | — | — | — | — | 1 | 0.6 | 11.6 | 9.50 | 16.5 | 25 | — | 23.0 | 19 900 | 28 000 |
| * 50BER10H | 50 | 80 | 16 | — | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.6] | [9.50] | 11.1 | 25 | — | 23.0 | 24 700 | 38 500 |
| * 50BER10X | 50 | 80 | 16 | 21 | 3.4 | 9.3 | 1.4 | 1 | 0.6 | [11.6] | [9.50] | 11.1 | 25 | — | 23.0 | 29 300 | 46 200 |
| * 50BNR20EV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | 12.2 | 9.90 | 14.0 | 18 | 10.8 | 19.9 | 23 100 | — |
| * 50BNR20HV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | [12.2] | [9.90] | 9.20 | 18 | 10.8 | 19.9 | 27 700 | — |
| * 50BNR20XV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | [12.2] | [9.90] | 9.20 | 18 | 10.8 | 19.9 | 32 400 | — |
| * 50BER20EV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | 11.6 | 9.50 | 16.5 | 25 | — | 24.5 | 19 900 | — |
| * 50BER20HV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | [11.6] | [9.50] | 11.1 | 25 | — | 24.5 | 24 700 | — |
| * 50BER20XV1V | 50 | 80 | 19 | — | — | — | — | 1 | 0.6 | [11.6] | [9.50] | 11.1 | 25 | — | 24.5 | 29 300 | — |
| 7210C | 50 | 90 | 20 | — | — | — | — | 1.1 | 0.6 | 45.0 | 31.5 | 21.1 | 15 | 14.5 | 19.4 | 16 500 | 25 000 |
| 7210CSN24 | 50 | 90 | 20 | — | — | — | — | 1.1 | 0.6 | [45.0] | [31.5] | 25.0 | 15 | 14.5 | 19.4 | 20 600 | 31 300 |
| 7210A5 | 50 | 90 | 20 | — | — | — | — | 1.1 | 0.6 | 43.0 | 30.5 | 25.2 | 25 | — | 26.3 | 14 300 | 21 500 |
| 7210A5SN24 | 50 | 90 | 20 | — | — | — | — | 1.1 | 0.6 | [43.0] | [30.5] | 29.9 | 25 | — | 26.3 | 17 900 | 26 900 |
| 7210A | 50 | 90 | 20 | — | — | — | — | 1.1 | 0.6 | 41.5 | 29.3 | 19.4 | 30 | — | 30.2 | 10 800 | 14 300 |

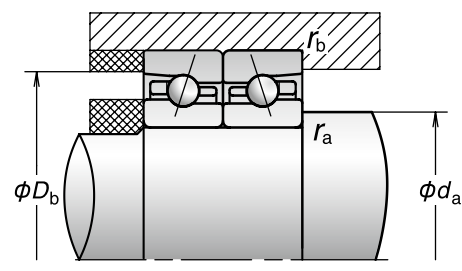
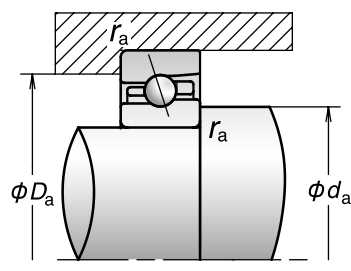
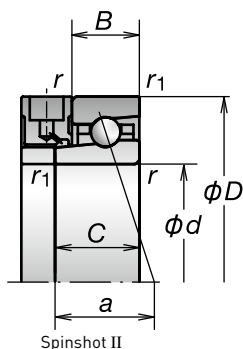
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------------------|-----------|-----------|-------------------------------------|-----|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | D _b (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 95 | 240 | 499 | 40 | 51 | 78 | 111 | 0 | -4 | -13 | -24 | 0.130 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 100 | 266 | 565 | 44 | 58 | 89 | 129 | 0 | -4 | -13 | -24 | 0.114 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 71 | 154 | 379 | 791 | 94 | 124 | 175 | 235 | -1 | -4 | -10 | -18 | 0.132 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 74 | 168 | 430 | 911 | 107 | 143 | 204 | 276 | -1 | -4 | -10 | -18 | 0.116 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 162 | 319 | — | 44 | 68 | 89 | — | 0 | -8 | -16 | — | 0.127 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 177 | 359 | — | 49 | 78 | 103 | — | 0 | -8 | -16 | — | 0.111 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 177 | 359 | — | 49 | 78 | 103 | — | 0 | -8 | -16 | — | 0.111 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 253 | 511 | — | 73 | 128 | 166 | — | 0 | -8 | -15 | — | 0.127 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 283 | 584 | — | 81 | 149 | 194 | — | 0 | -8 | -15 | — | 0.111 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 283 | 584 | — | 81 | 149 | 194 | — | 0 | -8 | -15 | — | 0.111 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 162 | 319 | — | 44 | 68 | 89 | — | 0 | -8 | -16 | — | 0.144 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 177 | 359 | — | 49 | 78 | 103 | — | 0 | -8 | -16 | — | 0.128 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 177 | 359 | — | 49 | 78 | 103 | — | 0 | -8 | -16 | — | 0.128 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 253 | 511 | — | 73 | 128 | 166 | — | 0 | -8 | -15 | — | 0.144 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 283 | 584 | — | 81 | 149 | 194 | — | 0 | -8 | -15 | — | 0.128 |
| 55 | 67 | 69.5 | 0.6 | 0.3 | 49 | 283 | 584 | — | 81 | 149 | 194 | — | 0 | -8 | -15 | — | 0.128 |
| 56 | 74 | 75 | 1 | 0.5 | 70 | 152 | 388 | 791 | 46 | 63 | 95 | 135 | -2 | -8 | -20 | -34 | 0.259 |
| 56 | 74 | 75 | 1 | 0.5 | 73 | 165 | 438 | 906 | 51 | 72 | 110 | 158 | -2 | -8 | -20 | -34 | 0.228 |
| 56 | 74 | 75 | 1 | 0.5 | 125 | 262 | 580 | 1 189 | 118 | 154 | 208 | 278 | -3 | -7 | -14 | -24 | 0.270 |
| 56 | 74 | 75 | 1 | 0.5 | 136 | 293 | 664 | 1 379 | 135 | 179 | 244 | 327 | -3 | -7 | -14 | -24 | 0.239 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 243 | 525 | 1 299 | 113 | 194 | 256 | 360 | 0 | -5 | -10 | -20 | 0.262 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 119 | 250 | — | 47 | 64 | 86 | — | 0 | -5 | -12 | — | 0.281 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 119 | 250 | — | 47 | 64 | 86 | — | 0 | -5 | -12 | — | 0.281 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 128 | 280 | — | 52 | 74 | 100 | — | 0 | -5 | -12 | — | 0.266 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 128 | 280 | — | 52 | 74 | 100 | — | 0 | -5 | -12 | — | 0.266 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 270 | 552 | — | 78 | 140 | 182 | — | 0 | -8 | -15 | — | 0.281 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 270 | 552 | — | 78 | 140 | 182 | — | 0 | -8 | -15 | — | 0.281 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 303 | 633 | — | 87 | 162 | 213 | — | 0 | -8 | -15 | — | 0.266 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 303 | 633 | — | 87 | 162 | 213 | — | 0 | -8 | -15 | — | 0.266 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 119 | 250 | — | 47 | 64 | 86 | — | 0 | -5 | -12 | — | 0.330 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 128 | 280 | — | 52 | 74 | 100 | — | 0 | -5 | -12 | — | 0.315 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 128 | 280 | — | 52 | 74 | 100 | — | 0 | -5 | -12 | — | 0.315 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 270 | 552 | — | 78 | 140 | 182 | — | 0 | -8 | -15 | — | 0.330 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 303 | 633 | — | 87 | 162 | 213 | — | 0 | -8 | -15 | — | 0.315 |
| 56 | 74 | 75 | 1 | 0.5 | 49 | 303 | 633 | — | 87 | 162 | 213 | — | 0 | -8 | -15 | — | 0.315 |
| 57 | 83 | 85 | 1 | 0.6 | 127 | 248 | 590 | 1 171 | 52 | 69 | 102 | 143 | -7 | -15 | -31 | -50 | 0.457 |
| 57 | 83 | 85 | 1 | 0.6 | 137 | 277 | 674 | 1 351 | 60 | 80 | 119 | 167 | -7 | -15 | -31 | -50 | 0.387 |
| 57 | 83 | 85 | 1 | 0.6 | 208 | 391 | 989 | 1 934 | 130 | 164 | 233 | 306 | -6 | -11 | -23 | -37 | 0.453 |
| 57 | 83 | 85 | 1 | 0.6 | 231 | 445 | 1 145 | 2 257 | 150 | 191 | 274 | 361 | -6 | -11 | -23 | -37 | 0.383 |
| 57 | 83 | 85 | 1 | 0.6 | 49 | 477 | 1 156 | 2 038 | 105 | 227 | 314 | 390 | 0 | -10 | -20 | -30 | 0.462 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

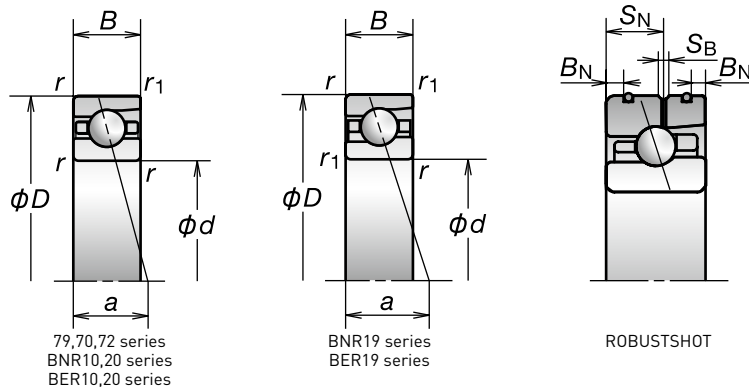
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

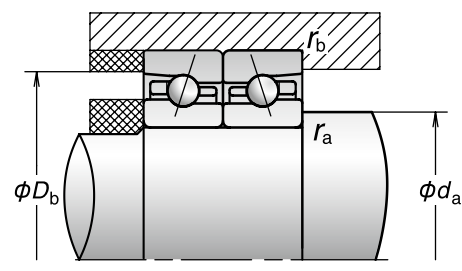
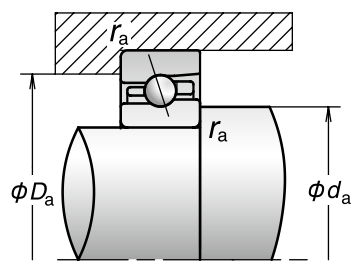
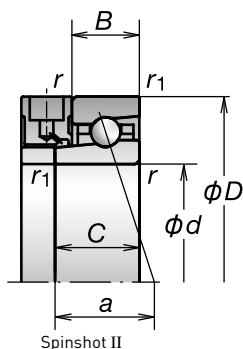
1. Angular Contact Ball Bearings

Bore Diameter 55 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7911C | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | 20.1 | 17.7 | 11.0 | 15 | 16.3 | 15.5 | 17 100 | 26 000 |
| * 7911CSN24 | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | [20.1] | [17.7] | 13.0 | 15 | 16.3 | 15.5 | 22 300 | 33 800 |
| * 7911A5 | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | 19.0 | 16.8 | 12.5 | 25 | — | 22.2 | 14 900 | 22 300 |
| * 7911A5SN24 | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | [19.0] | [16.8] | 14.8 | 25 | — | 22.2 | 19 300 | 28 900 |
| * 55BNR19S | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | 14.4 | 11.4 | 16.2 | 18 | 10.7 | 17.5 | 20 800 | 29 700 |
| * 55BNR19E | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | 14.4 | 11.4 | 16.2 | 18 | 10.7 | 17.5 | 22 300 | 31 800 |
| * 55BNR19H | 55 | 80 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [14.4] | [11.4] | 10.6 | 18 | 10.7 | 17.5 | 26 700 | 41 500 |
| * 55BNR19X | 55 | 80 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [14.4] | [11.4] | 10.6 | 18 | 10.7 | 17.5 | 31 200 | 48 900 |
| * 55BER19S | 55 | 80 | 13 | — | — | — | — | 0 | 0.5 | 13.8 | 10.9 | 16.1 | 25 | — | 22.2 | 17 800 | 25 200 |
| * 55BER19E | 55 | 80 | 13 | — | — | — | — | 1 | 0.6 | 13.8 | 10.9 | 16.1 | 25 | — | 22.2 | 19 200 | 27 000 |
| * 55BER19H | 55 | 80 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [13.8] | [10.9] | 12.9 | 25 | — | 22.2 | 23 800 | 37 100 |
| * 55BER19X | 55 | 80 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [13.8] | [10.9] | 12.9 | 25 | — | 22.2 | 28 200 | 44 500 |
| * 55BNR29EV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | 14.4 | 11.4 | 16.2 | 18 | 10.7 | 19.0 | 22 300 | — |
| * 55BNR29HV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | [14.4] | [11.4] | 10.6 | 18 | 10.7 | 19.0 | 26 700 | — |
| * 55BNR29XV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | [14.4] | [11.4] | 10.6 | 18 | 10.7 | 19.0 | 31 200 | — |
| * 55BER29EV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | 13.8 | 10.9 | 16.1 | 25 | — | 23.7 | 19 200 | — |
| * 55BER29HV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | [13.8] | [10.9] | 12.9 | 25 | — | 23.7 | 23 800 | — |
| * 55BER29XV1V | 55 | 80 | 16 | — | — | — | — | 1 | 0.6 | [13.8] | [10.9] | 12.9 | 25 | — | 23.7 | 28 200 | — |
| * 7011C | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 36.0 | 28.6 | 18.9 | 15 | 15.5 | 18.7 | 15 900 | 24 200 |
| * 7011CSN24 | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | [36.0] | [28.6] | 22.4 | 15 | 15.5 | 18.7 | 20 700 | 31 500 |
| * 7011A5 | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 34.0 | 27.2 | 21.8 | 25 | — | 25.9 | 13 800 | 20 700 |
| * 7011A5SN24 | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | [34.0] | [27.2] | 25.8 | 25 | — | 25.9 | 18 000 | 26 900 |
| * 7011A | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 32.5 | 26.3 | 16.6 | 30 | — | 29.9 | 10 400 | 13 800 |
| * 55BNR10S | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 15.1 | 12.5 | 17.8 | 18 | 10.8 | 20.6 | 19 400 | 27 600 |
| * 55BNR10E | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 15.1 | 12.5 | 17.8 | 18 | 10.8 | 20.6 | 20 700 | 29 600 |
| * 55BNR10H | 55 | 90 | 18 | — | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | [15.1] | [12.5] | 11.7 | 18 | 10.8 | 20.6 | 24 900 | 38 700 |
| * 55BNR10X | 55 | 90 | 18 | 23 | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | [15.1] | [12.5] | 11.7 | 18 | 10.8 | 20.6 | 29 000 | 45 600 |
| * 55BER10S | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 14.4 | 12.0 | 21.0 | 25 | — | 25.7 | 16 600 | 23 500 |
| * 55BER10E | 55 | 90 | 18 | — | — | — | — | 1.1 | 0.6 | 14.4 | 12.0 | 21.0 | 25 | — | 25.7 | 17 800 | 25 200 |
| * 55BER10H | 55 | 90 | 18 | — | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | [14.4] | [12.0] | 14.1 | 25 | — | 25.7 | 22 100 | 34 500 |
| * 55BER10X | 55 | 90 | 18 | 23 | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | [14.4] | [12.0] | 14.1 | 25 | — | 25.7 | 26 300 | 41 400 |
| * 55BNR20EV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | 15.1 | 12.5 | 17.8 | 18 | 10.8 | 22.6 | 20 700 | — |
| * 55BNR20HV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | [15.1] | [12.5] | 11.7 | 18 | 10.8 | 22.6 | 24 900 | — |
| * 55BNR20XV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | [15.1] | [12.5] | 11.7 | 18 | 10.8 | 22.6 | 29 000 | — |
| * 55BER20EV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | 14.4 | 12.0 | 21.0 | 25 | — | 27.7 | 17 800 | — |
| * 55BER20HV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | [14.4] | [12.0] | 14.1 | 25 | — | 27.7 | 22 100 | — |
| * 55BER20XV1V | 55 | 90 | 22 | — | — | — | — | 1.1 | 0.6 | [14.4] | [12.0] | 14.1 | 25 | — | 27.7 | 26 300 | — |
| 7211C | 55 | 100 | 21 | — | — | — | — | 1.5 | 1 | 55.5 | 40.0 | 27.6 | 15 | 14.5 | 20.9 | 14 900 | 22 600 |
| 7211CSN24 | 55 | 100 | 21 | — | — | — | — | 1.5 | 1 | [55.5] | [40.0] | 32.8 | 15 | 14.5 | 20.9 | 19 400 | 29 500 |
| 7211A5 | 55 | 100 | 21 | — | — | — | — | 1.5 | 1 | 53.0 | 38.0 | 32.5 | 25 | — | 28.6 | 13 000 | 19 400 |
| 7211A5SN24 | 55 | 100 | 21 | — | — | — | — | 1.5 | 1 | [53.0] | [38.0] | 38.6 | 25 | — | 28.6 | 16 800 | 25 200 |
| 7211A | 55 | 100 | 21 | — | — | — | — | 1.5 | 1 | 51.0 | 37.0 | 25.0 | 30 | — | 32.9 | 9 700 | 13 000 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.
 (2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.
 (3) Basic load rating values are reference values for ceramic ball bearings.
 (4) For permissible axial load, please refer to Page 201.
 (5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|------|------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 61 | 74 | 75 | 1 | 0.5 | 60 | 111 | 296 | 593 | 45 | 58 | 90 | 126 | -1 | -5 | -15 | -26 | 0.182 |
| 61 | 74 | 75 | 1 | 0.5 | 61 | 119 | 331 | 675 | 50 | 66 | 104 | 147 | -1 | -5 | -15 | -26 | 0.163 |
| 61 | 74 | 75 | 1 | 0.5 | 99 | 196 | 454 | 917 | 113 | 144 | 198 | 264 | -2 | -5 | -11 | -19 | 0.184 |
| 61 | 74 | 75 | 1 | 0.5 | 106 | 217 | 517 | 1059 | 129 | 167 | 232 | 309 | -2 | -5 | -11 | -19 | 0.165 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 167 | 333 | - | 46 | 72 | 94 | - | 0 | -8 | -16 | - | 0.178 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 167 | 333 | - | 46 | 72 | 94 | - | 0 | -8 | -16 | - | 0.178 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 184 | 375 | - | 51 | 82 | 109 | - | 0 | -8 | -16 | - | 0.158 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 184 | 375 | - | 51 | 82 | 109 | - | 0 | -8 | -16 | - | 0.158 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 264 | 538 | - | 76 | 136 | 176 | - | 0 | -8 | -15 | - | 0.178 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 264 | 538 | - | 76 | 136 | 176 | - | 0 | -8 | -15 | - | 0.178 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 296 | 615 | - | 85 | 158 | 206 | - | 0 | -8 | -15 | - | 0.158 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 296 | 615 | - | 85 | 158 | 206 | - | 0 | -8 | -15 | - | 0.158 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 167 | 333 | - | 46 | 72 | 94 | - | 0 | -8 | -16 | - | 0.213 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 184 | 375 | - | 51 | 82 | 109 | - | 0 | -8 | -16 | - | 0.194 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 184 | 375 | - | 51 | 82 | 109 | - | 0 | -8 | -16 | - | 0.194 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 264 | 538 | - | 76 | 136 | 176 | - | 0 | -8 | -15 | - | 0.213 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 296 | 615 | - | 85 | 158 | 206 | - | 0 | -8 | -15 | - | 0.194 |
| 61 | 74 | 75 | 1 | 0.5 | 49 | 296 | 615 | - | 85 | 158 | 206 | - | 0 | -8 | -15 | - | 0.194 |
| 62 | 83 | 85 | 1 | 0.6 | 95 | 200 | 479 | 971 | 51 | 69 | 102 | 144 | -4 | -11 | -24 | -40 | 0.380 |
| 62 | 83 | 85 | 1 | 0.6 | 100 | 221 | 544 | 1118 | 58 | 80 | 119 | 169 | -4 | -11 | -24 | -40 | 0.332 |
| 62 | 83 | 85 | 1 | 0.6 | 157 | 345 | 804 | 1552 | 129 | 171 | 236 | 307 | -4 | -9 | -18 | -29 | 0.383 |
| 62 | 83 | 85 | 1 | 0.6 | 172 | 391 | 928 | 1807 | 148 | 199 | 277 | 362 | -4 | -9 | -18 | -29 | 0.335 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 246 | 887 | 1307 | 115 | 196 | 311 | 360 | 0 | -5 | -15 | -20 | 0.385 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 121 | 305 | - | 49 | 67 | 95 | - | 0 | -5 | -14 | - | 0.414 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 121 | 305 | - | 49 | 67 | 95 | - | 0 | -5 | -14 | - | 0.414 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 131 | 343 | - | 54 | 77 | 111 | - | 0 | -5 | -14 | - | 0.393 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 131 | 343 | - | 54 | 77 | 111 | - | 0 | -5 | -14 | - | 0.393 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 356 | 725 | - | 81 | 160 | 208 | - | 0 | -10 | -18 | - | 0.414 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 356 | 725 | - | 81 | 160 | 208 | - | 0 | -10 | -18 | - | 0.414 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 404 | 836 | - | 90 | 186 | 244 | - | 0 | -10 | -18 | - | 0.393 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 404 | 836 | - | 90 | 186 | 244 | - | 0 | -10 | -18 | - | 0.393 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 121 | 305 | - | 49 | 67 | 95 | - | 0 | -5 | -14 | - | 0.501 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 131 | 343 | - | 54 | 77 | 111 | - | 0 | -5 | -14 | - | 0.480 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 131 | 343 | - | 54 | 77 | 111 | - | 0 | -5 | -14 | - | 0.480 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 356 | 725 | - | 81 | 160 | 208 | - | 0 | -10 | -18 | - | 0.501 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 404 | 836 | - | 90 | 186 | 244 | - | 0 | -10 | -18 | - | 0.480 |
| 62 | 83 | 85 | 1 | 0.6 | 49 | 404 | 836 | - | 90 | 186 | 244 | - | 0 | -10 | -18 | - | 0.480 |
| 64 | 91 | 94 | 1.5 | 0.8 | 142 | 289 | 788 | 1554 | 56 | 74 | 116 | 163 | -8 | -17 | -38 | -60 | 0.601 |
| 64 | 91 | 94 | 1.5 | 0.8 | 155 | 323 | 906 | 1802 | 64 | 86 | 136 | 191 | -8 | -17 | -38 | -60 | 0.502 |
| 64 | 91 | 94 | 1.5 | 0.8 | 248 | 491 | 1206 | 2397 | 142 | 182 | 256 | 338 | -7 | -13 | -26 | -42 | 0.596 |
| 64 | 91 | 94 | 1.5 | 0.8 | 277 | 562 | 1401 | 2804 | 165 | 213 | 301 | 399 | -7 | -13 | -26 | -42 | 0.497 |
| 64 | 91 | 94 | 1.5 | 0.8 | 49 | 494 | 1722 | 2635 | 108 | 236 | 372 | 438 | 0 | -10 | -26 | -35 | 0.609 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

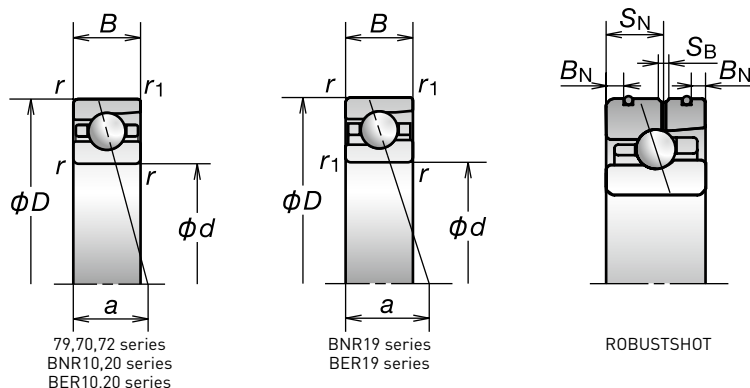
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 60 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7912C | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 20.4 | 18.7 | 11.5 | 15 | 16.5 | 16.2 | 15 900 | 24 200 |
| * 7912CSN24 | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | (20.4) | (18.7) | 13.6 | 15 | 16.5 | 16.2 | 20 700 | 31 500 |
| * 7912A5 | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 19.2 | 17.7 | 13.0 | 25 | — | 23.4 | 13 800 | 20 700 |
| * 7912A5SN24 | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | (19.2) | (17.7) | 15.5 | 25 | — | 23.4 | 18 000 | 26 900 |
| * 60BNR19S | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 14.6 | 12.0 | 17.1 | 18 | 10.7 | 18.3 | 19 400 | 27 600 |
| * 60BNR19E | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 14.6 | 12.0 | 17.1 | 18 | 10.7 | 18.3 | 20 700 | 29 600 |
| * 60BNR19H | 60 | 85 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (14.6) | (12.0) | 11.2 | 18 | 10.7 | 18.3 | 24 900 | 38 700 |
| * 60BNR19X | 60 | 85 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (14.6) | (12.0) | 11.2 | 18 | 10.7 | 18.3 | 29 000 | 45 600 |
| * 60BER19S | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 14.0 | 11.5 | 20.1 | 25 | — | 23.4 | 16 600 | 23 500 |
| * 60BER19E | 60 | 85 | 13 | — | — | — | — | 1 | 0.6 | 14.0 | 11.5 | 20.1 | 25 | — | 23.4 | 17 800 | 25 200 |
| * 60BER19H | 60 | 85 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (14.0) | (11.5) | 13.6 | 25 | — | 23.4 | 22 100 | 34 500 |
| * 60BER19X | 60 | 85 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | (14.0) | (11.5) | 13.6 | 25 | — | 23.4 | 26 300 | 41 400 |
| * 60BNR29EV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | 14.6 | 12.0 | 17.1 | 18 | 10.7 | 19.8 | 20 700 | — |
| * 60BNR29HV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | (14.6) | (12.0) | 11.2 | 18 | 10.7 | 19.8 | 24 900 | — |
| * 60BNR29XV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | (14.6) | (12.0) | 11.2 | 18 | 10.7 | 19.8 | 29 000 | — |
| * 60BER29EV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | 14.0 | 11.5 | 20.1 | 25 | — | 24.9 | 17 800 | — |
| * 60BER29HV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | (14.0) | (11.5) | 13.6 | 25 | — | 24.9 | 22 100 | — |
| * 60BER29XV1V | 60 | 85 | 16 | — | — | — | — | 1 | 0.6 | (14.0) | (11.5) | 13.6 | 25 | — | 24.9 | 26 300 | — |
| * 7012C | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 37.0 | 30.5 | 19.9 | 15 | 15.7 | 19.4 | 14 900 | 22 600 |
| * 7012CSN24 | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | (37.0) | (30.5) | 23.6 | 15 | 15.7 | 19.4 | 19 400 | 29 500 |
| * 7012A5 | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 35.0 | 29.1 | 23.0 | 25 | — | 27.1 | 13 000 | 19 400 |
| * 7012A5SN24 | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | (35.0) | (29.1) | 27.3 | 25 | — | 27.1 | 16 800 | 25 200 |
| * 7012A | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 33.5 | 28.1 | 17.6 | 30 | — | 31.4 | 9 700 | 13 000 |
| * 60BNR10S | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 15.6 | 13.7 | 19.5 | 18 | 10.8 | 21.5 | 18 100 | 25 900 |
| * 60BNR10E | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 15.6 | 13.7 | 19.5 | 18 | 10.8 | 21.5 | 19 400 | 27 700 |
| * 60BNR10H | 60 | 95 | 18 | — | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | (15.6) | (13.7) | 12.8 | 18 | 10.8 | 21.5 | 23 300 | 36 200 |
| * 60BNR10X | 60 | 95 | 18 | 23 | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | (15.6) | (13.7) | 12.8 | 18 | 10.8 | 21.5 | 27 100 | 42 600 |
| * 60BER10S | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 15.0 | 13.1 | 22.9 | 25 | — | 26.9 | 15 500 | 22 000 |
| * 60BER10E | 60 | 95 | 18 | — | — | — | — | 1.1 | 0.6 | 15.0 | 13.1 | 22.9 | 25 | — | 26.9 | 16 700 | 23 500 |
| * 60BER10H | 60 | 95 | 18 | — | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | (15.0) | (13.1) | 15.5 | 25 | — | 26.9 | 20 700 | 32 300 |
| * 60BER10X | 60 | 95 | 18 | 23 | 4.3 | 10.0 | 1.4 | 1.1 | 0.6 | (15.0) | (13.1) | 15.5 | 25 | — | 26.9 | 24 600 | 38 800 |
| * 60BNR20EV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | 15.6 | 13.7 | 19.5 | 18 | 10.8 | 23.5 | 19 400 | — |
| * 60BNR20HV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | (15.6) | (13.7) | 12.8 | 18 | 10.8 | 23.5 | 23 300 | — |
| * 60BNR20XV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | (15.6) | (13.7) | 12.8 | 18 | 10.8 | 23.5 | 27 100 | — |
| * 60BER20EV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | 15.0 | 13.1 | 22.9 | 25 | — | 28.9 | 16 700 | — |
| * 60BER20HV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | (15.0) | (13.1) | 15.5 | 25 | — | 28.9 | 20 700 | — |
| * 60BER20XV1V | 60 | 95 | 22 | — | — | — | — | 1.1 | 0.6 | (15.0) | (13.1) | 15.5 | 25 | — | 28.9 | 24 600 | — |
| 7212C | 60 | 110 | 22 | — | — | — | — | 1.5 | 1 | 67.5 | 49.0 | 34.0 | 15 | 14.4 | 22.4 | 13 600 | 20 600 |
| 7212CSN24 | 60 | 110 | 22 | — | — | — | — | 1.5 | 1 | (67.5) | (49.0) | 40.6 | 15 | 14.4 | 22.4 | 17 700 | 26 900 |
| 7212A5 | 60 | 110 | 22 | — | — | — | — | 1.5 | 1 | 64.0 | 47.0 | 40.0 | 25 | — | 30.8 | 11 800 | 17 700 |
| 7212A5SN24 | 60 | 110 | 22 | — | — | — | — | 1.5 | 1 | (64.0) | (47.0) | 47.3 | 25 | — | 30.8 | 15 300 | 23 000 |
| 7212A | 60 | 110 | 22 | — | — | — | — | 1.5 | 1 | 62.0 | 45.5 | 30.5 | 30 | — | 35.5 | 8 900 | 11 800 |

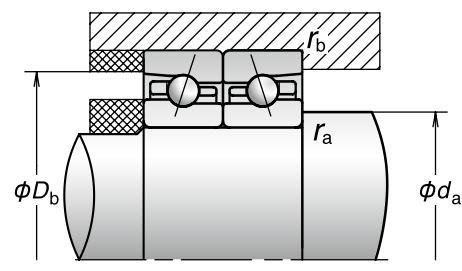
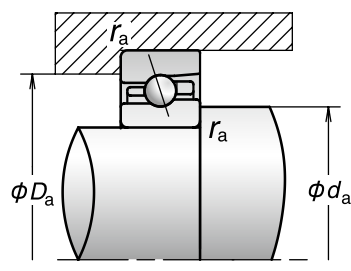
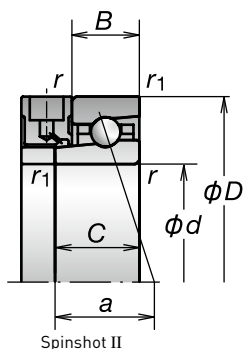
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 66 | 79 | 80 | 1 | 0.5 | 60 | 113 | 305 | 581 | 46 | 60 | 93 | 128 | -1 | -5 | -15 | -25 | 0.195 |
| 66 | 79 | 80 | 1 | 0.5 | 61 | 122 | 341 | 661 | 52 | 68 | 108 | 149 | -1 | -5 | -15 | -25 | 0.175 |
| 66 | 79 | 80 | 1 | 0.5 | 101 | 201 | 419 | 884 | 117 | 150 | 198 | 267 | -2 | -5 | -10 | -18 | 0.198 |
| 66 | 79 | 80 | 1 | 0.5 | 108 | 223 | 477 | 1 021 | 133 | 173 | 231 | 313 | -2 | -5 | -10 | -18 | 0.175 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 171 | 343 | — | 47 | 74 | 97 | — | 0 | -8 | -16 | — | 0.190 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 171 | 343 | — | 47 | 74 | 97 | — | 0 | -8 | -16 | — | 0.190 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 189 | 388 | — | 53 | 86 | 113 | — | 0 | -8 | -16 | — | 0.170 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 189 | 388 | — | 53 | 86 | 113 | — | 0 | -8 | -16 | — | 0.170 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 272 | 557 | — | 78 | 141 | 183 | — | 0 | -8 | -15 | — | 0.190 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 272 | 557 | — | 78 | 141 | 183 | — | 0 | -8 | -15 | — | 0.190 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 306 | 638 | — | 88 | 164 | 215 | — | 0 | -8 | -15 | — | 0.170 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 306 | 638 | — | 88 | 164 | 215 | — | 0 | -8 | -15 | — | 0.170 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 171 | 343 | — | 47 | 74 | 97 | — | 0 | -8 | -16 | — | 0.228 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 189 | 388 | — | 53 | 86 | 113 | — | 0 | -8 | -16 | — | 0.208 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 189 | 388 | — | 53 | 86 | 113 | — | 0 | -8 | -16 | — | 0.208 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 272 | 557 | — | 78 | 141 | 183 | — | 0 | -8 | -15 | — | 0.228 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 306 | 638 | — | 88 | 164 | 215 | — | 0 | -8 | -15 | — | 0.208 |
| 66 | 79 | 80 | 1 | 0.5 | 49 | 306 | 638 | — | 88 | 164 | 215 | — | 0 | -8 | -15 | — | 0.208 |
| 67 | 88 | 90 | 1 | 0.6 | 96 | 189 | 526 | 1 092 | 53 | 70 | 110 | 157 | -4 | -10 | -25 | -42 | 0.405 |
| 67 | 88 | 90 | 1 | 0.6 | 102 | 208 | 598 | 1 259 | 60 | 80 | 128 | 184 | -4 | -10 | -25 | -42 | 0.354 |
| 67 | 88 | 90 | 1 | 0.6 | 162 | 359 | 780 | 1 549 | 134 | 179 | 241 | 317 | -4 | -9 | -17 | -28 | 0.408 |
| 67 | 88 | 90 | 1 | 0.6 | 178 | 407 | 900 | 1 803 | 155 | 209 | 283 | 373 | -4 | -9 | -17 | -28 | 0.357 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 255 | 929 | 1 371 | 119 | 206 | 328 | 379 | 0 | -5 | -15 | -20 | 0.410 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 126 | 348 | — | 51 | 71 | 105 | — | 0 | -5 | -15 | — | 0.443 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 126 | 348 | — | 51 | 71 | 105 | — | 0 | -5 | -15 | — | 0.443 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 136 | 393 | — | 57 | 82 | 123 | — | 0 | -5 | -15 | — | 0.419 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 136 | 393 | — | 57 | 82 | 123 | — | 0 | -5 | -15 | — | 0.419 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 378 | 775 | — | 85 | 172 | 224 | — | 0 | -10 | -18 | — | 0.443 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 378 | 775 | — | 85 | 172 | 224 | — | 0 | -10 | -18 | — | 0.443 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 429 | 894 | — | 95 | 200 | 263 | — | 0 | -10 | -18 | — | 0.419 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 429 | 894 | — | 95 | 200 | 263 | — | 0 | -10 | -18 | — | 0.419 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 126 | 348 | — | 51 | 71 | 105 | — | 0 | -5 | -15 | — | 0.535 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 136 | 393 | — | 57 | 82 | 123 | — | 0 | -5 | -15 | — | 0.512 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 136 | 393 | — | 57 | 82 | 123 | — | 0 | -5 | -15 | — | 0.512 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 378 | 775 | — | 85 | 172 | 224 | — | 0 | -10 | -18 | — | 0.535 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 429 | 894 | — | 95 | 200 | 263 | — | 0 | -10 | -18 | — | 0.512 |
| 67 | 88 | 90 | 1 | 0.6 | 49 | 429 | 894 | — | 95 | 200 | 263 | — | 0 | -10 | -18 | — | 0.512 |
| 69 | 101 | 104 | 1.5 | 0.8 | 190 | 397 | 928 | 1 878 | 64 | 86 | 126 | 178 | -11 | -22 | -42 | -67 | 0.780 |
| 69 | 101 | 104 | 1.5 | 0.8 | 210 | 449 | 1 069 | 2 183 | 73 | 100 | 148 | 209 | -11 | -22 | -42 | -67 | 0.644 |
| 69 | 101 | 104 | 1.5 | 0.8 | 293 | 607 | 1 458 | 2 937 | 155 | 202 | 282 | 374 | -8 | -15 | -29 | -47 | 0.773 |
| 69 | 101 | 104 | 1.5 | 0.8 | 331 | 698 | 1 697 | 3 441 | 181 | 237 | 332 | 441 | -8 | -15 | -29 | -47 | 0.637 |
| 69 | 101 | 104 | 1.5 | 0.8 | 49 | 513 | 1 697 | 2 743 | 112 | 246 | 380 | 456 | 0 | -10 | -25 | -35 | 0.789 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

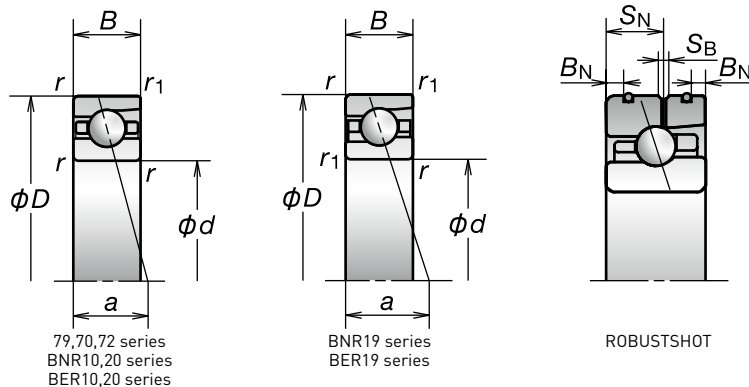
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 65 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7913C | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 21.2 | 20.5 | 12.5 | 15 | 16.7 | 16.9 | 14 900 | 22 600 |
| * 7913CSN24 | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | [21.2] | [20.5] | 14.8 | 15 | 16.7 | 16.9 | 19 400 | 29 500 |
| * 7913A5 | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 20.0 | 19.4 | 14.2 | 25 | — | 24.6 | 13 000 | 19 400 |
| * 7913A5SN24 | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | [20.0] | [19.4] | 16.8 | 25 | — | 24.6 | 16 800 | 25 200 |
| * 65BNR19S | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 15.2 | 13.2 | 18.7 | 18 | 10.8 | 19.1 | 18 100 | 25 900 |
| * 65BNR19E | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 15.2 | 13.2 | 18.7 | 18 | 10.8 | 19.1 | 19 400 | 27 700 |
| * 65BNR19H | 65 | 90 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [15.2] | [13.2] | 12.3 | 18 | 10.8 | 19.1 | 23 300 | 36 200 |
| * 65BNR19X | 65 | 90 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [15.2] | [13.2] | 12.3 | 18 | 10.8 | 19.1 | 27 100 | 42 600 |
| * 65BER19S | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 14.5 | 12.6 | 22.1 | 25 | — | 24.6 | 15 500 | 22 000 |
| * 65BER19E | 65 | 90 | 13 | — | — | — | — | 1 | 0.6 | 14.5 | 12.6 | 22.1 | 25 | — | 24.6 | 16 700 | 23 500 |
| * 65BER19H | 65 | 90 | 13 | — | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [14.5] | [12.6] | 14.9 | 25 | — | 24.6 | 20 700 | 32 300 |
| * 65BER19X | 65 | 90 | 13 | 18 | 2.8 | 7.5 | 1.4 | 1 | 0.6 | [14.5] | [12.6] | 14.9 | 25 | — | 24.6 | 24 600 | 38 800 |
| * 65BNR29EV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | 15.2 | 13.2 | 18.7 | 18 | 10.8 | 20.6 | 19 400 | — |
| * 65BNR29HV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | [15.2] | [13.2] | 12.3 | 18 | 10.8 | 20.6 | 23 300 | — |
| * 65BNR29XV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | [15.2] | [13.2] | 12.3 | 18 | 10.8 | 20.6 | 27 100 | — |
| * 65BER29EV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | 14.5 | 12.6 | 22.1 | 25 | — | 26.1 | 16 700 | — |
| * 65BER29HV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | [14.5] | [12.6] | 14.9 | 25 | — | 26.1 | 20 700 | — |
| * 65BER29XV1V | 65 | 90 | 16 | — | — | — | — | 1 | 0.6 | [14.5] | [12.6] | 14.9 | 25 | — | 26.1 | 24 600 | — |
| * 7013C | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 39.0 | 34.5 | 22.0 | 15 | 15.9 | 20.0 | 14 000 | 21 300 |
| * 7013CSN24 | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | [39.0] | [34.5] | 26.1 | 15 | 15.9 | 20.0 | 18 200 | 27 700 |
| * 7013A5 | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 37.0 | 32.5 | 25.4 | 25 | — | 28.2 | 12 200 | 18 200 |
| * 7013A5SN24 | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | [37.0] | [32.5] | 30.2 | 25 | — | 28.2 | 15 800 | 23 700 |
| * 7013A | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 35.5 | 31.5 | 19.5 | 30 | — | 32.8 | 9 100 | 12 200 |
| * 65BNR10S | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 16.2 | 14.8 | 21.1 | 18 | 10.9 | 22.3 | 17 000 | 24 300 |
| * 65BNR10E | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 16.2 | 14.8 | 21.1 | 18 | 10.9 | 22.3 | 18 200 | 26 000 |
| * 65BNR10H | 65 | 100 | 18 | — | 4.0 | 10.4 | 1.4 | 1.1 | 0.6 | [16.2] | [14.8] | 13.9 | 18 | 10.9 | 22.3 | 21 900 | 34 000 |
| * 65BNR10X | 65 | 100 | 18 | 23 | 4.0 | 10.4 | 1.4 | 1.1 | 0.6 | [16.2] | [14.8] | 13.9 | 18 | 10.9 | 22.3 | 25 500 | 40 000 |
| * 65BER10S | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 15.5 | 14.2 | 24.9 | 25 | — | 28.0 | 14 600 | 20 700 |
| * 65BER10E | 65 | 100 | 18 | — | — | — | — | 1.1 | 0.6 | 15.5 | 14.2 | 24.9 | 25 | — | 28.0 | 15 700 | 22 100 |
| * 65BER10H | 65 | 100 | 18 | — | 4.0 | 10.4 | 1.4 | 1.1 | 0.6 | [15.5] | [14.2] | 16.8 | 25 | — | 28.0 | 19 400 | 30 400 |
| * 65BER10X | 65 | 100 | 18 | 23 | 4.0 | 10.4 | 1.4 | 1.1 | 0.6 | [15.5] | [14.2] | 16.8 | 25 | — | 28.0 | 23 100 | 36 400 |
| * 65BNR20EV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | 16.2 | 14.8 | 21.1 | 18 | 10.9 | 24.3 | 18 200 | — |
| * 65BNR20HV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | [16.2] | [14.8] | 13.9 | 18 | 10.9 | 24.3 | 21 900 | — |
| * 65BNR20XV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | [16.2] | [14.8] | 13.9 | 18 | 10.9 | 24.3 | 25 500 | — |
| * 65BER20EV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | 15.5 | 14.2 | 24.9 | 25 | — | 30.0 | 15 700 | — |
| * 65BER20HV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | [15.5] | [14.2] | 16.8 | 25 | — | 30.0 | 19 400 | — |
| * 65BER20XV1V | 65 | 100 | 22 | — | — | — | — | 1.1 | 0.6 | [15.5] | [14.2] | 16.8 | 25 | — | 30.0 | 23 100 | — |
| 7213C | 65 | 120 | 23 | — | — | — | — | 1.5 | 1 | 77.0 | 58.5 | 40.0 | 15 | 14.6 | 23.9 | 12 500 | 19 000 |
| 7213CSN24 | 65 | 120 | 23 | — | — | — | — | 1.5 | 1 | [77.0] | [58.5] | 47.5 | 15 | 14.6 | 23.9 | 16 300 | 24 700 |
| 7213A5 | 65 | 120 | 23 | — | — | — | — | 1.5 | 1 | 73.0 | 56.0 | 46.5 | 25 | — | 33.1 | 10 900 | 16 300 |
| 7213A5SN24 | 65 | 120 | 23 | — | — | — | — | 1.5 | 1 | [73.0] | [56.0] | 55.4 | 25 | — | 33.1 | 14 100 | 21 100 |
| 7213A | 65 | 120 | 23 | — | — | — | — | 1.5 | 1 | 70.5 | 54.0 | 36.0 | 30 | — | 38.2 | 8 200 | 10 900 |

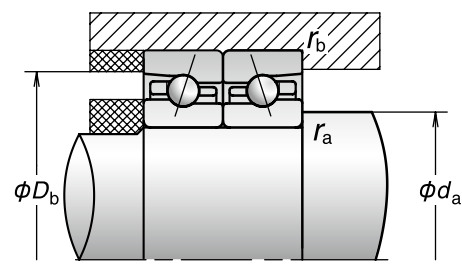
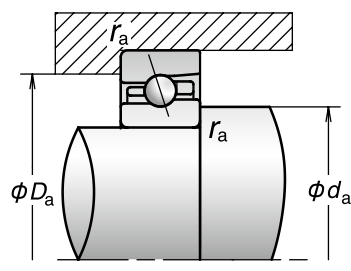
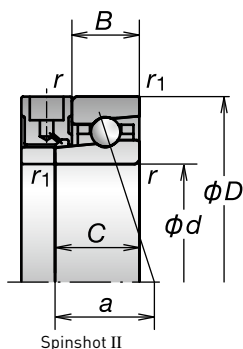
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-----|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 71 | 84 | 85 | 1 | 0.5 | 74 | 151 | 348 | 690 | 53 | 71 | 104 | 145 | -2 | -7 | -16 | -27 | 0.208 |
| 71 | 84 | 85 | 1 | 0.5 | 76 | 164 | 391 | 787 | 59 | 81 | 120 | 169 | -2 | -7 | -16 | -27 | 0.186 |
| 71 | 84 | 85 | 1 | 0.5 | 104 | 212 | 500 | 948 | 124 | 161 | 223 | 288 | -2 | -5 | -11 | -18 | 0.211 |
| 71 | 84 | 85 | 1 | 0.5 | 112 | 235 | 572 | 1 096 | 142 | 186 | 261 | 338 | -2 | -5 | -11 | -18 | 0.189 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 179 | 364 | - | 50 | 80 | 105 | - | 0 | -8 | -16 | - | 0.204 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 179 | 364 | - | 50 | 80 | 105 | - | 0 | -8 | -16 | - | 0.204 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 198 | 412 | - | 56 | 92 | 122 | - | 0 | -8 | -16 | - | 0.181 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 198 | 412 | - | 56 | 92 | 122 | - | 0 | -8 | -16 | - | 0.181 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 288 | 595 | - | 83 | 152 | 198 | - | 0 | -8 | -15 | - | 0.204 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 288 | 595 | - | 83 | 152 | 198 | - | 0 | -8 | -15 | - | 0.204 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 324 | 683 | - | 93 | 177 | 232 | - | 0 | -8 | -15 | - | 0.181 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 324 | 683 | - | 93 | 177 | 232 | - | 0 | -8 | -15 | - | 0.181 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 179 | 364 | - | 50 | 80 | 105 | - | 0 | -8 | -16 | - | 0.245 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 198 | 412 | - | 56 | 92 | 122 | - | 0 | -8 | -16 | - | 0.223 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 198 | 412 | - | 56 | 92 | 122 | - | 0 | -8 | -16 | - | 0.223 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 288 | 595 | - | 83 | 152 | 198 | - | 0 | -8 | -15 | - | 0.245 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 324 | 683 | - | 93 | 177 | 232 | - | 0 | -8 | -15 | - | 0.223 |
| 71 | 84 | 85 | 1 | 0.5 | 49 | 324 | 683 | - | 93 | 177 | 232 | - | 0 | -8 | -15 | - | 0.223 |
| 72 | 93 | 95 | 1 | 0.6 | 130 | 260 | 537 | 1 062 | 64 | 85 | 117 | 163 | -6 | -13 | -24 | -39 | 0.435 |
| 72 | 93 | 95 | 1 | 0.6 | 141 | 290 | 612 | 1 224 | 73 | 98 | 136 | 191 | -6 | -13 | -24 | -39 | 0.379 |
| 72 | 93 | 95 | 1 | 0.6 | 209 | 386 | 915 | 1 781 | 157 | 196 | 272 | 356 | -5 | -9 | -18 | -29 | 0.455 |
| 72 | 93 | 95 | 1 | 0.6 | 232 | 439 | 1 059 | 2 077 | 182 | 229 | 320 | 420 | -5 | -9 | -18 | -29 | 0.399 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 272 | 1 012 | 1 498 | 127 | 225 | 360 | 418 | 0 | -5 | -15 | -20 | 0.441 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 130 | 367 | - | 54 | 76 | 113 | - | 0 | -5 | -15 | - | 0.472 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 130 | 367 | - | 54 | 76 | 113 | - | 0 | -5 | -15 | - | 0.472 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 141 | 415 | - | 60 | 87 | 131 | - | 0 | -5 | -15 | - | 0.447 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 141 | 415 | - | 60 | 87 | 131 | - | 0 | -5 | -15 | - | 0.447 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 399 | 824 | - | 89 | 184 | 240 | - | 0 | -10 | -18 | - | 0.472 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 399 | 824 | - | 89 | 184 | 240 | - | 0 | -10 | -18 | - | 0.472 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 454 | 952 | - | 100 | 215 | 282 | - | 0 | -10 | -18 | - | 0.447 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 454 | 952 | - | 100 | 215 | 282 | - | 0 | -10 | -18 | - | 0.447 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 130 | 367 | - | 54 | 76 | 113 | - | 0 | -5 | -15 | - | 0.570 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 141 | 415 | - | 60 | 87 | 131 | - | 0 | -5 | -15 | - | 0.545 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 141 | 415 | - | 60 | 87 | 131 | - | 0 | -5 | -15 | - | 0.545 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 399 | 824 | - | 89 | 184 | 240 | - | 0 | -10 | -18 | - | 0.570 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 454 | 952 | - | 100 | 215 | 282 | - | 0 | -10 | -18 | - | 0.545 |
| 72 | 93 | 95 | 1 | 0.6 | 49 | 454 | 952 | - | 100 | 215 | 282 | - | 0 | -10 | -18 | - | 0.545 |
| 74 | 111 | 114 | 1.5 | 0.8 | 219 | 448 | 1 069 | 2 175 | 71 | 95 | 141 | 200 | -12 | -23 | -44 | -70 | 1.01 |
| 74 | 111 | 114 | 1.5 | 0.8 | 243 | 509 | 1 235 | 2 533 | 82 | 111 | 165 | 235 | -12 | -23 | -44 | -70 | 0.842 |
| 74 | 111 | 114 | 1.5 | 0.8 | 357 | 657 | 1 664 | 3 307 | 177 | 221 | 314 | 414 | -9 | -15 | -30 | -48 | 1.00 |
| 74 | 111 | 114 | 1.5 | 0.8 | 405 | 755 | 1 941 | 3 877 | 207 | 259 | 370 | 489 | -9 | -15 | -30 | -48 | 0.832 |
| 74 | 111 | 114 | 1.5 | 0.8 | 49 | 553 | 1 851 | 2 998 | 120 | 269 | 416 | 499 | 0 | -10 | -25 | -35 | 1.02 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

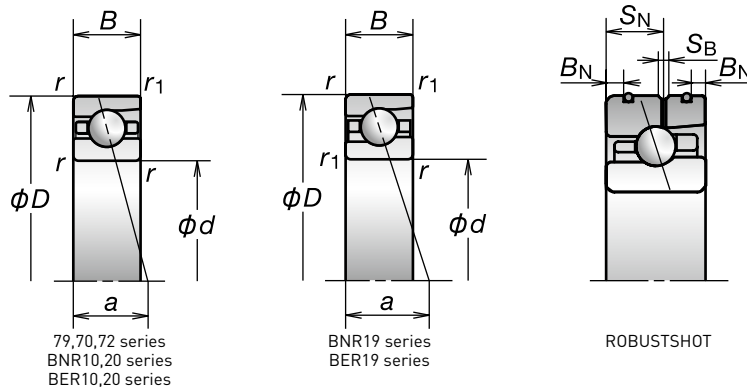
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 70 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7914C | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 29.5 | 27.8 | 17.3 | 15 | 16.4 | 19.4 | 13 600 | 20 600 |
| * 7914CSN24 | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | [29.5] | [27.8] | 20.5 | 15 | 16.4 | 19.4 | 17 700 | 26 900 |
| * 7914A5 | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 27.9 | 26.3 | 20.3 | 25 | — | 27.8 | 11 800 | 17 700 |
| * 7914A5SN24 | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | [27.9] | [26.3] | 24.1 | 25 | — | 27.8 | 15 300 | 23 000 |
| * 70BNR19S | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 21.3 | 18.1 | 26.1 | 18 | 10.8 | 21.8 | 16 500 | 23 600 |
| * 70BNR19E | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 21.3 | 18.1 | 26.1 | 18 | 10.8 | 21.8 | 17 700 | 25 200 |
| * 70BNR19H | 70 | 100 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [21.3] | [18.1] | 17.1 | 18 | 10.8 | 21.8 | 21 200 | 33 000 |
| * 70BNR19X | 70 | 100 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [21.3] | [18.1] | 17.1 | 18 | 10.8 | 21.8 | 24 800 | 38 900 |
| * 70BER19S | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 20.4 | 17.3 | 30.5 | 25 | — | 27.8 | 14 200 | 20 000 |
| * 70BER19E | 70 | 100 | 16 | — | — | — | — | 1 | 0.6 | 20.4 | 17.3 | 30.5 | 25 | — | 27.8 | 15 200 | 21 500 |
| * 70BER19H | 70 | 100 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [20.4] | [17.3] | 20.7 | 25 | — | 27.8 | 18 900 | 29 500 |
| * 70BER19X | 70 | 100 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [20.4] | [17.3] | 20.7 | 25 | — | 27.8 | 22 400 | 35 300 |
| * 70BNR29EV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | 21.3 | 18.1 | 26.1 | 18 | 10.8 | 23.3 | 17 700 | — |
| * 70BNR29HV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | [21.3] | [18.1] | 17.1 | 18 | 10.8 | 23.3 | 21 200 | — |
| * 70BNR29XV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | [21.3] | [18.1] | 17.1 | 18 | 10.8 | 23.3 | 24 800 | — |
| * 70BER29EV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | 20.4 | 17.3 | 30.5 | 25 | — | 29.3 | 15 200 | — |
| * 70BER29HV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | [20.4] | [17.3] | 20.7 | 25 | — | 29.3 | 18 900 | — |
| * 70BER29XV1V | 70 | 100 | 19 | — | — | — | — | 1 | 0.6 | [20.4] | [17.3] | 20.7 | 25 | — | 29.3 | 22 400 | — |
| * 7014C | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 49.0 | 43.0 | 26.8 | 15 | 15.7 | 22.1 | 12 800 | 19 500 |
| * 7014CSN24 | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | [49.0] | [43.0] | 31.8 | 15 | 15.7 | 22.1 | 16 700 | 25 400 |
| * 7014A5 | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 46.5 | 41.0 | 32.0 | 25 | — | 31.0 | 11 200 | 16 700 |
| * 7014A5SN24 | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | [46.5] | [41.0] | 38.0 | 25 | — | 31.0 | 14 500 | 21 700 |
| * 7014A | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 45.0 | 39.5 | 24.6 | 30 | — | 36.0 | 8 400 | 11 200 |
| * 70BNR10S | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 22.3 | 19.8 | 28.6 | 18 | 10.9 | 24.5 | 15 600 | 22 300 |
| * 70BNR10E | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 22.3 | 19.8 | 28.6 | 18 | 10.9 | 24.5 | 16 700 | 23 800 |
| * 70BNR10H | 70 | 110 | 20 | — | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [22.3] | [19.8] | 18.8 | 18 | 10.9 | 24.5 | 20 000 | 31 200 |
| * 70BNR10X | 70 | 110 | 20 | 25 | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [22.3] | [19.8] | 18.8 | 18 | 10.9 | 24.5 | 23 400 | 36 700 |
| * 70BER10S | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 21.3 | 18.9 | 33.5 | 25 | — | 30.8 | 13 400 | 18 900 |
| * 70BER10E | 70 | 110 | 20 | — | — | — | — | 1.1 | 0.6 | 21.3 | 18.9 | 33.5 | 25 | — | 30.8 | 14 400 | 20 300 |
| * 70BER10H | 70 | 110 | 20 | — | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [21.3] | [18.9] | 22.6 | 25 | — | 30.8 | 17 800 | 27 800 |
| * 70BER10X | 70 | 110 | 20 | 25 | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [21.3] | [18.9] | 22.6 | 25 | — | 30.8 | 21 200 | 33 400 |
| * 70BNR20EV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | 22.3 | 19.8 | 28.6 | 18 | 10.9 | 26.5 | 16 700 | — |
| * 70BNR20HV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | [22.3] | [19.8] | 18.8 | 18 | 10.9 | 26.5 | 20 000 | — |
| * 70BNR20XV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | [22.3] | [19.8] | 18.8 | 18 | 10.9 | 26.5 | 23 400 | — |
| * 70BER20EV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | 21.3 | 18.9 | 33.5 | 25 | — | 32.8 | 14 400 | — |
| * 70BER20HV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | [21.3] | [18.9] | 22.6 | 25 | — | 32.8 | 17 800 | — |
| * 70BER20XV1V | 70 | 110 | 24 | — | — | — | — | 1.1 | 0.6 | [21.3] | [18.9] | 22.6 | 25 | — | 32.8 | 21 200 | — |
| 7214C | 70 | 125 | 24 | — | — | — | — | 1.5 | 1 | 83.5 | 64.5 | 43.0 | 15 | 14.6 | 25.1 | 11 800 | 18 000 |
| 7214CSN24 | 70 | 125 | 24 | — | — | — | — | 1.5 | 1 | [83.5] | [64.5] | 51.3 | 15 | 14.6 | 25.1 | 15 400 | 23 400 |
| 7214A5 | 70 | 125 | 24 | — | — | — | — | 1.5 | 1 | 79.5 | 61.5 | 49.5 | 25 | — | 34.7 | 10 300 | 15 400 |
| 7214A5SN24 | 70 | 125 | 24 | — | — | — | — | 1.5 | 1 | [79.5] | [61.5] | 59.0 | 25 | — | 34.7 | 13 400 | 20 000 |
| 7214A | 70 | 125 | 24 | — | — | — | — | 1.5 | 1 | 77.0 | 59.5 | 38.0 | 30 | — | 40.1 | 7 700 | 10 300 |

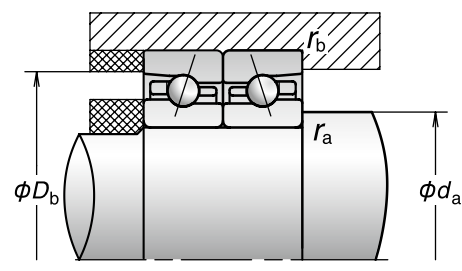
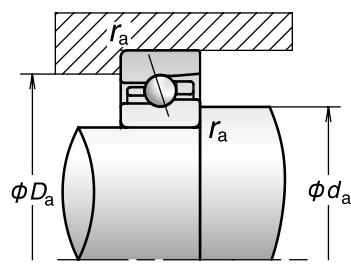
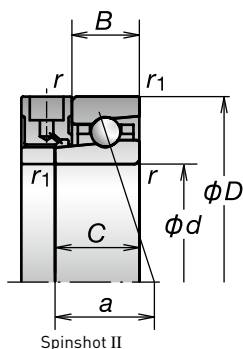
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------------------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | D _b (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 76 | 94 | 95 | 1 | 0.5 | 101 | 205 | 503 | 1 004 | 59 | 79 | 119 | 168 | -4 | -10 | -22 | -36 | 0.338 |
| 76 | 94 | 95 | 1 | 0.5 | 108 | 227 | 571 | 1 155 | 67 | 91 | 138 | 196 | -4 | -10 | -22 | -36 | 0.301 |
| 76 | 94 | 95 | 1 | 0.5 | 137 | 298 | 676 | 1 404 | 138 | 182 | 248 | 334 | -3 | -7 | -14 | -24 | 0.341 |
| 76 | 94 | 95 | 1 | 0.5 | 150 | 336 | 777 | 1 633 | 158 | 212 | 291 | 392 | -3 | -7 | -14 | -24 | 0.304 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 181 | 367 | — | 51 | 80 | 105 | — | 0 | -8 | -16 | — | 0.328 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 181 | 367 | — | 51 | 80 | 105 | — | 0 | -8 | -16 | — | 0.328 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 200 | 415 | — | 57 | 93 | 122 | — | 0 | -8 | -16 | — | 0.292 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 200 | 415 | — | 57 | 93 | 122 | — | 0 | -8 | -16 | — | 0.292 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 292 | 604 | — | 84 | 154 | 201 | — | 0 | -8 | -15 | — | 0.328 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 292 | 604 | — | 84 | 154 | 201 | — | 0 | -8 | -15 | — | 0.328 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 329 | 693 | — | 94 | 180 | 235 | — | 0 | -8 | -15 | — | 0.292 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 329 | 693 | — | 94 | 180 | 235 | — | 0 | -8 | -15 | — | 0.292 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 181 | 367 | — | 51 | 80 | 105 | — | 0 | -8 | -16 | — | 0.381 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 200 | 415 | — | 57 | 93 | 122 | — | 0 | -8 | -16 | — | 0.344 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 200 | 415 | — | 57 | 93 | 122 | — | 0 | -8 | -16 | — | 0.344 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 292 | 604 | — | 84 | 154 | 201 | — | 0 | -8 | -15 | — | 0.381 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 329 | 693 | — | 94 | 180 | 235 | — | 0 | -8 | -15 | — | 0.344 |
| 76 | 94 | 95 | 1 | 0.5 | 49 | 329 | 693 | — | 94 | 180 | 235 | — | 0 | -8 | -15 | — | 0.344 |
| 77 | 103 | 105 | 1 | 0.6 | 148 | 285 | 732 | 1 460 | 68 | 89 | 135 | 190 | -7 | -14 | -30 | -48 | 0.606 |
| 77 | 103 | 105 | 1 | 0.6 | 161 | 319 | 839 | 1 692 | 78 | 103 | 158 | 222 | -7 | -14 | -30 | -48 | 0.525 |
| 77 | 103 | 105 | 1 | 0.6 | 255 | 500 | 1 080 | 2 196 | 172 | 220 | 294 | 391 | -6 | -11 | -20 | -33 | 0.625 |
| 77 | 103 | 105 | 1 | 0.6 | 285 | 572 | 1 252 | 2 566 | 200 | 257 | 346 | 461 | -6 | -11 | -20 | -33 | 0.544 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 278 | 1 038 | 2 106 | 130 | 231 | 370 | 482 | 0 | -5 | -15 | -25 | 0.613 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 235 | 509 | — | 53 | 93 | 126 | — | 0 | -10 | -20 | — | 0.645 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 235 | 509 | — | 53 | 93 | 126 | — | 0 | -10 | -20 | — | 0.645 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 262 | 582 | — | 60 | 108 | 147 | — | 0 | -10 | -20 | — | 0.605 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 262 | 582 | — | 60 | 108 | 147 | — | 0 | -10 | -20 | — | 0.605 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 396 | 815 | — | 89 | 181 | 236 | — | 0 | -10 | -18 | — | 0.645 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 396 | 815 | — | 89 | 181 | 236 | — | 0 | -10 | -18 | — | 0.645 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 451 | 942 | — | 100 | 212 | 278 | — | 0 | -10 | -18 | — | 0.605 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 451 | 942 | — | 100 | 212 | 278 | — | 0 | -10 | -18 | — | 0.605 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 235 | 509 | — | 53 | 93 | 126 | — | 0 | -10 | -20 | — | 0.764 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 262 | 582 | — | 60 | 108 | 147 | — | 0 | -10 | -20 | — | 0.724 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 262 | 582 | — | 60 | 108 | 147 | — | 0 | -10 | -20 | — | 0.724 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 396 | 815 | — | 89 | 181 | 236 | — | 0 | -10 | -18 | — | 0.764 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 451 | 942 | — | 100 | 212 | 278 | — | 0 | -10 | -18 | — | 0.724 |
| 77 | 103 | 105 | 1 | 0.6 | 49 | 451 | 942 | — | 100 | 212 | 278 | — | 0 | -10 | -18 | — | 0.724 |
| 79 | 116 | 119 | 1.5 | 0.8 | 243 | 484 | 1 164 | 2 368 | 75 | 100 | 148 | 209 | -9 | -20 | -42 | -69 | 1.09 |
| 79 | 116 | 119 | 1.5 | 0.8 | 262 | 539 | 1 329 | 2 734 | 86 | 115 | 172 | 245 | -9 | -20 | -42 | -69 | 0.898 |
| 79 | 116 | 119 | 1.5 | 0.8 | 406 | 781 | 1 856 | 3 690 | 188 | 239 | 332 | 438 | -8 | -15 | -30 | -49 | 1.08 |
| 79 | 116 | 119 | 1.5 | 0.8 | 451 | 887 | 2 147 | 4 304 | 218 | 279 | 390 | 517 | -8 | -15 | -30 | -49 | 0.888 |
| 79 | 116 | 119 | 1.5 | 0.8 | 98 | 1 067 | 2 626 | 3 932 | 153 | 346 | 481 | 562 | 0 | -15 | -30 | -40 | 1.10 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

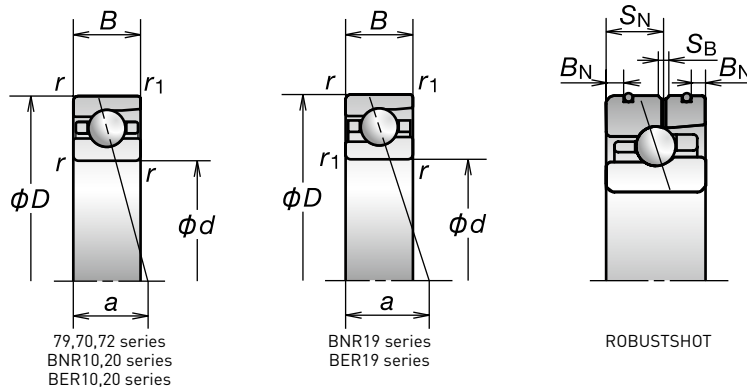
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 75 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7915C | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 30.0 | 29.3 | 18.0 | 15 | 16.6 | 20.1 | 12 800 | 19 500 |
| * 7915CSN24 | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | [30.0] | [29.3] | 21.3 | 15 | 16.6 | 20.1 | 16 700 | 25 400 |
| * 7915A5 | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 28.3 | 27.7 | 21.2 | 25 | — | 29.0 | 11 200 | 16 700 |
| * 7915A5SN24 | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | [28.3] | [27.7] | 25.1 | 25 | — | 29.0 | 14 500 | 21 700 |
| * 75BNR19S | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 21.6 | 19.0 | 27.5 | 18 | 10.9 | 22.6 | 15 600 | 22 300 |
| * 75BNR19E | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 21.6 | 19.0 | 27.5 | 18 | 10.9 | 22.6 | 16 700 | 23 800 |
| * 75BNR19H | 75 | 105 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [21.6] | [19.0] | 18.0 | 18 | 10.9 | 22.6 | 20 000 | 31 200 |
| * 75BNR19X | 75 | 105 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [21.6] | [19.0] | 18.0 | 18 | 10.9 | 22.6 | 23 400 | 36 700 |
| * 75BER19S | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 20.7 | 18.2 | 32.5 | 25 | — | 29.0 | 13 400 | 18 900 |
| * 75BER19E | 75 | 105 | 16 | — | — | — | — | 1 | 0.6 | 20.7 | 18.2 | 32.5 | 25 | — | 29.0 | 14 400 | 20 300 |
| * 75BER19H | 75 | 105 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [20.7] | [18.2] | 21.7 | 25 | — | 29.0 | 17 800 | 27 800 |
| * 75BER19X | 75 | 105 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | [20.7] | [18.2] | 21.7 | 25 | — | 29.0 | 21 200 | 33 400 |
| * 75BNR29EV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | 21.6 | 19.0 | 27.5 | 18 | 10.9 | 24.1 | 16 700 | — |
| * 75BNR29HV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | [21.6] | [19.0] | 18.0 | 18 | 10.9 | 24.1 | 20 000 | — |
| * 75BNR29XV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | [21.6] | [19.0] | 18.0 | 18 | 10.9 | 24.1 | 23 400 | — |
| * 75BER29EV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | 20.7 | 18.2 | 32.5 | 25 | — | 30.5 | 14 400 | — |
| * 75BER29HV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | [20.7] | [18.2] | 21.7 | 25 | — | 30.5 | 17 800 | — |
| * 75BER29XV1V | 75 | 105 | 19 | — | — | — | — | 1 | 0.6 | [20.7] | [18.2] | 21.7 | 25 | — | 30.5 | 21 200 | — |
| * 7015C | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 50.5 | 45.5 | 28.1 | 15 | 15.9 | 22.7 | 12 200 | 18 500 |
| * 7015CSN24 | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | [50.5] | [45.5] | 33.3 | 15 | 15.9 | 22.7 | 15 800 | 24 000 |
| * 7015A5 | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 47.5 | 43.5 | 33.5 | 25 | — | 32.1 | 10 600 | 15 800 |
| * 7015A5SN24 | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | [47.5] | [43.5] | 40.0 | 25 | — | 32.1 | 13 700 | 20 600 |
| * 7015A | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 46.0 | 41.5 | 25.9 | 30 | — | 37.4 | 7 900 | 10 600 |
| * 75BNR10S | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 22.6 | 20.7 | 30.0 | 18 | 11.0 | 25.3 | 14 800 | 21 100 |
| * 75BNR10E | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 22.6 | 20.7 | 30.0 | 18 | 11.0 | 25.3 | 15 800 | 22 600 |
| * 75BNR10H | 75 | 115 | 20 | — | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [22.6] | [20.7] | 19.7 | 18 | 11.0 | 25.3 | 19 000 | 29 500 |
| * 75BNR10X | 75 | 115 | 20 | 27 | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [22.6] | [20.7] | 19.7 | 18 | 11.0 | 25.3 | 22 200 | 34 800 |
| * 75BER10S | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 21.6 | 19.8 | 35.0 | 25 | — | 31.9 | 12 700 | 17 900 |
| * 75BER10E | 75 | 115 | 20 | — | — | — | — | 1.1 | 0.6 | 21.6 | 19.8 | 35.0 | 25 | — | 31.9 | 13 600 | 19 200 |
| * 75BER10H | 75 | 115 | 20 | — | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [21.6] | [19.8] | 23.7 | 25 | — | 31.9 | 16 900 | 26 400 |
| * 75BER10X | 75 | 115 | 20 | 27 | 4.0 | 11.6 | 1.4 | 1.1 | 0.6 | [21.6] | [19.8] | 23.7 | 25 | — | 31.9 | 20 000 | 31 600 |
| * 75BNR20EV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | 22.6 | 20.7 | 30.0 | 18 | 11.0 | 27.3 | 15 800 | — |
| * 75BNR20HV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | [22.6] | [20.7] | 19.7 | 18 | 11.0 | 27.3 | 19 000 | — |
| * 75BNR20XV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | [22.6] | [20.7] | 19.7 | 18 | 11.0 | 27.3 | 22 200 | — |
| * 75BER20EV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | 21.6 | 19.8 | 35.0 | 25 | — | 33.9 | 13 600 | — |
| * 75BER20HV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | [21.6] | [19.8] | 23.7 | 25 | — | 33.9 | 16 900 | — |
| * 75BER20XV1V | 75 | 115 | 24 | — | — | — | — | 1.1 | 0.6 | [21.6] | [19.8] | 23.7 | 25 | — | 33.9 | 20 000 | — |
| 7215C | 75 | 130 | 25 | — | — | — | — | 1.5 | 1 | 87.0 | 70.0 | 46.0 | 15 | 14.8 | 26.2 | 11 300 | 17 100 |
| 7215CSN24 | 75 | 130 | 25 | — | — | — | — | 1.5 | 1 | [87.0] | [70.0] | 54.9 | 15 | 14.8 | 26.2 | 14 700 | 22 300 |
| 7215A5 | 75 | 130 | 25 | — | — | — | — | 1.5 | 1 | 82.5 | 66.5 | 53.0 | 25 | — | 36.4 | 9 800 | 14 700 |
| 7215A5SN24 | 75 | 130 | 25 | — | — | — | — | 1.5 | 1 | [82.5] | [66.5] | 62.7 | 25 | — | 36.4 | 12 700 | 19 100 |
| 7215A | 75 | 130 | 25 | — | — | — | — | 1.5 | 1 | 80.0 | 64.5 | 40.5 | 30 | — | 42.1 | 7 400 | 9 800 |

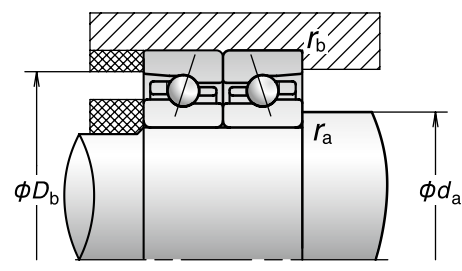
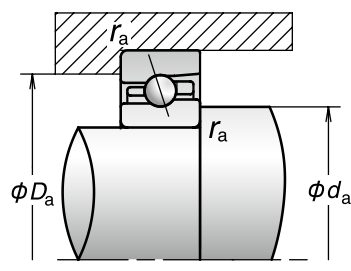
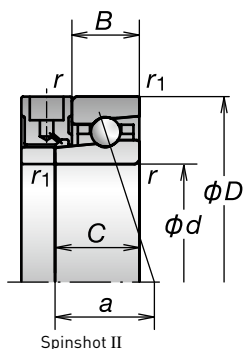
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------------------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | D _b (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 81 | 99 | 100 | 1 | 0.5 | 103 | 190 | 489 | 997 | 61 | 79 | 120 | 171 | -4 | -9 | -21 | -35 | 0.358 |
| 81 | 99 | 100 | 1 | 0.5 | 109 | 210 | 555 | 1 147 | 70 | 91 | 140 | 199 | -4 | -9 | -21 | -35 | 0.319 |
| 81 | 99 | 100 | 1 | 0.5 | 140 | 307 | 765 | 1 458 | 142 | 189 | 268 | 347 | -3 | -7 | -15 | -24 | 0.355 |
| 81 | 99 | 100 | 1 | 0.5 | 153 | 346 | 882 | 1 696 | 164 | 220 | 314 | 409 | -3 | -7 | -15 | -24 | 0.316 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 185 | 464 | — | 52 | 83 | 118 | — | 0 | -8 | -19 | — | 0.348 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 185 | 464 | — | 52 | 83 | 118 | — | 0 | -8 | -19 | — | 0.348 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 205 | 528 | — | 58 | 96 | 138 | — | 0 | -8 | -19 | — | 0.310 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 205 | 528 | — | 58 | 96 | 138 | — | 0 | -8 | -19 | — | 0.310 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 301 | 625 | — | 87 | 160 | 209 | — | 0 | -8 | -15 | — | 0.348 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 301 | 625 | — | 87 | 160 | 209 | — | 0 | -8 | -15 | — | 0.348 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 339 | 718 | — | 97 | 187 | 245 | — | 0 | -8 | -15 | — | 0.310 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 339 | 718 | — | 97 | 187 | 245 | — | 0 | -8 | -15 | — | 0.310 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 185 | 464 | — | 52 | 83 | 118 | — | 0 | -8 | -19 | — | 0.403 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 205 | 528 | — | 58 | 96 | 138 | — | 0 | -8 | -19 | — | 0.365 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 205 | 528 | — | 58 | 96 | 138 | — | 0 | -8 | -19 | — | 0.365 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 301 | 625 | — | 87 | 160 | 209 | — | 0 | -8 | -15 | — | 0.403 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 339 | 718 | — | 97 | 187 | 245 | — | 0 | -8 | -15 | — | 0.365 |
| 81 | 99 | 100 | 1 | 0.5 | 49 | 339 | 718 | — | 97 | 187 | 245 | — | 0 | -8 | -15 | — | 0.365 |
| 82 | 108 | 110 | 1 | 0.6 | 151 | 294 | 796 | 1 573 | 70 | 92 | 144 | 202 | -7 | -14 | -31 | -49 | 0.643 |
| 82 | 108 | 110 | 1 | 0.6 | 165 | 330 | 915 | 1 824 | 81 | 107 | 168 | 236 | -7 | -14 | -31 | -49 | 0.557 |
| 82 | 108 | 110 | 1 | 0.6 | 263 | 519 | 1 204 | 2 399 | 179 | 230 | 316 | 418 | -6 | -11 | -21 | -34 | 0.652 |
| 82 | 108 | 110 | 1 | 0.6 | 295 | 594 | 1 398 | 2 806 | 209 | 269 | 372 | 493 | -6 | -11 | -21 | -34 | 0.566 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 288 | 1 083 | 2 202 | 135 | 241 | 387 | 506 | 0 | -5 | -15 | -25 | 0.650 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 240 | 525 | — | 55 | 96 | 131 | — | 0 | -10 | -20 | — | 0.679 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 240 | 525 | — | 55 | 96 | 131 | — | 0 | -10 | -20 | — | 0.679 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 269 | 600 | — | 61 | 112 | 153 | — | 0 | -10 | -20 | — | 0.638 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 269 | 600 | — | 61 | 112 | 153 | — | 0 | -10 | -20 | — | 0.638 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 506 | 1 034 | — | 91 | 203 | 265 | — | 0 | -12 | -21 | — | 0.679 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 506 | 1 034 | — | 91 | 203 | 265 | — | 0 | -12 | -21 | — | 0.679 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 579 | 1 199 | — | 103 | 238 | 311 | — | 0 | -12 | -21 | — | 0.638 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 579 | 1 199 | — | 103 | 238 | 311 | — | 0 | -12 | -21 | — | 0.638 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 240 | 525 | — | 55 | 96 | 131 | — | 0 | -10 | -20 | — | 0.806 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 269 | 600 | — | 61 | 112 | 153 | — | 0 | -10 | -20 | — | 0.764 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 269 | 600 | — | 61 | 112 | 153 | — | 0 | -10 | -20 | — | 0.764 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 506 | 1 034 | — | 91 | 203 | 265 | — | 0 | -12 | -21 | — | 0.806 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 579 | 1 199 | — | 103 | 238 | 311 | — | 0 | -12 | -21 | — | 0.764 |
| 82 | 108 | 110 | 1 | 0.6 | 49 | 579 | 1 199 | — | 103 | 238 | 311 | — | 0 | -12 | -21 | — | 0.764 |
| 84 | 121 | 124 | 1.5 | 0.8 | 270 | 530 | 1 224 | 2 445 | 81 | 108 | 157 | 220 | -10 | -21 | -42 | -68 | 1.19 |
| 84 | 121 | 124 | 1.5 | 0.8 | 293 | 593 | 1 398 | 2 825 | 93 | 124 | 182 | 257 | -10 | -21 | -42 | -68 | 0.983 |
| 84 | 121 | 124 | 1.5 | 0.8 | 422 | 819 | 1 961 | 3 911 | 199 | 253 | 353 | 467 | -8 | -15 | -30 | -49 | 1.18 |
| 84 | 121 | 124 | 1.5 | 0.8 | 469 | 932 | 2 270 | 4 565 | 231 | 296 | 415 | 550 | -8 | -15 | -30 | -49 | 0.973 |
| 84 | 121 | 124 | 1.5 | 0.8 | 98 | 1 123 | 2 780 | 4 170 | 159 | 367 | 512 | 598 | 0 | -15 | -30 | -40 | 1.20 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

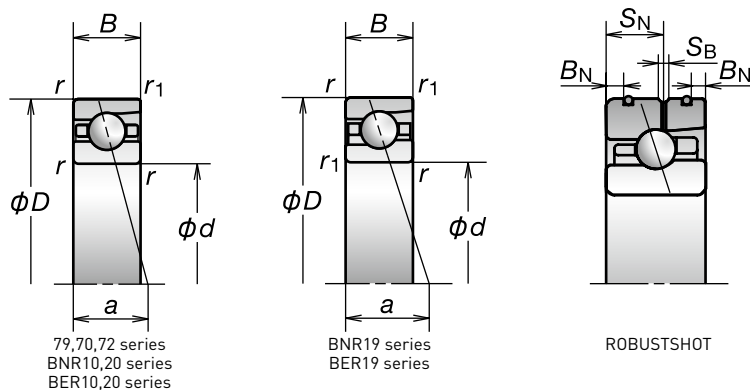
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 80 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|--------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7916C | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 30.5 | 30.5 | 18.7 | 15 | 16.7 | 20.7 | 12 200 | 18 500 |
| * 7916CSN24 | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | (30.5) | (30.5) | 22.2 | 15 | 16.7 | 20.7 | 15 800 | 24 000 |
| * 7916A5 | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 28.7 | 29.0 | 22.1 | 25 | — | 30.2 | 10 600 | 15 800 |
| * 7916A5SN24 | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | (28.7) | (29.0) | 26.2 | 25 | — | 30.2 | 13 700 | 20 600 |
| * 80BNR19S | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 22.0 | 19.9 | 28.9 | 18 | 11.0 | 23.4 | 14 800 | 21 100 |
| * 80BNR19E | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 22.0 | 19.9 | 28.9 | 18 | 11.0 | 23.4 | 15 800 | 22 600 |
| * 80BNR19H | 80 | 110 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | (22.0) | (19.9) | 18.9 | 18 | 11.0 | 23.4 | 19 000 | 29 500 |
| * 80BNR19X | 80 | 110 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | (22.0) | (19.9) | 18.9 | 18 | 11.0 | 23.4 | 22 200 | 34 800 |
| * 80BER19S | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 21.0 | 19.1 | 34.0 | 25 | — | 30.2 | 12 700 | 17 900 |
| * 80BER19E | 80 | 110 | 16 | — | — | — | — | 1 | 0.6 | 21.0 | 19.1 | 34.0 | 25 | — | 30.2 | 13 600 | 19 200 |
| * 80BER19H | 80 | 110 | 16 | — | 3.1 | 9.3 | 1.4 | 1 | 0.6 | (21.0) | (19.1) | 22.8 | 25 | — | 30.2 | 16 900 | 26 400 |
| * 80BER19X | 80 | 110 | 16 | 21 | 3.1 | 9.3 | 1.4 | 1 | 0.6 | (21.0) | (19.1) | 22.8 | 25 | — | 30.2 | 20 000 | 31 600 |
| * 80BNR29EV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | 22.0 | 19.9 | 28.9 | 18 | 11.0 | 24.9 | 15 800 | — |
| * 80BNR29HV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | (22.0) | (19.9) | 18.9 | 18 | 11.0 | 24.9 | 19 000 | — |
| * 80BNR29XV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | (22.0) | (19.9) | 18.9 | 18 | 11.0 | 24.9 | 22 200 | — |
| * 80BER29EV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | 21.0 | 19.1 | 34.0 | 25 | — | 31.7 | 13 600 | — |
| * 80BER29HV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | (21.0) | (19.1) | 22.8 | 25 | — | 31.7 | 16 900 | — |
| * 80BER29XV1V | 80 | 110 | 19 | — | — | — | — | 1 | 0.6 | (21.0) | (19.1) | 22.8 | 25 | — | 31.7 | 20 000 | — |
| * 7016C | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 61.5 | 55.5 | 34.5 | 15 | 15.7 | 24.7 | 11 300 | 17 100 |
| * 7016CSN24 | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | (61.5) | (55.5) | 40.9 | 15 | 15.7 | 24.7 | 14 700 | 22 300 |
| * 7016A5 | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 58.5 | 52.5 | 41.0 | 25 | — | 34.9 | 9 800 | 14 700 |
| * 7016A5SN24 | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | (58.5) | (52.5) | 48.3 | 25 | — | 34.9 | 12 700 | 19 100 |
| * 7016A | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 56.0 | 50.5 | 31.5 | 30 | — | 40.6 | 7 400 | 9 800 |
| * 80BNR10S | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 26.5 | 24.5 | 35.5 | 18 | 10.9 | 27.5 | 13 700 | 19 600 |
| * 80BNR10E | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 26.5 | 24.5 | 35.5 | 18 | 10.9 | 27.5 | 14 700 | 20 900 |
| * 80BNR10H | 80 | 125 | 22 | — | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | (26.5) | (24.5) | 23.4 | 18 | 10.9 | 27.5 | 17 600 | 27 400 |
| * 80BNR10X | 80 | 125 | 22 | 27 | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | (26.5) | (24.5) | 23.4 | 18 | 10.9 | 27.5 | 20 500 | 32 200 |
| * 80BER10S | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 25.3 | 23.5 | 42.0 | 25 | — | 34.6 | 11 800 | 16 600 |
| * 80BER10E | 80 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 25.3 | 23.5 | 42.0 | 25 | — | 34.6 | 12 600 | 17 800 |
| * 80BER10H | 80 | 125 | 22 | — | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | (25.3) | (23.5) | 28.2 | 25 | — | 34.6 | 15 700 | 24 400 |
| * 80BER10X | 80 | 125 | 22 | 27 | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | (25.3) | (23.5) | 28.2 | 25 | — | 34.6 | 18 600 | 29 300 |
| * 80BNR20EV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | 26.5 | 24.5 | 35.5 | 18 | 10.9 | 30.0 | 14 700 | — |
| * 80BNR20HV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | (26.5) | (24.5) | 23.4 | 18 | 10.9 | 30.0 | 17 600 | — |
| * 80BNR20XV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | (26.5) | (24.5) | 23.4 | 18 | 10.9 | 30.0 | 20 500 | — |
| * 80BER20EV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | 25.3 | 23.5 | 42.0 | 25 | — | 37.1 | 12 600 | — |
| * 80BER20HV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | (25.3) | (23.5) | 28.2 | 25 | — | 37.1 | 15 700 | — |
| * 80BER20XV1V | 80 | 125 | 27 | — | — | — | — | 1.1 | 0.6 | (25.3) | (23.5) | 28.2 | 25 | — | 37.1 | 18 600 | — |
| 7216C | 80 | 140 | 26 | — | — | — | — | 2 | 1 | 97.5 | 77.5 | 54.5 | 15 | 14.7 | 27.7 | 10 500 | 16 000 |
| 7216CSN24 | 80 | 140 | 26 | — | — | — | — | 2 | 1 | (97.5) | (77.5) | 64.5 | 15 | 14.7 | 27.7 | 13 700 | 20 800 |
| 7216A5 | 80 | 140 | 26 | — | — | — | — | 2 | 1 | 93.0 | 74.0 | 62.0 | 25 | — | 38.6 | 9 100 | 13 700 |
| 7216A5SN24 | 80 | 140 | 26 | — | — | — | — | 2 | 1 | (93.0) | (74.0) | 73.5 | 25 | — | 38.6 | 11 900 | 17 800 |
| 7216A | 80 | 140 | 26 | — | — | — | — | 2 | 1 | 89.5 | 71.5 | 47.5 | 30 | — | 44.8 | 6 900 | 9 100 |

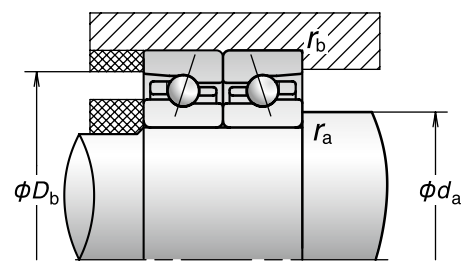
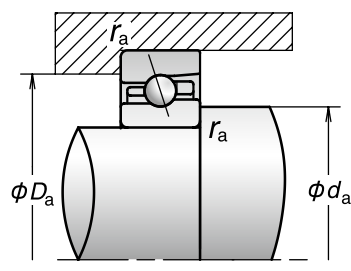
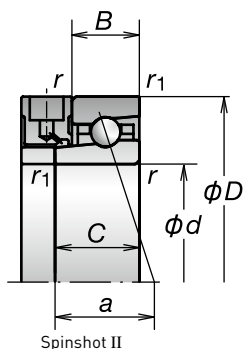
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------------------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | D _b (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 86 | 104 | 105 | 1 | 0.5 | 104 | 195 | 503 | 986 | 63 | 81 | 125 | 173 | -4 | -9 | -21 | -34 | 0.377 |
| 86 | 104 | 105 | 1 | 0.5 | 111 | 215 | 573 | 1 136 | 72 | 94 | 145 | 202 | -4 | -9 | -21 | -34 | 0.337 |
| 86 | 104 | 105 | 1 | 0.5 | 182 | 366 | 792 | 1 603 | 160 | 207 | 278 | 370 | -4 | -8 | -15 | -25 | 0.381 |
| 86 | 104 | 105 | 1 | 0.5 | 201 | 415 | 913 | 1 867 | 186 | 242 | 326 | 436 | -4 | -8 | -15 | -25 | 0.341 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 190 | 478 | — | 53 | 86 | 123 | — | 0 | -8 | -19 | — | 0.366 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 190 | 478 | — | 53 | 86 | 123 | — | 0 | -8 | -19 | — | 0.366 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 210 | 545 | — | 60 | 99 | 143 | — | 0 | -8 | -19 | — | 0.326 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 210 | 545 | — | 60 | 99 | 143 | — | 0 | -8 | -19 | — | 0.326 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 309 | 646 | — | 89 | 166 | 217 | — | 0 | -8 | -15 | — | 0.366 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 309 | 646 | — | 89 | 166 | 217 | — | 0 | -8 | -15 | — | 0.366 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 349 | 743 | — | 100 | 194 | 254 | — | 0 | -8 | -15 | — | 0.326 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 349 | 743 | — | 100 | 194 | 254 | — | 0 | -8 | -15 | — | 0.326 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 190 | 478 | — | 53 | 86 | 123 | — | 0 | -8 | -19 | — | 0.425 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 210 | 545 | — | 60 | 99 | 143 | — | 0 | -8 | -19 | — | 0.385 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 210 | 545 | — | 60 | 99 | 143 | — | 0 | -8 | -19 | — | 0.385 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 309 | 646 | — | 89 | 166 | 217 | — | 0 | -8 | -15 | — | 0.425 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 349 | 743 | — | 100 | 194 | 254 | — | 0 | -8 | -15 | — | 0.385 |
| 86 | 104 | 105 | 1 | 0.5 | 49 | 349 | 743 | — | 100 | 194 | 254 | — | 0 | -8 | -15 | — | 0.385 |
| 87 | 118 | 120 | 1 | 0.6 | 202 | 382 | 921 | 1 880 | 78 | 102 | 151 | 215 | -6 | -14 | -31 | -52 | 0.855 |
| 87 | 118 | 120 | 1 | 0.6 | 215 | 422 | 1 045 | 2 162 | 89 | 118 | 176 | 251 | -6 | -14 | -31 | -52 | 0.736 |
| 87 | 118 | 120 | 1 | 0.6 | 345 | 624 | 1 513 | 2 903 | 198 | 246 | 345 | 448 | -6 | -11 | -23 | -37 | 0.880 |
| 87 | 118 | 120 | 1 | 0.6 | 381 | 704 | 1 744 | 3 377 | 229 | 286 | 404 | 528 | -6 | -11 | -23 | -37 | 0.761 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 752 | 1 762 | 3 060 | 170 | 340 | 464 | 573 | 0 | -10 | -20 | -30 | 0.864 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 327 | 611 | — | 72 | 111 | 141 | — | 0 | -10 | -19 | — | 0.921 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 327 | 611 | — | 72 | 111 | 141 | — | 0 | -10 | -19 | — | 0.921 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 359 | 688 | — | 80 | 127 | 164 | — | 0 | -10 | -19 | — | 0.867 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 359 | 688 | — | 80 | 127 | 164 | — | 0 | -10 | -19 | — | 0.867 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 623 | 1 272 | — | 118 | 225 | 292 | — | 0 | -12 | -22 | — | 0.921 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 623 | 1 272 | — | 118 | 225 | 292 | — | 0 | -12 | -22 | — | 0.921 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 704 | 1 461 | — | 133 | 262 | 343 | — | 0 | -12 | -22 | — | 0.867 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 704 | 1 461 | — | 133 | 262 | 343 | — | 0 | -12 | -22 | — | 0.867 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 327 | 611 | — | 72 | 111 | 141 | — | 0 | -10 | -19 | — | 1.12 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 359 | 688 | — | 80 | 127 | 164 | — | 0 | -10 | -19 | — | 1.06 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 359 | 688 | — | 80 | 127 | 164 | — | 0 | -10 | -19 | — | 1.06 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 623 | 1 272 | — | 118 | 225 | 292 | — | 0 | -12 | -22 | — | 1.12 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 704 | 1 461 | — | 133 | 262 | 343 | — | 0 | -12 | -22 | — | 1.06 |
| 87 | 118 | 120 | 1 | 0.6 | 98 | 704 | 1 461 | — | 133 | 262 | 343 | — | 0 | -12 | -22 | — | 1.06 |
| 90 | 130 | 134 | 2 | 1 | 305 | 595 | 1 367 | 2 752 | 83 | 110 | 159 | 224 | -12 | -24 | -47 | -76 | 1.43 |
| 90 | 130 | 134 | 2 | 1 | 333 | 667 | 1 566 | 3 185 | 96 | 127 | 186 | 262 | -12 | -24 | -47 | -76 | 1.18 |
| 90 | 130 | 134 | 2 | 1 | 463 | 925 | 2 161 | 4 345 | 201 | 259 | 357 | 473 | -9 | -17 | -33 | -54 | 1.42 |
| 90 | 130 | 134 | 2 | 1 | 517 | 1 056 | 2 507 | 5 078 | 234 | 303 | 420 | 558 | -9 | -17 | -33 | -54 | 1.17 |
| 90 | 130 | 134 | 2 | 1 | 98 | 1 095 | 2 696 | 4 035 | 156 | 356 | 494 | 576 | 0 | -15 | -30 | -40 | 1.45 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

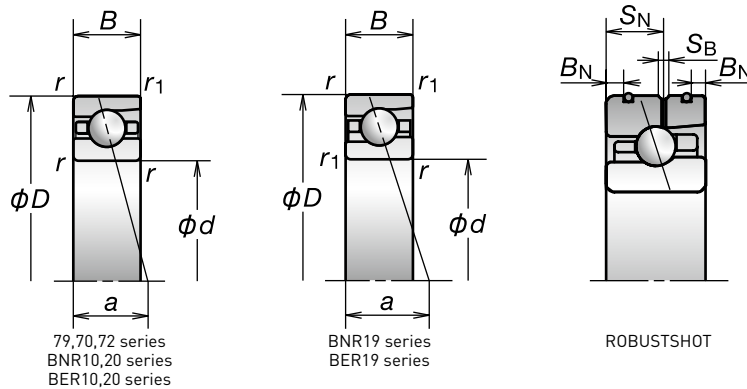
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 85 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7917C | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 41.0 | 40.5 | 25.9 | 15 | 16.5 | 22.7 | 11 300 | 17 100 |
| * 7917CSN24 | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | [41.0] | [40.5] | 30.7 | 15 | 16.5 | 22.7 | 14 700 | 22 300 |
| * 7917A5 | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 38.5 | 38.5 | 30.0 | 25 | — | 32.9 | 9 800 | 14 700 |
| * 7917A5SN24 | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | [38.5] | [38.5] | 35.6 | 25 | — | 32.9 | 12 700 | 19 100 |
| * 85BNR19S | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 29.4 | 26.3 | 38.0 | 18 | 10.8 | 25.7 | 13 700 | 19 600 |
| * 85BNR19E | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 29.4 | 26.3 | 38.0 | 18 | 10.8 | 25.7 | 14 700 | 20 900 |
| * 85BNR19H | 85 | 120 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [29.4] | [26.3] | 24.8 | 18 | 10.8 | 25.7 | 17 600 | 27 400 |
| * 85BNR19X | 85 | 120 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [29.4] | [26.3] | 24.8 | 18 | 10.8 | 25.7 | 20 500 | 32 200 |
| * 85BER19S | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 28.1 | 25.2 | 35.5 | 25 | — | 32.9 | 11 800 | 16 600 |
| * 85BER19E | 85 | 120 | 18 | — | — | — | — | 1.1 | 0.6 | 28.1 | 25.2 | 35.5 | 25 | — | 32.9 | 12 600 | 17 800 |
| * 85BER19H | 85 | 120 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [28.1] | [25.2] | 30.0 | 25 | — | 32.9 | 15 700 | 24 400 |
| * 85BER19X | 85 | 120 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [28.1] | [25.2] | 30.0 | 25 | — | 32.9 | 18 600 | 29 300 |
| * 85BNR29EV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | 29.4 | 26.3 | 38.0 | 18 | 10.8 | 27.7 | 14 700 | — |
| * 85BNR29HV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | [29.4] | [26.3] | 24.8 | 18 | 10.8 | 27.7 | 17 600 | — |
| * 85BNR29XV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | [29.4] | [26.3] | 24.8 | 18 | 10.8 | 27.7 | 20 500 | — |
| * 85BER29EV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | 28.1 | 25.2 | 35.5 | 25 | — | 34.9 | 12 600 | — |
| * 85BER29HV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | [28.1] | [25.2] | 30.0 | 25 | — | 34.9 | 15 700 | — |
| * 85BER29XV1V | 85 | 120 | 22 | — | — | — | — | 1.1 | 0.6 | [28.1] | [25.2] | 30.0 | 25 | — | 34.9 | 18 600 | — |
| * 7017C | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 63.0 | 58.5 | 38.0 | 15 | 15.9 | 25.4 | 10 700 | 16 300 |
| * 7017CSN24 | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | [63.0] | [58.5] | 45.0 | 15 | 15.9 | 25.4 | 14 000 | 21 300 |
| * 7017A5 | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 60.0 | 55.5 | 43.0 | 25 | — | 36.1 | 9 400 | 14 000 |
| * 7017A5SN24 | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | [60.0] | [55.5] | 50.9 | 25 | — | 36.1 | 12 100 | 18 200 |
| * 7017A | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 57.5 | 53.5 | 33.0 | 30 | — | 42.0 | 7 000 | 9 400 |
| * 85BNR10S | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 26.8 | 25.7 | 37.5 | 18 | 11.0 | 28.5 | 13 100 | 18 700 |
| * 85BNR10E | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 26.8 | 25.7 | 37.5 | 18 | 11.0 | 28.5 | 14 000 | 20 000 |
| * 85BNR10H | 85 | 130 | 22 | — | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | [26.8] | [25.7] | 24.5 | 18 | 11.0 | 28.5 | 16 800 | 26 100 |
| * 85BNR10X | 85 | 130 | 22 | 27 | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | [26.8] | [25.7] | 24.5 | 18 | 11.0 | 28.5 | 19 600 | 30 700 |
| * 85BER10S | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 25.6 | 24.6 | 43.5 | 25 | — | 36.1 | 11 200 | 15 900 |
| * 85BER10E | 85 | 130 | 22 | — | — | — | — | 1.1 | 0.6 | 25.6 | 24.6 | 43.5 | 25 | — | 36.1 | 12 000 | 17 000 |
| * 85BER10H | 85 | 130 | 22 | — | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | [25.6] | [24.6] | 29.5 | 25 | — | 36.1 | 14 900 | 23 300 |
| * 85BER10X | 85 | 130 | 22 | 27 | 4.7 | 12.2 | 2.2 | 1.1 | 0.6 | [25.6] | [24.6] | 29.5 | 25 | — | 36.1 | 17 700 | 28 000 |
| * 85BNR20EV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | 26.8 | 25.7 | 37.5 | 18 | 11.0 | 31.0 | 14 000 | — |
| * 85BNR20HV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | [26.8] | [25.7] | 24.5 | 18 | 11.0 | 31.0 | 16 800 | — |
| * 85BNR20XV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | [26.8] | [25.7] | 24.5 | 18 | 11.0 | 31.0 | 19 600 | — |
| * 85BER20EV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | 25.6 | 24.6 | 43.5 | 25 | — | 38.6 | 12 000 | — |
| * 85BER20HV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | [25.6] | [24.6] | 29.5 | 25 | — | 38.6 | 14 900 | — |
| * 85BER20XV1V | 85 | 130 | 27 | — | — | — | — | 1.1 | 0.6 | [25.6] | [24.6] | 29.5 | 25 | — | 38.6 | 17 700 | — |
| 7217C | 85 | 150 | 28 | — | — | — | — | 2 | 1 | 113 | 90.5 | 60.5 | 15 | 14.7 | 29.7 | 9 800 | 14 900 |
| 7217CSN24 | 85 | 150 | 28 | — | — | — | — | 2 | 1 | [113] | [90.5] | 71.9 | 15 | 14.7 | 29.7 | 12 800 | 19 500 |
| 7217A5 | 85 | 150 | 28 | — | — | — | — | 2 | 1 | 107 | 86.5 | 70.0 | 25 | — | 41.4 | 8 600 | 12 800 |
| 7217A5SN24 | 85 | 150 | 28 | — | — | — | — | 2 | 1 | [107] | [86.5] | 83.1 | 25 | — | 41.4 | 11 100 | 16 600 |
| 7217A | 85 | 150 | 28 | — | — | — | — | 2 | 1 | 104 | 83.5 | 53.5 | 30 | — | 47.9 | 6 400 | 8 600 |

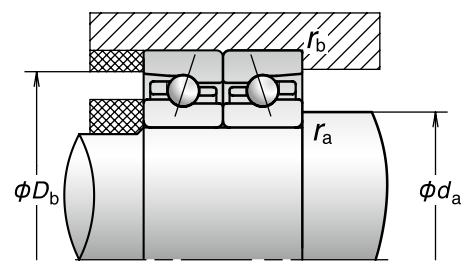
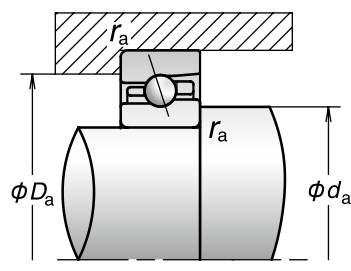
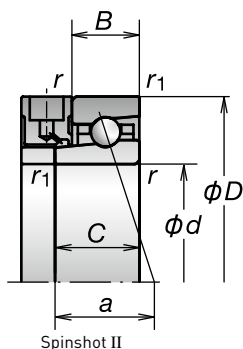
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 92 | 113 | 115 | 1 | 0.6 | 138 | 307 | 629 | 1 281 | 71 | 98 | 135 | 191 | -6 | -14 | -25 | -41 | 0.534 |
| 92 | 113 | 115 | 1 | 0.6 | 150 | 345 | 719 | 1 481 | 81 | 114 | 158 | 224 | -6 | -14 | -25 | -41 | 0.470 |
| 92 | 113 | 115 | 1 | 0.6 | 227 | 427 | 950 | 1 909 | 176 | 222 | 300 | 396 | -5 | -9 | -17 | -28 | 0.541 |
| 92 | 113 | 115 | 1 | 0.6 | 253 | 486 | 1 099 | 2 228 | 205 | 259 | 352 | 467 | -5 | -9 | -17 | -28 | 0.477 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 193 | 652 | — | 55 | 88 | 140 | — | 0 | -8 | -24 | — | 0.527 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 193 | 652 | — | 55 | 88 | 140 | — | 0 | -8 | -24 | — | 0.527 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 214 | 749 | — | 61 | 102 | 164 | — | 0 | -8 | -24 | — | 0.456 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 214 | 749 | — | 61 | 102 | 164 | — | 0 | -8 | -24 | — | 0.456 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 317 | 898 | — | 91 | 171 | 248 | — | 0 | -8 | -19 | — | 0.527 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 317 | 898 | — | 91 | 171 | 248 | — | 0 | -8 | -19 | — | 0.527 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 358 | 1 039 | — | 102 | 199 | 292 | — | 0 | -8 | -19 | — | 0.456 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 358 | 1 039 | — | 102 | 199 | 292 | — | 0 | -8 | -19 | — | 0.456 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 193 | 652 | — | 55 | 88 | 140 | — | 0 | -8 | -24 | — | 0.617 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 214 | 749 | — | 61 | 102 | 164 | — | 0 | -8 | -24 | — | 0.554 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 214 | 749 | — | 61 | 102 | 164 | — | 0 | -8 | -24 | — | 0.554 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 317 | 898 | — | 91 | 171 | 248 | — | 0 | -8 | -19 | — | 0.617 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 358 | 1 039 | — | 102 | 199 | 292 | — | 0 | -8 | -19 | — | 0.554 |
| 92 | 113 | 115 | 1 | 0.6 | 49 | 358 | 1 039 | — | 102 | 199 | 292 | — | 0 | -8 | -19 | — | 0.554 |
| 92 | 123 | 125 | 1 | 0.6 | 205 | 393 | 995 | 1 956 | 81 | 106 | 161 | 224 | -6 | -14 | -32 | -52 | 0.898 |
| 92 | 123 | 125 | 1 | 0.6 | 219 | 434 | 1 130 | 2 252 | 93 | 122 | 187 | 262 | -6 | -14 | -32 | -52 | 0.773 |
| 92 | 123 | 125 | 1 | 0.6 | 305 | 646 | 1 487 | 2 915 | 196 | 257 | 353 | 462 | -5 | -11 | -22 | -36 | 0.904 |
| 92 | 123 | 125 | 1 | 0.6 | 334 | 729 | 1 713 | 3 390 | 226 | 299 | 413 | 544 | -5 | -11 | -22 | -36 | 0.779 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 780 | 1 837 | 3 196 | 176 | 355 | 486 | 600 | 0 | -10 | -20 | -30 | 0.907 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 334 | 627 | — | 73 | 114 | 146 | — | 0 | -10 | -19 | — | 0.962 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 334 | 627 | — | 73 | 114 | 146 | — | 0 | -10 | -19 | — | 0.962 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 367 | 707 | — | 82 | 132 | 170 | — | 0 | -10 | -19 | — | 0.906 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 367 | 707 | — | 82 | 132 | 170 | — | 0 | -10 | -19 | — | 0.906 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 640 | 1 311 | — | 122 | 232 | 303 | — | 0 | -12 | -22 | — | 0.962 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 640 | 1 311 | — | 122 | 232 | 303 | — | 0 | -12 | -22 | — | 0.962 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 723 | 1 508 | — | 136 | 271 | 355 | — | 0 | -12 | -22 | — | 0.906 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 723 | 1 508 | — | 136 | 271 | 355 | — | 0 | -12 | -22 | — | 0.906 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 334 | 627 | — | 73 | 114 | 146 | — | 0 | -10 | -19 | — | 1.16 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 367 | 707 | — | 82 | 132 | 170 | — | 0 | -10 | -19 | — | 1.11 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 367 | 707 | — | 82 | 132 | 170 | — | 0 | -10 | -19 | — | 1.11 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 640 | 1 311 | — | 122 | 232 | 303 | — | 0 | -12 | -22 | — | 1.16 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 723 | 1 508 | — | 136 | 271 | 355 | — | 0 | -12 | -22 | — | 1.11 |
| 92 | 123 | 125 | 1 | 0.6 | 98 | 723 | 1 508 | — | 136 | 271 | 355 | — | 0 | -12 | -22 | — | 1.11 |
| 95 | 140 | 144 | 2 | 1 | 355 | 697 | 1 658 | 3 358 | 90 | 119 | 176 | 250 | -14 | -27 | -53 | -85 | 1.79 |
| 95 | 140 | 144 | 2 | 1 | 391 | 786 | 1 907 | 3 898 | 104 | 139 | 206 | 290 | -14 | -27 | -53 | -85 | 1.47 |
| 95 | 140 | 144 | 2 | 1 | 530 | 1 095 | 2 431 | 4 882 | 217 | 283 | 383 | 507 | -10 | -19 | -35 | -57 | 1.79 |
| 95 | 140 | 144 | 2 | 1 | 595 | 1 255 | 2 823 | 5 711 | 253 | 331 | 450 | 598 | -10 | -19 | -35 | -57 | 1.47 |
| 95 | 140 | 144 | 2 | 1 | 98 | 1 135 | 3 473 | 5 794 | 161 | 370 | 558 | 679 | 0 | -15 | -35 | -50 | 1.80 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

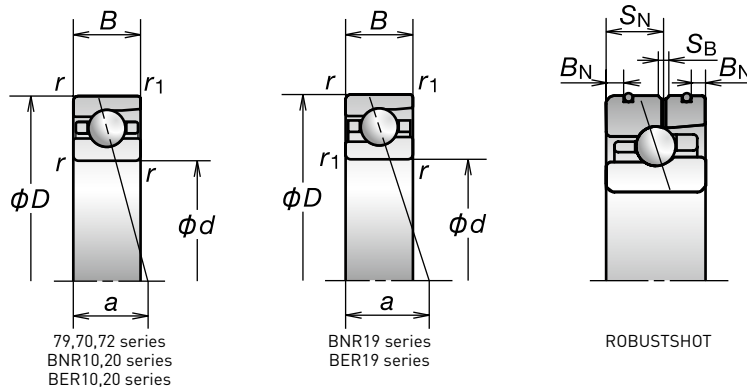
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 90 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7918C | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 44.0 | 46.0 | 29.1 | 15 | 16.6 | 23.4 | 10 700 | 16 300 |
| * 7918CSN24 | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | [44.0] | [46.0] | 34.6 | 15 | 16.6 | 23.4 | 14 000 | 21 300 |
| * 7918A5 | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 41.0 | 43.5 | 33.5 | 25 | — | 34.1 | 9 400 | 14 000 |
| * 7918A5SN24 | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | [41.0] | [43.5] | 40.0 | 25 | — | 34.1 | 12 100 | 18 200 |
| * 90BNR19S | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 31.5 | 29.7 | 43.0 | 18 | 10.9 | 26.5 | 13 100 | 18 700 |
| * 90BNR19E | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 31.5 | 29.7 | 43.0 | 18 | 10.9 | 26.5 | 14 000 | 20 000 |
| * 90BNR19H | 90 | 125 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [31.5] | [29.7] | 28.1 | 18 | 10.9 | 26.5 | 16 800 | 26 100 |
| * 90BNR19X | 90 | 125 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [31.5] | [29.7] | 28.1 | 18 | 10.9 | 26.5 | 19 600 | 30 700 |
| * 90BER19S | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 30.0 | 28.5 | 50.5 | 25 | — | 34.1 | 11 200 | 15 900 |
| * 90BER19E | 90 | 125 | 18 | — | — | — | — | 1.1 | 0.6 | 30.0 | 28.5 | 50.5 | 25 | — | 34.1 | 12 000 | 17 000 |
| * 90BER19H | 90 | 125 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [30.0] | [28.5] | 34.0 | 25 | — | 34.1 | 14 900 | 23 300 |
| * 90BER19X | 90 | 125 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [30.0] | [28.5] | 34.0 | 25 | — | 34.1 | 17 700 | 28 000 |
| * 90BNR29EV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 31.5 | 29.7 | 43.0 | 18 | 10.9 | 28.5 | 14 000 | — |
| * 90BNR29HV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | [31.5] | [29.7] | 28.1 | 18 | 10.9 | 28.5 | 16 800 | — |
| * 90BNR29XV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | [31.5] | [29.7] | 28.1 | 18 | 10.9 | 28.5 | 19 600 | — |
| * 90BER29EV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | 30.0 | 28.5 | 50.5 | 25 | — | 36.1 | 12 000 | — |
| * 90BER29HV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | [30.0] | [28.5] | 34.0 | 25 | — | 36.1 | 14 900 | — |
| * 90BER29XV1V | 90 | 125 | 22 | — | — | — | — | 1.1 | 0.6 | [30.0] | [28.5] | 34.0 | 25 | — | 36.1 | 17 700 | — |
| * 7018C | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 75.5 | 69.0 | 44.5 | 15 | 15.7 | 27.4 | 10 000 | 15 300 |
| * 7018CSN24 | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | [75.5] | [69.0] | 53.2 | 15 | 15.7 | 27.4 | 13 100 | 19 900 |
| * 7018A5 | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 71.0 | 65.5 | 52.0 | 25 | — | 38.8 | 8 700 | 13 100 |
| * 7018A5SN24 | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | [71.0] | [65.5] | 62.1 | 25 | — | 38.8 | 11 400 | 17 000 |
| * 7018A | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 68.5 | 63.5 | 40.5 | 30 | — | 45.2 | 6 600 | 8 700 |
| * 90BNR10S | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 35.0 | 33.0 | 48.0 | 18 | 10.9 | 30.7 | 12 200 | 17 400 |
| * 90BNR10E | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 35.0 | 33.0 | 48.0 | 18 | 10.9 | 30.7 | 13 100 | 18 700 |
| * 90BNR10H | 90 | 140 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [35.0] | [33.0] | 31.5 | 18 | 10.9 | 30.7 | 15 700 | 24 400 |
| * 90BNR10X | 90 | 140 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [35.0] | [33.0] | 31.5 | 18 | 10.9 | 30.7 | 18 300 | 28 700 |
| * 90BER10S | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 33.5 | 31.5 | 56.0 | 25 | — | 38.8 | 10 500 | 14 800 |
| * 90BER10E | 90 | 140 | 24 | — | — | — | — | 1.5 | 1 | 33.5 | 31.5 | 56.0 | 25 | — | 38.8 | 11 300 | 15 900 |
| * 90BER10H | 90 | 140 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [33.5] | [31.5] | 38.0 | 25 | — | 38.8 | 14 000 | 21 800 |
| * 90BER10X | 90 | 140 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [33.5] | [31.5] | 38.0 | 25 | — | 38.8 | 16 600 | 26 100 |
| * 90BNR20EV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | 35.0 | 33.0 | 48.0 | 18 | 10.9 | 33.7 | 13 100 | — |
| * 90BNR20HV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | [35.0] | [33.0] | 31.5 | 18 | 10.9 | 33.7 | 15 700 | — |
| * 90BNR20XV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | [35.0] | [33.0] | 31.5 | 18 | 10.9 | 33.7 | 18 300 | — |
| * 90BER20EV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | 33.5 | 31.5 | 56.0 | 25 | — | 41.8 | 11 300 | — |
| * 90BER20HV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | [33.5] | [31.5] | 38.0 | 25 | — | 41.8 | 14 000 | — |
| * 90BER20XV1V | 90 | 140 | 30 | — | — | — | — | 1.5 | 1 | [33.5] | [31.5] | 38.0 | 25 | — | 41.8 | 16 600 | — |
| 7218C | 90 | 160 | 30 | — | — | — | — | 2 | 1 | 129 | 105 | 72.0 | 15 | 14.6 | 31.7 | 9 200 | 14 000 |
| 7218CSN24 | 90 | 160 | 30 | — | — | — | — | 2 | 1 | [129] | [105] | 85.5 | 15 | 14.6 | 31.7 | 12 000 | 18 300 |
| 7218A5 | 90 | 160 | 30 | — | — | — | — | 2 | 1 | 123 | 100 | 83.5 | 25 | — | 44.1 | 8 000 | 12 000 |
| 7218A5SN24 | 90 | 160 | 30 | — | — | — | — | 2 | 1 | [123] | [100] | 99.2 | 25 | — | 44.1 | 10 400 | 15 600 |
| 7218A | 90 | 160 | 30 | — | — | — | — | 2 | 1 | 118 | 96.5 | 64.5 | 30 | — | 51.1 | 6 000 | 8 000 |

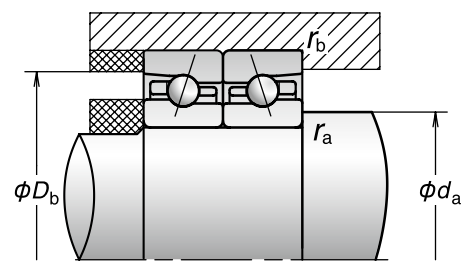
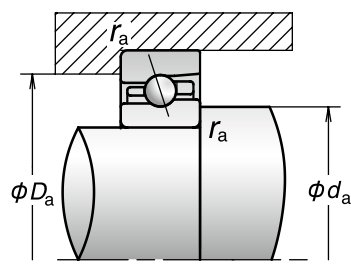
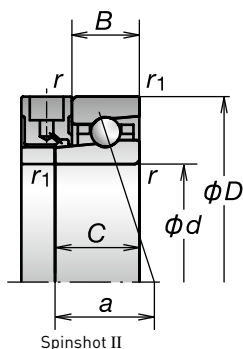
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(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 97 | 118 | 120 | 1 | 0.6 | 153 | 289 | 740 | 1 488 | 79 | 102 | 156 | 219 | -3 | -9 | -23 | -39 | 0.568 |
| 97 | 118 | 120 | 1 | 0.6 | 159 | 314 | 834 | 1 703 | 89 | 117 | 180 | 255 | -3 | -9 | -23 | -39 | 0.496 |
| 97 | 118 | 120 | 1 | 0.6 | 272 | 500 | 1 096 | 2 184 | 203 | 253 | 341 | 449 | -4 | -8 | -16 | -27 | 0.560 |
| 97 | 118 | 120 | 1 | 0.6 | 296 | 560 | 1 255 | 2 531 | 233 | 294 | 399 | 528 | -4 | -8 | -16 | -27 | 0.488 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 282 | 711 | — | 75 | 109 | 156 | — | 0 | -8 | -21 | — | 0.552 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 282 | 711 | — | 75 | 109 | 156 | — | 0 | -8 | -21 | — | 0.552 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 308 | 804 | — | 84 | 125 | 181 | — | 0 | -8 | -21 | — | 0.480 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 308 | 804 | — | 84 | 125 | 181 | — | 0 | -8 | -21 | — | 0.480 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 432 | 977 | — | 124 | 206 | 276 | — | 0 | -8 | -17 | — | 0.552 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 432 | 977 | — | 124 | 206 | 276 | — | 0 | -8 | -17 | — | 0.552 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 482 | 1 117 | — | 139 | 239 | 323 | — | 0 | -8 | -17 | — | 0.480 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 482 | 1 117 | — | 139 | 239 | 323 | — | 0 | -8 | -17 | — | 0.480 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 282 | 711 | — | 75 | 109 | 156 | — | 0 | -8 | -21 | — | 0.653 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 308 | 804 | — | 84 | 125 | 181 | — | 0 | -8 | -21 | — | 0.582 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 308 | 804 | — | 84 | 125 | 181 | — | 0 | -8 | -21 | — | 0.582 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 432 | 977 | — | 124 | 206 | 276 | — | 0 | -8 | -17 | — | 0.653 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 482 | 1 117 | — | 139 | 239 | 323 | — | 0 | -8 | -17 | — | 0.582 |
| 97 | 118 | 120 | 1 | 0.6 | 98 | 482 | 1 117 | — | 139 | 239 | 323 | — | 0 | -8 | -17 | — | 0.582 |
| 99 | 131 | 134 | 1.5 | 0.8 | 247 | 502 | 1 187 | 2 373 | 87 | 117 | 172 | 241 | -8 | -18 | -37 | -60 | 1.16 |
| 99 | 131 | 134 | 1.5 | 0.8 | 266 | 560 | 1 355 | 2 741 | 99 | 135 | 200 | 282 | -8 | -18 | -37 | -60 | 0.994 |
| 99 | 131 | 134 | 1.5 | 0.8 | 409 | 779 | 1 758 | 3 498 | 218 | 275 | 374 | 494 | -7 | -13 | -25 | -41 | 1.17 |
| 99 | 131 | 134 | 1.5 | 0.8 | 454 | 886 | 2 031 | 4 079 | 252 | 321 | 440 | 582 | -7 | -13 | -25 | -41 | 1.00 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 782 | 2 483 | 3 977 | 176 | 356 | 543 | 650 | 0 | -10 | -25 | -35 | 1.18 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 338 | 830 | — | 75 | 116 | 164 | — | 0 | -10 | -24 | — | 1.24 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 338 | 830 | — | 75 | 116 | 164 | — | 0 | -10 | -24 | — | 1.24 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 372 | 943 | — | 83 | 134 | 191 | — | 0 | -10 | -24 | — | 1.16 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 372 | 943 | — | 83 | 134 | 191 | — | 0 | -10 | -24 | — | 1.16 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 653 | 1 339 | — | 124 | 238 | 309 | — | 0 | -12 | -22 | — | 1.24 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 653 | 1 339 | — | 124 | 238 | 309 | — | 0 | -12 | -22 | — | 1.24 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 739 | 1 541 | — | 139 | 277 | 362 | — | 0 | -12 | -22 | — | 1.16 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 739 | 1 541 | — | 139 | 277 | 362 | — | 0 | -12 | -22 | — | 1.16 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 338 | 830 | — | 75 | 116 | 164 | — | 0 | -10 | -24 | — | 1.52 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 372 | 943 | — | 83 | 134 | 191 | — | 0 | -10 | -24 | — | 1.44 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 372 | 943 | — | 83 | 134 | 191 | — | 0 | -10 | -24 | — | 1.44 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 653 | 1 339 | — | 124 | 238 | 309 | — | 0 | -12 | -22 | — | 1.52 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 739 | 1 541 | — | 139 | 277 | 362 | — | 0 | -12 | -22 | — | 1.44 |
| 99 | 131 | 134 | 1.5 | 0.8 | 98 | 739 | 1 541 | — | 139 | 277 | 362 | — | 0 | -12 | -22 | — | 1.44 |
| 100 | 150 | 154 | 2 | 1 | 384 | 771 | 1 865 | 3 713 | 95 | 126 | 187 | 262 | -15 | -29 | -57 | -90 | 2.20 |
| 100 | 150 | 154 | 2 | 1 | 425 | 872 | 2 150 | 4 316 | 109 | 146 | 219 | 308 | -15 | -29 | -57 | -90 | 1.80 |
| 100 | 150 | 154 | 2 | 1 | 658 | 1 272 | 2 899 | 5 945 | 240 | 304 | 416 | 556 | -12 | -21 | -39 | -64 | 2.31 |
| 100 | 150 | 154 | 2 | 1 | 744 | 1 462 | 3 375 | 6 965 | 279 | 357 | 490 | 657 | -12 | -21 | -39 | -64 | 1.91 |
| 100 | 150 | 154 | 2 | 1 | 98 | 1 676 | 4 314 | 5 954 | 165 | 434 | 616 | 697 | 0 | -20 | -40 | -50 | 2.23 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.

Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

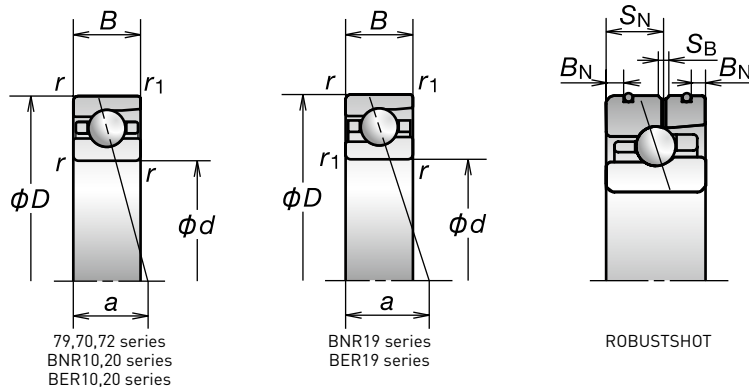
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 95 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7919C | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 44.5 | 48.0 | 30.0 | 15 | 16.7 | 24.1 | 10 300 | 15 600 |
| * 7919CSN24 | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | [44.5] | [48.0] | 35.8 | 15 | 16.7 | 24.1 | 13 400 | 20 300 |
| * 7919A5 | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 42.0 | 45.5 | 35.0 | 25 | — | 35.2 | 8 900 | 13 400 |
| * 7919A5SN24 | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | [42.0] | [45.5] | 41.5 | 25 | — | 35.2 | 11 600 | 17 400 |
| 95BNR19S | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 32.0 | 31.0 | 50.0 | 18 | 10.9 | 27.3 | 12 500 | 17 800 |
| 95BNR19E | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 32.0 | 31.0 | 50.0 | 18 | 10.9 | 27.3 | 13 400 | 19 100 |
| 95BNR19H | 95 | 130 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [32.0] | [31.0] | 32.5 | 18 | 10.9 | 27.3 | 16 000 | 24 900 |
| 95BNR19X | 95 | 130 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [32.0] | [31.0] | 32.5 | 18 | 10.9 | 27.3 | 18 700 | 29 400 |
| 95BER19S | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 30.5 | 29.7 | 58.5 | 25 | — | 35.2 | 10 700 | 15 200 |
| 95BER19E | 95 | 130 | 18 | — | — | — | — | 1.1 | 0.6 | 30.5 | 29.7 | 58.5 | 25 | — | 35.2 | 11 500 | 16 200 |
| 95BER19H | 95 | 130 | 18 | — | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [30.5] | [29.7] | 39.5 | 25 | — | 35.2 | 14 300 | 22 300 |
| 95BER19X | 95 | 130 | 18 | 23 | 4.0 | 10.4 | 2.2 | 1.1 | 0.6 | [30.5] | [29.7] | 39.5 | 25 | — | 35.2 | 16 900 | 26 700 |
| 7019C | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 77.0 | 73.0 | 47.0 | 15 | 15.9 | 28.1 | 9 600 | 14 600 |
| 7019CSN24 | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | [77.0] | [73.0] | 55.8 | 15 | 15.9 | 28.1 | 12 500 | 19 000 |
| 7019A5 | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 73.0 | 69.5 | 52.5 | 25 | — | 40.0 | 8 400 | 12 500 |
| 7019A5SN24 | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | [73.0] | [69.5] | 62.7 | 25 | — | 40.0 | 10 900 | 16 300 |
| 7019A | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 70.0 | 67.0 | 40.5 | 30 | — | 46.6 | 6 300 | 8 400 |
| 95BNR10S | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 35.5 | 34.5 | 50.0 | 18 | 10.8 | 31.3 | 11 700 | 16 700 |
| 95BNR10E | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 35.5 | 34.5 | 50.0 | 18 | 10.8 | 31.3 | 12 500 | 17 900 |
| 95BNR10H | 95 | 145 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [35.5] | [34.5] | 32.5 | 18 | 10.8 | 31.3 | 15 000 | 23 400 |
| 95BNR10X | 95 | 145 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [35.5] | [34.5] | 32.5 | 18 | 10.8 | 31.3 | 17 500 | 27 500 |
| 95BER10S | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 34.0 | 33.0 | 58.5 | 25 | — | 39.7 | 10 000 | 14 200 |
| 95BER10E | 95 | 145 | 24 | — | — | — | — | 1.5 | 1 | 34.0 | 33.0 | 58.5 | 25 | — | 39.7 | 10 800 | 15 200 |
| 95BER10H | 95 | 145 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [34.0] | [33.0] | 39.5 | 25 | — | 39.7 | 13 400 | 20 900 |
| 95BER10X | 95 | 145 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | [34.0] | [33.0] | 39.5 | 25 | — | 39.7 | 15 900 | 25 000 |
| 7219C | 95 | 170 | 32 | — | — | — | — | 2.1 | 1.1 | 139 | 112 | 76.0 | 15 | 14.6 | 33.7 | 8 700 | 13 300 |
| 7219CSN24 | 95 | 170 | 32 | — | — | — | — | 2.1 | 1.1 | [139] | [112] | 90.0 | 15 | 14.6 | 33.7 | 11 400 | 17 300 |
| 7219A5 | 95 | 170 | 32 | — | — | — | — | 2.1 | 1.1 | 133 | 107 | 87.0 | 25 | — | 46.9 | 7 600 | 11 400 |
| 7219A5SN24 | 95 | 170 | 32 | — | — | — | — | 2.1 | 1.1 | [133] | [107] | 103 | 25 | — | 46.9 | 9 900 | 14 800 |
| 7219A | 95 | 170 | 32 | — | — | — | — | 2.1 | 1.1 | 128 | 103 | 67.0 | 30 | — | 54.2 | 5 700 | 7 600 |

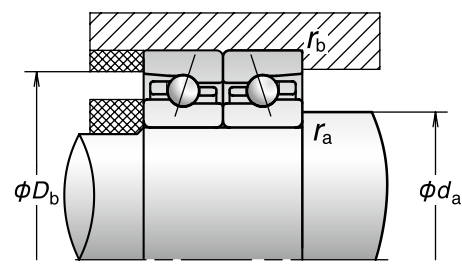
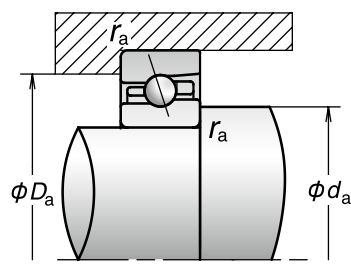
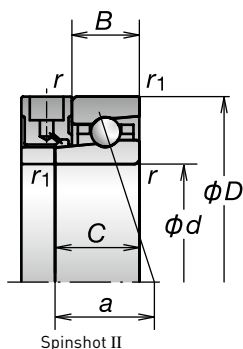
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|-----|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 102 | 123 | 125 | 1 | 0.6 | 154 | 294 | 800 | 1 588 | 81 | 105 | 164 | 230 | -3 | -9 | -24 | -40 | 0.597 |
| 102 | 123 | 125 | 1 | 0.6 | 161 | 320 | 903 | 1 819 | 91 | 121 | 191 | 268 | -3 | -9 | -24 | -40 | 0.522 |
| 102 | 123 | 125 | 1 | 0.6 | 226 | 512 | 1 218 | 2 371 | 195 | 261 | 363 | 475 | -3 | -8 | -17 | -28 | 0.603 |
| 102 | 123 | 125 | 1 | 0.6 | 244 | 574 | 1 397 | 2 751 | 223 | 304 | 425 | 558 | -3 | -8 | -17 | -28 | 0.528 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 288 | 775 | — | 77 | 112 | 164 | — | 0 | -8 | -22 | — | 0.571 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 288 | 775 | — | 77 | 112 | 164 | — | 0 | -8 | -22 | — | 0.571 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 314 | 878 | — | 86 | 129 | 191 | — | 0 | -8 | -22 | — | 0.497 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 314 | 878 | — | 86 | 129 | 191 | — | 0 | -8 | -22 | — | 0.497 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 442 | 1 005 | — | 127 | 212 | 286 | — | 0 | -8 | -17 | — | 0.571 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 442 | 1 005 | — | 127 | 212 | 286 | — | 0 | -8 | -17 | — | 0.571 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 493 | 1 150 | — | 143 | 247 | 334 | — | 0 | -8 | -17 | — | 0.497 |
| 102 | 123 | 125 | 1 | 0.6 | 98 | 493 | 1 150 | — | 143 | 247 | 334 | — | 0 | -8 | -17 | — | 0.497 |
| 104 | 136 | 139 | 1.5 | 0.8 | 275 | 549 | 1 188 | 2 348 | 94 | 125 | 176 | 246 | -9 | -19 | -36 | -58 | 1.21 |
| 104 | 136 | 139 | 1.5 | 0.8 | 299 | 614 | 1 357 | 2 712 | 107 | 144 | 205 | 288 | -9 | -19 | -36 | -58 | 1.04 |
| 104 | 136 | 139 | 1.5 | 0.8 | 421 | 808 | 1 832 | 3 786 | 227 | 287 | 392 | 525 | -7 | -13 | -25 | -42 | 1.21 |
| 104 | 136 | 139 | 1.5 | 0.8 | 469 | 919 | 2 119 | 4 417 | 263 | 336 | 460 | 619 | -7 | -13 | -25 | -42 | 1.04 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 811 | 2 592 | 4 157 | 182 | 372 | 569 | 682 | 0 | -10 | -25 | -35 | 1.23 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 345 | 854 | — | 77 | 120 | 170 | — | 0 | -10 | -24 | — | 1.30 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 345 | 854 | — | 77 | 120 | 170 | — | 0 | -10 | -24 | — | 1.30 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 380 | 971 | — | 86 | 138 | 198 | — | 0 | -10 | -24 | — | 1.21 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 380 | 971 | — | 86 | 138 | 198 | — | 0 | -10 | -24 | — | 1.21 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 671 | 1 381 | — | 127 | 246 | 320 | — | 0 | -12 | -22 | — | 1.30 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 671 | 1 381 | — | 127 | 246 | 320 | — | 0 | -12 | -22 | — | 1.30 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 760 | 1 590 | — | 143 | 287 | 375 | — | 0 | -12 | -22 | — | 1.21 |
| 104 | 136 | 139 | 1.5 | 0.8 | 98 | 760 | 1 590 | — | 143 | 287 | 375 | — | 0 | -12 | -22 | — | 1.21 |
| 107 | 158 | 163 | 2 | 1 | 448 | 876 | 2 081 | 4 153 | 98 | 130 | 192 | 270 | -18 | -33 | -63 | -99 | 2.64 |
| 107 | 158 | 163 | 2 | 1 | 498 | 995 | 2 404 | 4 834 | 114 | 151 | 225 | 317 | -18 | -33 | -63 | -99 | 2.18 |
| 107 | 158 | 163 | 2 | 1 | 703 | 1 390 | 3 124 | 6 301 | 240 | 308 | 419 | 557 | -13 | -23 | -42 | -68 | 2.63 |
| 107 | 158 | 163 | 2 | 1 | 796 | 1 601 | 3 639 | 7 386 | 280 | 361 | 494 | 657 | -13 | -23 | -42 | -68 | 2.17 |
| 107 | 158 | 163 | 2 | 1 | 356 | 1 633 | 4 191 | 6 644 | 248 | 422 | 596 | 711 | -5 | -20 | -40 | -55 | 2.67 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

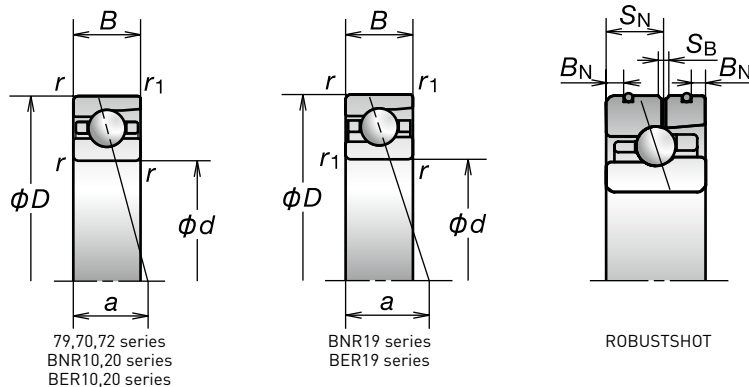
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 100 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| * 7920C | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 52.5 | 54.0 | 33.0 | 15 | 16.5 | 26.1 | 9 600 | 14 600 |
| * 7920CSN24 | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | (52.5) | (54.0) | 39.2 | 15 | 16.5 | 26.1 | 12 500 | 19 000 |
| * 7920A5 | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 49.5 | 51.5 | 39.5 | 25 | — | 38.0 | 8 400 | 12 500 |
| * 7920A5SN24 | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | (49.5) | (51.5) | 46.8 | 25 | — | 38.0 | 10 900 | 16 300 |
| * 100BNR19S | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 38.0 | 35.0 | 50.5 | 18 | 10.8 | 29.5 | 11 700 | 16 700 |
| * 100BNR19E | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 38.0 | 35.0 | 50.5 | 18 | 10.8 | 29.5 | 12 500 | 17 900 |
| * 100BNR19H | 100 | 140 | 20 | — | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (38.0) | (35.0) | 33.0 | 18 | 10.8 | 29.5 | 15 000 | 23 400 |
| * 100BNR19X | 100 | 140 | 20 | 25 | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (38.0) | (35.0) | 33.0 | 18 | 10.8 | 29.5 | 17 500 | 27 500 |
| * 100BER19S | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 36.0 | 33.5 | 59.5 | 25 | — | 38.0 | 10 000 | 14 200 |
| * 100BER19E | 100 | 140 | 20 | — | — | — | — | 1.1 | 0.6 | 36.0 | 33.5 | 59.5 | 25 | — | 38.0 | 10 800 | 15 200 |
| * 100BER19H | 100 | 140 | 20 | — | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (36.0) | (33.5) | 40.0 | 25 | — | 38.0 | 13 400 | 20 900 |
| * 100BER19X | 100 | 140 | 20 | 25 | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (36.0) | (33.5) | 40.0 | 25 | — | 38.0 | 15 900 | 25 000 |
| * 100BNR29EV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | 38.0 | 35.0 | 50.5 | 18 | 10.8 | 31.5 | 12 500 | — |
| * 100BNR29HV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | (38.0) | (35.0) | 33.0 | 18 | 10.8 | 31.5 | 15 000 | — |
| * 100BNR29XV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | (38.0) | (35.0) | 33.0 | 18 | 10.8 | 31.5 | 17 500 | — |
| * 100BER29EV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | 36.0 | 33.5 | 59.5 | 25 | — | 40.0 | 10 800 | — |
| * 100BER29HV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | (36.0) | (33.5) | 40.0 | 25 | — | 40.0 | 13 400 | — |
| * 100BER29XV1V | 100 | 140 | 24 | — | — | — | — | 1.1 | 0.6 | (36.0) | (33.5) | 40.0 | 25 | — | 40.0 | 15 900 | — |
| * 7020C | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 79.0 | 77.0 | 49.0 | 15 | 16.0 | 28.7 | 9 200 | 14 000 |
| * 7020CSN24 | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | (79.0) | (77.0) | 58.4 | 15 | 16.0 | 28.7 | 12 000 | 18 300 |
| * 7020A5 | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 75.0 | 73.5 | 57.5 | 25 | — | 41.1 | 8 000 | 12 000 |
| * 7020A5SN24 | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | (75.0) | (73.5) | 68.3 | 25 | — | 41.1 | 10 400 | 15 600 |
| * 7020A | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 72.0 | 70.5 | 44.5 | 30 | — | 48.1 | 6 000 | 8 000 |
| * 100BNR10S | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 36.0 | 36.0 | 52.0 | 18 | 10.9 | 32.3 | 11 200 | 16 000 |
| * 100BNR10E | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 36.0 | 36.0 | 52.0 | 18 | 10.9 | 32.3 | 12 000 | 17 200 |
| * 100BNR10H | 100 | 150 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | (36.0) | (36.0) | 34.0 | 18 | 10.9 | 32.3 | 14 400 | 22 400 |
| * 100BNR10X | 100 | 150 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | (36.0) | (36.0) | 34.0 | 18 | 10.9 | 32.3 | 16 800 | 26 400 |
| * 100BER10S | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 34.5 | 34.5 | 61.0 | 25 | — | 41.2 | 9 600 | 13 600 |
| * 100BER10E | 100 | 150 | 24 | — | — | — | — | 1.5 | 1 | 34.5 | 34.5 | 61.0 | 25 | — | 41.2 | 10 400 | 14 600 |
| * 100BER10H | 100 | 150 | 24 | — | 5.5 | 14.5 | 2.2 | 1.5 | 1 | (34.5) | (34.5) | 41.0 | 25 | — | 41.2 | 12 800 | 20 000 |
| * 100BER10X | 100 | 150 | 24 | 29 | 5.5 | 14.5 | 2.2 | 1.5 | 1 | (34.5) | (34.5) | 41.0 | 25 | — | 41.2 | 15 200 | 24 000 |
| * 100BNR20EV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | 36.0 | 36.0 | 52.0 | 18 | 10.9 | 35.3 | 12 000 | — |
| * 100BNR20HV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | (36.0) | (36.0) | 34.0 | 18 | 10.9 | 35.3 | 14 400 | — |
| * 100BNR20XV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | (36.0) | (36.0) | 34.0 | 18 | 10.9 | 35.3 | 16 800 | — |
| * 100BER20EV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | 34.5 | 34.5 | 61.0 | 25 | — | 44.2 | 10 400 | — |
| * 100BER20HV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | (34.5) | (34.5) | 41.0 | 25 | — | 44.2 | 12 800 | — |
| * 100BER20XV1V | 100 | 150 | 30 | — | — | — | — | 1.5 | 1 | (34.5) | (34.5) | 41.0 | 25 | — | 44.2 | 15 200 | — |
| 7220C | 100 | 180 | 34 | — | — | — | — | 2.1 | 1.1 | 157 | 127 | 88.5 | 15 | 14.5 | 35.7 | 8 300 | 12 500 |
| 7220A5 | 100 | 180 | 34 | — | — | — | — | 2.1 | 1.1 | 149 | 121 | 103 | 25 | — | 49.6 | 7 200 | 10 800 |
| 7220A | 100 | 180 | 34 | — | — | — | — | 2.1 | 1.1 | 144 | 117 | 79.5 | 30 | — | 57.4 | 5 400 | 7 200 |

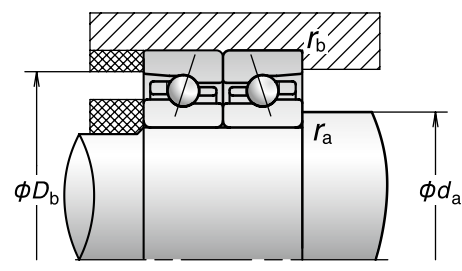
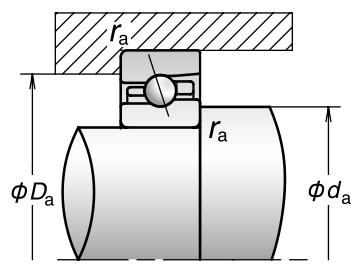
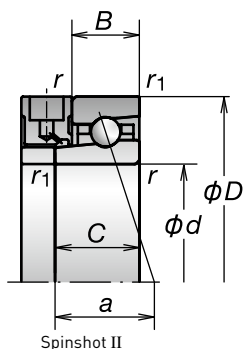
(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.

(2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

(3) Basic load rating values are reference values for ceramic ball bearings.

(4) For permissible axial load, please refer to Page 201.

(5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|------|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 107 | 133 | 135 | 1 | 0.6 | 191 | 387 | 905 | 1 790 | 84 | 112 | 164 | 230 | -5 | -13 | -28 | -46 | 0.800 |
| 107 | 133 | 135 | 1 | 0.6 | 203 | 427 | 1 026 | 2 057 | 95 | 129 | 191 | 268 | -5 | -13 | -28 | -46 | 0.702 |
| 107 | 133 | 135 | 1 | 0.6 | 318 | 615 | 1 229 | 2 546 | 209 | 266 | 346 | 463 | -5 | -10 | -18 | -31 | 0.808 |
| 107 | 133 | 135 | 1 | 0.6 | 348 | 694 | 1 410 | 2 956 | 241 | 310 | 405 | 545 | -5 | -10 | -18 | -31 | 0.710 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 329 | 879 | - | 72 | 111 | 162 | - | 0 | -10 | -26 | - | 0.770 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 329 | 879 | - | 72 | 111 | 162 | - | 0 | -10 | -26 | - | 0.770 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 362 | 1 000 | - | 81 | 128 | 189 | - | 0 | -10 | -26 | - | 0.673 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 362 | 1 000 | - | 81 | 128 | 189 | - | 0 | -10 | -26 | - | 0.673 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 522 | 1 142 | - | 120 | 213 | 282 | - | 0 | -10 | -20 | - | 0.770 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 522 | 1 142 | - | 120 | 213 | 282 | - | 0 | -10 | -20 | - | 0.770 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 585 | 1 311 | - | 135 | 247 | 330 | - | 0 | -10 | -20 | - | 0.673 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 585 | 1 311 | - | 135 | 247 | 330 | - | 0 | -10 | -20 | - | 0.673 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 329 | 879 | - | 72 | 111 | 162 | - | 0 | -10 | -26 | - | 0.902 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 362 | 1 000 | - | 81 | 128 | 189 | - | 0 | -10 | -26 | - | 0.805 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 362 | 1 000 | - | 81 | 128 | 189 | - | 0 | -10 | -26 | - | 0.805 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 522 | 1 142 | - | 120 | 213 | 282 | - | 0 | -10 | -20 | - | 0.902 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 585 | 1 311 | - | 135 | 247 | 330 | - | 0 | -10 | -20 | - | 0.805 |
| 107 | 133 | 135 | 1 | 0.6 | 98 | 585 | 1 311 | - | 135 | 247 | 330 | - | 0 | -10 | -20 | - | 0.805 |
| 109 | 141 | 144 | 1.5 | 0.8 | 282 | 534 | 1 278 | 2 572 | 97 | 126 | 187 | 264 | -9 | -18 | -37 | -60 | 1.27 |
| 109 | 141 | 144 | 1.5 | 0.8 | 306 | 596 | 1 462 | 2 974 | 111 | 146 | 218 | 309 | -9 | -18 | -37 | -60 | 1.09 |
| 109 | 141 | 144 | 1.5 | 0.8 | 434 | 837 | 2 009 | 3 948 | 236 | 300 | 418 | 549 | -7 | -13 | -26 | -42 | 1.45 |
| 109 | 141 | 144 | 1.5 | 0.8 | 483 | 953 | 2 327 | 4 609 | 274 | 350 | 491 | 647 | -7 | -13 | -26 | -42 | 1.27 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 840 | 2 701 | 4 338 | 188 | 388 | 595 | 713 | 0 | -10 | -25 | -35 | 1.28 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 352 | 877 | - | 78 | 123 | 175 | - | 0 | -10 | -24 | - | 1.34 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 352 | 877 | - | 78 | 123 | 175 | - | 0 | -10 | -24 | - | 1.34 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 389 | 999 | - | 88 | 142 | 205 | - | 0 | -10 | -24 | - | 1.25 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 389 | 999 | - | 88 | 142 | 205 | - | 0 | -10 | -24 | - | 1.25 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 689 | 1 423 | - | 130 | 254 | 331 | - | 0 | -12 | -22 | - | 1.34 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 689 | 1 423 | - | 130 | 254 | 331 | - | 0 | -12 | -22 | - | 1.34 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 780 | 1 639 | - | 146 | 296 | 388 | - | 0 | -12 | -22 | - | 1.25 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 780 | 1 639 | - | 146 | 296 | 388 | - | 0 | -12 | -22 | - | 1.25 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 352 | 877 | - | 78 | 123 | 175 | - | 0 | -10 | -24 | - | 1.65 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 389 | 999 | - | 88 | 142 | 205 | - | 0 | -10 | -24 | - | 1.56 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 389 | 999 | - | 88 | 142 | 205 | - | 0 | -10 | -24 | - | 1.56 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 689 | 1 423 | - | 130 | 254 | 331 | - | 0 | -12 | -22 | - | 1.65 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 780 | 1 639 | - | 146 | 296 | 388 | - | 0 | -12 | -22 | - | 1.56 |
| 109 | 141 | 144 | 1.5 | 0.8 | 98 | 780 | 1 639 | - | 146 | 296 | 388 | - | 0 | -12 | -22 | - | 1.56 |
| 112 | 168 | 173 | 2 | 1 | 503 | 984 | 2 337 | 4 700 | 104 | 137 | 202 | 284 | -20 | -36 | -68 | -107 | 3.18 |
| 112 | 168 | 173 | 2 | 1 | 776 | 1 574 | 3 500 | 7 110 | 252 | 327 | 442 | 588 | -14 | -25 | -45 | -73 | 3.16 |
| 112 | 168 | 173 | 2 | 1 | 361 | 1 664 | 5 052 | 7 687 | 253 | 430 | 646 | 758 | -5 | -20 | -45 | -60 | 3.21 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

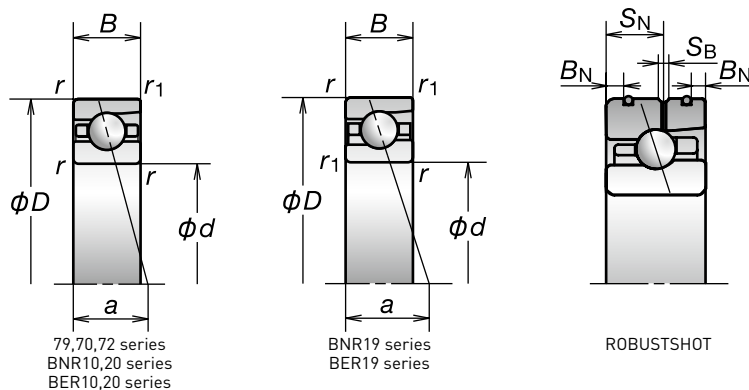
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

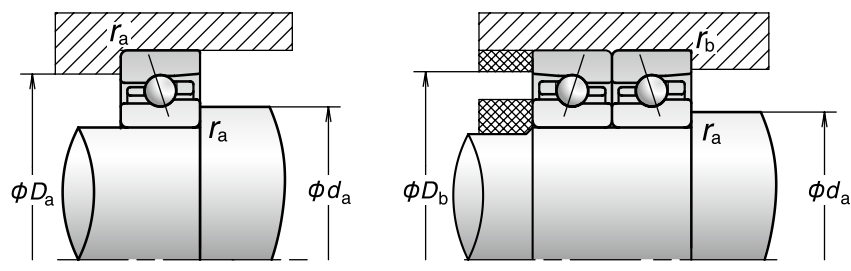
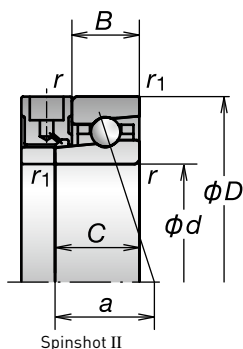
1. Angular Contact Ball Bearings

Bore Diameter 105 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f ₀ | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| 7921C | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 53.5 | 57.0 | 34.5 | 15 | 16.6 | 26.7 | 9 200 | 14 000 |
| 7921CSN24 | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | (53.5) | (57.0) | 40.8 | 15 | 16.6 | 26.7 | 12 000 | 18 300 |
| 7921A5 | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 50.5 | 54.0 | 41.0 | 25 | — | 39.2 | 8 000 | 12 000 |
| 7921A5SN24 | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | (50.5) | (54.0) | 48.7 | 25 | — | 39.2 | 10 400 | 15 600 |
| 105BNR19S | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 38.5 | 36.5 | 53.0 | 18 | 10.8 | 30.3 | 11 200 | 16 000 |
| 105BNR19E | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 38.5 | 36.5 | 53.0 | 18 | 10.8 | 30.3 | 12 000 | 17 200 |
| 105BNR19H | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | (38.5) | (36.5) | 39.0 | 18 | 10.8 | 30.3 | 14 400 | 22 400 |
| 105BNR19X | 105 | 145 | 20 | 25 | — | — | — | 1.1 | 0.6 | (38.5) | (36.5) | 39.0 | 18 | 10.8 | 30.3 | 16 800 | 26 400 |
| 105BER19S | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 37.0 | 35.0 | 62.0 | 25 | — | 39.2 | 9 600 | 13 600 |
| 105BER19E | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | 37.0 | 35.0 | 62.0 | 25 | — | 39.2 | 10 400 | 14 600 |
| 105BER19H | 105 | 145 | 20 | — | — | — | — | 1.1 | 0.6 | (37.0) | (35.0) | 42.0 | 25 | — | 39.2 | 12 800 | 20 000 |
| 105BER19X | 105 | 145 | 20 | 25 | — | — | — | 1.1 | 0.6 | (37.0) | (35.0) | 42.0 | 25 | — | 39.2 | 15 200 | 24 000 |
| 7021C | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 92.5 | 89.5 | 57.0 | 15 | 15.9 | 30.7 | 8 700 | 13 300 |
| 7021CSN24 | 105 | 160 | 26 | — | — | — | — | 2 | 1 | (92.5) | (89.5) | 68.1 | 15 | 15.9 | 30.7 | 11 400 | 17 300 |
| 7021A5 | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 87.5 | 85.0 | 66.5 | 25 | — | 43.9 | 7 600 | 11 400 |
| 7021A5SN24 | 105 | 160 | 26 | — | — | — | — | 2 | 1 | (87.5) | (85.0) | 79.0 | 25 | — | 43.9 | 9 900 | 14 800 |
| 7021A | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 84.0 | 81.5 | 51.0 | 30 | — | 51.2 | 5 700 | 7 600 |
| 105BNR10S | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 41.0 | 41.0 | 59.5 | 18 | 10.9 | 34.5 | 10 600 | 15 100 |
| 105BNR10E | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 41.0 | 41.0 | 59.5 | 18 | 10.9 | 34.5 | 11 400 | 16 200 |
| 105BNR10H | 105 | 160 | 26 | — | 6.0 | 15.2 | 2.2 | 2 | 1 | (41.0) | (41.0) | 39.0 | 18 | 10.9 | 34.5 | 13 600 | 21 200 |
| 105BNR10X | 105 | 160 | 26 | 31 | 6.0 | 15.2 | 2.2 | 2 | 1 | (41.0) | (41.0) | 39.0 | 18 | 10.9 | 34.5 | 15 900 | 25 000 |
| 105BER10S | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 39.0 | 39.5 | 70.0 | 25 | — | 43.9 | 9 100 | 12 900 |
| 105BER10E | 105 | 160 | 26 | — | — | — | — | 2 | 1 | 39.0 | 39.5 | 70.0 | 25 | — | 43.9 | 9 800 | 13 800 |
| 105BER10H | 105 | 160 | 26 | — | 6.0 | 15.2 | 2.2 | 2 | 1 | (39.0) | (39.5) | 47.5 | 25 | — | 43.9 | 12 100 | 18 900 |
| 105BER10X | 105 | 160 | 26 | 31 | 6.0 | 15.2 | 2.2 | 2 | 1 | (39.0) | (39.5) | 47.5 | 25 | — | 43.9 | 14 400 | 22 700 |
| 7221C | 105 | 190 | 36 | — | — | — | — | 2.1 | 1.1 | 171 | 143 | 97.5 | 15 | 14.5 | 37.7 | 7 800 | 11 900 |
| 7221A5 | 105 | 190 | 36 | — | — | — | — | 2.1 | 1.1 | 163 | 137 | 111 | 25 | — | 52.4 | 6 800 | 10 200 |
| 7221A | 105 | 190 | 36 | — | — | — | — | 2.1 | 1.1 | 157 | 132 | 85.0 | 30 | — | 60.6 | 5 100 | 6 800 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.
 (2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.
 (3) Basic load rating values are reference values for ceramic ball bearings.
 (4) For permissible axial load, please refer to Page 201.
 (5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------|-----------|-----------|-------------------------------------|-------|-------|-------|---|-----|-----|-----|-------------------------------|-----|-----|------|---------------------|
| da (min.) | Da (max.) | Db (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 112 | 138 | 140 | 1 | 0.6 | 194 | 396 | 890 | 1 791 | 86 | 116 | 167 | 235 | -5 | -13 | -27 | -45 | 0.831 |
| 112 | 138 | 140 | 1 | 0.6 | 206 | 437 | 1 009 | 2 058 | 98 | 133 | 193 | 274 | -5 | -13 | -27 | -45 | 0.729 |
| 112 | 138 | 140 | 1 | 0.6 | 272 | 565 | 1 361 | 2 760 | 203 | 265 | 369 | 491 | -4 | -9 | -19 | -32 | 0.820 |
| 112 | 138 | 140 | 1 | 0.6 | 296 | 636 | 1 565 | 3 208 | 234 | 308 | 432 | 577 | -4 | -9 | -19 | -32 | 0.718 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 336 | 906 | - | 74 | 115 | 168 | - | 0 | -10 | -26 | - | 0.795 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 336 | 906 | - | 74 | 115 | 168 | - | 0 | -10 | -26 | - | 0.795 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 370 | 1 032 | - | 83 | 133 | 196 | - | 0 | -10 | -26 | - | 0.693 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 370 | 1 032 | - | 83 | 133 | 196 | - | 0 | -10 | -26 | - | 0.693 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 536 | 1 180 | - | 124 | 220 | 293 | - | 0 | -10 | -20 | - | 0.795 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 536 | 1 180 | - | 124 | 220 | 293 | - | 0 | -10 | -20 | - | 0.795 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 602 | 1 355 | - | 139 | 256 | 343 | - | 0 | -10 | -20 | - | 0.693 |
| 112 | 138 | 140 | 1 | 0.6 | 98 | 602 | 1 355 | - | 139 | 256 | 343 | - | 0 | -10 | -20 | - | 0.693 |
| 115 | 150 | 154 | 2 | 1 | 330 | 625 | 1 494 | 2 973 | 103 | 134 | 197 | 276 | -11 | -21 | -42 | -67 | 1.58 |
| 115 | 150 | 154 | 2 | 1 | 362 | 703 | 1 715 | 3 446 | 118 | 155 | 230 | 324 | -11 | -21 | -42 | -67 | 1.34 |
| 115 | 150 | 154 | 2 | 1 | 493 | 989 | 2 211 | 4 473 | 247 | 318 | 431 | 572 | -8 | -15 | -28 | -46 | 1.82 |
| 115 | 150 | 154 | 2 | 1 | 553 | 1 131 | 2 564 | 5 228 | 287 | 372 | 507 | 674 | -8 | -15 | -28 | -46 | 1.58 |
| 115 | 150 | 154 | 2 | 1 | 98 | 840 | 2 693 | 4 318 | 188 | 388 | 591 | 707 | 0 | -10 | -25 | -35 | 1.60 |
| 115 | 150 | 154 | 2 | 1 | 98 | 424 | 1 034 | - | 80 | 135 | 190 | - | 0 | -12 | -27 | - | 1.70 |
| 115 | 150 | 154 | 2 | 1 | 98 | 424 | 1 034 | - | 80 | 135 | 190 | - | 0 | -12 | -27 | - | 1.70 |
| 115 | 150 | 154 | 2 | 1 | 98 | 471 | 1 182 | - | 89 | 156 | 222 | - | 0 | -12 | -27 | - | 1.59 |
| 115 | 150 | 154 | 2 | 1 | 98 | 471 | 1 182 | - | 89 | 156 | 222 | - | 0 | -12 | -27 | - | 1.59 |
| 115 | 150 | 154 | 2 | 1 | 98 | 911 | 1 815 | - | 133 | 286 | 369 | - | 0 | -15 | -26 | - | 1.70 |
| 115 | 150 | 154 | 2 | 1 | 98 | 911 | 1 815 | - | 133 | 286 | 369 | - | 0 | -15 | -26 | - | 1.70 |
| 115 | 150 | 154 | 2 | 1 | 98 | 1 039 | 2 100 | - | 149 | 335 | 434 | - | 0 | -15 | -26 | - | 1.59 |
| 115 | 150 | 154 | 2 | 1 | 98 | 1 039 | 2 100 | - | 149 | 335 | 434 | - | 0 | -15 | -26 | - | 1.59 |
| 117 | 178 | 183 | 2 | 1 | 540 | 1 077 | 2 651 | 5 311 | 108 | 144 | 216 | 304 | -21 | -38 | -73 | -114 | 3.78 |
| 117 | 178 | 183 | 2 | 1 | 862 | 1 790 | 3 950 | 7 929 | 268 | 348 | 471 | 625 | -15 | -27 | -48 | -77 | 3.77 |
| 117 | 178 | 183 | 2 | 1 | 368 | 2 298 | 5 208 | 8 924 | 260 | 493 | 666 | 818 | -5 | -25 | -45 | -65 | 3.82 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

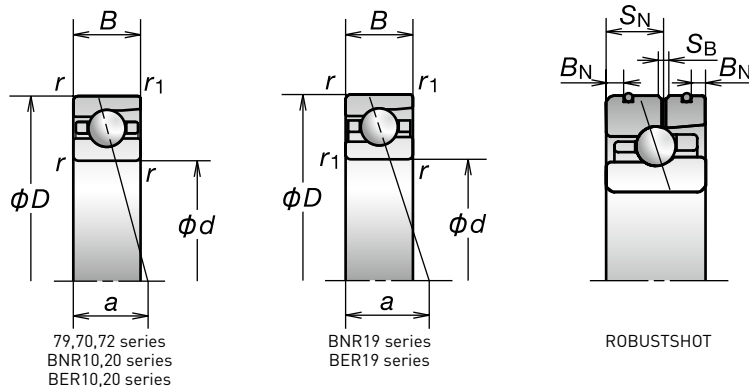
Table B

| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

- For additional information:
- Dynamic equivalent load P193
 - Static equivalent load P200
 - Spacer Dimensions and Nozzle Position P239
 - Recommended Grease Quantities P259

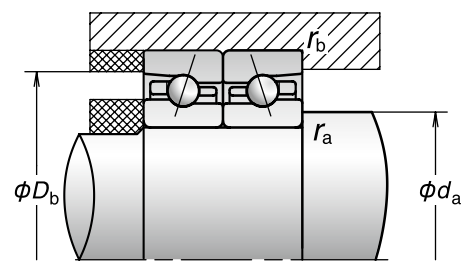
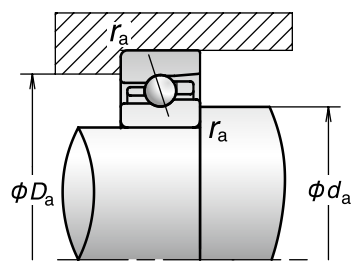
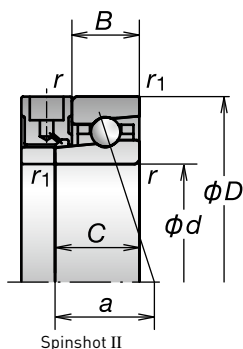
1. Angular Contact Ball Bearings

Bore Diameter 110 mm



| Bearing Designation (1) | Boundary Dimensions (2) (mm) | | | | | | | | Basic Load Ratings (3) (kN) | | Permissible Axial Load (4) (kN) | Contact angle (Degree) | Factor f _o | Effective Load Center (mm) a | Limiting Speeds (5) (min ⁻¹) | | |
|-------------------------|------------------------------|-----|----|----|----------------|----------------|----------------|----------|-----------------------------|--------------------------|---------------------------------|------------------------|-----------------------|------------------------------|--|--------|--------|
| | d | D | B | C | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | | | | | C _{or} (Static) | Grease | Oil |
| 7922C | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 54.5 | 59.5 | 35.5 | 15 | 16.7 | 27.4 | 8 900 | 13 500 |
| 7922CSN24 | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | (54.5) | (59.5) | 42.4 | 15 | 16.7 | 27.4 | 11 600 | 17 600 |
| 7922A5 | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 51.5 | 56.0 | 43.0 | 25 | — | 40.3 | 7 700 | 11 600 |
| 7922A5SN24 | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | (51.5) | (56.0) | 50.7 | 25 | — | 40.3 | 10 000 | 15 000 |
| * 110BNR19S | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 39.0 | 38.0 | 55.5 | 18 | 10.9 | 31.1 | 10 800 | 15 400 |
| * 110BNR19E | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 39.0 | 38.0 | 55.5 | 18 | 10.9 | 31.1 | 11 600 | 16 500 |
| * 110BNR19H | 110 | 150 | 20 | — | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (39.0) | (38.0) | 36.5 | 18 | 10.9 | 31.1 | 13 900 | 21 600 |
| * 110BNR19X | 110 | 150 | 20 | 25 | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (39.0) | (38.0) | 36.5 | 18 | 10.9 | 31.1 | 16 200 | 25 400 |
| * 110BER19S | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 37.5 | 36.5 | 65.0 | 25 | — | 40.3 | 9 300 | 13 100 |
| * 110BER19E | 110 | 150 | 20 | — | — | — | — | 1.1 | 0.6 | 37.5 | 36.5 | 65.0 | 25 | — | 40.3 | 10 000 | 14 000 |
| * 110BER19H | 110 | 150 | 20 | — | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (37.5) | (36.5) | 44.0 | 25 | — | 40.3 | 12 400 | 19 300 |
| * 110BER19X | 110 | 150 | 20 | 25 | 4.0 | 12.0 | 2.2 | 1.1 | 0.6 | (37.5) | (36.5) | 44.0 | 25 | — | 40.3 | 14 700 | 23 100 |
| 7022C | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 111 | 104 | 68.5 | 15 | 15.6 | 32.7 | 8 300 | 12 500 |
| 7022CSN24 | 110 | 170 | 28 | — | — | — | — | 2 | 1 | (111) | (104) | 81.0 | 15 | 15.6 | 32.7 | 10 800 | 16 300 |
| 7022A5 | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 105 | 99.0 | 79.5 | 25 | — | 46.6 | 7 200 | 10 800 |
| 7022A5SN24 | 110 | 170 | 28 | — | — | — | — | 2 | 1 | (105) | (99.0) | 94.1 | 25 | — | 46.6 | 9 300 | 14 000 |
| 7022A | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 101 | 95.5 | 61.0 | 30 | — | 54.4 | 5 400 | 7 200 |
| 110BNR10S | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 46.0 | 47.0 | 68.0 | 18 | 10.9 | 36.7 | 10 000 | 14 300 |
| 110BNR10E | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 46.0 | 47.0 | 68.0 | 18 | 10.9 | 36.7 | 10 800 | 15 300 |
| 110BNR10H | 110 | 170 | 28 | — | 6.0 | 16.2 | 2.2 | 2 | 1 | (46.0) | (47.0) | 44.5 | 18 | 10.9 | 36.7 | 12 900 | 20 000 |
| 110BNR10X | 110 | 170 | 28 | 33 | 6.0 | 16.2 | 2.2 | 2 | 1 | (46.0) | (47.0) | 44.5 | 18 | 10.9 | 36.7 | 15 000 | 23 600 |
| 110BER10S | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 44.0 | 45.0 | 79.5 | 25 | — | 46.7 | 8 600 | 12 200 |
| 110BER10E | 110 | 170 | 28 | — | — | — | — | 2 | 1 | 44.0 | 45.0 | 79.5 | 25 | — | 46.7 | 9 300 | 13 000 |
| 110BER10H | 110 | 170 | 28 | — | 6.0 | 16.2 | 2.2 | 2 | 1 | (44.0) | (45.0) | 54.0 | 25 | — | 46.7 | 11 500 | 17 900 |
| 110BER10X | 110 | 170 | 28 | 33 | 6.0 | 16.2 | 2.2 | 2 | 1 | (44.0) | (45.0) | 54.0 | 25 | — | 46.7 | 13 600 | 21 500 |
| 7222C | 110 | 200 | 38 | — | — | — | — | 2.1 | 1.1 | 185 | 160 | 108 | 15 | 14.5 | 39.8 | 7 500 | 11 300 |
| 7222A5 | 110 | 200 | 38 | — | — | — | — | 2.1 | 1.1 | 176 | 153 | 126 | 25 | — | 55.1 | 6 500 | 9 700 |
| 7222A | 110 | 200 | 38 | — | — | — | — | 2.1 | 1.1 | 170 | 148 | 97.0 | 30 | — | 63.7 | 4 900 | 6 500 |

(1) The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 and 29 are exclusively for sealed bearings.
 (2) A bearing with C values at column indicate a bearing which Spinshot II are available, and a bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.
 (3) Basic load rating values are reference values for ceramic ball bearings.
 (4) For permissible axial load, please refer to Page 201.
 (5) For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|-----------|-----------------------|-----------|-----------|-------------------------------------|-------|-------|--------|---|-----|-----|-----|-------------------------------|-----|-----|------|---------------------|
| da (min.) | Da (max.) | D _b (max.) | ra (max.) | rb (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 117 | 143 | 145 | 1 | 0.6 | 196 | 405 | 916 | 1 849 | 89 | 120 | 173 | 243 | -5 | -13 | -27 | -45 | 0.867 |
| 117 | 143 | 145 | 1 | 0.6 | 209 | 447 | 1 039 | 2 126 | 101 | 138 | 200 | 284 | -5 | -13 | -27 | -45 | 0.761 |
| 117 | 143 | 145 | 1 | 0.6 | 332 | 651 | 1 502 | 2 985 | 224 | 286 | 393 | 519 | -5 | -10 | -20 | -33 | 0.877 |
| 117 | 143 | 145 | 1 | 0.6 | 365 | 735 | 1 731 | 3 474 | 258 | 333 | 461 | 610 | -5 | -10 | -20 | -33 | 0.771 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 405 | 933 | — | 76 | 126 | 174 | — | 0 | -12 | -26 | — | 0.838 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 405 | 933 | — | 76 | 126 | 174 | — | 0 | -12 | -26 | — | 0.838 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 450 | 1 064 | — | 85 | 146 | 204 | — | 0 | -12 | -26 | — | 0.733 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 450 | 1 064 | — | 85 | 146 | 204 | — | 0 | -12 | -26 | — | 0.733 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 550 | 1 218 | — | 127 | 228 | 304 | — | 0 | -10 | -20 | — | 0.838 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 550 | 1 218 | — | 127 | 228 | 304 | — | 0 | -10 | -20 | — | 0.838 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 619 | 1 400 | — | 142 | 266 | 356 | — | 0 | -10 | -20 | — | 0.733 |
| 117 | 143 | 145 | 1 | 0.6 | 98 | 619 | 1 400 | — | 142 | 266 | 356 | — | 0 | -10 | -20 | — | 0.733 |
| 120 | 160 | 164 | 2 | 1 | 371 | 733 | 1 752 | 3 516 | 104 | 137 | 203 | 285 | -13 | -25 | -49 | -78 | 1.97 |
| 120 | 160 | 164 | 2 | 1 | 409 | 829 | 2 018 | 4 085 | 120 | 160 | 237 | 334 | -13 | -25 | -49 | -78 | 1.65 |
| 120 | 160 | 164 | 2 | 1 | 604 | 1 194 | 2 657 | 5 250 | 258 | 330 | 447 | 588 | -10 | -18 | -33 | -53 | 1.97 |
| 120 | 160 | 164 | 2 | 1 | 682 | 1 371 | 3 090 | 6 146 | 300 | 387 | 527 | 694 | -10 | -18 | -33 | -53 | 1.65 |
| 120 | 160 | 164 | 2 | 1 | 98 | 1 325 | 3 331 | 5 949 | 183 | 443 | 620 | 774 | 0 | -15 | -30 | -45 | 1.97 |
| 120 | 160 | 164 | 2 | 1 | 98 | 539 | 1 154 | — | 82 | 150 | 201 | — | 0 | -15 | -29 | — | 2.13 |
| 120 | 160 | 164 | 2 | 1 | 98 | 539 | 1 154 | — | 82 | 150 | 201 | — | 0 | -15 | -29 | — | 2.13 |
| 120 | 160 | 164 | 2 | 1 | 98 | 605 | 1 323 | — | 91 | 174 | 235 | — | 0 | -15 | -29 | — | 2.00 |
| 120 | 160 | 164 | 2 | 1 | 98 | 605 | 1 323 | — | 91 | 174 | 235 | — | 0 | -15 | -29 | — | 2.00 |
| 120 | 160 | 164 | 2 | 1 | 98 | 932 | 1 860 | — | 136 | 294 | 379 | — | 0 | -15 | -26 | — | 2.13 |
| 120 | 160 | 164 | 2 | 1 | 98 | 932 | 1 860 | — | 136 | 294 | 379 | — | 0 | -15 | -26 | — | 2.13 |
| 120 | 160 | 164 | 2 | 1 | 98 | 1 065 | 2 153 | — | 153 | 344 | 445 | — | 0 | -15 | -26 | — | 2.00 |
| 120 | 160 | 164 | 2 | 1 | 98 | 1 065 | 2 153 | — | 153 | 344 | 445 | — | 0 | -15 | -26 | — | 2.00 |
| 122 | 188 | 193 | 2 | 1 | 632 | 1 281 | 2 962 | 5 901 | 117 | 156 | 228 | 320 | -24 | -43 | -78 | -121 | 4.45 |
| 122 | 188 | 193 | 2 | 1 | 948 | 2 009 | 4 400 | 9 396 | 281 | 369 | 497 | 676 | -16 | -29 | -51 | -85 | 4.45 |
| 122 | 188 | 193 | 2 | 1 | 374 | 2 350 | 6 201 | 10 187 | 266 | 505 | 721 | 872 | -5 | -25 | -50 | -70 | 4.49 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

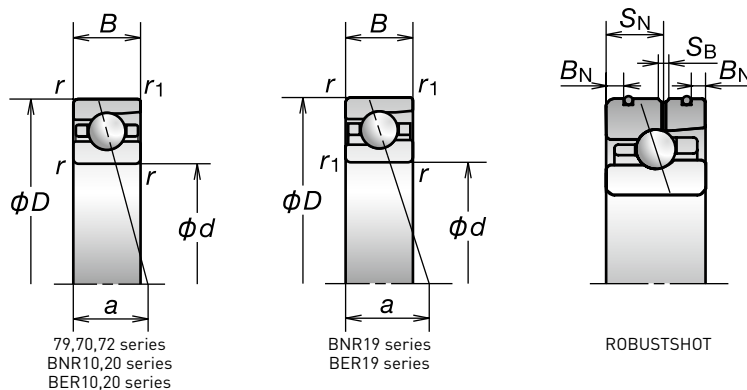
Table B

| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

- For additional information:
- Dynamic equivalent load.....P193
 - Static equivalent load.....P200
 - Spacer Dimensions and Nozzle Position.....P239
 - Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 120 mm



| Bearing Designation ⁽¹⁾ | Boundary Dimensions ⁽²⁾ (mm) | | | | | | | | Basic Load Ratings ⁽³⁾ (kN) | | Permissible Axial Load ⁽⁴⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽⁵⁾ (min ⁻¹) | |
|------------------------------------|---|-----|----|----------------|----------------|----------------|----------|-----------------------|--|--------------------------|--|------------------------|--------------|------------------------------|---|--------|
| | d | D | B | B _N | S _N | S _B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7924C | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | 75.5 | 81.0 | 50.5 | 15 | 16.5 | 30.1 | 8 100 | 12 300 |
| 7924CSN24 | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (75.5) | (81.0) | 59.8 | 15 | 16.5 | 30.1 | 10 600 | 16 000 |
| 7924A5 | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | 71.0 | 77.0 | 59.5 | 25 | — | 44.2 | 7 100 | 10 600 |
| 7924A5SN24 | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (71.0) | (77.0) | 70.8 | 25 | — | 44.2 | 9 200 | 13 700 |
| 120BNR19S | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | 54.0 | 52.0 | 75.0 | 18 | 10.8 | 34.2 | 9 900 | 14 100 |
| 120BNR19H | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (54.0) | (52.0) | 49.0 | 18 | 10.8 | 34.2 | 12 700 | 19 700 |
| 120BNR19X | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (54.0) | (52.0) | 49.0 | 18 | 10.8 | 34.2 | 14 800 | 23 200 |
| 120BER19S | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | 51.5 | 50.0 | 88.0 | 25 | — | 44.2 | 8 500 | 12 000 |
| 120BER19H | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (51.5) | (50.0) | 59.5 | 25 | — | 44.2 | 11 300 | 17 600 |
| 120BER19X | 120 | 165 | 22 | — | — | — | 1.1 | 0.6 | (51.5) | (50.0) | 59.5 | 25 | — | 44.2 | 13 400 | 21 100 |
| 7024C | 120 | 180 | 28 | — | — | — | 2 | 1 | 118 | 117 | 75.5 | 15 | 15.8 | 34.1 | 7 700 | 11 700 |
| 7024CSN24 | 120 | 180 | 28 | — | — | — | 2 | 1 | (118) | (117) | 89.4 | 15 | 15.8 | 34.1 | 10 000 | 15 200 |
| 7024A5 | 120 | 180 | 28 | — | — | — | 2 | 1 | 111 | 111 | 87.5 | 25 | — | 49.0 | 6 700 | 10 000 |
| 7024A5SN24 | 120 | 180 | 28 | — | — | — | 2 | 1 | (111) | (111) | 104 | 25 | — | 49.0 | 8 700 | 13 000 |
| 7024A | 120 | 180 | 28 | — | — | — | 2 | 1 | 107 | 107 | 67.5 | 30 | — | 57.3 | 5 000 | 6 700 |
| * 120BNR10E | 120 | 180 | 28 | — | — | — | 2 | 1 | 47.5 | 50.5 | 73.5 | 18 | 11.0 | 38.4 | 9 400 | 13 400 |
| * 120BNR10H | 120 | 180 | 28 | 6.0 | 16.2 | 2.2 | 2 | 1 | (47.5) | (50.5) | 48.0 | 18 | 11.0 | 38.4 | 12 000 | 18 700 |
| * 120BNR10X | 120 | 180 | 28 | 6.0 | 16.2 | 2.2 | 2 | 1 | (47.5) | (50.5) | 48.0 | 18 | 11.0 | 38.4 | 14 000 | 22 000 |
| * 120BER10E | 120 | 180 | 28 | — | — | — | 2 | 1 | 45.5 | 48.5 | 86.0 | 25 | — | 49.0 | 8 000 | 11 400 |
| * 120BER10H | 120 | 180 | 28 | 6.0 | 16.2 | 2.2 | 2 | 1 | (45.5) | (48.5) | 58.0 | 25 | — | 49.0 | 10 700 | 16 700 |
| * 120BER10X | 120 | 180 | 28 | 6.0 | 16.2 | 2.2 | 2 | 1 | (45.5) | (48.5) | 58.0 | 25 | — | 49.0 | 12 700 | 20 000 |
| 7224C | 120 | 215 | 40 | — | — | — | 2.1 | 1.1 | 209 | 192 | 132 | 15 | 14.6 | 42.4 | 6 900 | 10 500 |
| 7224A5 | 120 | 215 | 40 | — | — | — | 2.1 | 1.1 | 199 | 184 | 150 | 25 | — | 59.1 | 6 000 | 9 000 |
| 7224A | 120 | 215 | 40 | — | — | — | 2.1 | 1.1 | 192 | 177 | 116 | 30 | — | 68.3 | 4 500 | 6 000 |

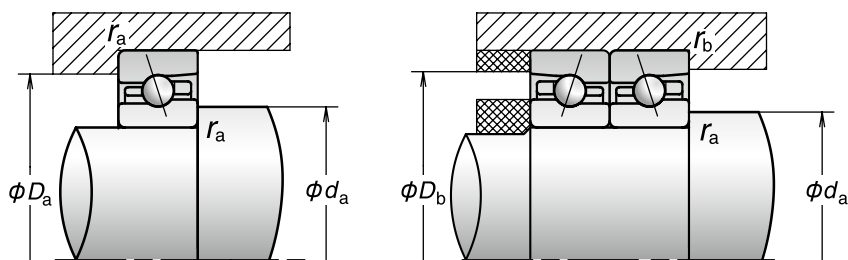
⁽¹⁾ The bearings denoted by an asterisk (*) indicates the bearings which sealed bearings are available. Series 20 is exclusively for sealed bearings.

⁽²⁾ A bearing with BN,SN,SB values at column indicate a bearing which ROBUSTSHOT are available.

⁽³⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽⁴⁾ For permissible axial load, please refer to Page 201.

⁽⁵⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-------|-------|--------|---|-----|-----|-----|--------------------------------------|-----|-----|------|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 127 | 158 | 160 | 1 | 0.6 | 270 | 536 | 1 288 | 2 539 | 102 | 135 | 199 | 278 | -8 | -17 | -35 | -56 | 1.16 |
| 127 | 158 | 160 | 1 | 0.6 | 293 | 600 | 1 474 | 2 935 | 116 | 156 | 232 | 325 | -8 | -17 | -35 | -56 | 0.983 |
| 127 | 158 | 160 | 1 | 0.6 | 461 | 902 | 1 964 | 3 884 | 257 | 328 | 441 | 580 | -7 | -13 | -24 | -39 | 1.15 |
| 127 | 158 | 160 | 1 | 0.6 | 515 | 1 029 | 2 275 | 4 533 | 299 | 384 | 518 | 684 | -7 | -13 | -24 | -39 | 0.973 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 414 | 1 287 | — | 78 | 130 | 200 | — | 0 | -12 | -33 | — | 1.12 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 460 | 1 477 | — | 88 | 150 | 234 | — | 0 | -12 | -33 | — | 0.949 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 460 | 1 477 | — | 88 | 150 | 234 | — | 0 | -12 | -33 | — | 0.949 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 689 | 1 761 | — | 131 | 253 | 355 | — | 0 | -12 | -26 | — | 1.12 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 781 | 2 037 | — | 147 | 296 | 417 | — | 0 | -12 | -26 | — | 0.949 |
| 127 | 158 | 160 | 1 | 0.6 | 98 | 781 | 2 037 | — | 147 | 296 | 417 | — | 0 | -12 | -26 | — | 0.949 |
| 130 | 170 | 174 | 2 | 1 | 422 | 825 | 1 959 | 3 918 | 116 | 153 | 225 | 316 | -14 | -26 | -50 | -79 | 2.09 |
| 130 | 170 | 174 | 2 | 1 | 468 | 936 | 2 260 | 4 557 | 134 | 178 | 264 | 371 | -14 | -26 | -50 | -79 | 1.74 |
| 130 | 170 | 174 | 2 | 1 | 648 | 1 295 | 2 903 | 5 921 | 282 | 363 | 492 | 656 | -10 | -18 | -33 | -54 | 2.43 |
| 130 | 170 | 174 | 2 | 1 | 733 | 1 489 | 3 380 | 6 939 | 329 | 425 | 580 | 774 | -10 | -18 | -33 | -54 | 2.08 |
| 130 | 170 | 174 | 2 | 1 | 98 | 1 439 | 3 645 | 6 531 | 196 | 487 | 683 | 853 | 0 | -15 | -30 | -45 | 2.12 |
| 130 | 170 | 174 | 2 | 1 | 98 | 565 | 1 220 | — | 85 | 159 | 214 | — | 0 | -15 | -29 | — | 2.29 |
| 130 | 170 | 174 | 2 | 1 | 98 | 634 | 1 399 | — | 96 | 185 | 251 | — | 0 | -15 | -29 | — | 2.14 |
| 130 | 170 | 174 | 2 | 1 | 98 | 634 | 1 399 | — | 96 | 185 | 251 | — | 0 | -15 | -29 | — | 2.14 |
| 130 | 170 | 174 | 2 | 1 | 98 | 983 | 1 973 | — | 143 | 313 | 404 | — | 0 | -15 | -26 | — | 2.29 |
| 130 | 170 | 174 | 2 | 1 | 98 | 1 125 | 2 286 | — | 160 | 367 | 475 | — | 0 | -15 | -26 | — | 2.14 |
| 130 | 170 | 174 | 2 | 1 | 98 | 1 125 | 2 286 | — | 160 | 367 | 475 | — | 0 | -15 | -26 | — | 2.14 |
| 132 | 203 | 208 | 2 | 1 | 690 | 1 395 | 3 212 | 6 371 | 127 | 170 | 246 | 343 | -19 | -38 | -73 | -116 | 5.42 |
| 132 | 203 | 208 | 2 | 1 | 1 137 | 2 327 | 5 259 | 1 0296 | 318 | 412 | 562 | 736 | -15 | -28 | -52 | -83 | 5.42 |
| 132 | 203 | 208 | 2 | 1 | 542 | 2 817 | 8 158 | 1 1550 | 321 | 570 | 844 | 964 | -5 | -25 | -55 | -70 | 5.45 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

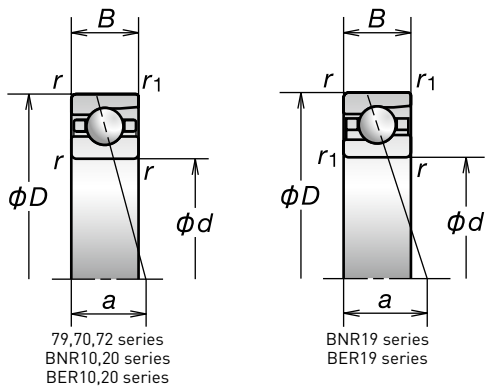
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

1. Angular Contact Ball Bearings

Bore Diameter 130 mm

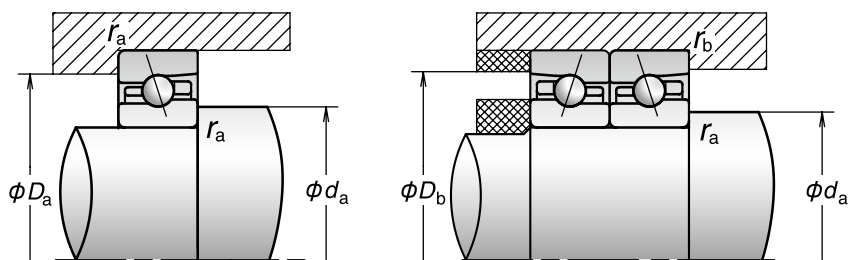


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----------|-----------------------|--|--------------------------|--|------------------------|--------------|------------------------------|---|--------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7926C | 130 | 180 | 24 | 1.5 | 1 | 82.5 | 91.0 | 55.0 | 15 | 16.5 | 32.8 | 7 500 | 11 300 |
| 7926CSN24 | 130 | 180 | 24 | 1.5 | 1 | [82.5] | [91.0] | 65.6 | 15 | 16.5 | 32.8 | 9 700 | 14 800 |
| 7926A5 | 130 | 180 | 24 | 1.5 | 1 | 78.0 | 86.0 | 63.5 | 25 | — | 48.1 | 6 500 | 9 700 |
| 7926A5SN24 | 130 | 180 | 24 | 1.5 | 1 | [78.0] | [86.0] | 75.6 | 25 | — | 48.1 | 8 400 | 12 600 |
| 130BNR19E | 130 | 180 | 24 | 1.5 | 1 | 59.5 | 58.5 | 85.0 | 18 | 10.9 | 37.2 | 9 700 | 13 900 |
| 130BNR19H | 130 | 180 | 24 | 1.5 | 1 | [59.5] | [58.5] | 56.0 | 18 | 10.9 | 37.2 | 11 700 | 18 100 |
| 130BER19E | 130 | 180 | 24 | 1.5 | 1 | 57.0 | 56.5 | 100 | 25 | — | 48.1 | 8 400 | 11 800 |
| 130BER19H | 130 | 180 | 24 | 1.5 | 1 | [57.0] | [56.5] | 67.5 | 25 | — | 48.1 | 10 400 | 16 200 |
| 7026C | 130 | 200 | 33 | 2 | 1 | 136 | 137 | 86.0 | 15 | 15.9 | 38.6 | 7 000 | 10 700 |
| 7026CSN24 | 130 | 200 | 33 | 2 | 1 | [136] | [137] | 102 | 15 | 15.9 | 38.6 | 9 100 | 13 900 |
| 7026A5 | 130 | 200 | 33 | 2 | 1 | 128 | 130 | 99.5 | 25 | — | 55.0 | 6 100 | 9 100 |
| 7026A5SN24 | 130 | 200 | 33 | 2 | 1 | [128] | [130] | 118 | 25 | — | 55.0 | 7 900 | 11 900 |
| 7026A | 130 | 200 | 33 | 2 | 1 | 123 | 125 | 76.5 | 30 | — | 64.1 | 4 600 | 6 100 |
| 130BNR10E | 130 | 200 | 33 | 2 | 1 | 60.0 | 61.5 | 89.5 | 18 | 11.0 | 43.0 | 9 100 | 13 000 |
| 130BNR10H | 130 | 200 | 33 | 2 | 1 | [60.0] | [61.5] | 58.5 | 18 | 11.0 | 43.0 | 11 000 | 17 000 |
| 130BER10E | 130 | 200 | 33 | 2 | 1 | 57.5 | 59.0 | 105 | 25 | — | 55.0 | 7 900 | 11 100 |
| 130BER10H | 130 | 200 | 33 | 2 | 1 | [57.5] | [59.0] | 70.5 | 25 | — | 55.0 | 9 700 | 15 200 |
| 7226C | 130 | 230 | 40 | 3 | 1.1 | 217 | 209 | 144 | 15 | 14.9 | 44.1 | 6 400 | 9 800 |
| 7226A5 | 130 | 230 | 40 | 3 | 1.1 | 206 | 199 | 163 | 25 | — | 62.0 | 5 600 | 8 400 |
| 7226A | 130 | 230 | 40 | 3 | 1.1 | 199 | 193 | 127 | 30 | — | 72.0 | 4 200 | 5 600 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | | | Measured Axial Clearance (μm) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-------|-------|--------|---|-----|-----|-------|-------------------------------|-----|-----|------|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 139 | 171 | 174 | 1.5 | 0.8 | 327 | 652 | 1 466 | 2 943 | 111 | 148 | 213 | 301 | -10 | -20 | -38 | -61 | 1.50 |
| 139 | 171 | 174 | 1.5 | 0.8 | 358 | 734 | 1 682 | 3 410 | 128 | 172 | 249 | 352 | -10 | -20 | -38 | -61 | 1.29 |
| 139 | 171 | 174 | 1.5 | 0.8 | 470 | 1 008 | 2 126 | 4 280 | 264 | 348 | 462 | 612 | -7 | -14 | -25 | -41 | 1.54 |
| 139 | 171 | 174 | 1.5 | 0.8 | 525 | 1 153 | 2 465 | 5 001 | 307 | 408 | 543 | 722 | -7 | -14 | -25 | -41 | 1.33 |
| 139 | 171 | 174 | 1.5 | 0.8 | 98 | 718 | 1 420 | — | 80 | 162 | 212 | — | 0 | -20 | -35 | — | 1.48 |
| 139 | 171 | 174 | 1.5 | 0.8 | 98 | 813 | 1 635 | — | 89 | 189 | 248 | — | 0 | -20 | -35 | — | 1.27 |
| 139 | 171 | 174 | 1.5 | 0.8 | 98 | 982 | 1 899 | — | 134 | 293 | 372 | — | 0 | -16 | -27 | — | 1.48 |
| 139 | 171 | 174 | 1.5 | 0.8 | 98 | 1 123 | 2 199 | — | 150 | 343 | 437 | — | 0 | -16 | -27 | — | 1.27 |
| 140 | 190 | 194 | 2 | 1 | 493 | 970 | 2 252 | 4 518 | 126 | 167 | 244 | 343 | -16 | -29 | -54 | -85 | 3.22 |
| 140 | 190 | 194 | 2 | 1 | 551 | 1 105 | 2 605 | 5 265 | 146 | 195 | 285 | 403 | -16 | -29 | -54 | -85 | 2.77 |
| 140 | 190 | 194 | 2 | 1 | 821 | 1 535 | 3 407 | 6 842 | 316 | 396 | 537 | 710 | -12 | -20 | -36 | -58 | 3.66 |
| 140 | 190 | 194 | 2 | 1 | 935 | 1 772 | 3 974 | 8 025 | 369 | 466 | 632 | 839 | -12 | -20 | -36 | -58 | 3.21 |
| 140 | 190 | 194 | 2 | 1 | 98 | 1 494 | 4 721 | 7 942 | 202 | 508 | 772 | 943 | 0 | -15 | -35 | -50 | 3.26 |
| 140 | 190 | 194 | 2 | 1 | 98 | 739 | 1 522 | — | 82 | 168 | 223 | — | 0 | -20 | -36 | — | 3.41 |
| 140 | 190 | 194 | 2 | 1 | 98 | 837 | 1 754 | — | 92 | 196 | 261 | — | 0 | -20 | -36 | — | 3.19 |
| 140 | 190 | 194 | 2 | 1 | 98 | 1 013 | 1 964 | — | 137 | 304 | 386 | — | 0 | -16 | -27 | — | 3.41 |
| 140 | 190 | 194 | 2 | 1 | 98 | 1 159 | 2 276 | — | 154 | 356 | 454 | — | 0 | -16 | -27 | — | 3.19 |
| 144 | 216 | 223 | 2.5 | 1 | 749 | 1 506 | 3 386 | 6 740 | 136 | 182 | 261 | 364 | -20 | -39 | -73 | -116 | 6.23 |
| 144 | 216 | 223 | 2.5 | 1 | 1 189 | 2 452 | 5 569 | 10 929 | 337 | 438 | 597 | 783 | -15 | -28 | -52 | -83 | 6.22 |
| 144 | 216 | 223 | 2.5 | 1 | 559 | 3 764 | 9 804 | 13 576 | 339 | 660 | 942 | 1 068 | -5 | -30 | -60 | -75 | 6.28 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

Table A

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

Table B

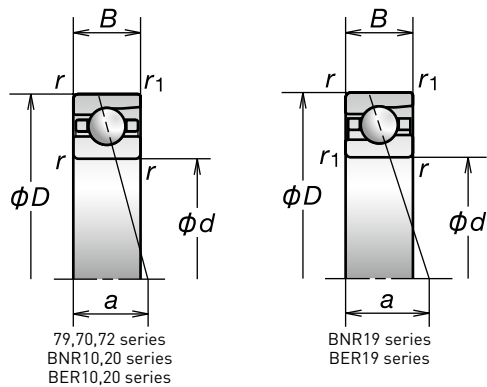
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 140-150 mm

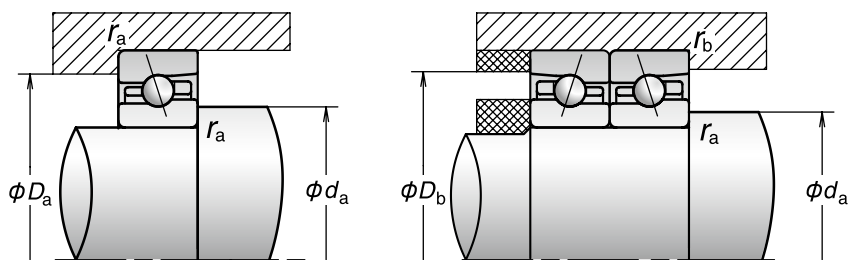


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----------|--------------|--|-------------------|--|------------------------|--------------|--------------------------------|---|--------|
| | d | D | B | r (min.) | r_1 (min.) | C_r (Dynamic) | C_{or} (Static) | | | | | Grease | Oil |
| 7928C | 140 | 190 | 24 | 1.5 | 1 | 83.5 | 95.5 | 58.0 | 15 | 16.7 | 34.1 | 7 000 | 10 700 |
| 7928CSN24 | 140 | 190 | 24 | 1.5 | 1 | (83.5) | (95.5) | 69.1 | 15 | 16.7 | 34.1 | 9 100 | 13 900 |
| 7928A5 | 140 | 190 | 24 | 1.5 | 1 | 78.5 | 90.0 | 68.0 | 25 | — | 50.5 | 6 100 | 9 100 |
| 7928A5SN24 | 140 | 190 | 24 | 1.5 | 1 | (78.5) | (90.0) | 80.7 | 25 | — | 50.5 | 7 900 | 11 900 |
| 140BNR19E | 140 | 190 | 24 | 1.5 | 1 | 60.0 | 61.5 | 89.5 | 18 | 11.0 | 38.8 | 9 100 | 13 000 |
| 140BNR19H | 140 | 190 | 24 | 1.5 | 1 | (60.0) | (61.5) | 58.5 | 18 | 11.0 | 38.8 | 11 000 | 17 000 |
| 140BER19E | 140 | 190 | 24 | 1.5 | 1 | 57.5 | 59.0 | 105 | 25 | — | 50.5 | 7 900 | 11 100 |
| 140BER19H | 140 | 190 | 24 | 1.5 | 1 | (57.5) | (59.0) | 70.5 | 25 | — | 50.5 | 9 700 | 15 200 |
| 7028C | 140 | 210 | 33 | 2 | 1 | 139 | 145 | 90.0 | 15 | 16.0 | 39.9 | 6 600 | 10 000 |
| 7028CSN24 | 140 | 210 | 33 | 2 | 1 | (139) | (145) | 107 | 15 | 16.0 | 39.9 | 8 600 | 13 100 |
| 7028A5 | 140 | 210 | 33 | 2 | 1 | 131 | 138 | 104 | 25 | — | 57.3 | 5 800 | 8 600 |
| 7028A5SN24 | 140 | 210 | 33 | 2 | 1 | (131) | (138) | 124 | 25 | — | 57.3 | 7 500 | 11 200 |
| 7028A | 140 | 210 | 33 | 2 | 1 | 126 | 133 | 80.5 | 30 | — | 67.0 | 4 300 | 5 800 |
| 140BNR10E | 140 | 210 | 33 | 2 | 1 | 62.5 | 66.5 | 97.0 | 18 | 11.0 | 44.9 | 8 600 | 12 300 |
| 140BNR10H | 140 | 210 | 33 | 2 | 1 | (62.5) | (66.5) | 63.5 | 18 | 11.0 | 44.9 | 10 300 | 16 000 |
| 140BER10E | 140 | 210 | 33 | 2 | 1 | 59.5 | 64.0 | 113 | 25 | — | 57.3 | 7 400 | 10 400 |
| 140BER10H | 140 | 210 | 33 | 2 | 1 | (59.5) | (64.0) | 76.5 | 25 | — | 57.3 | 9 200 | 14 300 |
| 7228C | 140 | 250 | 42 | 3 | 1.1 | 250 | 254 | 172 | 15 | 14.8 | 47.1 | 5 900 | 9 000 |
| 7228A5 | 140 | 250 | 42 | 3 | 1.1 | 238 | 242 | 194 | 25 | — | 66.5 | 5 200 | 7 700 |
| 7228A | 140 | 250 | 42 | 3 | 1.1 | 229 | 234 | 150 | 30 | — | 77.3 | 3 900 | 5 200 |
| 7930C | 150 | 210 | 28 | 2 | 1 | 107 | 122 | 74.0 | 15 | 16.6 | 38.1 | 6 400 | 9 800 |
| 7930CSN24 | 150 | 210 | 28 | 2 | 1 | (107) | (122) | 87.9 | 15 | 16.6 | 38.1 | 8 400 | 12 700 |
| 7930A5 | 150 | 210 | 28 | 2 | 1 | 101 | 115 | 84.5 | 25 | — | 56.0 | 5 600 | 8 400 |
| 7930A5SN24 | 150 | 210 | 28 | 2 | 1 | (101) | (115) | 103 | 25 | — | 56.0 | 7 300 | 10 900 |
| 150BNR19S | 150 | 210 | 28 | 2 | 1 | 77.0 | 78.5 | 114 | 18 | 10.8 | 43.2 | 7 800 | 11 200 |
| 150BNR19H | 150 | 210 | 28 | 2 | 1 | (77.0) | (78.5) | 75.0 | 18 | 10.8 | 43.2 | 10 000 | 15 600 |
| 150BER19S | 150 | 210 | 28 | 2 | 1 | 73.5 | 75.5 | 134 | 25 | — | 55.9 | 6 700 | 9 500 |
| 150BER19H | 150 | 210 | 28 | 2 | 1 | (73.5) | (75.5) | 90.5 | 25 | — | 55.9 | 8 900 | 13 900 |
| 7030C | 150 | 225 | 35 | 2.1 | 1.1 | 158 | 168 | 105 | 15 | 16.0 | 42.6 | 6 200 | 9 400 |
| 7030CSN24 | 150 | 225 | 35 | 2.1 | 1.1 | (158) | (168) | 125 | 15 | 16.0 | 42.6 | 8 000 | 12 200 |
| 7030A5 | 150 | 225 | 35 | 2.1 | 1.1 | 150 | 160 | 123 | 25 | — | 61.2 | 5 400 | 8 000 |
| 7030A5SN24 | 150 | 225 | 35 | 2.1 | 1.1 | (150) | (160) | 146 | 25 | — | 61.2 | 7 000 | 10 400 |
| 7030A | 150 | 225 | 35 | 2.1 | 1.1 | 144 | 154 | 95.0 | 30 | — | 71.6 | 4 000 | 5 400 |
| 150BNR10S | 150 | 225 | 35 | 2.1 | 1.1 | 73.5 | 78.0 | 114 | 18 | 11.0 | 48.0 | 7 500 | 10 700 |
| 150BNR10H | 150 | 225 | 35 | 2.1 | 1.1 | (73.5) | (78.0) | 74.5 | 18 | 11.0 | 48.0 | 9 600 | 15 000 |
| 150BER10S | 150 | 225 | 35 | 2.1 | 1.1 | 70.0 | 75.0 | 99.5 | 25 | — | 61.2 | 6 400 | 9 100 |
| 150BER10H | 150 | 225 | 35 | 2.1 | 1.1 | (70.0) | (75.0) | 90.0 | 25 | — | 61.2 | 8 600 | 13 400 |
| 7230C | 150 | 270 | 45 | 3 | 1.1 | 284 | 305 | 205 | 15 | 14.7 | 50.6 | 5 500 | 8 400 |
| 7230A5 | 150 | 270 | 45 | 3 | 1.1 | 270 | 290 | 231 | 25 | — | 71.5 | 4 800 | 7 200 |
| 7230A | 150 | 270 | 45 | 3 | 1.1 | 261 | 280 | 179 | 30 | — | 83.1 | 3 600 | 4 800 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-------|--------|--------|---|-----|-------|-------|--------------------------------------|-----|-----|------|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 149 | 181 | 184 | 1.5 | 0.8 | 334 | 632 | 1 459 | 2 967 | 115 | 150 | 217 | 308 | -10 | -19 | -37 | -60 | 1.63 |
| 149 | 181 | 184 | 1.5 | 0.8 | 366 | 711 | 1 673 | 3 438 | 132 | 174 | 254 | 361 | -10 | -19 | -37 | -60 | 1.41 |
| 149 | 181 | 184 | 1.5 | 0.8 | 482 | 950 | 2 200 | 4 436 | 273 | 349 | 480 | 636 | -7 | -13 | -25 | -41 | 1.63 |
| 149 | 181 | 184 | 1.5 | 0.8 | 539 | 1 086 | 2 552 | 5 185 | 317 | 409 | 564 | 749 | -7 | -13 | -25 | -41 | 1.41 |
| 149 | 181 | 184 | 1.5 | 0.8 | 98 | 739 | 1 522 | — | 82 | 168 | 223 | — | 0 | -20 | -36 | — | 1.57 |
| 149 | 181 | 184 | 1.5 | 0.8 | 98 | 837 | 1 754 | — | 92 | 196 | 261 | — | 0 | -20 | -36 | — | 1.35 |
| 149 | 181 | 184 | 1.5 | 0.8 | 98 | 1 013 | 1 964 | — | 137 | 304 | 386 | — | 0 | -16 | -27 | — | 1.57 |
| 149 | 181 | 184 | 1.5 | 0.8 | 98 | 1 159 | 2 276 | — | 154 | 356 | 454 | — | 0 | -16 | -27 | — | 1.35 |
| 150 | 200 | 204 | 2 | 1 | 503 | 998 | 2 332 | 4 785 | 131 | 174 | 254 | 361 | -11 | -24 | -49 | -81 | 3.41 |
| 150 | 200 | 204 | 2 | 1 | 543 | 1 113 | 2 662 | 5 527 | 150 | 201 | 296 | 422 | -11 | -24 | -49 | -81 | 2.94 |
| 150 | 200 | 204 | 2 | 1 | 787 | 1 516 | 3 444 | 6 817 | 320 | 406 | 554 | 729 | -9 | -17 | -33 | -54 | 3.87 |
| 150 | 200 | 204 | 2 | 1 | 873 | 1 721 | 3 979 | 7 947 | 371 | 474 | 651 | 859 | -9 | -17 | -33 | -54 | 3.40 |
| 150 | 200 | 204 | 2 | 1 | 196 | 1 782 | 5 273 | 8 717 | 262 | 557 | 829 | 1 006 | 0 | -15 | -35 | -50 | 3.44 |
| 150 | 200 | 204 | 2 | 1 | 196 | 766 | 1 642 | — | 114 | 186 | 250 | — | 0 | -15 | -31 | — | 3.65 |
| 150 | 200 | 204 | 2 | 1 | 196 | 848 | 1 865 | — | 128 | 215 | 292 | — | 0 | -15 | -31 | — | 3.42 |
| 150 | 200 | 204 | 2 | 1 | 196 | 1 075 | 2 257 | — | 190 | 340 | 445 | — | 0 | -13 | -25 | — | 3.65 |
| 150 | 200 | 204 | 2 | 1 | 196 | 1 208 | 2 589 | — | 213 | 396 | 521 | — | 0 | -13 | -25 | — | 3.42 |
| 154 | 236 | 243 | 2.5 | 1 | 910 | 1 832 | 4 081 | 8 296 | 150 | 200 | 286 | 404 | -24 | -45 | -82 | -131 | 7.91 |
| 154 | 236 | 243 | 2.5 | 1 | 1 499 | 3 010 | 6 731 | 13 407 | 376 | 484 | 657 | 867 | -18 | -32 | -58 | -93 | 7.91 |
| 154 | 236 | 243 | 2.5 | 1 | 573 | 4 992 | 11 447 | 15 522 | 352 | 751 | 1 022 | 1 149 | -5 | -36 | -65 | -80 | 7.97 |
| 160 | 200 | 204 | 2 | 1 | 387 | 825 | 1 969 | 3 990 | 123 | 168 | 248 | 351 | -7 | -19 | -41 | -68 | 2.96 |
| 160 | 200 | 204 | 2 | 1 | 411 | 912 | 2 238 | 4 593 | 140 | 193 | 288 | 410 | -7 | -19 | -41 | -68 | 2.64 |
| 160 | 200 | 204 | 2 | 1 | 651 | 1 269 | 2 914 | 5 914 | 310 | 395 | 541 | 720 | -7 | -14 | -28 | -47 | 2.97 |
| 160 | 200 | 204 | 2 | 1 | 715 | 1 433 | 3 355 | 6 881 | 358 | 460 | 634 | 847 | -7 | -14 | -28 | -47 | 2.65 |
| 160 | 200 | 204 | 2 | 1 | 196 | 937 | 1 910 | — | 106 | 186 | 245 | — | 0 | -20 | -38 | — | 2.46 |
| 160 | 200 | 204 | 2 | 1 | 196 | 1 046 | 2 179 | — | 119 | 216 | 286 | — | 0 | -20 | -38 | — | 2.14 |
| 160 | 200 | 204 | 2 | 1 | 196 | 1 321 | 2 580 | — | 177 | 340 | 433 | — | 0 | -17 | -30 | — | 2.46 |
| 160 | 200 | 204 | 2 | 1 | 196 | 1 494 | 2 967 | — | 198 | 396 | 508 | — | 0 | -17 | -30 | — | 2.14 |
| 162 | 213 | 218 | 2 | 1 | 577 | 1 149 | 2 764 | 5 487 | 140 | 186 | 276 | 386 | -13 | -27 | -55 | -88 | 4.15 |
| 162 | 213 | 218 | 2 | 1 | 629 | 1 288 | 3 167 | 6 352 | 161 | 215 | 322 | 452 | -13 | -27 | -55 | -88 | 3.56 |
| 162 | 213 | 218 | 2 | 1 | 973 | 1 877 | 4 118 | 8 340 | 353 | 448 | 603 | 802 | -11 | -20 | -37 | -61 | 4.69 |
| 162 | 213 | 218 | 2 | 1 | 1 089 | 2 142 | 4 771 | 9 741 | 410 | 524 | 709 | 945 | -11 | -20 | -37 | -61 | 4.10 |
| 162 | 213 | 218 | 2 | 1 | 196 | 1 828 | 5 852 | 11 679 | 268 | 574 | 877 | 1 145 | 0 | -15 | -37 | -60 | 4.19 |
| 162 | 213 | 218 | 2 | 1 | 196 | 916 | 1 908 | — | 115 | 200 | 266 | — | 0 | -18 | -35 | — | 4.41 |
| 162 | 213 | 218 | 2 | 1 | 196 | 1 021 | 2 177 | — | 129 | 232 | 310 | — | 0 | -18 | -35 | — | 4.13 |
| 162 | 213 | 218 | 2 | 1 | 196 | 1 262 | 2 624 | — | 192 | 363 | 473 | — | 0 | -15 | -28 | — | 4.41 |
| 162 | 213 | 218 | 2 | 1 | 196 | 1 425 | 3 019 | — | 215 | 423 | 554 | — | 0 | -15 | -28 | — | 4.13 |
| 164 | 256 | 263 | 2.5 | 1 | 1 093 | 2 203 | 4 952 | 9 979 | 165 | 220 | 316 | 444 | -28 | -51 | -92 | -145 | 11.10 |
| 164 | 256 | 263 | 2.5 | 1 | 1 854 | 3 642 | 8 044 | 16 467 | 417 | 533 | 720 | 961 | -21 | -36 | -64 | -104 | 11.10 |
| 164 | 256 | 263 | 2.5 | 1 | 587 | 5 000 | 11 917 | 16 154 | 366 | 772 | 1 063 | 1 194 | -5 | -35 | -65 | -80 | 11.20 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

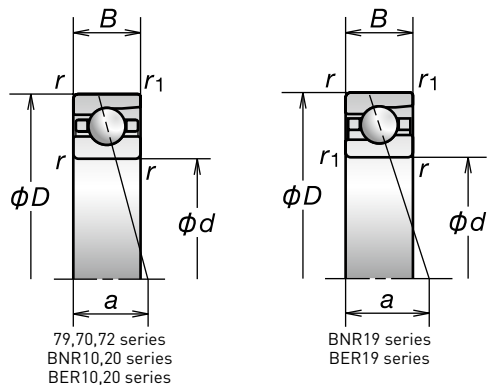
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 160-180 mm

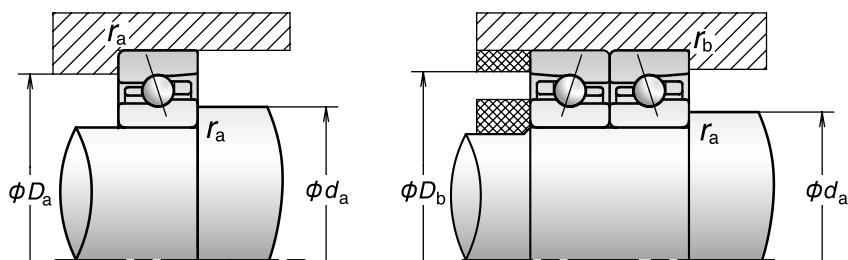


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----------|--------------|--|-------------------|--|------------------------|--------------|--------------------------------|---|--------|
| | d | D | B | r (min.) | r_1 (min.) | C_r (Dynamic) | C_{or} (Static) | | | | | Grease | Oil |
| 7932C | 160 | 220 | 28 | 2 | 1 | 112 | 133 | 80.0 | 15 | 16.7 | 39.4 | 5 600 | 8 700 |
| 7932CSN24 | 160 | 220 | 28 | 2 | 1 | [112] | [133] | 94.8 | 15 | 16.7 | 39.4 | 7 400 | 11 500 |
| 7932A5 | 160 | 220 | 28 | 2 | 1 | 105 | 125 | 93.5 | 25 | — | 58.3 | 4 800 | 7 400 |
| 7932A5SN24 | 160 | 220 | 28 | 2 | 1 | [105] | [125] | 111 | 25 | — | 58.3 | 6 400 | 9 800 |
| 160BNR19S | 160 | 220 | 28 | 2 | 1 | 80.0 | 85.5 | 124 | 18 | 10.9 | 44.9 | 6 900 | 10 000 |
| 160BNR19H | 160 | 220 | 28 | 2 | 1 | [80.0] | [85.5] | 81.5 | 18 | 10.9 | 44.9 | 9 000 | 14 300 |
| 160BER19S | 160 | 220 | 28 | 2 | 1 | 76.5 | 82.0 | 146 | 25 | — | 58.3 | 5 800 | 8 500 |
| 160BER19H | 160 | 220 | 28 | 2 | 1 | [76.5] | [82.0] | 98.5 | 25 | — | 58.3 | 7 900 | 12 700 |
| 7032C | 160 | 240 | 38 | 2.1 | 1.1 | 180 | 193 | 118 | 15 | 16.0 | 45.8 | 5 300 | 8 300 |
| 7032CSN24 | 160 | 240 | 38 | 2.1 | 1.1 | [180] | [193] | 140 | 15 | 16.0 | 45.8 | 7 000 | 10 900 |
| 7032A5 | 160 | 240 | 38 | 2.1 | 1.1 | 170 | 183 | 138 | 25 | — | 65.6 | 4 500 | 7 000 |
| 7032A5SN24 | 160 | 240 | 38 | 2.1 | 1.1 | [170] | [183] | 168 | 25 | — | 65.6 | 6 000 | 9 300 |
| 7032A | 160 | 240 | 38 | 2.1 | 1.1 | 163 | 176 | 106 | 30 | — | 76.7 | 3 300 | 4 500 |
| 160BNR10S | 160 | 240 | 38 | 2.1 | 1.1 | 83.0 | 92.5 | 134 | 18 | 11.0 | 51.5 | 6 500 | 9 500 |
| 160BNR10H | 160 | 240 | 38 | 2.1 | 1.1 | [83.0] | [92.5] | 88.0 | 18 | 11.0 | 51.5 | 8 500 | 13 500 |
| 160BER10S | 160 | 240 | 38 | 2.1 | 1.1 | 79.5 | 88.5 | 158 | 25 | — | 65.6 | 5 500 | 8 000 |
| 160BER10H | 160 | 240 | 38 | 2.1 | 1.1 | [79.5] | [88.5] | 106 | 25 | — | 65.6 | 7 500 | 12 000 |
| 7232A | 160 | 290 | 48 | 3 | 1.1 | 263 | 305 | 195 | 30 | — | 89 | 2 900 | 4 000 |
| 7934C | 170 | 230 | 28 | 2 | 1 | 118 | 148 | 88.5 | 15 | 16.8 | 40.8 | 5 300 | 8 300 |
| 7934CSN24 | 170 | 230 | 28 | 2 | 1 | [118] | [148] | 105 | 15 | 16.8 | 40.8 | 7 000 | 10 900 |
| 7934A5 | 170 | 230 | 28 | 2 | 1 | 112 | 140 | 103 | 25 | — | 60.6 | 4 500 | 7 000 |
| 7934A5SN24 | 170 | 230 | 28 | 2 | 1 | [112] | [140] | 124 | 25 | — | 60.6 | 6 000 | 9 300 |
| 170BNR19S | 170 | 230 | 28 | 2 | 1 | 85.0 | 95.5 | 104 | 18 | 11.0 | 46.5 | 6 500 | 9 500 |
| 170BNR19H | 170 | 230 | 28 | 2 | 1 | [85.0] | [95.5] | 91.0 | 18 | 11.0 | 46.5 | 8 500 | 13 500 |
| 170BER19S | 170 | 230 | 28 | 2 | 1 | 81.0 | 91.5 | 163 | 25 | — | 60.6 | 5 500 | 8 000 |
| 170BER19H | 170 | 230 | 28 | 2 | 1 | [81.0] | [91.5] | 110 | 25 | — | 60.6 | 7 500 | 12 000 |
| 7034C | 170 | 260 | 42 | 2.1 | 1.1 | 215 | 234 | 149 | 15 | 15.9 | 49.8 | 4 900 | 7 700 |
| 7034A5 | 170 | 260 | 42 | 2.1 | 1.1 | 203 | 223 | 168 | 25 | — | 71.1 | 4 200 | 6 600 |
| 7034A | 170 | 260 | 42 | 2.1 | 1.1 | 195 | 214 | 129 | 30 | — | 83.1 | 3 100 | 4 200 |
| 7234C | 170 | 310 | 52 | 4 | 1.5 | 320 | 390 | 265 | 15 | 14.7 | 58.2 | 4 400 | 6 900 |
| 7234A | 170 | 310 | 52 | 4 | 1.5 | 295 | 360 | 231 | 30 | — | 95.3 | 2 800 | 3 800 |
| 7936C | 180 | 250 | 33 | 2 | 1 | 152 | 184 | 111 | 15 | 16.6 | 45.3 | 4 900 | 7 700 |
| 7936CSN24 | 180 | 250 | 33 | 2 | 1 | [152] | [184] | 132 | 15 | 16.6 | 45.3 | 6 600 | 10 200 |
| 7936A5 | 180 | 250 | 33 | 2 | 1 | 144 | 174 | 128 | 25 | — | 66.6 | 4 200 | 6 600 |
| 7936A5SN24 | 180 | 250 | 33 | 2 | 1 | [144] | [174] | 152 | 25 | — | 66.6 | 5 600 | 8 700 |
| 180BNR19S | 180 | 250 | 33 | 2 | 1 | 110 | 119 | 173 | 18 | 10.9 | 51.4 | 6 100 | 8 900 |
| 180BNR19H | 180 | 250 | 33 | 2 | 1 | [110] | [119] | 114 | 18 | 10.9 | 51.4 | 8 000 | 12 600 |
| 180BER19S | 180 | 250 | 33 | 2 | 1 | 105 | 114 | 203 | 25 | — | 66.6 | 5 200 | 7 500 |
| 180BER19H | 180 | 250 | 33 | 2 | 1 | [105] | [114] | 137 | 25 | — | 66.6 | 7 000 | 11 200 |
| 7036C | 180 | 280 | 46 | 2.1 | 1.1 | 240 | 276 | 175 | 15 | 15.8 | 53.8 | 4 600 | 7 200 |
| 7036A5 | 180 | 280 | 46 | 2.1 | 1.1 | 227 | 262 | 195 | 25 | — | 76.6 | 4 000 | 6 100 |
| 7036A | 180 | 280 | 46 | 2.1 | 1.1 | 218 | 252 | 151 | 30 | — | 89.4 | 2 900 | 4 000 |
| 7236A | 180 | 320 | 52 | 4 | 1.5 | 305 | 385 | 246 | 30 | — | 98.2 | 2 600 | 3 600 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|-------|--------|--------|---|-----|-------|-------|-------------------------------------|-----|------|------|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 170 | 210 | 214 | 2 | 1 | 431 | 863 | 1 954 | 3 882 | 134 | 179 | 258 | 360 | -8 | -19 | -39 | -64 | 3.10 |
| 170 | 210 | 214 | 2 | 1 | 461 | 956 | 2 222 | 4 469 | 153 | 206 | 299 | 420 | -8 | -19 | -39 | -64 | 2.75 |
| 170 | 210 | 214 | 2 | 1 | 678 | 1 340 | 3 252 | 6 333 | 330 | 423 | 592 | 774 | -7 | -14 | -29 | -47 | 3.12 |
| 170 | 210 | 214 | 2 | 1 | 747 | 1 516 | 3 753 | 7 375 | 382 | 493 | 695 | 912 | -7 | -14 | -29 | -47 | 2.77 |
| 170 | 210 | 214 | 2 | 1 | 196 | 1 035 | 2 093 | — | 112 | 203 | 266 | — | 0 | -21 | -39 | — | 2.65 |
| 170 | 210 | 214 | 2 | 1 | 196 | 1 159 | 2 392 | — | 125 | 235 | 311 | — | 0 | -21 | -39 | — | 2.31 |
| 170 | 210 | 214 | 2 | 1 | 196 | 1 396 | 2 747 | — | 186 | 364 | 465 | — | 0 | -17 | -30 | — | 2.65 |
| 170 | 210 | 214 | 2 | 1 | 196 | 1 581 | 3 163 | — | 208 | 425 | 546 | — | 0 | -17 | -30 | — | 2.31 |
| 172 | 228 | 233 | 2 | 1 | 623 | 1 270 | 2 968 | 5 798 | 147 | 197 | 288 | 399 | -14 | -29 | -57 | -90 | 5.11 |
| 172 | 228 | 233 | 2 | 1 | 681 | 1 429 | 3 407 | 6 718 | 169 | 229 | 336 | 468 | -14 | -29 | -57 | -90 | 4.29 |
| 172 | 228 | 233 | 2 | 1 | 1 090 | 2 168 | 4 725 | 9 446 | 376 | 483 | 649 | 858 | -12 | -22 | -40 | -65 | 5.71 |
| 172 | 228 | 233 | 2 | 1 | 1 225 | 2 484 | 5 485 | 11 045 | 438 | 566 | 764 | 1 012 | -12 | -22 | -40 | -65 | 4.99 |
| 172 | 228 | 233 | 2 | 1 | 196 | 1 883 | 5 601 | 12 072 | 276 | 594 | 882 | 1 183 | 0 | -15 | -35 | -60 | 5.16 |
| 172 | 228 | 233 | 2 | 1 | 196 | 1 085 | 2 284 | — | 117 | 216 | 288 | — | 0 | -21 | -40 | — | 5.50 |
| 172 | 228 | 233 | 2 | 1 | 196 | 1 217 | 2 616 | — | 131 | 251 | 337 | — | 0 | -21 | -40 | — | 5.20 |
| 172 | 228 | 233 | 2 | 1 | 196 | 1 470 | 3 039 | — | 195 | 388 | 505 | — | 0 | -17 | -31 | — | 5.50 |
| 172 | 228 | 233 | 2 | 1 | 196 | 1 668 | 3 506 | — | 218 | 453 | 593 | — | 0 | -17 | -31 | — | 5.20 |
| 174 | 276 | 283 | 2.5 | 1 | 1 120 | 4 154 | 15 301 | 23 729 | 464 | 733 | 1 185 | 1 405 | -10 | -30 | -76 | -102 | 14.1 |
| 180 | 220 | 224 | 2 | 1 | 486 | 968 | 2 186 | 4 334 | 150 | 200 | 287 | 400 | -9 | -20 | -40 | -65 | 3.36 |
| 180 | 220 | 224 | 2 | 1 | 524 | 1 079 | 2 492 | 4 998 | 172 | 231 | 334 | 468 | -9 | -20 | -40 | -65 | 2.97 |
| 180 | 220 | 224 | 2 | 1 | 812 | 1 564 | 3 553 | 7 173 | 377 | 478 | 653 | 867 | -8 | -15 | -29 | -48 | 3.36 |
| 180 | 220 | 224 | 2 | 1 | 902 | 1 777 | 4 106 | 8 365 | 437 | 558 | 767 | 1 021 | -8 | -15 | -29 | -48 | 2.97 |
| 180 | 220 | 224 | 2 | 1 | 196 | 1 166 | 2 346 | — | 120 | 226 | 297 | — | 0 | -22 | -40 | — | 2.86 |
| 180 | 220 | 224 | 2 | 1 | 196 | 1 311 | 2 689 | — | 134 | 263 | 346 | — | 0 | -22 | -40 | — | 2.47 |
| 180 | 220 | 224 | 2 | 1 | 196 | 1 507 | 3 126 | — | 199 | 400 | 521 | — | 0 | -17 | -31 | — | 2.86 |
| 180 | 220 | 224 | 2 | 1 | 196 | 1 712 | 3 609 | — | 223 | 468 | 612 | — | 0 | -17 | -31 | — | 2.47 |
| 182 | 248 | 253 | 2 | 1 | 777 | 1 572 | 3 598 | 7 104 | 160 | 214 | 309 | 431 | -18 | -35 | -66 | -104 | 6.88 |
| 182 | 248 | 253 | 2 | 1 | 1 292 | 2 555 | 5 927 | 11 666 | 401 | 514 | 708 | 930 | -14 | -25 | -47 | -75 | 7.83 |
| 182 | 248 | 253 | 2 | 1 | 196 | 2 697 | 6 086 | 12 116 | 278 | 678 | 910 | 1 181 | 0 | -20 | -37 | -60 | 6.94 |
| 188 | 292 | 301 | 3 | 1.5 | 1 493 | 3 005 | 6 205 | 12 460 | 192 | 256 | 354 | 496 | -36 | -63 | -105 | -164 | 19.4 |
| 188 | 292 | 301 | 3 | 1.5 | 1 394 | 6 746 | 17 921 | 28 082 | 512 | 890 | 1 278 | 1 522 | -12 | -42 | -83 | -112 | 17.3 |
| 190 | 240 | 244 | 2 | 1 | 591 | 1 138 | 2 659 | 5 370 | 158 | 206 | 301 | 423 | -12 | -24 | -48 | -78 | 4.90 |
| 190 | 240 | 244 | 2 | 1 | 645 | 1 276 | 3 047 | 6 217 | 181 | 239 | 351 | 496 | -12 | -24 | -48 | -78 | 4.33 |
| 190 | 240 | 244 | 2 | 1 | 990 | 2 017 | 4 440 | 8 876 | 397 | 514 | 694 | 917 | -10 | -19 | -35 | -57 | 4.94 |
| 190 | 240 | 244 | 2 | 1 | 1 108 | 2 307 | 5 150 | 10 373 | 461 | 602 | 816 | 1 081 | -10 | -19 | -35 | -57 | 4.37 |
| 190 | 240 | 244 | 2 | 1 | 196 | 1 427 | 2 958 | — | 118 | 239 | 317 | — | 0 | -27 | -49 | — | 4.17 |
| 190 | 240 | 244 | 2 | 1 | 196 | 1 617 | 3 408 | — | 132 | 278 | 371 | — | 0 | -27 | -49 | — | 3.60 |
| 190 | 240 | 244 | 2 | 1 | 196 | 1 887 | 3 847 | — | 196 | 426 | 551 | — | 0 | -21 | -37 | — | 4.17 |
| 190 | 240 | 244 | 2 | 1 | 196 | 2 156 | 4 456 | — | 220 | 498 | 648 | — | 0 | -21 | -37 | — | 3.60 |
| 192 | 268 | 273 | 2 | 1 | 938 | 1 880 | 4 201 | 8 277 | 179 | 239 | 342 | 475 | -21 | -39 | -71 | -111 | 10.4 |
| 192 | 268 | 273 | 2 | 1 | 1 580 | 3 130 | 6 880 | 13 679 | 451 | 579 | 781 | 1 030 | -16 | -28 | -50 | -80 | 10.4 |
| 192 | 268 | 273 | 2 | 1 | 196 | 3 618 | 7 232 | 14 216 | 292 | 788 | 1 013 | 1 309 | 0 | -24 | -40 | -64 | 9.27 |
| 198 | 302 | 311 | 3 | 1.5 | 1 458 | 7 364 | 18 983 | 29 769 | 541 | 955 | 1 357 | 1 616 | -12 | -43 | -83 | -112 | 18.1 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

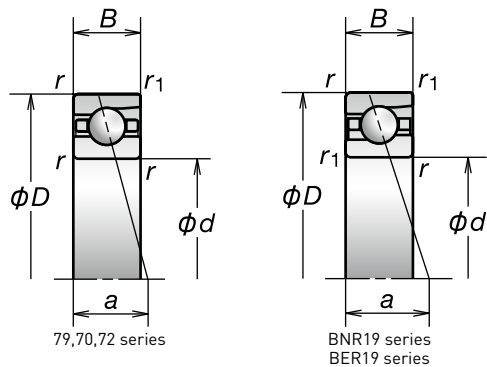
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

Bore Diameter 190-260 mm

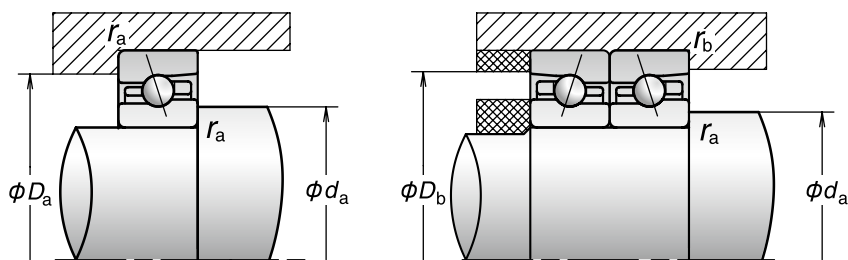


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----------|-----------------------|--|--------------------------|--|------------------------|--------------|--------------------------------|---|--------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | | | Grease | Oil |
| 7938C | 190 | 260 | 33 | 2 | 1 | 155 | 192 | 115 | 15 | 16.7 | 46.6 | 4 700 | 7 400 |
| 7938CSN24 | 190 | 260 | 33 | 2 | 1 | (155) | (192) | 137 | 15 | 16.7 | 46.6 | 6 300 | 9 700 |
| 7938A5 | 190 | 260 | 33 | 2 | 1 | 146 | 182 | 131 | 25 | — | 69.0 | 4 000 | 6 300 |
| 7938A5SN24 | 190 | 260 | 33 | 2 | 1 | (146) | (182) | 158 | 25 | — | 69.0 | 5 400 | 8 300 |
| 190BNR19S | 190 | 260 | 33 | 2 | 1 | 111 | 124 | 181 | 18 | 10.9 | 53.1 | 5 800 | 8 500 |
| 190BNR19H | 190 | 260 | 33 | 2 | 1 | (111) | (124) | 119 | 18 | 10.9 | 53.1 | 7 600 | 12 000 |
| 190BER19S | 190 | 260 | 33 | 2 | 1 | 106 | 119 | 212 | 25 | — | 69.0 | 4 900 | 7 200 |
| 190BER19H | 190 | 260 | 33 | 2 | 1 | (106) | (119) | 143 | 25 | — | 69.0 | 6 700 | 10 700 |
| 7038C | 190 | 290 | 46 | 2.1 | 1.1 | 259 | 305 | 192 | 15 | 15.9 | 55.2 | 4 400 | 6 900 |
| 7038A5 | 190 | 290 | 46 | 2.1 | 1.1 | 245 | 291 | 222 | 25 | — | 79.0 | 3 800 | 5 900 |
| 7038A | 190 | 290 | 46 | 2.1 | 1.1 | 235 | 280 | 172 | 30 | — | 92.3 | 2 800 | 3 800 |
| 7238C | 190 | 340 | 55 | 4 | 1.5 | 345 | 450 | 293 | 15 | 15.2 | 63.0 | 4 000 | 6 300 |
| 7238A | 190 | 340 | 55 | 4 | 1.5 | 315 | 410 | 261 | 30 | — | 104.0 | 2 500 | 3 400 |
| 7940C | 200 | 280 | 38 | 2.1 | 1.1 | 199 | 244 | 144 | 15 | 16.5 | 51.2 | 4 400 | 6 900 |
| 7940CSN24 | 200 | 280 | 38 | 2.1 | 1.1 | (199) | (244) | 171 | 15 | 16.5 | 51.2 | 5 900 | 9 100 |
| 7940A5 | 200 | 280 | 38 | 2.1 | 1.1 | 187 | 231 | 170 | 25 | — | 75.0 | 3 800 | 5 900 |
| 7940A5SN24 | 200 | 280 | 38 | 2.1 | 1.1 | (187) | (231) | 202 | 25 | — | 75.0 | 5 000 | 7 800 |
| 200BNR19S | 200 | 280 | 38 | 2.1 | 1.1 | 142 | 157 | 229 | 18 | 10.8 | 58.0 | 5 500 | 8 000 |
| 200BNR19H | 200 | 280 | 38 | 2.1 | 1.1 | (142) | (157) | 150 | 18 | 10.8 | 58.0 | 7 100 | 11 300 |
| 200BER19S | 200 | 280 | 38 | 2.1 | 1.1 | 136 | 151 | 269 | 25 | — | 75.0 | 4 600 | 6 700 |
| 200BER19H | 200 | 280 | 38 | 2.1 | 1.1 | (136) | (151) | 181 | 25 | — | 75.0 | 6 300 | 10 000 |
| 7040C | 200 | 310 | 51 | 2.1 | 1.1 | 278 | 340 | 213 | 15 | 15.9 | 59.7 | 4 200 | 6 500 |
| 7040A5 | 200 | 310 | 51 | 2.1 | 1.1 | 263 | 325 | 245 | 25 | — | 85.0 | 3 600 | 5 500 |
| 7040A | 200 | 310 | 51 | 2.1 | 1.1 | 252 | 310 | 190 | 30 | — | 99.1 | 2 600 | 3 600 |
| 7240C | 200 | 360 | 58 | 4 | 1.5 | 370 | 490 | 320 | 15 | 15.1 | 66.5 | 3 800 | 5 900 |
| 7240A | 200 | 360 | 58 | 4 | 1.5 | 335 | 450 | 281 | 30 | — | 109.8 | 2 400 | 3 300 |
| 7944C | 220 | 300 | 38 | 2.1 | 1.1 | 200 | 256 | 150 | 15 | 16.7 | 53.8 | 4 100 | 6 400 |
| 7944CSN24 | 220 | 300 | 38 | 2.1 | 1.1 | (200) | (256) | 178 | 15 | 16.7 | 53.8 | 5 400 | 8 400 |
| 7944A5 | 220 | 300 | 38 | 2.1 | 1.1 | 188 | 242 | 176 | 25 | — | 79.6 | 3 500 | 5 400 |
| 7944A5SN24 | 220 | 300 | 38 | 2.1 | 1.1 | (188) | (242) | 117 | 25 | — | 79.6 | 4 700 | 7 200 |
| 7044C | 220 | 340 | 56 | 3 | 1.1 | 310 | 430 | 266 | 15 | 15.9 | 65.5 | 3 800 | 5 900 |
| 7044A | 220 | 340 | 56 | 3 | 1.1 | 283 | 395 | 235 | 30 | — | 108.8 | 2 400 | 3 300 |
| 7244A | 220 | 400 | 65 | 4 | 1.5 | 410 | 585 | 385 | 30 | — | 122.0 | 2 100 | 3 000 |
| 7948C | 240 | 320 | 38 | 2.1 | 1.1 | 210 | 286 | 166 | 15 | 16.8 | 56.5 | 3 800 | 5 900 |
| 7948CSN24 | 240 | 320 | 38 | 2.1 | 1.1 | (210) | (286) | 197 | 15 | 16.8 | 56.5 | 5 000 | 7 800 |
| 7948A5 | 240 | 320 | 38 | 2.1 | 1.1 | 198 | 270 | 195 | 25 | — | 84.3 | 3 300 | 5 000 |
| 7948A5SN24 | 240 | 320 | 38 | 2.1 | 1.1 | (198) | (270) | 231 | 25 | — | 84.3 | 4 300 | 6 700 |
| 7048C | 240 | 360 | 56 | 3 | 1.1 | 330 | 475 | 292 | 15 | 15.9 | 68.2 | 3 500 | 5 500 |
| 7048A | 240 | 360 | 56 | 3 | 1.1 | 300 | 430 | 265 | 30 | — | 114.6 | 2 200 | 3 000 |
| 7952C | 260 | 360 | 46 | 2.1 | 1.1 | 268 | 365 | 350 | 15 | 16.6 | 64.5 | 3 400 | 5 400 |
| 7952A5 | 260 | 360 | 46 | 2.1 | 1.1 | 253 | 345 | 255 | 25 | — | 95.3 | 3 000 | 4 600 |
| 7052A5 | 260 | 400 | 65 | 4 | 1.5 | 360 | 545 | 420 | 25 | — | 109.4 | 2 800 | 4 300 |
| 7052A | 260 | 400 | 65 | 4 | 1.5 | 345 | 525 | 325 | 30 | — | 127.8 | 2 000 | 2 800 |
| 7252A | 260 | 480 | 80 | 5 | 2 | 480 | 750 | 475 | 30 | — | 146.8 | 1 800 | 2 500 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|--------|--------|--------|---|-------|-------|-------|--------------------------------------|-----|------|------|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 200 | 250 | 254 | 2 | 1 | 602 | 1 219 | 2 815 | 5 649 | 163 | 217 | 315 | 442 | -12 | -25 | -49 | -79 | 4.98 |
| 200 | 250 | 254 | 2 | 1 | 657 | 1 370 | 3 228 | 6 543 | 187 | 252 | 368 | 518 | -12 | -25 | -49 | -79 | 4.38 |
| 200 | 250 | 254 | 2 | 1 | 1 013 | 2 075 | 4 582 | 9 175 | 410 | 531 | 718 | 950 | -10 | -19 | -35 | -57 | 5.12 |
| 200 | 250 | 254 | 2 | 1 | 1 136 | 2 375 | 5 318 | 10 726 | 476 | 622 | 845 | 1 120 | -10 | -19 | -35 | -57 | 4.52 |
| 200 | 250 | 254 | 2 | 1 | 196 | 1 466 | 3 049 | — | 120 | 247 | 328 | — | 0 | -27 | -49 | — | 4.38 |
| 200 | 250 | 254 | 2 | 1 | 196 | 1 661 | 3 512 | — | 135 | 288 | 384 | — | 0 | -27 | -49 | — | 3.78 |
| 200 | 250 | 254 | 2 | 1 | 196 | 2 052 | 4 112 | — | 201 | 449 | 578 | — | 0 | -22 | -38 | — | 4.38 |
| 200 | 250 | 254 | 2 | 1 | 196 | 2 349 | 4 768 | — | 226 | 526 | 679 | — | 0 | -22 | -38 | — | 3.78 |
| 202 | 278 | 283 | 2 | 1 | 1 042 | 2 087 | 4 682 | 9 306 | 189 | 251 | 360 | 502 | -23 | -42 | -76 | -119 | 11.2 |
| 202 | 278 | 283 | 2 | 1 | 1 723 | 3 640 | 7 610 | 15 239 | 472 | 619 | 820 | 1 084 | -17 | -31 | -53 | -85 | 11.2 |
| 202 | 278 | 283 | 2 | 1 | 196 | 3 890 | 8 161 | 16 183 | 287 | 819 | 1 073 | 1 390 | 0 | -25 | -43 | -69 | 11.3 |
| 208 | 322 | 331 | 3 | 1.5 | 1 680 | 3 382 | 6 984 | 14 023 | 216 | 288 | 398 | 558 | -37 | -64 | -106 | -165 | 22.2 |
| 208 | 322 | 331 | 3 | 1.5 | 1 520 | 7 758 | 20 405 | 31 456 | 570 | 1 009 | 1 445 | 1 710 | -12 | -43 | -84 | -112 | 22.4 |
| 212 | 268 | 273 | 2 | 1 | 784 | 1 584 | 3 592 | 7 168 | 183 | 244 | 351 | 492 | -16 | -31 | -58 | -92 | 5.95 |
| 212 | 268 | 273 | 2 | 1 | 867 | 1 794 | 4 138 | 8 330 | 211 | 284 | 411 | 577 | -16 | -31 | -58 | -92 | 5.07 |
| 212 | 268 | 273 | 2 | 1 | 1 256 | 2 554 | 5 855 | 11 667 | 451 | 584 | 800 | 1 056 | -12 | -22 | -41 | -66 | 5.95 |
| 212 | 268 | 273 | 2 | 1 | 1 418 | 2 938 | 6 817 | 13 669 | 526 | 685 | 942 | 1 247 | -12 | -22 | -41 | -66 | 5.07 |
| 212 | 268 | 273 | 2 | 1 | 196 | 1 888 | 3 887 | — | 123 | 275 | 364 | — | 0 | -33 | -58 | — | 5.95 |
| 212 | 268 | 273 | 2 | 1 | 196 | 2 156 | 4 499 | — | 138 | 321 | 427 | — | 0 | -33 | -58 | — | 5.07 |
| 212 | 268 | 273 | 2 | 1 | 196 | 2 581 | 5 136 | — | 206 | 496 | 636 | — | 0 | -26 | -44 | — | 5.95 |
| 212 | 268 | 273 | 2 | 1 | 196 | 2 970 | 5 974 | — | 230 | 582 | 749 | — | 0 | -26 | -44 | — | 5.07 |
| 212 | 298 | 303 | 2 | 1 | 1 153 | 2 310 | 5 202 | 10 293 | 198 | 264 | 379 | 527 | -25 | -45 | -81 | -126 | 13.6 |
| 212 | 298 | 303 | 2 | 1 | 1 876 | 3 710 | 8 392 | 16 917 | 493 | 632 | 861 | 1 141 | -18 | -31 | -56 | -90 | 13.7 |
| 212 | 298 | 303 | 2 | 1 | 196 | 5 065 | 13 451 | 26 693 | 302 | 913 | 1 310 | 1 711 | 0 | -30 | -60 | -95 | 13.7 |
| 218 | 342 | 351 | 3 | 1.5 | 1 811 | 3 665 | 7 583 | 15 074 | 219 | 292 | 404 | 564 | -40 | -69 | -114 | -176 | 26.3 |
| 218 | 342 | 351 | 3 | 1.5 | 1 641 | 8 371 | 22 145 | 34 607 | 577 | 1 023 | 1 467 | 1 746 | -13 | -46 | -90 | -121 | 26.5 |
| 232 | 288 | 293 | 2 | 1 | 848 | 1 690 | 3 793 | 7 530 | 193 | 256 | 367 | 513 | -17 | -32 | -59 | -93 | 7.50 |
| 232 | 288 | 293 | 2 | 1 | 941 | 1 918 | 4 374 | 8 755 | 222 | 297 | 430 | 603 | -17 | -32 | -59 | -93 | 6.58 |
| 232 | 288 | 293 | 2 | 1 | 1 288 | 2 631 | 6 047 | 12 067 | 465 | 604 | 828 | 1 094 | -12 | -22 | -41 | -66 | 7.50 |
| 232 | 288 | 293 | 2 | 1 | 1 456 | 3 028 | 7 044 | 14 142 | 544 | 709 | 976 | 1 292 | -12 | -22 | -41 | -66 | 6.58 |
| 234 | 326 | 333 | 2.5 | 1 | 1 443 | 2 907 | 6 509 | 13 026 | 228 | 304 | 435 | 609 | -29 | -51 | -90 | -140 | 18.5 |
| 234 | 326 | 333 | 2.5 | 1 | 1 402 | 7 065 | 18 373 | 29 052 | 618 | 1 091 | 1 555 | 1 858 | -10 | -36 | -70 | -95 | 18.5 |
| 238 | 382 | 391 | 3 | 1.5 | 2 187 | 11 037 | 28 837 | 44 290 | 661 | 1 167 | 1 666 | 1 967 | — | — | — | — | 36.5 |
| 252 | 308 | 313 | 2 | 1 | 902 | 1 822 | 4 129 | 8 237 | 210 | 280 | 403 | 565 | -17 | -32 | -59 | -93 | 8.30 |
| 252 | 308 | 313 | 2 | 1 | 1 004 | 2 072 | 4 769 | 9 589 | 243 | 326 | 473 | 664 | -17 | -32 | -59 | -93 | 7.29 |
| 252 | 308 | 313 | 2 | 1 | 1 385 | 2 860 | 6 622 | 13 265 | 511 | 664 | 913 | 1 208 | -12 | -22 | -41 | -66 | 8.30 |
| 252 | 308 | 313 | 2 | 1 | 1 569 | 3 296 | 7 721 | 15 556 | 596 | 780 | 1 076 | 1 426 | -12 | -22 | -41 | -66 | 7.29 |
| 254 | 346 | 353 | 2.5 | 1 | 1 699 | 3 337 | 7 134 | 14 212 | 244 | 324 | 455 | 636 | -33 | -56 | -95 | -147 | 19.3 |
| 254 | 346 | 353 | 2.5 | 1 | 1 584 | 7 755 | 20 305 | 31 460 | 653 | 1 141 | 1 631 | 1 934 | -11 | -38 | -74 | -99 | 19.3 |
| 272 | 348 | 353 | 2 | 1 | 1 187 | 2 376 | 5 327 | 10 728 | 215 | 285 | 409 | 575 | -24 | -43 | -77 | -121 | 14.3 |
| 272 | 348 | 353 | 2 | 1 | 1 901 | 3 888 | 8 783 | 17 498 | 531 | 688 | 937 | 1 237 | -17 | -30 | -54 | -86 | 14.3 |
| 278 | 382 | 391 | 3 | 1.5 | 3 144 | 6 469 | 12 677 | 25 109 | 640 | 832 | 1 073 | 1 409 | — | — | — | — | 28.7 |
| 278 | 382 | 391 | 3 | 1.5 | 1 834 | 9 135 | 24 886 | 38 387 | 693 | 1 217 | 1 765 | 2 089 | — | — | — | — | 28.7 |
| 282 | 458 | 470 | 4 | 2 | 2 688 | 13 626 | 35 981 | 56 494 | 739 | 1 305 | 1 870 | 2 228 | — | — | — | — | 65.3 |

Calculation of radial rigidity
Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
Multiply by factors in table B.
For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

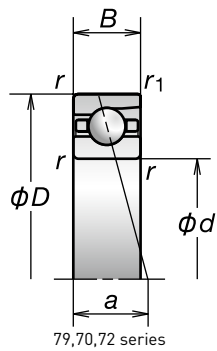
| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Spacer Dimensions and Nozzle Position.....P239
- Recommended Grease Quantities.....P259

1. Angular Contact Ball Bearings

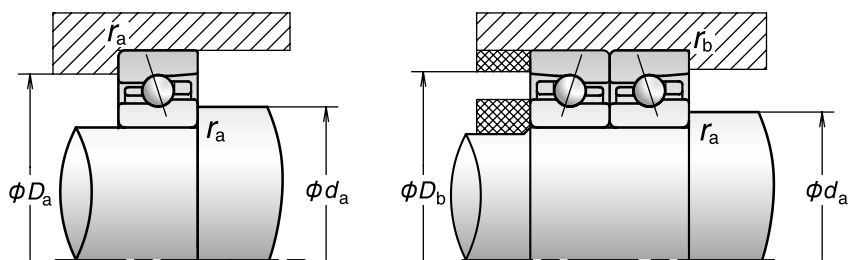
Bore Diameter 280-420 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings (kN) | | Permissible Axial Load ⁽¹⁾ (kN) | Contact angle (Degree) | Factor f_0 | Effective Load Center (mm) a | Limiting Speeds ⁽²⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----------|-----------------------|--------------------------|--------------------------|--|------------------------|--------------|--------------------------------|---|-------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{0r} (Static) | | | | | Grease | Oil |
| 7956C | 280 | 380 | 46 | 2.1 | 1.1 | 272 | 410 | 390 | 15 | 16.7 | 67.2 | 3 200 | 5 000 |
| 7956A5 | 280 | 380 | 46 | 2.1 | 1.1 | 256 | 390 | 286 | 25 | — | 99.9 | 2 800 | 4 300 |
| 7056A | 280 | 420 | 65 | 4 | 1.5 | 345 | 530 | 325 | 30 | — | 133.5 | 1 900 | 2 600 |
| 7960C | 300 | 420 | 56 | 3 | 1.1 | 345 | 550 | 530 | 15 | 16.4 | 76.2 | 3 000 | 4 600 |
| 7960A5 | 300 | 420 | 56 | 3 | 1.1 | 325 | 520 | 395 | 25 | — | 111.9 | 2 500 | 3 900 |
| 7960A | 300 | 420 | 56 | 3 | 1.1 | 315 | 500 | 300 | 30 | — | 131.9 | 1 900 | 2 500 |
| 7060C | 300 | 460 | 74 | 4 | 1.5 | 425 | 660 | 415 | 15 | 15.9 | 87.9 | 2 800 | 4 400 |
| 7060A | 300 | 460 | 74 | 4 | 1.5 | 385 | 605 | 365 | 30 | — | 146.7 | 1 800 | 2 400 |
| 7964C | 320 | 440 | 56 | 3 | 1.5 | 350 | 575 | 350 | 15 | 16.6 | 78.9 | 2 800 | 4 400 |
| 7964A5 | 320 | 440 | 56 | 3 | 1.5 | 330 | 545 | 405 | 25 | — | 116.6 | 2 400 | 3 700 |
| 7964A | 320 | 440 | 56 | 3 | 1.5 | 315 | 525 | 310 | 30 | — | 137.7 | 1 800 | 2 400 |
| 7064A | 320 | 480 | 74 | 4 | 1.5 | 465 | 795 | 500 | 30 | — | 152.5 | 1 700 | 2 300 |
| 7264A | 320 | 580 | 92 | 5 | 2 | 665 | 1 120 | 655 | 30 | — | 175.9 | 1 500 | 2 000 |
| 7968C | 340 | 460 | 56 | 3 | 1.1 | 365 | 625 | 375 | 15 | 16.7 | 81.6 | 2 700 | 4 200 |
| 7968A5 | 340 | 460 | 56 | 3 | 1.1 | 340 | 590 | 435 | 25 | — | 121.3 | 2 300 | 3 500 |
| 7968A | 340 | 460 | 56 | 3 | 1.1 | 330 | 565 | 335 | 30 | — | 143.5 | 1 700 | 2 300 |
| 7068A | 340 | 520 | 82 | 5 | 2 | 520 | 905 | 560 | 30 | — | 165.1 | 1 600 | 2 100 |
| 7268A | 340 | 620 | 92 | 6 | 3 | 675 | 1 260 | 780 | 30 | — | 184.6 | 1 400 | 1 900 |
| 7972A5 | 360 | 480 | 56 | 3 | 1.1 | 345 | 615 | 450 | 25 | — | 125.9 | 2 200 | 3 400 |
| 7072A5 | 360 | 540 | 82 | 5 | 2 | 555 | 995 | 750 | 25 | — | 145.9 | 2 000 | 3 200 |
| 7072A | 360 | 540 | 82 | 5 | 2 | 530 | 960 | 575 | 30 | — | 170.9 | 1 500 | 2 000 |
| 7976A | 380 | 520 | 65 | 4 | 1.5 | 390 | 725 | 430 | 30 | — | 157.9 | 1 500 | 2 000 |
| 7980A | 400 | 540 | 65 | 4 | 1.5 | 395 | 750 | 445 | 30 | — | 168.2 | 1 400 | 2 000 |
| 7080A | 400 | 600 | 90 | 5 | 2 | 555 | 1 010 | 612 | 30 | — | 189.3 | 1 300 | 1 800 |
| 7984C | 420 | 560 | 65 | 4 | 1.5 | 450 | 890 | 525 | 15 | 16.9 | 98.1 | 2 200 | 3 400 |
| 7984A | 420 | 560 | 65 | 4 | 1.5 | 410 | 805 | 475 | 30 | — | 174.0 | 1 400 | 1 900 |
| 7084A | 420 | 620 | 90 | 5 | 2 | 610 | 1 190 | 725 | 30 | — | 195.1 | 1 300 | 1 800 |

⁽¹⁾ For permissible axial load, please refer to Page 201.

⁽²⁾ For application of limiting speeds, please refer to Page 218.



| Abutment and Fillet Dimensions (mm) | | | | | Preload (DB and DF Arrangement) (N) | | | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | | | Measured Axial Clearance. (μ m) | | | | Mass (kg) (approx.) |
|-------------------------------------|--------------|--------------|--------------|--------------|-------------------------------------|--------|--------|--------|---|-------|-------|-------|--------------------------------------|---|---|---|---------------------|
| d_a (min.) | D_a (max.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | M | H | EL | L | M | H | EL | L | M | H | |
| 292 | 368 | 373 | 2 | 1 | 1 334 | 2 668 | 5 977 | 12 032 | 241 | 321 | 459 | 645 | — | — | — | — | 15.0 |
| 292 | 368 | 373 | 2 | 1 | 2 147 | 4 379 | 9 870 | 18 954 | 589 | 766 | 1 046 | 1 372 | — | — | — | — | 15.0 |
| 298 | 402 | 411 | 3 | 1.5 | 1 834 | 9 136 | 19 408 | 38 390 | 693 | 1 217 | 1 603 | 2 089 | — | — | — | — | 31.2 |
| 314 | 406 | 413 | 2.5 | 1 | 1 931 | 3 880 | 7 832 | 15 388 | 278 | 371 | 507 | 703 | — | — | — | — | 24.4 |
| 314 | 406 | 413 | 2.5 | 1 | 2 821 | 5 674 | 12 747 | 25 563 | 669 | 859 | 1 164 | 1 538 | — | — | — | — | 24.4 |
| 314 | 406 | 413 | 2.5 | 1 | 1 670 | 8 238 | 16 993 | 35 209 | 721 | 1 262 | 1 646 | 2 178 | — | — | — | — | 24.4 |
| 318 | 442 | 451 | 3 | 1.5 | 2 320 | 4 610 | 9 591 | 19 107 | 262 | 348 | 482 | 673 | — | — | — | — | 44.9 |
| 318 | 442 | 451 | 3 | 1.5 | 2 039 | 10 839 | 21 816 | 44 468 | 685 | 1 231 | 1 593 | 2 096 | — | — | — | — | 44.9 |
| 334 | 426 | 431 | 2.5 | 1.5 | 1 863 | 3 839 | 8 134 | 16 349 | 280 | 377 | 527 | 739 | — | — | — | — | 25.7 |
| 334 | 426 | 431 | 2.5 | 1.5 | 3 281 | 6 117 | 12 940 | 24 591 | 717 | 899 | 1 194 | 1 543 | — | — | — | — | 25.9 |
| 334 | 426 | 431 | 2.5 | 1.5 | 1 735 | 8 555 | 17 647 | 36 566 | 749 | 1 310 | 1 709 | 2 262 | — | — | — | — | 25.9 |
| 338 | 462 | 471 | 3 | 1.5 | 2 832 | 14 291 | 37 339 | 57 347 | 856 | 1 511 | 2 157 | 2 547 | — | — | — | — | 47.2 |
| 342 | 558 | 570 | 4 | 2 | 3 839 | 20 397 | 53 741 | 83 944 | 893 | 1 604 | 2 298 | 2 733 | — | — | — | — | 110 |
| 354 | 446 | 453 | 2.5 | 1 | 2 002 | 4 123 | 8 736 | 17 561 | 301 | 405 | 566 | 793 | — | — | — | — | 27.2 |
| 354 | 446 | 453 | 2.5 | 1 | 3 147 | 5 631 | 13 580 | 26 414 | 739 | 912 | 1 271 | 1 657 | — | — | — | — | 27.2 |
| 354 | 446 | 453 | 2.5 | 1 | 1 863 | 9 190 | 18 955 | 39 276 | 804 | 1 407 | 1 836 | 2 429 | — | — | — | — | 27.2 |
| 362 | 498 | 510 | 4 | 2 | 3 163 | 16 035 | 42 344 | 66 484 | 869 | 1 536 | 2 201 | 2 622 | — | — | — | — | 60.5 |
| 368 | 592 | 606 | 5 | 2.5 | 4 293 | 22 810 | 61 387 | 95 407 | 998 | 1 793 | 2 590 | 3 075 | — | — | — | — | 128 |
| 374 | 466 | 473 | 2.5 | 1 | 3 256 | 6 797 | 14 379 | 27 326 | 765 | 999 | 1 326 | 1 714 | — | — | — | — | 27.9 |
| 382 | 518 | 530 | 4 | 2 | 5 851 | 11 710 | 23 743 | 46 950 | 851 | 1 095 | 1 431 | 1 878 | — | — | — | — | 62.4 |
| 382 | 518 | 530 | 4 | 2 | 3 321 | 15 254 | 43 314 | 68 443 | 913 | 1 556 | 2 288 | 2 732 | — | — | — | — | 62.4 |
| 398 | 502 | 511 | 3 | 1.5 | 2 419 | 12 046 | 25 063 | 50 619 | 914 | 1 605 | 2 101 | 2 754 | — | — | — | — | 39.8 |
| 418 | 522 | 531 | 3 | 1.5 | 2 502 | 12 461 | 25 928 | 52 366 | 946 | 1 661 | 2 174 | 2 850 | — | — | — | — | 42.1 |
| 422 | 578 | 590 | 4 | 2 | 3 649 | 18 229 | 36 022 | 74 336 | 883 | 1 553 | 1 995 | 2 637 | — | — | — | — | 85.9 |
| 438 | 542 | 551 | 3 | 1.5 | 1 102 | 2 153 | 12 382 | 24 643 | 262 | 337 | 707 | 987 | — | — | — | — | 44.0 |
| 438 | 542 | 551 | 3 | 1.5 | 2 669 | 10 733 | 27 658 | 55 859 | 1 009 | 1 640 | 2 319 | 3 040 | — | — | — | — | 44.0 |
| 442 | 598 | 610 | 4 | 2 | 4 003 | 21 269 | 42 028 | 86 731 | 1 008 | 1 812 | 2 328 | 3 077 | — | — | — | — | 90.3 |

Calculation of radial rigidity
 Multiply axial rigidity by factors in table A.
Calculation of preload and axial rigidity for combination bearings
 Multiply by factors in table B.
 For radial rigidity, multiply the value obtained in table A with factors in table B.

| | EL | L | M | H |
|-----|-----|-----|-----|-----|
| 15° | 6.5 | 6.0 | 5.0 | 4.5 |
| 25° | 2.0 | | | |
| 30° | 1.4 | | | |

| | DBD | DBB |
|-----------------|------|-----|
| Preload factor | 1.36 | 2 |
| Axial rigidity | 1.48 | 2 |
| Radial rigidity | 1.54 | 2 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

2. Cylindrical Roller Bearings



Single-Row Cylindrical Roller Bearings

Standard Series



Ultra High-Speed Single-Row Cylindrical Roller Bearings

NSKROBUST Series

NSKROBUST Low Heat Generation Series



Double-Row Cylindrical Roller Bearings

High Rigidity Series

Low Heat Generation Series

Cylindrical Roller Bearings

Part 4

Cylindrical Roller Bearings.....112-129

Features

Designation System

Bearing Tables

Single-Row Cylindrical Roller Bearings (Standard Series)

Ultra High-Speed Single-Row Cylindrical Roller Bearings
(NSKROBUST Series)

Ultra High-Speed Single-Row Cylindrical Roller Bearings
(NSKROBUST Low Heat Generation Series)

Double-Row Cylindrical Roller Bearings (High Rigidity Series)

Double-Row Cylindrical Roller Bearings (Low Heat Generation Series)



2. Cylindrical Roller Bearings

Features

Cylindrical roller bearings (CRB) feature higher radial rigidity and can take higher radial loads than ball bearings; this makes them especially suitable for applications that require high rigidity such as lathe spindles, and for use as rear end bearings subjected to large belt loads.

The optimized internal design and cage shape of NSK cylindrical roller bearings are the reason why they achieve low heat generation and stable operation in high-speed applications.

Double-row cylindrical roller bearings are also available in "E44" specification for oil lubrication with lubrication holes and oil groove in the center of the outer ring.

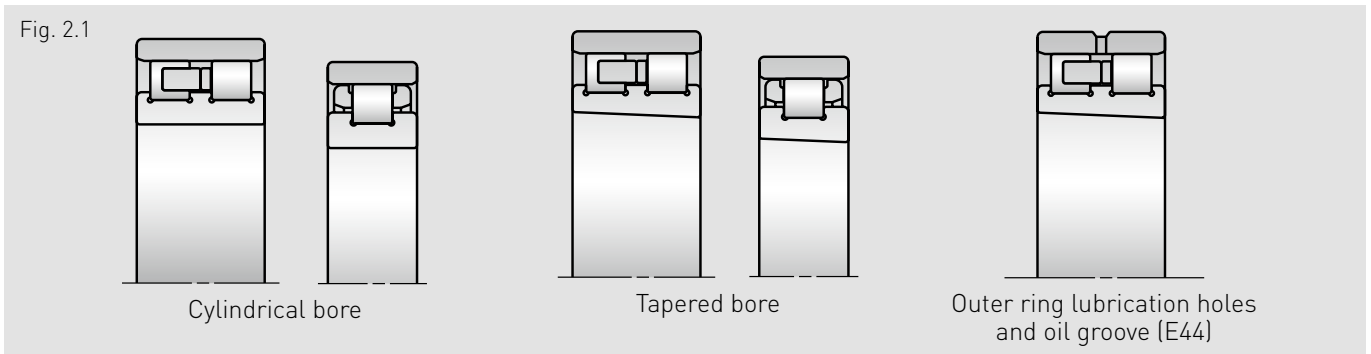
Different types and their features

NN type cylindrical roller bearings are equipped with ribs on the inner ring, NNU type bearings with ribs on the outer ring. The NN type is widely used, as initial running-in with grease lubrication is short, and oil is prevented from accumulating inside the bearing with oil lubrication.

| Bearing type | Cage | Specification | Available Sizes |
|-------------------|------|-----------------------------|----------------------------------|
| NN | MB | Roller guided brass cage | NN3005-NN3048 (NN3008-NN3048) |
| | | | NN3920-NN3956 (NN3920-NN3952) |
| | TB | Roller guided PPS cage | NN4920-NN4952 (NN4920-NN4952) |
| NNU | MB | Roller guided brass cage | NN3006-NN3032 (NN3008-NN3032) |
| N | MR | Roller guided brass cage | NN4920-NN4952 (NN4920-NN4952) |
| NSK ROBUST Series | TP | Outer ring guided PEEK cage | N1006-N1044 (N1007-N1044) |
| | | | N1009-N1017 |

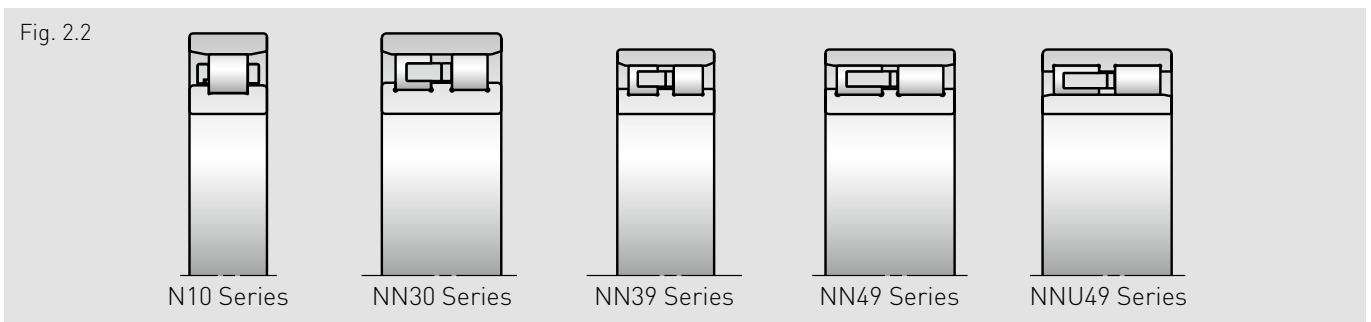
The values in brackets indicate bearing sizes for which NSKHPS and APTSURF are available. For further information, please refer to page 27.

Bore Specifications and Lubrication Holes

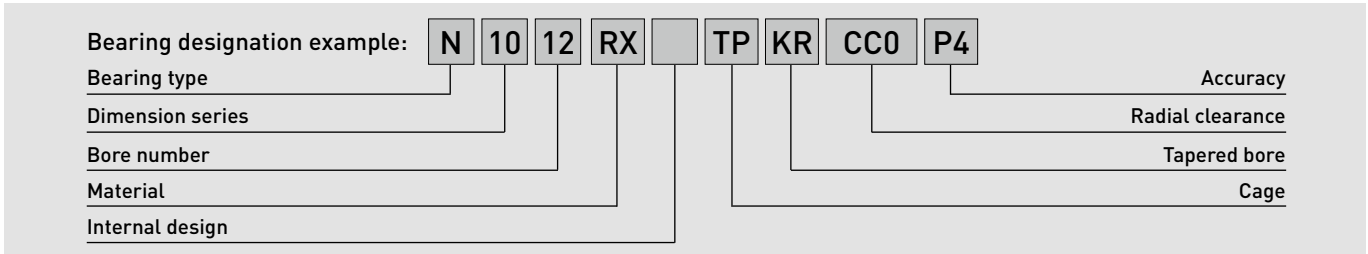


Both cylindrical bore and tapered bore are available. We recommend the latter, as the tapered bore makes it possible to adjust the radial internal clearance after mounting. Thus, dispersion in clearance after assembly may be avoided.

Bearing Types and Dimension Series

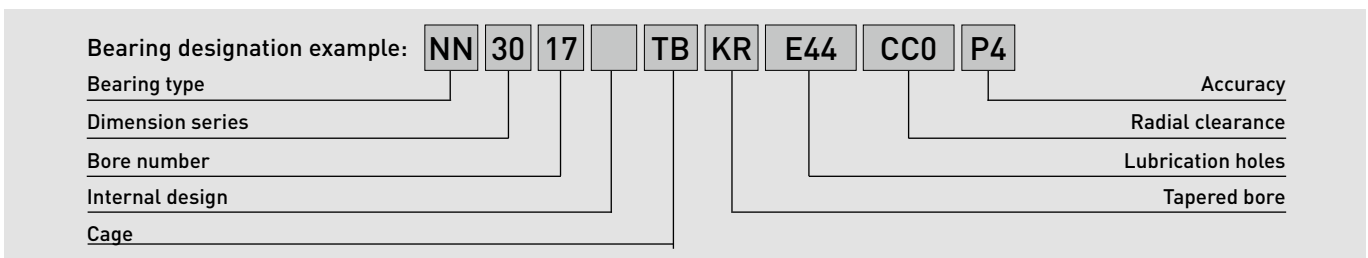


Designation System of Single-Row Cylindrical Roller Bearings (Standard Series and NSKROBUST Series)



| | | | Reference pages | | | | | | | | | | | |
|------------------|--|--|-----------------|------|----------|--|------------------|---------|----|----------------------|----------------------|----|--|--|
| N | Bearing type | N: Single-row CRB (inner ring rib type) | 48-49, 112 | | | | | | | | | | | |
| 10 | Dimension series | 10: 10 Series | 48-49, 112 | | | | | | | | | | | |
| 12 | Bore number | Bearing bore = Bore number × 5 (mm) | 114-117 | | | | | | | | | | | |
| RX | Material | No symbol: Standard CRB (material of inner and outer ring and rollers: SUJ2 bearing steel) RS, RX: Ultra high-speed single-row CRB (NSKROBUST Series) | 16-17 26-27 | | | | | | | | | | | |
| | | <table border="1"> <thead> <tr> <th rowspan="2">Type</th> <th colspan="2">Material</th> </tr> <tr> <th>Inner/Outer ring</th> <th>Rollers</th> </tr> </thead> <tbody> <tr> <td>RS</td> <td>Bearing steel (SUJ2)</td> <td>Bearing steel (SUJ2)</td> </tr> <tr> <td>RX</td> <td>Heat resistant steel for highspeed operation (SHX)</td> <td>Heat resistant steel for highspeed operation (SHX)</td> </tr> </tbody> </table> | | Type | Material | | Inner/Outer ring | Rollers | RS | Bearing steel (SUJ2) | Bearing steel (SUJ2) | RX | Heat resistant steel for highspeed operation (SHX) | Heat resistant steel for highspeed operation (SHX) |
| | | Type | | | Material | | | | | | | | | |
| Inner/Outer ring | Rollers | | | | | | | | | | | | | |
| RS | Bearing steel (SUJ2) | Bearing steel (SUJ2) | | | | | | | | | | | | |
| RX | Heat resistant steel for highspeed operation (SHX) | Heat resistant steel for highspeed operation (SHX) | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Z | Internal design | No symbol: Standard type Z: Low heat generation type (half number of rollers) | 114-117 | | | | | | | | | | | |
| TP | Cage | TP: Outer ring guided PEEK cage No symbol: Rib guided brass cage MR: Roller guided brass cage | 21, 26-27 | | | | | | | | | | | |
| KR | Tapered bore | No symbol: Cylindrical bore KR (K): 1/12 Tapered bore | 228-229 | | | | | | | | | | | |
| CC0 | Radial clearance | CC1: Standard clearance for cylindrical bore (Non-interchangeable) | 48-49 | | | | | | | | | | | |
| | | CC0: Standard clearance for tapered bore (Non-interchangeable) | 114-116 | | | | | | | | | | | |
| | | CCG: Special radial clearance | | | | | | | | | | | | |
| P4 | Accuracy | P2: ISO Class 2, P4: ISO Class 4, P5: ISO Class 5 | 224-227 | | | | | | | | | | | |
| | | P4Y: Special class (bore diameter and outside diameter are exclusive to NSK, all others are ISO Class 4) | | | | | | | | | | | | |

Designation System of Double-Row Cylindrical Roller Bearings (High Rigidity Series)

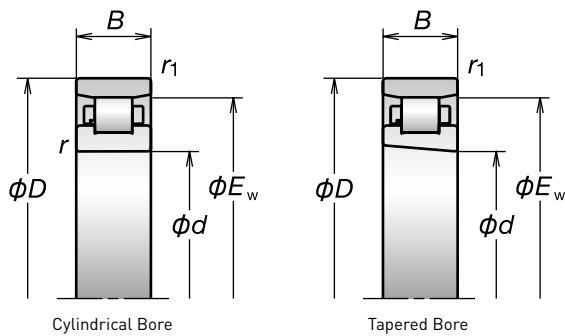


| | | | Reference pages |
|------------|--------------------------|--|-----------------|
| NN | Bearing type | NN: Double-row CRB (inner ring rib type) NNU: Double-row CRB (outer ring rib type) | 48-49, 112 |
| 30 | Dimension series | 30: 30 Series 39: 39 Series 49: 49 Series | 48-49, 112 |
| 17 | Bore number | Bearing bore = Bore number × 5 (mm) | 118-129 |
| Z | Internal design | No symbol: Standard type Z: Low heat generation type (half number of rollers) | 118-129 |
| TB | Cage | TB: Roller guided PPS cage No symbol: Rib guided brass cage MB: Roller guided brass cage | 21, 26-27 |
| KR | Tapered bore | No symbol: Cylindrical bore KR (K): 1/12 Tapered bore | 228-229 |
| E44 | Lubrication holes | No symbol: No lubrication holes E44: Outer ring with oil groove and lubrication holes | 118-129 |
| CC0 | Radial clearance | CC1: Standard clearance for cylindrical bore (Non-interchangeable) | 48-49 |
| | | CC0: Standard clearance for tapered bore (Non-interchangeable) | 118-129 |
| | | CCG: Special radial clearance | |
| P4 | Accuracy | P2: ISO Class 2, P4: ISO Class 4, P5: ISO Class 5 | 224-227 |
| | | P4Y: Special class (bore diameter and outside diameter are exclusive to NSK, all others are ISO Class 4) | |

2. Cylindrical Roller Bearings

Single-Row Cylindrical Roller Bearings

Bore Diameter 30-70 mm



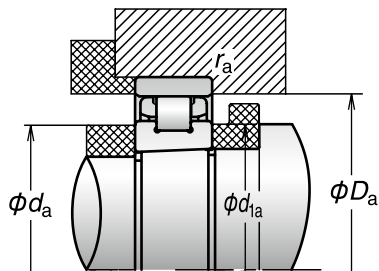
| Bearing Designation ⁽¹⁾ ⁽²⁾ | Boundary Dimensions (mm) | | | | | Basic Load Ratings (kN) | | E_w (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽³⁾ (min^{-1}) | |
|---|--------------------------|-----|----|----------|--------------|-------------------------|-------------------|------------------------|---------------------|--|--------|
| | d | D | B | r (min.) | r_1 (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| * N1006MR1KR | 30 | 55 | 13 | 1 | 0.6 | 19.7 | 19.6 | 48.5 | 0.135 | 19 000 | 31 000 |
| * N1007MRKR | 35 | 62 | 14 | 1 | 0.6 | 26.0 | 23.2 | 55 | 0.172 | 17 000 | 27 000 |
| * N1008MRKR | 40 | 68 | 15 | 1 | 0.6 | 31.5 | 29.0 | 61 | 0.213 | 15 000 | 25 000 |
| * N1009MRKR | 45 | 75 | 16 | 1 | 0.6 | 37.5 | 35.5 | 67.5 | 0.279 | 14 000 | 22 000 |
| * N1009RSTPKR | 45 | 75 | 16 | 1 | 0.6 | 26.9 | 29.4 | 67.5 | 0.243 | 16 000 | 23 000 |
| * N1009RXTPKR | 45 | 75 | 16 | 1 | 0.6 | 26.9 | 29.4 | 67.5 | 0.243 | 21 000 | 30 000 |
| * N1009RSZTPKR | 45 | 75 | 16 | 1 | 0.6 | 16.0 | 14.7 | 67.5 | 0.224 | 16 000 | 23 000 |
| * N1009RXZTPKR | 45 | 75 | 16 | 1 | 0.6 | 16.0 | 14.7 | 67.5 | 0.224 | 21 000 | 30 000 |
| * N1010MRKR | 50 | 80 | 16 | 1 | 0.6 | 37.0 | 36.0 | 72.5 | 0.286 | 13 000 | 20 000 |
| * N1010RSTPKR | 50 | 80 | 16 | 1 | 0.6 | 28.8 | 33.0 | 72.5 | 0.265 | 15 000 | 21 000 |
| * N1010RXTPKR | 50 | 80 | 16 | 1 | 0.6 | 28.8 | 33.0 | 72.5 | 0.265 | 20 000 | 27 000 |
| * N1010RSZTPKR | 50 | 80 | 16 | 1 | 0.6 | 17.1 | 16.5 | 72.5 | 0.244 | 15 000 | 21 000 |
| * N1010RXZTPKR | 50 | 80 | 16 | 1 | 0.6 | 17.1 | 16.5 | 72.5 | 0.244 | 20 000 | 27 000 |
| * N1011BMR1KR | 55 | 90 | 18 | 1.1 | 1 | 43.5 | 44.0 | 81 | 0.425 | 12 000 | 18 000 |
| * N1011RSTPKR | 55 | 90 | 18 | 1.1 | 1 | 35.0 | 39.5 | 81 | 0.383 | 13 000 | 19 000 |
| * N1011RXTPKR | 55 | 90 | 18 | 1.1 | 1 | 35.0 | 39.5 | 81 | 0.383 | 18 000 | 25 000 |
| * N1011RSZTPKR | 55 | 90 | 18 | 1.1 | 1 | 20.7 | 19.7 | 81 | 0.355 | 13 000 | 19 000 |
| * N1011RXZTPKR | 55 | 90 | 18 | 1.1 | 1 | 20.7 | 19.7 | 81 | 0.355 | 18 000 | 25 000 |
| * N1012BMR1KR | 60 | 95 | 18 | 1.1 | 1 | 46.0 | 48.5 | 86.1 | 0.454 | 11 000 | 17 000 |
| * N1012RSTPKR | 60 | 95 | 18 | 1.1 | 1 | 37.5 | 44.0 | 86.1 | 0.411 | 12 000 | 18 000 |
| * N1012RXTPKR | 60 | 95 | 18 | 1.1 | 1 | 37.5 | 44.0 | 86.1 | 0.411 | 17 000 | 23 000 |
| * N1012RSZTPKR | 60 | 95 | 18 | 1.1 | 1 | 22.2 | 22.1 | 86.1 | 0.380 | 12 000 | 18 000 |
| * N1012RXZTPKR | 60 | 95 | 18 | 1.1 | 1 | 22.2 | 22.1 | 86.1 | 0.380 | 17 000 | 23 000 |
| * N1013BMR1KR | 65 | 100 | 18 | 1.1 | 1 | 47.0 | 51.0 | 91 | 0.483 | 10 000 | 16 000 |
| * N1013RSTPKR | 65 | 100 | 18 | 1.1 | 1 | 39.5 | 49.0 | 91 | 0.440 | 11 000 | 17 000 |
| * N1013RXTPKR | 65 | 100 | 18 | 1.1 | 1 | 39.5 | 49.0 | 91 | 0.440 | 16 000 | 22 000 |
| * N1013RSZTPKR | 65 | 100 | 18 | 1.1 | 1 | 23.6 | 24.5 | 91 | 0.406 | 11 000 | 17 000 |
| * N1013RXZTPKR | 65 | 100 | 18 | 1.1 | 1 | 23.6 | 24.5 | 91 | 0.406 | 16 000 | 22 000 |
| * N1014BMR1KR | 70 | 110 | 20 | 1.1 | 1 | 57.5 | 63.0 | 100 | 0.668 | 9 000 | 15 000 |
| * N1014RSTPKR | 70 | 110 | 20 | 1.1 | 1 | 46.5 | 57.0 | 100 | 0.607 | 10 000 | 16 000 |
| * N1014RXTPKR | 70 | 110 | 20 | 1.1 | 1 | 46.5 | 57.0 | 100 | 0.607 | 15 000 | 20 000 |
| * N1014RSZTPKR | 70 | 110 | 20 | 1.1 | 1 | 27.8 | 28.5 | 100 | 0.563 | 10 000 | 16 000 |
| * N1014RXZTPKR | 70 | 110 | 20 | 1.1 | 1 | 27.8 | 28.5 | 100 | 0.563 | 15 000 | 20 000 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ GN gauge is available for the bearings denoted by an asterisk (*). For GN gauge, please refer to Page 182.

⁽³⁾ For application of limiting speeds, please refer to Page 218.

⁽⁴⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (°) | | CC0 | | CC1 | | CC1 | |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. |
| 35 | 36 | 51 | 49 | 0.5 | 5 | 10 | 8 | 15 | 10 | 25 | 5 | 15 |
| 40 | 41 | 58 | 56 | 0.5 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 |
| 45 | 46 | 64 | 62 | 0.6 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 |
| 50 | 51 | 71 | 68 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 50 | 51 | 71 | 68 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 50 | 51 | 71 | 68 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 50 | 51 | 71 | 68 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 55 | 56 | 76 | 73 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 55 | 56 | 76 | 73 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 55 | 56 | 76 | 73 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 55 | 56 | 76 | 73 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 55 | 56 | 76 | 73 | 0.6 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 |
| 61.5 | 63 | 85 | 82 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 61.5 | 63 | 85 | 82 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 61.5 | 63 | 85 | 82 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 61.5 | 63 | 85 | 82 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 61.5 | 63 | 85 | 82 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 66.5 | 68 | 90 | 87 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 66.5 | 68 | 90 | 87 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 66.5 | 68 | 90 | 87 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 66.5 | 68 | 90 | 87 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 66.5 | 68 | 90 | 87 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 71.5 | 73 | 95 | 92 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 71.5 | 73 | 95 | 92 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 71.5 | 73 | 95 | 92 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 71.5 | 73 | 95 | 92 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 71.5 | 73 | 95 | 92 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 |
| 76.5 | 78 | 105 | 101 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 76.5 | 78 | 105 | 101 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 76.5 | 78 | 105 | 101 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 76.5 | 78 | 105 | 101 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 76.5 | 78 | 105 | 101 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |

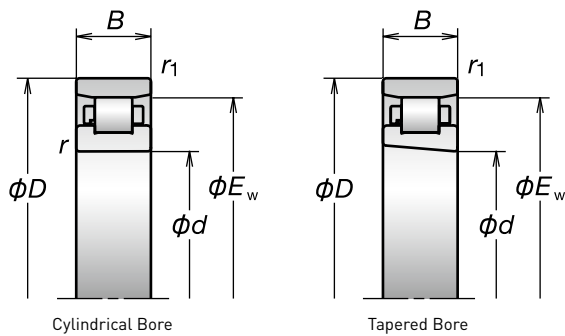
For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Nozzle Position.....P242
- Recommended Grease Quantities.....P259

2. Cylindrical Roller Bearings

Single-Row Cylindrical Roller Bearings

Bore Diameter 75-400 mm



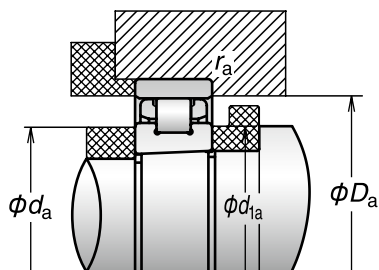
| Bearing Designation ⁽¹⁾ / ₍₂₎ | Boundary Dimensions (mm) | | | | | Basic Load Ratings (kN) | | E _w (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---|--------------------------|-----|----|----------|-----------------------|--------------------------|--------------------------|---------------------------------|---------------------|---|--------|
| | d | D | B | r (min.) | r ₁ (min.) | C _r (Dynamic) | C _{or} (Static) | | | Grease | Oil |
| * N1015MRKR | 75 | 115 | 20 | 1.1 | 1 | 69.0 | 74.5 | 105 | 0.700 | 8 500 | 13 700 |
| * N1015RSTPKR | 75 | 115 | 20 | 1.1 | 1 | 49.5 | 63.0 | 105 | 0.645 | 9 900 | 15 000 |
| * N1015RXTPKR | 75 | 115 | 20 | 1.1 | 1 | 49.5 | 63.0 | 105 | 0.645 | 14 000 | 19 000 |
| * N1015RSZTPKR | 75 | 115 | 20 | 1.1 | 1 | 29.6 | 31.5 | 105 | 0.596 | 9 900 | 15 000 |
| * N1015RXZTPKR | 75 | 115 | 20 | 1.1 | 1 | 29.6 | 31.5 | 105 | 0.596 | 14 000 | 19 000 |
| * N1016BMR1KR | 80 | 125 | 22 | 1.1 | 1 | 73.0 | 82.0 | 113 | 0.957 | 7 900 | 12 700 |
| * N1016RSTPKR | 80 | 125 | 22 | 1.1 | 1 | 61.5 | 78.5 | 113 | 0.872 | 9 200 | 14 000 |
| * N1016RXTPKR | 80 | 125 | 22 | 1.1 | 1 | 61.5 | 78.5 | 113 | 0.872 | 13 000 | 17 000 |
| * N1016RSZTPKR | 80 | 125 | 22 | 1.1 | 1 | 36.5 | 39.5 | 113 | 0.805 | 9 200 | 14 000 |
| * N1016RXZTPKR | 80 | 125 | 22 | 1.1 | 1 | 36.5 | 39.5 | 113 | 0.805 | 13 000 | 17 000 |
| * N1017BMR1KR | 85 | 130 | 22 | 1.1 | 1 | 75.0 | 86.0 | 118 | 1.067 | 7 500 | 10 300 |
| * N1017RSTPKR | 85 | 130 | 22 | 1.1 | 1 | 65.0 | 86.0 | 118 | 0.933 | 8 800 | 13 000 |
| * N1017RXTPKR | 85 | 130 | 22 | 1.1 | 1 | 65.0 | 86.0 | 118 | 0.933 | 12 000 | 17 000 |
| * N1017RSZTPKR | 85 | 130 | 22 | 1.1 | 1 | 38.5 | 43.0 | 118 | 0.859 | 8 800 | 13 000 |
| * N1017RXZTPKR | 85 | 130 | 22 | 1.1 | 1 | 38.5 | 43.0 | 118 | 0.859 | 12 000 | 17 000 |
| * N1018MRKR | 90 | 140 | 24 | 1.5 | 1.1 | 101 | 114 | 127 | 1.27 | 7 000 | 9 600 |
| * N1019BMR1KR | 95 | 145 | 24 | 1.5 | 1.1 | 95.0 | 114 | 132 | 1.37 | 6 700 | 9 200 |
| * N1020MRKR | 100 | 150 | 24 | 1.5 | 1.1 | 107 | 126 | 137 | 1.46 | 6 400 | 8 800 |
| * N1021BMR1KR | 105 | 160 | 26 | 2 | 1.1 | 129 | 155 | 146 | 1.79 | 6 100 | 8 300 |
| * N1022BMR1KR | 110 | 170 | 28 | 2 | 1.1 | 144 | 173 | 155 | 2.22 | 5 800 | 7 900 |
| * N1024MRKR | 120 | 180 | 28 | 2 | 1.1 | 159 | 191 | 165 | 2.34 | 5 400 | 7 300 |
| * N1026MRKR | 130 | 200 | 33 | 2 | 1.1 | 198 | 238 | 182 | 3.55 | 4 900 | 6 700 |
| * N1028BMR1KR | 140 | 210 | 33 | 2 | 1.1 | 189 | 240 | 192 | 3.78 | 4 600 | 6 300 |
| * N1030BMRKR | 150 | 225 | 35 | 2.1 | 1.5 | 233 | 294 | 206 | 4.56 | 4 300 | 5 100 |
| * N1032BMRKR | 160 | 240 | 38 | 2.1 | 1.5 | 330 | 340 | 219 | 5.59 | 4 000 | 4 800 |
| N1034MRKR | 170 | 260 | 42 | 2.1 | 2.1 | 330 | 415 | 237 | 7.85 | 3 600 | 4 400 |
| N1036MRKR | 180 | 280 | 46 | 2.1 | 2.1 | 405 | 510 | 255 | 9.76 | 3 400 | 4 100 |
| N1038KR | 190 | 290 | 46 | 2.1 | 2.1 | 415 | 535 | 265 | 10.4 | 3 200 | 4 000 |
| N1040MRKR | 200 | 310 | 51 | 2.1 | 2.1 | 450 | 580 | 281 | 13.5 | 3 000 | 3 700 |
| N1044MRKR | 220 | 340 | 56 | 3 | 3 | 575 | 750 | 310 | 17.4 | 2 500 | 3 000 |
| N1048KR | 240 | 360 | 56 | 3 | 3 | 605 | 820 | 330 | 18.6 | 2 300 | 2 800 |
| N1052KR | 260 | 400 | 65 | 4 | 4 | 645 | 1 000 | 364 | 27.6 | 2 100 | 2 600 |
| N1060KR | 300 | 460 | 74 | 4 | 4 | 885 | 1 400 | 420 | 42.2 | 1 800 | 2 200 |
| N1064KR | 320 | 480 | 74 | 4 | 4 | 905 | 1 470 | 440 | 43.8 | 1 800 | 2 100 |
| N1068KR | 340 | 520 | 82 | 5 | 5 | 1 080 | 1 740 | 475 | 59.8 | 1 600 | 2 000 |
| N1072KR | 360 | 540 | 82 | 5 | 5 | 1 110 | 1 830 | 495 | 61.6 | 1 600 | 1 900 |
| N1080KR | 400 | 600 | 90 | 5 | 5 | 1 360 | 2 280 | 550 | 84.1 | 1 400 | 1 700 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ GN gauge is available for the bearings denoted by an asterisk (*). For GN gauge, please refer to Page 182.

⁽³⁾ For application of limiting speeds, please refer to Page 218.

⁽⁴⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



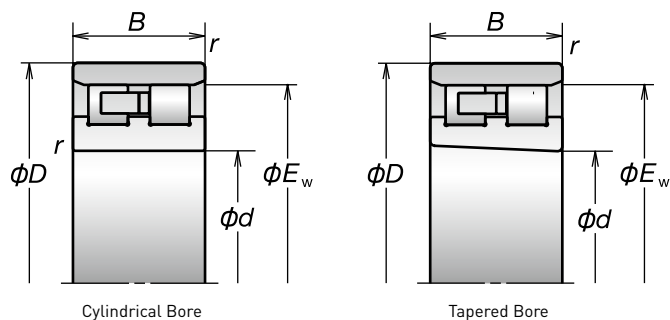
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (°) | | CC0 | | CC1 | | CC1 | |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. |
| 81.5 | 83 | 110 | 106 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 81.5 | 83 | 110 | 106 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 81.5 | 83 | 110 | 106 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 81.5 | 83 | 110 | 106 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 81.5 | 83 | 110 | 106 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 86.5 | 88 | 120 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 86.5 | 88 | 120 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 86.5 | 88 | 120 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 86.5 | 88 | 120 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 86.5 | 88 | 120 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 |
| 91.5 | 93 | 125 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 91.5 | 93 | 125 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 91.5 | 93 | 125 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 91.5 | 93 | 125 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 91.5 | 93 | 125 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 98 | 100 | 133.5 | 129 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 103 | 105 | 138.5 | 134 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 108 | 110 | 143.5 | 139 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 |
| 114 | 116 | 153.5 | 148 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 |
| 119 | 121 | 163.5 | 157 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 |
| 129 | 131 | 173.5 | 167 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 |
| 139 | 142 | 193.5 | 184 | 1 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 |
| 149 | 152 | 203.5 | 194 | 1 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 |
| 161 | 164 | 217 | 208 | 1.5 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 |
| 171 | 174 | 232 | 221 | 1.5 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 |
| 181 | 185 | 249 | 239 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 |
| 191 | 195 | 269 | 258 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 |
| 201 | 205 | 279 | 268 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 |
| 211 | 215 | 299 | 284 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 |
| 233 | 238 | 327 | 313 | 2.5 | 20 | 45 | 35 | 60 | 45 | 90 | 15 | 50 |
| 253 | 258 | 347 | 333 | 2.5 | 25 | 50 | 40 | 65 | 50 | 100 | 15 | 50 |
| 276 | 281 | 384 | 367 | 3 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 |
| 316 | 322 | 444 | 424 | 3 | 30 | 60 | 45 | 75 | 60 | 120 | 20 | 60 |
| 336 | 342 | 464 | 444 | 3 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 |
| 360 | 367 | 500 | 479 | 4 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 |
| 380 | 387 | 520 | 499 | 4 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 |
| 420 | 428 | 580 | 554.5 | 4 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Nozzle Position.....P242
- Recommended Grease Quantities.....P259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 25-65 mm



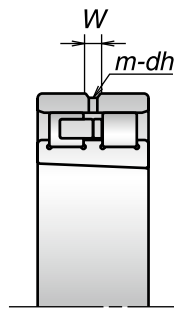
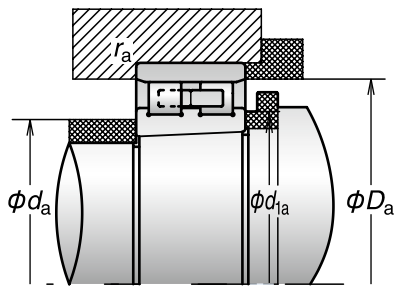
| Bearing Designation ⁽¹⁾ ⁽²⁾ | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽³⁾ (min^{-1}) | |
|---|--------------------------|-----|----|----------|-------------------------|-------------------|------------------------|---------------------|--|--------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| * NN3005MBKR | 25 | 47 | 16 | 0.6 | 25.8 | 30.0 | 41.3 | 0.121 | 20 900 | 25 000 |
| * NN3006MBKR | 30 | 55 | 19 | 1 | 31.0 | 37.0 | 48.5 | 0.186 | 17 700 | 21 200 |
| * NN3006TBKR | 30 | 55 | 19 | 1 | 31.0 | 37.0 | 48.5 | 0.171 | 20 000 | 23 600 |
| * NN3006ZTBKR | 30 | 55 | 19 | 1 | 18.3 | 18.6 | 48.5 | 0.152 | 21 000 | 27 900 |
| * NN3007MBKR | 35 | 62 | 20 | 1 | 39.5 | 50.0 | 55 | 0.297 | 15 500 | 18 600 |
| * NN3007TBKR | 35 | 62 | 20 | 1 | 39.5 | 50.0 | 55 | 0.227 | 17 600 | 20 700 |
| * NN3007ZTBKR | 35 | 62 | 20 | 1 | 23.3 | 25.0 | 55 | 0.198 | 18 400 | 24 500 |
| * NN3008MBKR | 40 | 68 | 21 | 1 | 50.0 | 55.5 | 61 | 0.356 | 13 900 | 16 700 |
| * NN3008TBKR | 40 | 68 | 21 | 1 | 50.0 | 55.5 | 61 | 0.269 | 15 800 | 18 600 |
| * NN3008ZTBKR | 40 | 68 | 21 | 1 | 29.6 | 27.7 | 61 | 0.234 | 16 600 | 22 000 |
| * NN3009MBKR | 45 | 75 | 23 | 1 | 59.5 | 68.5 | 67.5 | 0.471 | 12 500 | 15 000 |
| * NN3009TBKR | 45 | 75 | 23 | 1 | 57.5 | 65.5 | 67.5 | 0.348 | 14 200 | 16 700 |
| * NN3009ZTBKR | 45 | 75 | 23 | 1 | 34.0 | 32.5 | 67.5 | 0.302 | 14 900 | 19 800 |
| * NN3010MBKR | 50 | 80 | 23 | 1 | 61.0 | 72.5 | 72.5 | 0.502 | 11 600 | 13 900 |
| * NN3010TBKR | 50 | 80 | 23 | 1 | 61.0 | 72.5 | 72.5 | 0.378 | 13 100 | 15 400 |
| * NN3010ZTBKR | 50 | 80 | 23 | 1 | 36.5 | 36.5 | 72.5 | 0.328 | 13 800 | 18 300 |
| * NN3011MBKR | 55 | 90 | 26 | 1.1 | 79.5 | 96.5 | 81 | 0.748 | 10 400 | 12 500 |
| * NN3011TBKR | 55 | 90 | 26 | 1.1 | 79.5 | 96.5 | 81 | 0.562 | 11 800 | 13 800 |
| * NN3011ZTBKR | 55 | 90 | 26 | 1.1 | 47.5 | 48.5 | 81 | 0.488 | 12 400 | 16 400 |
| * NN3012MBKR | 60 | 95 | 26 | 1.1 | 84.5 | 106 | 86.1 | 0.804 | 9 700 | 11 700 |
| * NN3012TBKR | 60 | 95 | 26 | 1.1 | 84.5 | 106 | 86.1 | 0.602 | 11 000 | 13 000 |
| * NN3012ZTBKR | 60 | 95 | 26 | 1.1 | 50.0 | 53.0 | 86.1 | 0.522 | 11 600 | 15 400 |
| * NN3013MBKR | 65 | 100 | 26 | 1.1 | 88.5 | 116 | 91 | 0.862 | 9 100 | 11 000 |
| * NN3013TBKR | 65 | 100 | 26 | 1.1 | 88.5 | 116 | 91 | 0.644 | 10 400 | 12 200 |
| * NN3013ZTBKR | 65 | 100 | 26 | 1.1 | 52.5 | 58.0 | 91 | 0.557 | 10 900 | 14 500 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ GN gauge is available for the bearings denoted by an asterisk (*). For GN gauge, please refer to Page 182.

⁽³⁾ For application of limiting speeds, please refer to Page 218.

⁽⁴⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

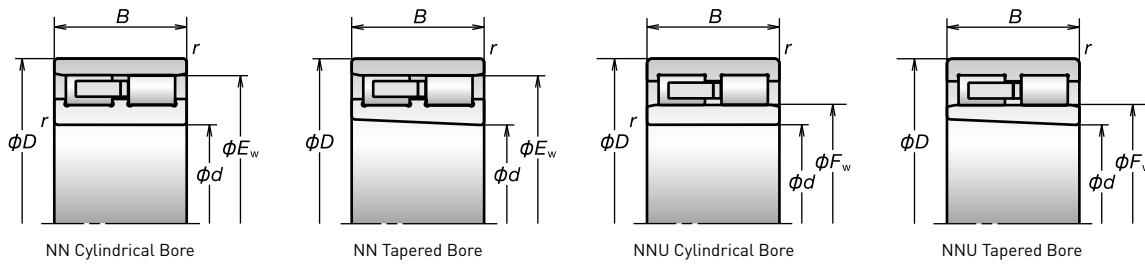
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (4) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 29 | 29 | 43 | 42 | 0.6 | 5 | 10 | 8 | 15 | 10 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 35 | 36 | 50 | 50 | 1 | 5 | 10 | 8 | 15 | 10 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 35 | 36 | 50 | 50 | 1 | 5 | 10 | 8 | 15 | 10 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 35 | 36 | 50 | 50 | 1 | 5 | 10 | 8 | 15 | 10 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 40 | 41 | 57 | 56 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 40 | 41 | 57 | 56 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 40 | 41 | 57 | 56 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 45 | 46 | 63 | 62 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 45 | 46 | 63 | 62 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 45 | 46 | 63 | 62 | 1 | 5 | 12 | 8 | 15 | 12 | 25 | 5 | 15 | 2 | 3.5 | 4 |
| 50 | 51 | 70 | 69 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 50 | 51 | 70 | 69 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 50 | 51 | 70 | 69 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 55 | 56 | 75 | 74 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 55 | 56 | 75 | 74 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 55 | 56 | 75 | 74 | 1 | 5 | 15 | 10 | 20 | 15 | 30 | 5 | 18 | 2 | 3.5 | 4 |
| 61.5 | 62 | 83.5 | 83 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 61.5 | 62 | 83.5 | 83 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 61.5 | 62 | 83.5 | 83 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 66.5 | 67 | 88.5 | 88 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 66.5 | 67 | 88.5 | 88 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 66.5 | 67 | 88.5 | 88 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 71.5 | 72 | 93.5 | 93 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 71.5 | 72 | 93.5 | 93 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |
| 71.5 | 72 | 93.5 | 93 | 1 | 5 | 15 | 10 | 20 | 15 | 35 | 5 | 20 | 2 | 3.5 | 4 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Nozzle Position.....P242
- Recommended Grease Quantities.....P259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 70-105 mm



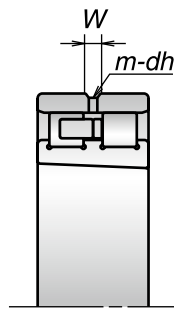
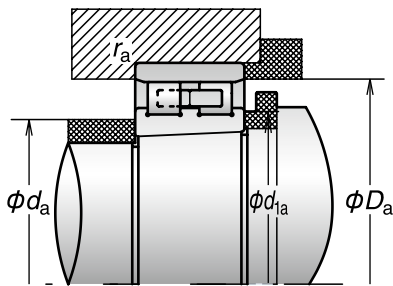
| Bearing Designation ⁽¹⁾ ⁽²⁾ | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (F_w in case of NNU type) (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽³⁾ (min^{-1}) | |
|---|--------------------------|-----|----|----------|-------------------------|-------------------|---|---------------------|--|--------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| * NN3014MBKR | 70 | 110 | 30 | 1.1 | 112 | 148 | 100 | 1.23 | 8 000 | 10 000 |
| * NN3014TBKR | 70 | 110 | 30 | 1.1 | 112 | 148 | 100 | 0.925 | 9 500 | 11 200 |
| * NN3014ZTBKR | 70 | 110 | 30 | 1.1 | 66.5 | 74.0 | 100 | 0.809 | 9 900 | 13 200 |
| * NN3015MBKR | 75 | 115 | 30 | 1.1 | 111 | 149 | 105 | 1.28 | 7 900 | 9 500 |
| * NN3015TBKR | 75 | 115 | 30 | 1.1 | 111 | 149 | 105 | 0.964 | 9 000 | 10 600 |
| * NN3015ZTBKR | 75 | 115 | 30 | 1.1 | 66.0 | 74.5 | 105 | 0.848 | 9 400 | 12 500 |
| * NN3016MBKR | 80 | 125 | 34 | 1.1 | 137 | 186 | 113 | 1.77 | 7 400 | 8 800 |
| * NN3016TBKR | 80 | 125 | 34 | 1.1 | 137 | 186 | 113 | 1.35 | 8 300 | 9 800 |
| * NN3016ZTBKR | 80 | 125 | 34 | 1.1 | 81.5 | 93.0 | 113 | 1.19 | 8 800 | 11 700 |
| * NN3017MBKR | 85 | 130 | 34 | 1.1 | 144 | 201 | 118 | 1.87 | 7 000 | 8 400 |
| * NN3017TBKR | 85 | 130 | 34 | 1.1 | 144 | 201 | 118 | 1.42 | 8 000 | 9 400 |
| * NN3017ZTBKR | 85 | 130 | 34 | 1.1 | 85.5 | 101 | 118 | 1.25 | 8 400 | 11 100 |
| * NN3018MBKR | 90 | 140 | 37 | 1.5 | 164 | 228 | 127 | 2.38 | 6 600 | 7 900 |
| * NN3018TBKR | 90 | 140 | 37 | 1.5 | 164 | 228 | 127 | 1.82 | 7 400 | 8 700 |
| * NN3018ZTBKR | 90 | 140 | 37 | 1.5 | 97.5 | 114 | 127 | 1.61 | 7 800 | 10 300 |
| * NN3019MBKR | 95 | 145 | 37 | 1.5 | 173 | 246 | 132 | 2.51 | 6 300 | 7 500 |
| * NN3019TBKR | 95 | 145 | 37 | 1.5 | 173 | 246 | 132 | 1.91 | 7 100 | 8 400 |
| * NN3019ZTBKR | 95 | 145 | 37 | 1.5 | 103 | 123 | 132 | 1.68 | 7 500 | 9 900 |
| NN3920MBKR | 100 | 140 | 30 | 1.1 | 122 | 182 | 130 | 1.32 | 6 300 | 7 500 |
| NN4920MBKR | 100 | 140 | 40 | 1.1 | 178 | 295 | 130 | 1.76 | 6 300 | 7 500 |
| NNU4920MBKR | 100 | 140 | 40 | 1.1 | 178 | 295 | 112 | 1.75 | 6 300 | 7 500 |
| * NN3020MBKR | 100 | 150 | 37 | 1.5 | 180 | 265 | 137 | 2.63 | 6 000 | 7 200 |
| * NN3020TBKR | 100 | 150 | 37 | 1.5 | 180 | 265 | 137 | 2.00 | 6 800 | 8 000 |
| * NN3020ZTBKR | 100 | 150 | 37 | 1.5 | 107 | 133 | 137 | 1.76 | 7 200 | 9 500 |
| NN3921MBKR | 105 | 145 | 30 | 1.1 | 127 | 194 | 135 | 1.50 | 6 000 | 7 200 |
| NN4921MBKR | 105 | 145 | 40 | 1.1 | 185 | 315 | 135 | 1.91 | 6 000 | 7 200 |
| NNU4921MBKR | 105 | 145 | 40 | 1.1 | 185 | 315 | 117 | 1.83 | 6 000 | 7 200 |
| * NN3021MBKR | 105 | 160 | 41 | 2 | 228 | 320 | 146 | 3.40 | 5 700 | 6 800 |
| * NN3021TBKR | 105 | 160 | 41 | 2 | 228 | 320 | 146 | 2.52 | 6 500 | 7 600 |
| * NN3021ZTBKR | 105 | 160 | 41 | 2 | 135 | 161 | 146 | 2.17 | 6 800 | 9 000 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ GN gauge is available for the bearings denoted by an asterisk (*). For GN gauge, please refer to Page 182.

⁽³⁾ For application of limiting speeds, please refer to Page 218.

⁽⁴⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

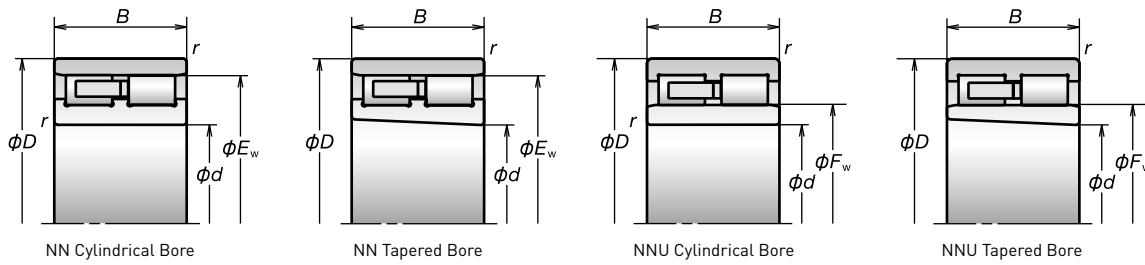
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (*) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 76.5 | 77 | 103.5 | 102 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 76.5 | 77 | 103.5 | 102 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 76.5 | 77 | 103.5 | 102 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 81.5 | 82 | 108.5 | 107 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 81.5 | 82 | 108.5 | 107 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 81.5 | 82 | 108.5 | 107 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2 | 3.5 | 4 |
| 86.5 | 87 | 118.5 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2.5 | 5 | 4 |
| 86.5 | 87 | 118.5 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2.5 | 5 | 4 |
| 86.5 | 87 | 118.5 | 115 | 1 | 10 | 20 | 15 | 30 | 20 | 40 | 10 | 25 | 2.5 | 5 | 4 |
| 91.5 | 92 | 123.5 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 91.5 | 92 | 123.5 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 91.5 | 92 | 123.5 | 120 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 98 | 99 | 132 | 129 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 98 | 99 | 132 | 129 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 98 | 99 | 132 | 129 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 103 | 104 | 137 | 134 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 103 | 104 | 137 | 134 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 103 | 104 | 137 | 134 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 106.5 | 108 | 133.5 | 132 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2 | 3.5 | 4 |
| 106.5 | 108 | 133.5 | 132 | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 106.5 | 108 | 133.5 | — | 1 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 108 | 109 | 142 | 139 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 108 | 109 | 142 | 139 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 108 | 109 | 142 | 139 | 1.5 | 10 | 25 | 20 | 35 | 25 | 45 | 10 | 30 | 2.5 | 5 | 4 |
| 111.5 | 113 | 138.5 | 137 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2 | 3.5 | 4 |
| 111.5 | 113 | 138.5 | 137 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2.5 | 5 | 4 |
| 111.5 | 113 | 138.5 | — | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2.5 | 5 | 4 |
| 114 | 115 | 151 | 148 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 114 | 115 | 151 | 148 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 114 | 115 | 151 | 148 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |

For additional information:

- Dynamic equivalent loadP193
- Static equivalent loadP200
- Nozzle Position P242
- Recommended Grease QuantitiesP259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 110-160 mm



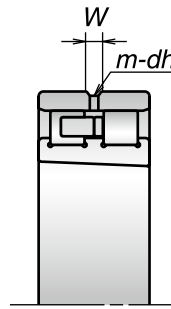
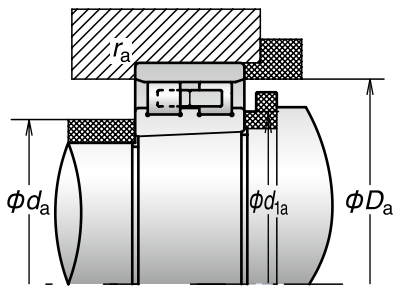
| Bearing Designation ⁽¹⁾ / ₍₂₎ | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (F_w in case of NNU type) (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽³⁾ (min^{-1}) | |
|---|--------------------------|-----|----|----------|-------------------------|-------------------|---|---------------------|--|-------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| NN3922MBKR | 110 | 150 | 30 | 1.1 | 131 | 207 | 140 | 1.44 | 5 800 | 7 000 |
| NN4922MBKR | 110 | 150 | 40 | 1.1 | 192 | 335 | 140 | 1.92 | 5 800 | 7 000 |
| NNU4922MBKR | 110 | 150 | 40 | 1.1 | 192 | 335 | 122 | 1.90 | 5 800 | 7 000 |
| * NN3022MBKR | 110 | 170 | 45 | 2 | 263 | 375 | 155 | 4.35 | 5 400 | 6 500 |
| * NN3022TBKR | 110 | 170 | 45 | 2 | 263 | 375 | 155 | 3.21 | 6 100 | 7 200 |
| * NN3022ZTBKR | 110 | 170 | 45 | 2 | 156 | 188 | 155 | 2.78 | 6 400 | 8 500 |
| NN3924MBKR | 120 | 165 | 34 | 1.1 | 158 | 251 | 153.5 | 2.02 | 5 300 | 6 400 |
| NN4924MBKR | 120 | 165 | 45 | 1.1 | 211 | 360 | 153.5 | 2.62 | 5 300 | 6 400 |
| NNU4924MBKR | 120 | 165 | 45 | 1.1 | 211 | 360 | 133.5 | 2.59 | 5 300 | 6 400 |
| * NN3024MBKR | 120 | 180 | 46 | 2 | 275 | 405 | 165 | 4.72 | 5 000 | 6 000 |
| * NN3024TBKR | 120 | 180 | 46 | 2 | 275 | 405 | 165 | 3.50 | 5 700 | 6 700 |
| * NN3024ZTBKR | 120 | 180 | 46 | 2 | 164 | 203 | 165 | 3.03 | 6 000 | 7 900 |
| NN3926MBKR | 130 | 180 | 37 | 1.5 | 199 | 325 | 167 | 2.64 | 4 900 | 5 900 |
| NN4926MBKR | 130 | 180 | 50 | 1.5 | 315 | 545 | 168 | 3.51 | 4 900 | 5 900 |
| NNU4926MBKR | 130 | 180 | 50 | 1.5 | 315 | 545 | 144 | 3.48 | 4 900 | 5 900 |
| * NN3026MBKR | 130 | 200 | 52 | 2 | 325 | 475 | 182 | 5.53 | 4 600 | 5 500 |
| * NN3026TBKR | 130 | 200 | 52 | 2 | 325 | 475 | 182 | 5.10 | 5 200 | 6 100 |
| * NN3026ZTBKR | 130 | 200 | 52 | 2 | 195 | 238 | 182 | 4.46 | 5 500 | 7 200 |
| NN3928MBKR | 140 | 190 | 37 | 1.5 | 232 | 375 | 178 | 2.79 | 4 600 | 5 500 |
| NN4928MBKR | 140 | 190 | 50 | 1.5 | 325 | 585 | 178 | 3.73 | 4 600 | 5 500 |
| NNU4928MBKR | 140 | 190 | 50 | 1.5 | 325 | 585 | 154 | 3.70 | 4 600 | 5 500 |
| * NN3028MBKR | 140 | 210 | 53 | 2 | 345 | 515 | 192 | 5.95 | 4 300 | 5 200 |
| * NN3028TBKR | 140 | 210 | 53 | 2 | 345 | 515 | 192 | 5.51 | 4 900 | 5 700 |
| * NN3028ZTBKR | 140 | 210 | 53 | 2 | 204 | 258 | 192 | 4.81 | 5 200 | 6 800 |
| NN3930MBKR | 150 | 210 | 45 | 2 | 300 | 490 | 195 | 4.47 | 4 200 | 5 000 |
| NN4930MBKR | 150 | 210 | 60 | 2 | 405 | 715 | 195 | 5.79 | 4 200 | 5 000 |
| NNU4930MBKR | 150 | 210 | 60 | 2 | 405 | 715 | 167 | 5.85 | 4 200 | 5 000 |
| * NN3030MBKR | 150 | 225 | 56 | 2.1 | 385 | 585 | 206 | 7.29 | 4 000 | 4 800 |
| * NN3030TBKR | 150 | 225 | 56 | 2.1 | 385 | 585 | 206 | 6.70 | 4 500 | 5 300 |
| * NN3030ZTBKR | 150 | 225 | 56 | 2.1 | 229 | 294 | 206 | 5.87 | 4 800 | 6 300 |
| NN3932MBKR | 160 | 220 | 45 | 2 | 310 | 520 | 205 | 4.72 | 4 000 | 4 800 |
| NN4932MBKR | 160 | 220 | 60 | 2 | 420 | 760 | 205 | 6.19 | 4 000 | 4 800 |
| NNU4932MBKR | 160 | 220 | 60 | 2 | 420 | 760 | 177 | 6.18 | 4 000 | 4 800 |
| * NN3032MBKR | 160 | 240 | 60 | 2.1 | 430 | 660 | 219 | 8.83 | 3 800 | 4 500 |
| * NN3032TBKR | 160 | 240 | 60 | 2.1 | 430 | 660 | 219 | 8.18 | 4 300 | 5 000 |
| * NN3032ZTBKR | 160 | 240 | 60 | 2.1 | 255 | 330 | 219 | 7.20 | 4 500 | 6 000 |

(1) The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

(2) GN gauge is available for the bearings denoted by an asterisk (*). For GN gauge, please refer to Page 182.

(3) For application of limiting speeds, please refer to Page 218.

(4) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

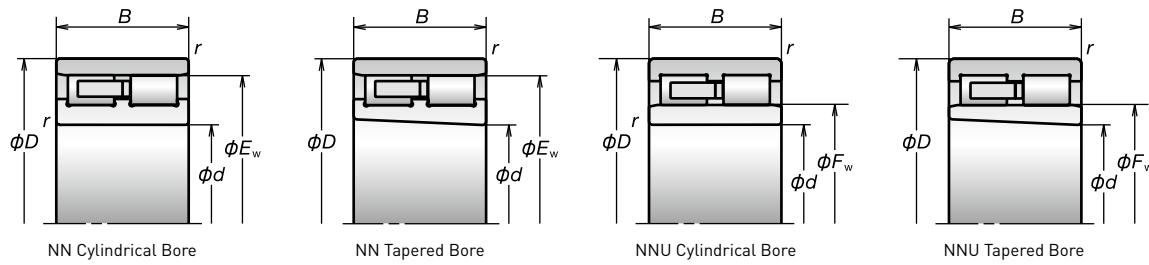
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (*) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 116.5 | 118 | 143.5 | 142 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2 | 3.5 | 4 |
| 116.5 | 118 | 143.5 | 142 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2.5 | 5 | 4 |
| 116.5 | 118 | 143.5 | — | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2.5 | 5 | 4 |
| 119 | 121 | 161 | 157 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 119 | 121 | 161 | 157 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 119 | 121 | 161 | 157 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 126.5 | 128 | 158.5 | 156 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 2.5 | 5 | 4 |
| 126.5 | 128 | 158.5 | 156 | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 126.5 | 128 | 158.5 | — | 1 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 129 | 131 | 171 | 167 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 129 | 131 | 171 | 167 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 129 | 131 | 171 | 167 | 2 | 10 | 25 | 20 | 35 | 25 | 50 | 10 | 30 | 3 | 6 | 4 |
| 138 | 140 | 172 | 169 | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 2.5 | 5 | 4 |
| 138 | 140 | 172 | 170 | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 3 | 6 | 4 |
| 138 | 140 | 172 | — | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 3 | 6 | 4 |
| 139 | 141 | 191 | 185 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 139 | 141 | 191 | 185 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 139 | 141 | 191 | 185 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 148 | 150 | 182 | 180 | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 2.5 | 5 | 4 |
| 148 | 150 | 182 | 180 | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 3 | 6 | 4 |
| 148 | 150 | 182 | — | 1.5 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 3 | 6 | 4 |
| 149 | 151 | 201 | 195 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 149 | 151 | 201 | 195 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 149 | 151 | 201 | 195 | 2 | 15 | 30 | 25 | 40 | 30 | 60 | 10 | 35 | 4 | 8 | 4 |
| 159 | 162 | 201 | 197 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 3 | 6 | 4 |
| 159 | 162 | 201 | 197 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 159 | 162 | 201 | — | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 161 | 162 | 214 | 209 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 161 | 162 | 214 | 209 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 161 | 162 | 214 | 209 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 169 | 172 | 211 | 207 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 3 | 6 | 4 |
| 169 | 172 | 211 | 207 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 169 | 172 | 211 | — | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 171 | 172 | 229 | 222 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 171 | 172 | 229 | 222 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |
| 171 | 172 | 229 | 222 | 2 | 15 | 35 | 30 | 50 | 35 | 65 | 10 | 35 | 4 | 8 | 4 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Nozzle Position.....P242
- Recommended Grease Quantities.....P259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 170-260 mm

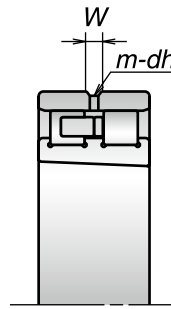
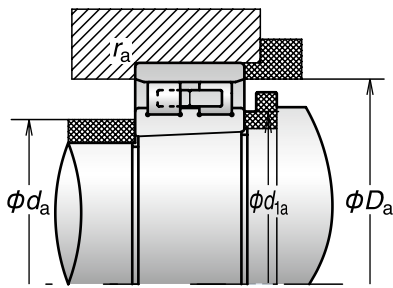


| Bearing Designation (1) | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (F_w in case of NNU type) (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds (2) (min ⁻¹) | |
|-------------------------|--------------------------|-----|-----|-------------|-------------------------|----------------------|---|------------------------|---|-------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| NN3934MBKR | 170 | 230 | 45 | 2 | 320 | 550 | 215 | 5.01 | 3 800 | 4 500 |
| NN4934MBKR | 170 | 230 | 60 | 2 | 435 | 805 | 215 | 6.42 | 3 800 | 4 500 |
| NNU4934MBKR | 170 | 230 | 60 | 2 | 435 | 805 | 187 | 6.50 | 3 800 | 4 500 |
| NN3034MBKR | 170 | 260 | 67 | 2.1 | 520 | 805 | 236 | 12.1 | 3 500 | 4 200 |
| NN3936MBKR | 180 | 250 | 52 | 2 | 390 | 655 | 232 | 7.20 | 3 500 | 4 200 |
| NN4936MBKR | 180 | 250 | 69 | 2 | 550 | 1 020 | 232 | 9.47 | 3 500 | 4 200 |
| NNU4936MBKR | 180 | 250 | 69 | 2 | 550 | 1 020 | 200 | 9.55 | 3 500 | 4 200 |
| NN3036MBKR | 180 | 280 | 74 | 2.1 | 650 | 995 | 255 | 15.7 | 3 300 | 4 000 |
| NN3938MBKR | 190 | 260 | 52 | 2 | 395 | 680 | 243.5 | 7.57 | 3 400 | 4 000 |
| NN4938MBKR | 190 | 260 | 69 | 2 | 555 | 1 060 | 243.5 | 9.72 | 3 400 | 4 000 |
| NNU4938MBKR | 190 | 260 | 69 | 2 | 555 | 1 060 | 211.5 | 9.91 | 3 400 | 4 000 |
| NN3038MBKR | 190 | 290 | 75 | 2.1 | 685 | 1 080 | 265 | 16.7 | 3 200 | 3 800 |
| NN3940MBKR | 200 | 280 | 60 | 2.1 | 480 | 815 | 259 | 10.6 | 3 200 | 3 800 |
| NN4940MBKR | 200 | 280 | 80 | 2.1 | 655 | 1 220 | 259 | 14.0 | 3 200 | 3 800 |
| NNU4940MBKR | 200 | 280 | 80 | 2.1 | 655 | 1 220 | 223 | 14.0 | 3 200 | 3 800 |
| NN3040MBKR | 200 | 310 | 82 | 2.1 | 750 | 1 170 | 282 | 21.3 | 3 000 | 3 600 |
| NN3944MBKR | 220 | 300 | 60 | 2.1 | 505 | 895 | 279 | 11.5 | 2 500 | 3 100 |
| NN4944MBKR | 220 | 300 | 80 | 2.1 | 690 | 1 330 | 279 | 15.1 | 2 500 | 3 100 |
| NNU4944MBK | 220 | 300 | 80 | 2.1 | 690 | 1 330 | 243 | 15.2 | 2 500 | 3 100 |
| NN3044MBKR | 220 | 340 | 90 | 3 | 940 | 1 480 | 310 | 27.7 | 2 400 | 2 900 |
| NN3948MBKR | 240 | 320 | 60 | 2.1 | 525 | 975 | 300 | 12.3 | 2 400 | 2 900 |
| NN4948MBKR | 240 | 320 | 80 | 2.1 | 720 | 1 450 | 300 | 17.8 | 2 400 | 2 900 |
| NNU4948MBKR | 240 | 320 | 80 | 2.1 | 720 | 1 450 | 263 | 16.2 | 2 400 | 2 900 |
| NN3048MBKR | 240 | 360 | 92 | 3 | 980 | 1 600 | 330 | 30.4 | 2 200 | 2 700 |
| NN3952MBKR | 260 | 360 | 75 | 2.1 | 775 | 1 380 | 335 | 21.4 | 2 100 | 2 600 |
| NN4952MBKR | 260 | 360 | 100 | 2.1 | 1 070 | 2 100 | 335 | 28.4 | 2 100 | 2 600 |
| NNU4952MBKR | 260 | 360 | 100 | 2.1 | 1 070 | 2 100 | 289 | 28.3 | 2 100 | 2 600 |
| NN3052KR | 260 | 400 | 104 | 4 | 1 030 | 1 920 | 364 | 44.7 | 2 000 | 2 500 |

(1) The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

(2) For application of limiting speeds, please refer to Page 218.

(3) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

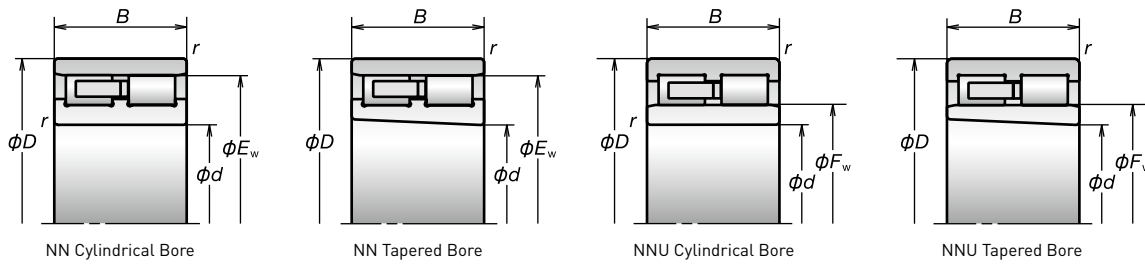
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (*) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 179 | 182 | 221 | 217 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 3 | 6 | 4 |
| 179 | 182 | 221 | 217 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 4 | 8 | 4 |
| 179 | 182 | 221 | — | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 4 | 8 | 4 |
| 181 | 183 | 249 | 239 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 5 | 9 | 4 |
| 189 | 193 | 241 | 234 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 4 | 8 | 4 |
| 189 | 193 | 241 | 234 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 5 | 9 | 4 |
| 189 | 193 | 241 | — | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 5 | 9 | 4 |
| 191 | 193 | 269 | 258 | 2 | 15 | 35 | 30 | 50 | 35 | 75 | 10 | 40 | 5 | 9 | 4 |
| 199 | 203 | 251 | 246 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 4 | 8 | 4 |
| 199 | 203 | 251 | 246 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 5 | 9 | 4 |
| 199 | 203 | 251 | — | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 5 | 9 | 4 |
| 201 | 203 | 279 | 268 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 5 | 9 | 4 |
| 211 | 214 | 269 | 261 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 4 | 8 | 4 |
| 211 | 214 | 269 | 261 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 5 | 9 | 4 |
| 211 | 214 | 269 | — | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 5 | 9 | 4 |
| 211 | 214 | 299 | 285 | 2 | 20 | 40 | 30 | 50 | 40 | 80 | 15 | 45 | 6 | 12 | 4 |
| 231 | 234 | 289 | 281 | 2 | 20 | 45 | 35 | 60 | 45 | 90 | 15 | 50 | 4 | 8 | 4 |
| 231 | 234 | 289 | 281 | 2 | 20 | 45 | 35 | 60 | 45 | 90 | 15 | 50 | 5 | 9 | 4 |
| 231 | 234 | 289 | — | 2 | 20 | 45 | 35 | 60 | 45 | 90 | 15 | 50 | 5 | 9 | 4 |
| 233 | 236 | 327 | 313 | 2.5 | 20 | 45 | 35 | 60 | 45 | 90 | 15 | 50 | 6 | 12 | 4 |
| 251 | 254 | 309 | 302 | 2 | 25 | 50 | 40 | 65 | 50 | 100 | 15 | 50 | 4 | 8 | 4 |
| 251 | 254 | 309 | 302 | 2 | 25 | 50 | 40 | 65 | 50 | 100 | 15 | 50 | 5 | 9 | 4 |
| 251 | 254 | 309 | — | 2 | 25 | 50 | 40 | 65 | 50 | 100 | 15 | 50 | 5 | 9 | 4 |
| 253 | 256 | 347 | 334 | 2.5 | 25 | 50 | 40 | 65 | 50 | 100 | 15 | 50 | 6 | 12 | 4 |
| 271 | 275 | 349 | 338 | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 5 | 9 | 4 |
| 271 | 275 | 349 | 338 | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |
| 271 | 275 | 349 | — | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |
| 276 | 278 | 384 | 368 | 3 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |

For additional information:

- Dynamic equivalent load.....P193
- Static equivalent load.....P200
- Nozzle Position.....P242
- Recommended Grease Quantities.....P259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 280-420 mm

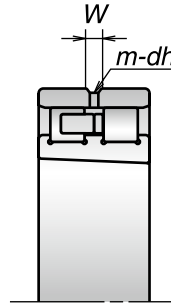
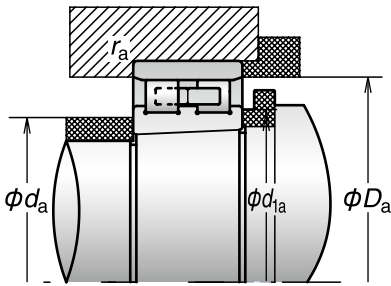


| Bearing Designation ⁽¹⁾ | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (F_w in case of NNU type) (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽²⁾ (min ⁻¹) | |
|------------------------------------|--------------------------|-----|-----|----------|-------------------------|-------------------|---|---------------------|---|-------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| NN3956MBKR | 280 | 380 | 75 | 2.1 | 695 | 1 460 | 355 | 22.8 | 2 000 | 2 500 |
| NN4956KR | 280 | 380 | 100 | 2.1 | 960 | 2 230 | 355 | 30.1 | 2 000 | 2 500 |
| NNU4956KR | 280 | 380 | 100 | 2.1 | 960 | 2 230 | 309 | 33.1 | 2 000 | 2 500 |
| NN3056KR | 280 | 420 | 106 | 4 | 1 080 | 2 080 | 384 | 47.7 | 1 900 | 2 300 |
| NN3960KR | 300 | 420 | 90 | 3 | 855 | 1 800 | 388 | 36.2 | 1 800 | 2 300 |
| NN4960KR | 300 | 420 | 118 | 3 | 1 230 | 2 870 | 388 | 47.6 | 1 800 | 2 300 |
| NNU4960KR | 300 | 420 | 118 | 3 | 1 230 | 2 870 | 336 | 47.6 | 1 800 | 2 300 |
| NN3060KR | 300 | 460 | 118 | 4 | 1 290 | 2 460 | 418 | 66.5 | 1 800 | 2 100 |
| NN3964KR | 320 | 440 | 90 | 3 | 880 | 1 910 | 408 | 38.2 | 1 800 | 2 100 |
| NN4964KR | 320 | 440 | 118 | 3 | 1 260 | 3 050 | 408 | 50.3 | 1 800 | 2 100 |
| NNU4964KR | 320 | 440 | 118 | 3 | 1 260 | 3 050 | 356 | 50.3 | 1 800 | 2 100 |
| NN3064KR | 320 | 480 | 121 | 4 | 1 350 | 2 670 | 438 | 71.8 | 1 700 | 2 000 |
| NN4968KR | 340 | 460 | 118 | 3 | 1 350 | 3 400 | 428 | 52.6 | 1 700 | 2 000 |
| NNU4968KR | 340 | 460 | 118 | 3 | 1 350 | 3 400 | 376 | 52.9 | 1 700 | 2 000 |
| NN3068KR | 340 | 520 | 133 | 5 | 1 670 | 3 300 | 473 | 95.6 | 1 600 | 1 900 |
| NN3972KR | 360 | 480 | 90 | 3 | 930 | 2 130 | 448 | 42.1 | 1 600 | 1 900 |
| NN4972KR | 360 | 480 | 118 | 3 | 1 390 | 3 550 | 448 | 55.1 | 1 600 | 1 900 |
| NNU4972KR | 360 | 480 | 118 | 3 | 1 390 | 3 550 | 396 | 55.2 | 1 600 | 1 900 |
| NN3072KR | 360 | 540 | 134 | 5 | 1 700 | 3 450 | 493 | 99.7 | 1 500 | 1 800 |
| NN3976KR | 380 | 520 | 106 | 4 | 1 250 | 2 730 | 484 | 63.5 | 1 500 | 1 800 |
| NN4976KR | 380 | 520 | 140 | 4 | 1 880 | 4 600 | 485 | 81.3 | 1 500 | 1 800 |
| NNU4976KR | 380 | 520 | 140 | 4 | 1 880 | 4 600 | 421 | 88.8 | 1 500 | 1 800 |
| NN3076KR | 380 | 560 | 135 | 5 | 1 770 | 3 700 | 513 | 113 | 1 400 | 1 700 |
| NN4980KR | 400 | 540 | 140 | 4 | 1 940 | 4 900 | 505 | 84.1 | 1 400 | 1 700 |
| NNU4980KR | 400 | 540 | 140 | 4 | 1 940 | 4 900 | 441 | 85.1 | 1 400 | 1 700 |
| NN3080KR | 400 | 600 | 148 | 5 | 2 090 | 4 300 | 548 | 138 | 1 300 | 1 600 |
| NN4984K | 420 | 560 | 140 | 4 | 2 000 | 5 150 | 525 | 87.9 | 1 200 | 1 500 |
| NNU4984K | 420 | 560 | 140 | 4 | 2 000 | 5 150 | 461 | 88.4 | 1 200 | 1 500 |
| NN3084K | 420 | 620 | 150 | 5 | 2 130 | 4 450 | 568 | 145 | 1 100 | 1 400 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ For application of limiting speeds, please refer to Page 218.

⁽³⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

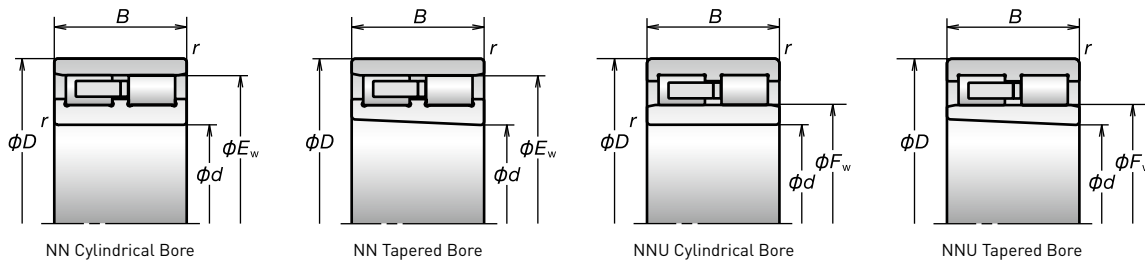
| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (*) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 291 | 295 | 369 | 358 | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 5 | 9 | 4 |
| 291 | 295 | 369 | 358 | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |
| 291 | 295 | 369 | — | 2 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |
| 296 | 298 | 404 | 388 | 3 | 25 | 55 | 40 | 70 | 55 | 110 | 20 | 55 | 6 | 12 | 4 |
| 313 | 318 | 407 | 391 | 2.5 | 30 | 60 | 45 | 75 | 60 | 120 | 20 | 60 | 6 | 12 | 4 |
| 313 | 318 | 407 | 391 | 2.5 | 30 | 60 | 45 | 75 | 60 | 120 | 20 | 60 | 6 | 12 | 4 |
| 313 | 318 | 407 | — | 2.5 | 30 | 60 | 45 | 75 | 60 | 120 | 20 | 60 | 6 | 12 | 4 |
| 316 | 319 | 444 | 422 | 3 | 30 | 60 | 45 | 75 | 60 | 120 | 20 | 60 | 6 | 12 | 4 |
| 333 | 338 | 427 | 411 | 2.5 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 6 | 12 | 4 |
| 333 | 338 | 427 | 411 | 2.5 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 6 | 12 | 4 |
| 333 | 338 | 427 | — | 2.5 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 6 | 12 | 4 |
| 336 | 340 | 464 | 442 | 3 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 8 | 15 | 4 |
| 353 | 363 | 447 | 431 | 2.5 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 6 | 12 | 4 |
| 353 | 363 | 447 | — | 2.5 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 6 | 12 | 4 |
| 360 | 365 | 500 | 477 | 4 | 30 | 65 | 45 | 80 | 65 | 135 | 20 | 65 | 8 | 15 | 4 |
| 373 | 381 | 467 | 451 | 2.5 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 6 | 12 | 4 |
| 373 | 383 | 467 | 451 | 2.5 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 6 | 12 | 4 |
| 373 | 383 | 467 | — | 2.5 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 6 | 12 | 4 |
| 380 | 385 | 520 | 497 | 4 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 396 | 405 | 504 | 487 | 3 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 6 | 12 | 4 |
| 396 | 408 | 504 | 488 | 3 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 396 | 408 | 504 | — | 3 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 400 | 411 | 540 | 518 | 4 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 416 | 428 | 524 | 508 | 3 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 416 | 428 | 524 | — | 3 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 420 | 432 | 580 | 553 | 4 | 35 | 75 | 50 | 90 | 75 | 150 | 25 | 75 | 8 | 15 | 4 |
| 436 | 448 | 544 | 528 | 3 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |
| 436 | 448 | 544 | — | 3 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |
| 440 | 453 | 600 | 573 | 4 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Nozzle Position P242
- Recommended Grease Quantities P259

2. Cylindrical Roller Bearings Double-Row Cylindrical Roller Bearings

Bore Diameter 440-800 mm

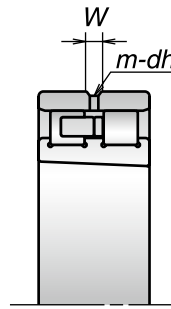
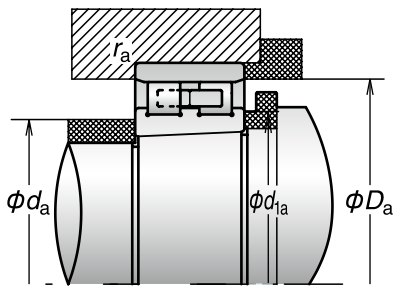


| Bearing Designation ⁽¹⁾ | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | E_w (F_w in case of NNU type) (mm) (reference) | Mass (kg) (approx.) | Limiting Speeds ⁽²⁾ (min^{-1}) | |
|------------------------------------|--------------------------|-------|-----|----------|-------------------------|-------------------|---|---------------------|--|-------|
| | d | D | B | r (min.) | C_r (Dynamic) | C_{or} (Static) | | | Grease | Oil |
| NN4988K | 440 | 600 | 160 | 4 | 2 370 | 6 000 | 559 | 123 | 1 100 | 1 400 |
| NNU4988K | 440 | 600 | 160 | 4 | 2 370 | 6 000 | 487 | 123 | 1 100 | 1 400 |
| NN3088K | 440 | 650 | 157 | 6 | 2 360 | 4 900 | 596 | 166 | 1 100 | 1 300 |
| NN3992K | 460 | 620 | 118 | 4 | 1 610 | 3 700 | 578 | 94.5 | 1 100 | 1 300 |
| NN4992K | 460 | 620 | 160 | 4 | 2 400 | 6 200 | 579 | 127 | 1 100 | 1 300 |
| NNU4992K | 460 | 620 | 160 | 4 | 2 400 | 6 200 | 507 | 128 | 1 100 | 1 300 |
| NN3092K | 460 | 680 | 163 | 6 | 2 550 | 5 350 | 623 | 189 | 1 000 | 1 300 |
| NN4996K | 480 | 650 | 170 | 5 | 2 690 | 7 000 | 607 | 151 | 1 000 | 1 300 |
| NNU4996K | 480 | 650 | 170 | 5 | 2 690 | 7 000 | 531 | 150 | 1 000 | 1 300 |
| NN3096K | 480 | 700 | 165 | 6 | 2 600 | 5 550 | 643 | 211 | 1 000 | 1 200 |
| NN49/500K | 500 | 670 | 170 | 5 | 2 720 | 7 200 | 627 | 155 | 1 000 | 1 200 |
| NNU49/500K | 500 | 670 | 170 | 5 | 2 720 | 7 200 | 551 | 157 | 1 000 | 1 200 |
| NN30/500K | 500 | 720 | 167 | 6 | 2 580 | 5 600 | 663 | 205 | 900 | 1 200 |
| NN39/530K | 530 | 710 | 136 | 5 | 2 040 | 4 900 | 663 | 139 | 900 | 1 200 |
| NN49/530K | 530 | 710 | 180 | 5 | 3 050 | 8 150 | 664 | 185 | 900 | 1 200 |
| NNU49/530K | 530 | 710 | 180 | 5 | 3 050 | 8 150 | 584 | 186 | 900 | 1 200 |
| NN30/530K | 530 | 780 | 185 | 6 | 3 200 | 6 900 | 715 | 280 | 900 | 1 100 |
| NN49/560K | 560 | 750 | 190 | 5 | 3 250 | 8 700 | 701 | 218 | 900 | 1 100 |
| NNU49/560K | 560 | 750 | 190 | 5 | 3 250 | 8 700 | 617 | 230 | 900 | 1 100 |
| NN49/600K | 600 | 800 | 200 | 5 | 3 850 | 10 500 | 749 | 273 | 800 | 1 000 |
| NNU49/600K | 600 | 800 | 200 | 5 | 3 850 | 10 500 | 659 | 284 | 800 | 1 000 |
| NN49/630K | 630 | 850 | 218 | 6 | 4 200 | 11 400 | 793 | 328 | 800 | 1 000 |
| NNU49/630K | 630 | 850 | 218 | 6 | 4 200 | 11 400 | 697 | 328 | 800 | 1 000 |
| NN49/670K | 670 | 900 | 230 | 6 | 4 150 | 11 500 | 838 | 419 | 700 | 900 |
| NNU49/670K | 670 | 900 | 230 | 6 | 4 150 | 11 500 | 742 | 381 | 700 | 900 |
| NNU49/710BK | 710 | 950 | 243 | 6 | 4 450 | 12 600 | 775 | 472 | 700 | 900 |
| NNU49/750K | 750 | 1 000 | 250 | 6 | 5 500 | 15 900 | 826 | 530 | 700 | 800 |
| NNU49/800K | 800 | 1 060 | 258 | 6 | 5 700 | 16 500 | 879 | 573 | 600 | 800 |

⁽¹⁾ The suffix "K" or "KR" represents bearings with tapered bores (1 : 12). For the cylindrical bore type, eliminate the symbol and leave this symbol blank.

⁽²⁾ For application of limiting speeds, please refer to Page 218.

⁽³⁾ Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



E44 Specification

| Abutment and Fillet Dimensions | | | | | Clearances in Bearings with Tapered Bores (μm) | | | | | | Clearances in Bearings with Cylindrical Bores (μm) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|--------------------------------|--------------------|--------|--------|-----------------|--|------|------|------|------|------|--|------|---|--------------------------|-------------------------|
| d_a (min.) | d_{1a} (min.) | D_a | | r_a (max.) | CC9 (*) | | CC0 | | CC1 | | CC1 | | Hole Dia. dh | Oil Groove Width W | Number of Holes m |
| | | (max.) | (min.) | | min. | max. | min. | max. | min. | max. | min. | max. | | | |
| 456 | 469 | 584 | 562 | 3 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |
| 456 | 469 | 584 | — | 3 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |
| 466 | 479 | 624 | 601 | 5 | 40 | 85 | 60 | 105 | 85 | 170 | 25 | 85 | 8 | 15 | 4 |
| 476 | 486 | 604 | 581 | 3 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 6 | 12 | 4 |
| 476 | 489 | 604 | 582 | 3 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 8 | 15 | 4 |
| 476 | 489 | 604 | — | 3 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 8 | 15 | 4 |
| 486 | 500 | 654 | 628 | 5 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 500 | 514 | 630 | 610 | 4 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 500 | 514 | 630 | — | 4 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 506 | 520 | 674 | 648 | 5 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 520 | 534 | 650 | 630 | 4 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 520 | 534 | 650 | — | 4 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 526 | 540 | 694 | 668 | 5 | 45 | 95 | 70 | 120 | 95 | 190 | 25 | 95 | 10 | 18 | 4 |
| 550 | 561 | 690 | 668 | 4 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 8 | 15 | 4 |
| 550 | 565 | 690 | 667 | 4 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 10 | 18 | 4 |
| 550 | 565 | 690 | — | 4 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 10 | 18 | 4 |
| 556 | 571 | 754 | 720 | 5 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 10 | 18 | 4 |
| 580 | 596 | 730 | 704 | 4 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 10 | 18 | 4 |
| 580 | 596 | 730 | — | 4 | 50 | 105 | 80 | 135 | 105 | 210 | 30 | 105 | 10 | 18 | 4 |
| 620 | 637 | 780 | 752 | 4 | 55 | 115 | 85 | 145 | 115 | 230 | 30 | 115 | 10 | 18 | 4 |
| 620 | 637 | 780 | — | 4 | 55 | 115 | 85 | 145 | 115 | 230 | 30 | 115 | 10 | 18 | 4 |
| 656 | 674 | 824 | 796 | 5 | 55 | 115 | 85 | 145 | 115 | 230 | 30 | 115 | 12 | 20 | 4 |
| 656 | 674 | 824 | — | 5 | 55 | 115 | 85 | 145 | 115 | 230 | 30 | 115 | 12 | 20 | 4 |
| 696 | 715 | 874 | 841 | 5 | 60 | 130 | 90 | 160 | 130 | 260 | 30 | 130 | 12 | 20 | 4 |
| 696 | 715 | 874 | — | 5 | 60 | 130 | 90 | 160 | 130 | 260 | 30 | 130 | 12 | 20 | 4 |
| 736 | 756 | 924 | — | 5 | 60 | 130 | 90 | 160 | 130 | 260 | 30 | 130 | 12 | 20 | 4 |
| 776 | 797 | 974 | — | 5 | 70 | 150 | 110 | 190 | 145 | 290 | 35 | 145 | 12 | 20 | 4 |
| 826 | 848 | 1 034 | — | 5 | 70 | 150 | 110 | 190 | 145 | 290 | 35 | 145 | 12 | 20 | 4 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Nozzle Position P242
- Recommended Grease Quantities P259

3. Angular Contact Thrust Ball Bearings



High-Speed Angular Contact Thrust Ball Bearings

NSKROBUST Series



Angular Contact Thrust Ball Bearings

NSKTAC F Series



Double-Direction Angular Contact Thrust Ball Bearings

NSKTAC D Series

Angular Contact Thrust Ball Bearings

Angular Contact Thrust Ball Bearings 132-143

Features

Designation System

Bearing Tables

High-Speed Angular Contact Thrust Ball Bearings

(NSKROBUST Series)

BAR10 Series

BTR10 Series

Angular Contact Thrust Ball Bearings

(NSKTAC F Series)

TAC29F Series

TAC20F Series

Double-Direction Angular Contact Thrust Ball Bearings

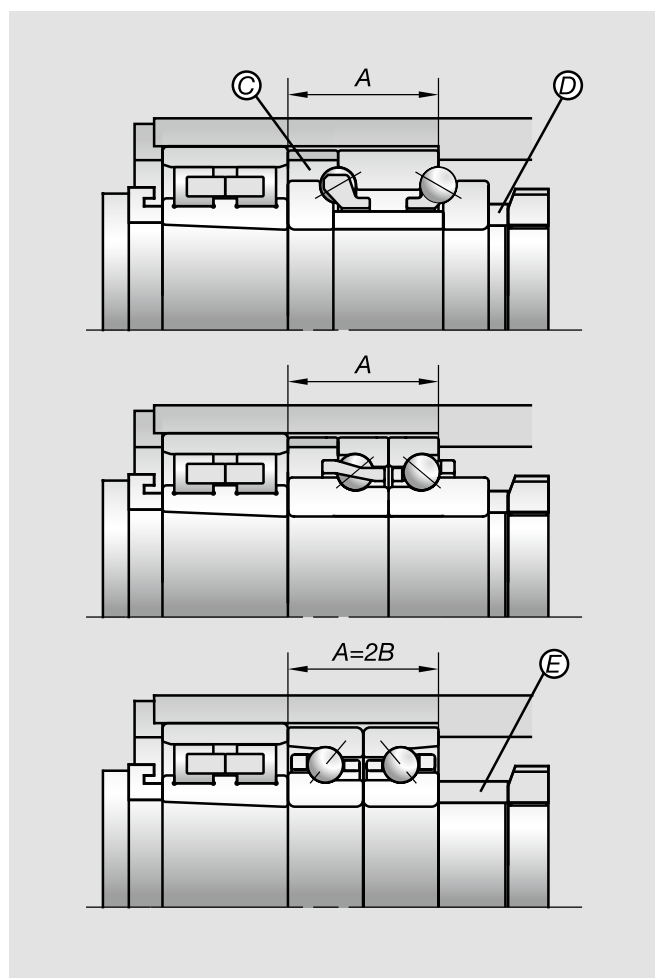
(NSKTAC D Series)

TAC29D Series

TAC20D Series



3. Angular Contact Thrust Ball Bearings



Features

Superior high-speed capability and high rigidity are required of ball bearings used for sustaining axial loads in machine tool spindles. For such application requirements, NSK offers three types of bearings for customers to choose from depending on the structure and the characteristics of the machine.

All of these bearings are designed for use in combination with cylindrical roller bearings. They are manufactured with special outer ring outer diameter tolerances in order to provide clearance between the outer diameter of the bearing and the inner diameter of the housing when mounted, so that any radial load is supported by the cylindrical roller bearings only.

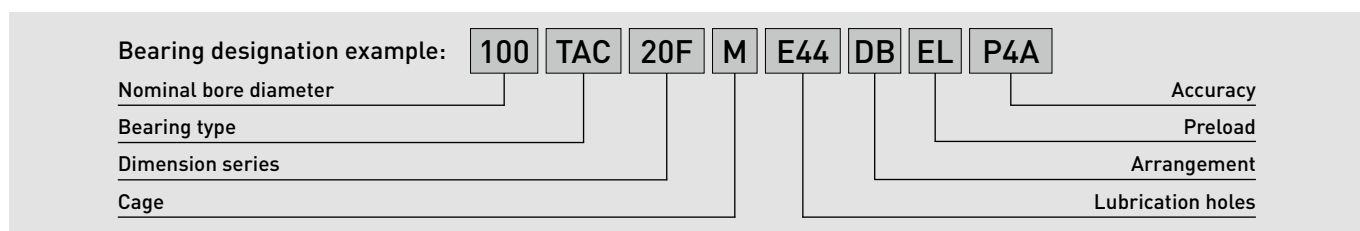
The high-speed angular contact thrust ball bearings of the NSKROBUST series are capable of high-speed performance while maintaining high rigidity. Contact angles of 40° (BTR) and 30° (BAR) result in superior high-speed performance and low heat generation.

Interchangeability

The BAR and BTR Series have special width dimensions to enable customers to easily replace their angular contact thrust ball bearings of the 20 Series with the BAR and BTR type without having to modify the shaft or housing. As shown in the figure on the left, remove spacer (C) and replace spacer (D) with spacer (E).

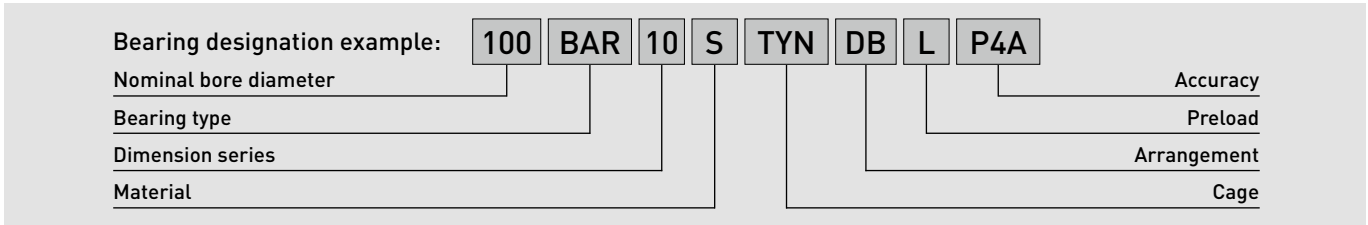
For the replacement of 29 Series bearings with BAR and BTR type bearings, please contact NSK.

Designation System of Angular Contact Thrust Ball Bearings (NSKTAC F Series)



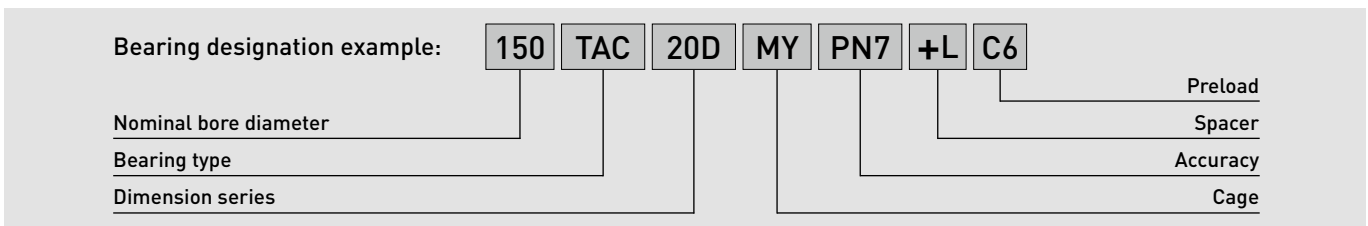
| | | | Reference pages |
|------------|-----------------------|--|-----------------|
| 100 | Nominal bore diameter | Bore diameter (mm) (50-130mm) | 140-141 |
| TAC | Bearing type | TAC: Angular contact thrust ball bearing | 28 |
| 20F | Dimension series | 20F: For combination with NN30 series 29F: For combination with NN39 and NN49 series | 140-141 |
| M | Cage | M: Machined brass cage | — |
| E44 | Lubrication holes | No symbol: No lubrication holes E44: Lubrication groove and lubrication holes on outer ring | 140-141 |
| DB | Arrangement | DB: Back-to-back arrangement | 202-207 |
| EL | Preload | L: Light preload (standard for this series) EL: Extra light preload | 212 |
| P4A | Preload | P4A: Outer diameter tolerances are NSK-specific, all others are ISO Class 4 P5A: Outer diameter tolerances are NSK-specific, all others are ISO Class 5 | 230 |

Designation System of High-Speed Angular Contact Thrust Ball Bearings (NSKROBUST Series)



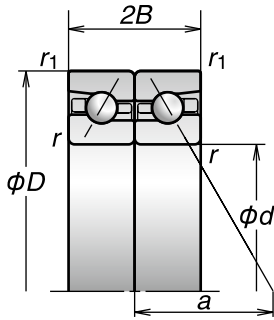
| | | | Reference pages | | | | | | | | | | | | | | | |
|------------|-----------------------|--|-----------------|----------|--|--|------------------|------------------|---|----------------------|----------------------|---|----------------------|---|---|----------------------|--|-----------|
| 100 | Nominal bore diameter | Bore diameter [mm] | 134-139 | | | | | | | | | | | | | | | |
| BAR | Bearing type | BAR: 30° contact angle BTR: 40° contact angle | 28, 46-47 | | | | | | | | | | | | | | | |
| 10 | Dimension series | 10: 10 Series bore and outer diameter, special width | 134-139 | | | | | | | | | | | | | | | |
| S | Material | <table border="1"> <thead> <tr> <th>Type</th> <th colspan="2">Material</th> </tr> <tr> <td></td> <th>Inner/Outer ring</th> <th>Rolling elements</th> </tr> </thead> <tbody> <tr> <td>S</td> <td>Bearing steel (SUJ2)</td> <td>Bearing steel (SUJ2)</td> </tr> <tr> <td>E</td> <td>Bearing steel (SUJ2)</td> <td>Ultra long life bearing rolling elements (EOTF)</td> </tr> <tr> <td>H</td> <td>Bearing steel (SUJ2)</td> <td>Ceramics (Si₃N₄)</td> </tr> </tbody> </table> | Type | Material | | | Inner/Outer ring | Rolling elements | S | Bearing steel (SUJ2) | Bearing steel (SUJ2) | E | Bearing steel (SUJ2) | Ultra long life bearing rolling elements (EOTF) | H | Bearing steel (SUJ2) | Ceramics (Si ₃ N ₄) | 16-19, 28 |
| Type | Material | | | | | | | | | | | | | | | | | |
| | Inner/Outer ring | Rolling elements | | | | | | | | | | | | | | | | |
| S | Bearing steel (SUJ2) | Bearing steel (SUJ2) | | | | | | | | | | | | | | | | |
| E | Bearing steel (SUJ2) | Ultra long life bearing rolling elements (EOTF) | | | | | | | | | | | | | | | | |
| H | Bearing steel (SUJ2) | Ceramics (Si ₃ N ₄) | | | | | | | | | | | | | | | | |
| TYN | Cage | TYN: Rolling element guided polyamide cage; limiting speed $d_m n = 1.2$ million (grease), 1.4 million (oil) MY: Rolling element guided machined brass cage No symbol: Outer ring guided machined brass cage TYN cage is available up to 160mm bore diameter bearings | 20 | | | | | | | | | | | | | | | |
| DB | Arrangement | DB: Back-to-back arrangement | 202-207 | | | | | | | | | | | | | | | |
| L | Preload | L: Light preload (standard for this series) EL: Extra light preload | 134-139, 212 | | | | | | | | | | | | | | | |
| P4A | Accuracy | P2A: Outer diameter tolerances are NSK-specific, all others are ISO Class 2 P4A: Outer diameter tolerances are NSK-specific, all others are ISO Class 4 | 230 | | | | | | | | | | | | | | | |

Designation System of Double-Direction Angular Contact Thrust Ball Bearings (NSKTAC D Series)



| | | | Reference pages |
|------------|-----------------------|--|-----------------|
| 150 | Nominal bore diameter | Bore diameter [mm] (140-320mm) | 142-143 |
| TAC | Bearing type | TAC: Angular contact thrust ball bearing | 28 |
| 20D | Dimension series | 20D, 20X: For combination with NN30 series 29D: For combination with NN39 and NN49 series | 142-143 |
| MY | Cage | MY: Machined brass cage | — |
| PN7 | Accuracy | PN7: Special precision accuracy | 230 |
| +L | Spacer | Inner ring spacer | — |
| C6 | Preload | C6: Extra light preload C7: Light preload (standard for this series) | 142-143 |

3. Angular Contact Thrust Ball Bearings Bore Diameter 150-380 mm High-Speed Angular Contact Thrust Ball Bearings (NSK ROBUST Series)

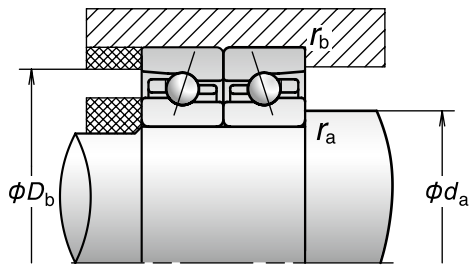


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Effective Load Center (mm) a | Mass (kg/row) (Reference) | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|------|----------|-----------------------|--|--------------------------|--|------------------------|------------------------------|---------------------------|---|--------|
| | d | D | 2B | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | | Grease | Oil |
| 50BAR10E | 50 | 80 | 28.5 | 1 | 0.6 | 14.7 | 27.7 | 18.4 | 30 | 25.6 | 0.272 | 12 400 | 15 700 |
| 50BAR10H | 50 | 80 | 28.5 | 1 | 0.6 | [14.7] | [27.7] | 12.6 | 30 | 25.6 | 0.257 | 13 100 | 16 200 |
| 50BTR10E | 50 | 80 | 28.5 | 1 | 0.6 | 17.4 | 31.5 | 19.3 | 40 | 34.1 | 0.272 | 10 800 | 14 000 |
| 50BTR10H | 50 | 80 | 28.5 | 1 | 0.6 | [17.4] | [31.5] | 15.5 | 40 | 34.1 | 0.257 | 11 600 | 14 700 |
| 55BAR10E | 55 | 90 | 33 | 1.1 | 0.6 | 18.2 | 35.0 | 23.4 | 30 | 28.9 | 0.390 | 11 100 | 14 100 |
| 55BAR10H | 55 | 90 | 33 | 1.1 | 0.6 | [18.2] | [35.0] | 16.0 | 30 | 28.9 | 0.369 | 11 800 | 14 500 |
| 55BTR10E | 55 | 90 | 33 | 1.1 | 0.6 | 21.6 | 40.0 | 23.6 | 40 | 38.3 | 0.390 | 9 700 | 12 600 |
| 55BTR10H | 55 | 90 | 33 | 1.1 | 0.6 | [21.6] | [40.0] | 19.7 | 40 | 38.3 | 0.369 | 10 400 | 13 200 |
| 60BAR10E | 60 | 95 | 33 | 1.1 | 0.6 | 18.9 | 38.0 | 25.5 | 30 | 30.4 | 0.420 | 10 400 | 13 200 |
| 60BAR10H | 60 | 95 | 33 | 1.1 | 0.6 | [18.9] | [38.0] | 17.5 | 30 | 30.4 | 0.397 | 11 000 | 13 600 |
| 60BTR10E | 60 | 95 | 33 | 1.1 | 0.6 | 22.4 | 43.5 | 25.8 | 40 | 40.4 | 0.420 | 9 100 | 11 800 |
| 60BTR10H | 60 | 95 | 33 | 1.1 | 0.6 | [22.4] | [43.5] | 21.5 | 40 | 40.4 | 0.397 | 9 700 | 12 300 |
| 65BAR10E | 65 | 100 | 33 | 1.1 | 0.6 | 19.5 | 41.5 | 27.7 | 30 | 31.8 | 0.450 | 9 700 | 12 400 |
| 65BAR10H | 65 | 100 | 33 | 1.1 | 0.6 | [19.5] | [41.5] | 19.0 | 30 | 31.8 | 0.425 | 10 400 | 12 800 |
| 65BTR10E | 65 | 100 | 33 | 1.1 | 0.6 | 23.1 | 47.0 | 27.3 | 40 | 42.5 | 0.450 | 8 500 | 11 100 |
| 65BTR10H | 65 | 100 | 33 | 1.1 | 0.6 | [23.1] | [47.0] | 23.3 | 40 | 42.5 | 0.425 | 9 100 | 11 600 |
| 70BAR10E | 70 | 110 | 36 | 1.1 | 0.6 | 26.9 | 55.0 | 37.5 | 30 | 34.7 | 0.601 | 8 900 | 11 400 |
| 70BAR10H | 70 | 110 | 36 | 1.1 | 0.6 | [26.9] | [55.0] | 25.5 | 30 | 34.7 | 0.561 | 9 500 | 11 700 |
| 70BTR10E | 70 | 110 | 36 | 1.1 | 0.6 | 32.0 | 63.0 | 35.0 | 40 | 46.3 | 0.601 | 7 800 | 10 200 |
| 70BTR10H | 70 | 110 | 36 | 1.1 | 0.6 | [32.0] | [63.0] | 31.5 | 40 | 46.3 | 0.561 | 8 400 | 10 600 |
| 75BAR10E | 75 | 115 | 36 | 1.1 | 0.6 | 27.3 | 57.5 | 39.0 | 30 | 36.1 | 0.634 | 8 500 | 10 800 |
| 75BAR10H | 75 | 115 | 36 | 1.1 | 0.6 | [27.3] | [57.5] | 26.7 | 30 | 36.1 | 0.592 | 9 000 | 11 100 |
| 75BTR10E | 75 | 115 | 36 | 1.1 | 0.6 | 32.5 | 65.5 | 36.5 | 40 | 48.4 | 0.634 | 7 400 | 9 600 |
| 75BTR10H | 75 | 115 | 36 | 1.1 | 0.6 | [32.5] | [65.5] | 33.0 | 40 | 48.4 | 0.592 | 7 900 | 10 000 |
| 80BAR10E | 80 | 125 | 40.5 | 1.1 | 0.6 | 32.0 | 68.5 | 46.5 | 30 | 39.4 | 0.830 | 7 900 | 10 000 |
| 80BAR10H | 80 | 125 | 40.5 | 1.1 | 0.6 | [32.0] | [68.5] | 32.0 | 30 | 39.4 | 0.776 | 8 300 | 10 300 |
| 80BTR10E | 80 | 125 | 40.5 | 1.1 | 0.6 | 38.0 | 78.0 | 43.0 | 40 | 52.7 | 0.830 | 6 900 | 8 900 |
| 80BTR10H | 80 | 125 | 40.5 | 1.1 | 0.6 | [38.0] | [78.0] | 39.0 | 40 | 52.7 | 0.776 | 7 400 | 9 300 |
| 85BAR10E | 85 | 130 | 40.5 | 1.1 | 0.6 | 32.5 | 71.5 | 48.5 | 30 | 41.1 | 0.983 | 7 500 | 9 500 |
| 85BAR10H | 85 | 130 | 40.5 | 1.1 | 0.6 | [32.5] | [71.5] | 33.0 | 30 | 41.1 | 0.926 | 8 000 | 9 800 |
| 85BTR10E | 85 | 130 | 40.5 | 1.1 | 0.6 | 38.5 | 81.5 | 43.5 | 40 | 55.2 | 0.983 | 6 600 | 8 500 |
| 85BTR10H | 85 | 130 | 40.5 | 1.1 | 0.6 | [38.5] | [81.5] | 41.0 | 40 | 55.2 | 0.926 | 7 000 | 8 900 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218. Limiting speeds listed on this page are based on a DB arrangement with extra light preload (EL). Adjust the limiting speed to 85% of the figure shown when a light preload (L) has been selected.

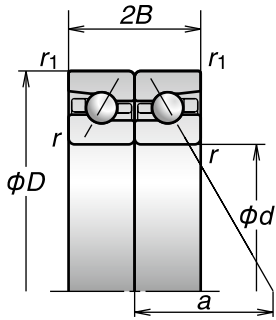


| Abutment and Fillet Dimensions (mm) | | | | Preload (DB and DF Arrangement) (N) | | Axial Rigidity (DB and DF Arrangement) (N/μm) | | Measured Axial Clearance (μm) | |
|-------------------------------------|-----------------------|-----------------------|-----------------------|-------------------------------------|-------|---|-----|-------------------------------|-----|
| d _a (min.) | D _b (max.) | r _a (max.) | r _b (max.) | EL | L | EL | L | EL | L |
| 56 | 75 | 1 | 0.6 | 221 | 464 | 169 | 220 | -5 | -10 |
| 56 | 75 | 1 | 0.6 | 246 | 531 | 196 | 257 | -5 | -10 |
| 56 | 75 | 1 | 0.6 | 335 | 761 | 292 | 387 | -5 | -10 |
| 56 | 75 | 1 | 0.6 | 379 | 879 | 341 | 455 | -5 | -10 |
| 62 | 85 | 1 | 0.6 | 229 | 606 | 177 | 250 | -5 | -12 |
| 62 | 85 | 1 | 0.6 | 256 | 696 | 206 | 293 | -5 | -12 |
| 62 | 85 | 1 | 0.6 | 349 | 800 | 307 | 409 | -5 | -10 |
| 62 | 85 | 1 | 0.6 | 396 | 924 | 359 | 480 | -5 | -10 |
| 67 | 90 | 1 | 0.6 | 241 | 646 | 190 | 270 | -5 | -12 |
| 67 | 90 | 1 | 0.6 | 270 | 743 | 221 | 316 | -5 | -12 |
| 67 | 90 | 1 | 0.6 | 371 | 855 | 331 | 441 | -5 | -10 |
| 67 | 90 | 1 | 0.6 | 421 | 990 | 387 | 518 | -5 | -10 |
| 72 | 95 | 1 | 0.6 | 253 | 687 | 203 | 289 | -5 | -12 |
| 72 | 95 | 1 | 0.6 | 284 | 791 | 236 | 339 | -5 | -12 |
| 72 | 95 | 1 | 0.6 | 392 | 912 | 354 | 473 | -5 | -10 |
| 72 | 95 | 1 | 0.6 | 446 | 1 056 | 414 | 556 | -5 | -10 |
| 77 | 105 | 1 | 0.6 | 252 | 908 | 202 | 317 | -5 | -15 |
| 77 | 105 | 1 | 0.6 | 282 | 1 051 | 235 | 373 | -5 | -15 |
| 77 | 105 | 1 | 0.6 | 390 | 1 556 | 352 | 566 | -5 | -15 |
| 77 | 105 | 1 | 0.6 | 444 | 1 815 | 412 | 668 | -5 | -15 |
| 82 | 110 | 1 | 0.6 | 258 | 939 | 209 | 329 | -5 | -15 |
| 82 | 110 | 1 | 0.6 | 290 | 1 088 | 243 | 387 | -5 | -15 |
| 82 | 110 | 1 | 0.6 | 402 | 1 612 | 365 | 588 | -5 | -15 |
| 82 | 110 | 1 | 0.6 | 458 | 1 881 | 427 | 694 | -5 | -15 |
| 87 | 120 | 1 | 0.6 | 346 | 1 095 | 237 | 356 | -5 | -15 |
| 87 | 120 | 1 | 0.6 | 382 | 1 256 | 275 | 417 | -5 | -15 |
| 87 | 120 | 1 | 0.6 | 507 | 1 819 | 406 | 630 | -5 | -15 |
| 87 | 120 | 1 | 0.6 | 569 | 2 107 | 473 | 741 | -5 | -15 |
| 92 | 125 | 1 | 0.6 | 354 | 1 129 | 245 | 369 | -5 | -15 |
| 92 | 125 | 1 | 0.6 | 391 | 1 295 | 284 | 432 | -5 | -15 |
| 92 | 125 | 1 | 0.6 | 520 | 1 879 | 420 | 653 | -5 | -15 |
| 92 | 125 | 1 | 0.6 | 584 | 2 177 | 489 | 768 | -5 | -15 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

3. Angular Contact Thrust Ball Bearings Bore Diameter 90-140 mm High-Speed Angular Contact Thrust Ball Bearings (NSK ROBUST Series)

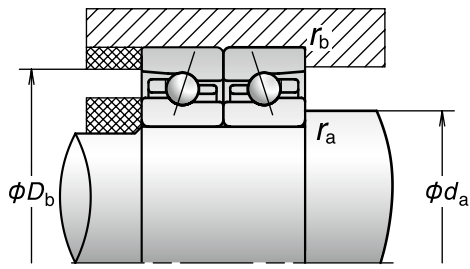


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Effective Load Center (mm) a | Mass (kg/row) (Reference) | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|------|----------|-----------------------|--|--------------------------|--|------------------------|------------------------------|---------------------------|---|-------|
| | d | D | 2B | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | | Grease | Oil |
| 90BAR10E | 90 | 140 | 45 | 1.5 | 1 | 42.5 | 92.5 | 62.5 | 30 | 44.4 | 1.21 | 7 000 | 8 900 |
| 90BAR10H | 90 | 140 | 45 | 1.5 | 1 | (42.5) | (92.5) | 43.0 | 30 | 44.4 | 1.12 | 7 400 | 9 200 |
| 90BTR10E | 90 | 140 | 45 | 1.5 | 1 | 50.0 | 105 | 58.0 | 40 | 59.5 | 1.21 | 6 100 | 8 000 |
| 90BTR10H | 90 | 140 | 45 | 1.5 | 1 | (50.0) | (105) | 52.5 | 40 | 59.5 | 1.12 | 6 600 | 8 300 |
| 95BAR10E | 95 | 145 | 45 | 1.5 | 1 | 43.0 | 96.5 | 65.0 | 30 | 45.5 | 1.25 | 6 700 | 8 500 |
| 95BAR10H | 95 | 145 | 45 | 1.5 | 1 | (43.0) | (96.5) | 44.5 | 30 | 45.5 | 1.16 | 7 100 | 8 800 |
| 95BTR10E | 95 | 145 | 45 | 1.5 | 1 | 51.0 | 110 | 61.0 | 40 | 61.0 | 1.25 | 5 900 | 7 600 |
| 95BTR10H | 95 | 145 | 45 | 1.5 | 1 | (51.0) | (110) | 55.0 | 40 | 61.0 | 1.16 | 6 300 | 8 000 |
| 100BAR10E | 100 | 150 | 45 | 1.5 | 1 | 43.5 | 100 | 68.0 | 30 | 47.3 | 1.31 | 6 400 | 8 200 |
| 100BAR10H | 100 | 150 | 45 | 1.5 | 1 | (43.5) | (100) | 46.5 | 30 | 47.3 | 1.22 | 6 800 | 8 400 |
| 100BTR10E | 100 | 150 | 45 | 1.5 | 1 | 51.5 | 114 | 73.0 | 40 | 63.7 | 1.31 | 5 600 | 7 300 |
| 100BTR10H | 100 | 150 | 45 | 1.5 | 1 | (51.5) | (114) | 57.0 | 40 | 63.7 | 1.22 | 6 000 | 7 600 |
| 105BAR10E | 105 | 160 | 49.5 | 2 | 1 | 49.5 | 115 | 78.0 | 30 | 50.6 | 1.74 | 6 100 | 7 700 |
| 105BAR10H | 105 | 160 | 49.5 | 2 | 1 | (49.5) | (115) | 53.5 | 30 | 50.6 | 1.62 | 6 500 | 8 000 |
| 105BTR10E | 105 | 160 | 49.5 | 2 | 1 | 58.5 | 131 | 74.5 | 40 | 68.0 | 1.74 | 5 300 | 6 900 |
| 105BTR10H | 105 | 160 | 49.5 | 2 | 1 | (58.5) | (131) | 65.5 | 40 | 68.0 | 1.62 | 5 700 | 7 200 |
| 110BAR10E | 110 | 170 | 54 | 2 | 1 | 55.5 | 131 | 89.0 | 30 | 53.9 | 1.97 | 5 800 | 7 300 |
| 110BAR10H | 110 | 170 | 54 | 2 | 1 | (55.5) | (131) | 60.5 | 30 | 53.9 | 1.83 | 6 100 | 7 500 |
| 110BTR10E | 110 | 170 | 54 | 2 | 1 | 66.0 | 148 | 82.5 | 40 | 72.2 | 1.97 | 5 000 | 6 500 |
| 110BTR10H | 110 | 170 | 54 | 2 | 1 | (66.0) | (148) | 74.5 | 40 | 72.2 | 1.83 | 5 400 | 6 800 |
| 120BAR10E | 120 | 180 | 54 | 2 | 1 | 57.0 | 141 | 96.0 | 30 | 56.8 | 2.29 | 5 400 | 6 800 |
| 120BAR10H | 120 | 180 | 54 | 2 | 1 | (57.0) | (141) | 65.5 | 30 | 56.8 | 2.14 | 5 700 | 7 000 |
| 120BTR10E | 120 | 180 | 54 | 2 | 1 | 68.0 | 160 | 88.5 | 40 | 76.4 | 2.29 | 4 700 | 6 100 |
| 120BTR10H | 120 | 180 | 54 | 2 | 1 | (68.0) | (160) | 80.5 | 40 | 76.4 | 2.14 | 5 000 | 6 400 |
| 130BAR10E | 130 | 200 | 63 | 2 | 1 | 72.5 | 172 | 117 | 30 | 63.3 | 3.20 | 4 900 | 6 200 |
| 130BAR10H | 130 | 200 | 63 | 2 | 1 | (72.5) | (172) | 79.5 | 30 | 63.3 | 2.98 | 5 200 | 6 400 |
| 130BTR10E | 130 | 200 | 63 | 2 | 1 | 86.0 | 195 | 106 | 40 | 85.0 | 3.20 | 4 300 | 5 600 |
| 130BTR10H | 130 | 200 | 63 | 2 | 1 | (86.0) | (195) | 98.0 | 40 | 85.0 | 2.98 | 4 600 | 5 800 |
| 140BAR10E | 140 | 210 | 63 | 2 | 1 | 78.5 | 200 | 135 | 30 | 66.2 | 3.56 | 4 600 | 5 900 |
| 140BAR10H | 140 | 210 | 63 | 2 | 1 | (78.5) | (200) | 92.5 | 30 | 66.2 | 3.30 | 4 900 | 6 000 |
| 140BTR10E | 140 | 210 | 63 | 2 | 1 | 93.0 | 227 | 84.0 | 40 | 89.2 | 3.56 | 4 000 | 5 200 |
| 140BTR10H | 140 | 210 | 63 | 2 | 1 | (93.0) | (227) | 100 | 40 | 89.2 | 3.30 | 4 300 | 5 500 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218. Limiting speeds listed on this page are based on a DB arrangement with extra light preload (EL). Adjust the limiting speed to 85% of the figure shown when a light preload (L) has been selected.

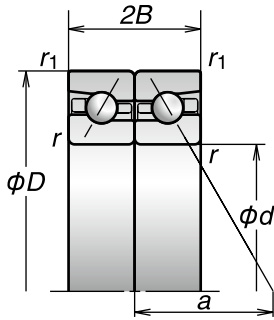


| Abutment and Fillet Dimensions (mm) | | | | Preload (DB and DF Arrangement) (N) | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | Measured Axial Clearance (μ m) | |
|-------------------------------------|--------------|--------------|--------------|-------------------------------------|-------|---|-------|-------------------------------------|-----|
| d_a (min.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | EL | L | EL | L |
| 99 | 134 | 1.5 | 0.8 | 360 | 1 662 | 252 | 431 | -5 | -20 |
| 99 | 134 | 1.5 | 0.8 | 398 | 1 922 | 292 | 506 | -5 | -20 |
| 99 | 134 | 1.5 | 0.8 | 532 | 2 834 | 433 | 768 | -5 | -20 |
| 99 | 134 | 1.5 | 0.8 | 598 | 3 303 | 504 | 906 | -5 | -20 |
| 104 | 139 | 1.5 | 0.8 | 368 | 1 717 | 260 | 447 | -5 | -20 |
| 104 | 139 | 1.5 | 0.8 | 408 | 1 986 | 301 | 525 | -5 | -20 |
| 104 | 139 | 1.5 | 0.8 | 546 | 2 931 | 448 | 797 | -5 | -20 |
| 104 | 139 | 1.5 | 0.8 | 614 | 3 417 | 521 | 940 | -5 | -20 |
| 109 | 144 | 1.5 | 0.8 | 376 | 1 770 | 268 | 462 | -5 | -20 |
| 109 | 144 | 1.5 | 0.8 | 417 | 2 049 | 311 | 543 | -5 | -20 |
| 109 | 144 | 1.5 | 0.8 | 559 | 3 029 | 462 | 825 | -5 | -20 |
| 109 | 144 | 1.5 | 0.8 | 630 | 3 531 | 539 | 973 | -5 | -20 |
| 115 | 154 | 2 | 1 | 384 | 1 820 | 276 | 476 | -5 | -20 |
| 115 | 154 | 2 | 1 | 426 | 2 107 | 320 | 560 | -5 | -20 |
| 115 | 154 | 2 | 1 | 573 | 3 121 | 477 | 852 | -5 | -20 |
| 115 | 154 | 2 | 1 | 645 | 3 640 | 556 | 1 005 | -5 | -20 |
| 120 | 164 | 2 | 1 | 391 | 1 868 | 284 | 489 | -5 | -20 |
| 120 | 164 | 2 | 1 | 434 | 2 164 | 329 | 576 | -5 | -20 |
| 120 | 164 | 2 | 1 | 586 | 3 210 | 490 | 877 | -5 | -20 |
| 120 | 164 | 2 | 1 | 661 | 3 746 | 572 | 1 035 | -5 | -20 |
| 130 | 174 | 2 | 1 | 408 | 1 982 | 301 | 523 | -5 | -20 |
| 130 | 174 | 2 | 1 | 454 | 2 298 | 350 | 615 | -5 | -20 |
| 130 | 174 | 2 | 1 | 615 | 3 417 | 522 | 938 | -5 | -20 |
| 130 | 174 | 2 | 1 | 694 | 3 989 | 609 | 1 107 | -5 | -20 |
| 140 | 194 | 2 | 1 | 394 | 2 532 | 286 | 547 | -5 | -25 |
| 140 | 194 | 2 | 1 | 437 | 2 945 | 332 | 644 | -5 | -25 |
| 140 | 194 | 2 | 1 | 591 | 4 411 | 496 | 985 | -5 | -25 |
| 140 | 194 | 2 | 1 | 667 | 5 163 | 578 | 1 163 | -5 | -25 |
| 150 | 204 | 2 | 1 | 580 | 3 154 | 359 | 649 | -5 | -25 |
| 150 | 204 | 2 | 1 | 634 | 3 642 | 414 | 762 | -5 | -25 |
| 150 | 204 | 2 | 1 | 823 | 5 365 | 610 | 1 157 | -5 | -25 |
| 150 | 204 | 2 | 1 | 916 | 6 248 | 708 | 1 364 | -5 | -25 |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

3. Angular Contact Thrust Ball Bearings Bore Diameter 90-140 mm High-Speed Angular Contact Thrust Ball Bearings (NSK ROBUST Series)

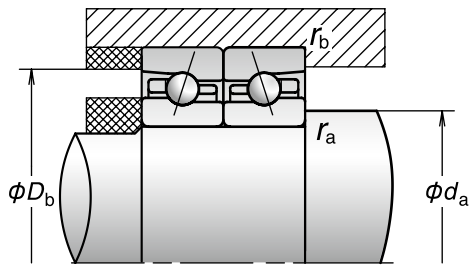


| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings ⁽¹⁾ (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Effective Load Center (mm) a | Mass (kg/row) (Reference) | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|-------|----------|-----------------------|--|--------------------------|--|------------------------|------------------------------|---------------------------|---|-------|
| | d | D | 2B | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | | Grease | Oil |
| 150BAR10S | 150 | 225 | 67.5 | 2.1 | 1.1 | 92.5 | 234 | 160 | 30 | 71.0 | 4.35 | 4 000 | 5 100 |
| 150BAR10H | 150 | 225 | 67.5 | 2.1 | 1.1 | [92.5] | [234] | 109 | 30 | 71.0 | 4.03 | 4 600 | 5 600 |
| 150BTR10S | 150 | 225 | 67.5 | 2.1 | 1.1 | 110 | 267 | 104 | 40 | 95.5 | 4.35 | 3 500 | 4 600 |
| 150BTR10H | 150 | 225 | 67.5 | 2.1 | 1.1 | [110] | [267] | 123 | 40 | 95.5 | 4.03 | 4 000 | 5 100 |
| 160BAR10S | 160 | 240 | 72 | 2.1 | 1.1 | 100 | 257 | 175 | 30 | 75.7 | 5.33 | 3 800 | 4 800 |
| 160BAR10H | 160 | 240 | 72 | 2.1 | 1.1 | [100] | [257] | 120 | 30 | 75.7 | 4.95 | 4 300 | 5 300 |
| 160BTR10S | 160 | 240 | 72 | 2.1 | 1.1 | 119 | 293 | 184 | 40 | 101.9 | 5.33 | 3 300 | 4 300 |
| 160BTR10H | 160 | 240 | 72 | 2.1 | 1.1 | [119] | [293] | 147 | 40 | 101.9 | 4.95 | 3 800 | 4 800 |
| 170BAR10S | 170 | 260 | 81 | 2.1 | 1.1 | 117 | 305 | 207 | 30 | 82.3 | 7.95 | 3 500 | 4 500 |
| 170BTR10S | 170 | 260 | 81 | 2.1 | 1.1 | 139 | 345 | 204 | 40 | 110.5 | 7.95 | 3 100 | 4 000 |
| 180BAR10S | 180 | 280 | 90 | 2.1 | 1.1 | 151 | 385 | 262 | 30 | 88.8 | 10.2 | 3 300 | 4 200 |
| 180BTR10S | 180 | 280 | 90 | 2.1 | 1.1 | 179 | 440 | 271 | 40 | 118.9 | 10.2 | 2 900 | 3 700 |
| 190BAR10S | 190 | 290 | 90 | 2.1 | 1.1 | 150 | 385 | 263 | 30 | 91.8 | 11.0 | 3 200 | 4 000 |
| 190BTR10S | 190 | 290 | 90 | 2.1 | 1.1 | 177 | 440 | 255 | 40 | 123.2 | 11.0 | 2 800 | 3 600 |
| 200BAR10S | 200 | 310 | 99 | 2.1 | 1.1 | 169 | 444 | 300 | 30 | 98.3 | 14.2 | 3 000 | 3 800 |
| 200BTR10S | 200 | 310 | 99 | 2.1 | 1.1 | 201 | 505 | 292 | 40 | 131.7 | 14.2 | 2 600 | 3 400 |
| 220BAR10S | 220 | 340 | 108 | 3 | 1.1 | 189 | 505 | 340 | 30 | 107.8 | 18.5 | 2 400 | 3 100 |
| 220BTR10S | 220 | 340 | 108 | 3 | 1.1 | 224 | 575 | 305 | 40 | 144.5 | 18.5 | 2 000 | 2 700 |
| 240BAR10S | 240 | 360 | 108 | 3 | 1.1 | 195 | 545 | 370 | 30 | 113.5 | 19.9 | 2 200 | 2 900 |
| 240BTR10S | 240 | 360 | 108 | 3 | 1.1 | 231 | 620 | 362 | 40 | 152.9 | 19.9 | 1 900 | 2 500 |
| 260BAR10S | 260 | 400 | 123 | 4 | 1.5 | 253 | 765 | 520 | 30 | 125.9 | 29.0 | 2 000 | 2 600 |
| 260BTR10S | 260 | 400 | 123 | 4 | 1.5 | 300 | 870 | 463 | 40 | 169.2 | 29.0 | 1 700 | 2 300 |
| 300BAR10S | 300 | 460 | 142.5 | 4 | 1.5 | 310 | 1 020 | 696 | 30 | 145.3 | 44.9 | 1 800 | 2 300 |
| 300BTR10S | 300 | 460 | 142.5 | 4 | 1.5 | 370 | 1 160 | 675 | 40 | 195.1 | 44.9 | 1 500 | 2 000 |
| 360BAR10S | 360 | 540 | 159 | 5 | 2 | 360 | 1 320 | 815 | 30 | 169.7 | 67.6 | 1 500 | 1 900 |
| 360BTR10S | 360 | 540 | 159 | 5 | 2 | 425 | 1 500 | 870 | 40 | 228.5 | 67.6 | 1 300 | 1 700 |
| 380BAR10S | 380 | 560 | 159 | 5 | 2 | 370 | 1 410 | 965 | 30 | 175.4 | 69.8 | 1 400 | 1 900 |
| 380BTR10S | 380 | 560 | 159 | 5 | 2 | 440 | 1 600 | 930 | 40 | 236.9 | 69.8 | 1 200 | 1 600 |

⁽¹⁾ Basic load rating values are reference values for ceramic ball bearings.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218. Limiting speeds listed on this page are based on a DB arrangement with extra light preload (EL). Adjust the limiting speed to 85% of the figure shown when a light preload (L) has been selected.



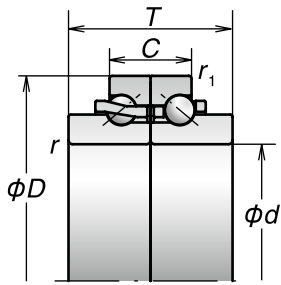
| Abutment and Fillet Dimensions (mm) | | | | Preload (DB and DF Arrangement) (N) | | Axial Rigidity (DB and DF Arrangement) (N/ μ m) | | Measured Axial Clearance (μ m) | |
|-------------------------------------|--------------|--------------|--------------|-------------------------------------|--------|---|-------|-------------------------------------|-----|
| d_a (min.) | D_b (max.) | r_a (max.) | r_b (max.) | EL | L | EL | L | EL | L |
| 162 | 218 | 2 | 1 | 584 | 3 694 | 364 | 691 | -5 | -28 |
| 162 | 218 | 2 | 1 | 639 | 4 278 | 419 | 813 | -5 | -28 |
| 162 | 218 | 2 | 1 | 831 | 5 435 | 618 | 1 172 | -5 | -25 |
| 162 | 218 | 2 | 1 | 925 | 6 330 | 717 | 1 382 | -5 | -25 |
| 172 | 233 | 2 | 1 | 591 | 4 121 | 370 | 728 | -5 | -30 |
| 172 | 233 | 2 | 1 | 647 | 4 780 | 427 | 857 | -5 | -30 |
| 172 | 233 | 2 | 1 | 843 | 5 545 | 630 | 1 198 | -5 | -25 |
| 172 | 233 | 2 | 1 | 939 | 6 458 | 732 | 1 412 | -5 | -25 |
| 182 | 253 | 2 | 1 | 604 | 4 258 | 383 | 754 | -5 | -30 |
| 182 | 253 | 2 | 1 | 865 | 7 366 | 653 | 1 355 | -5 | -30 |
| 192 | 273 | 2 | 1 | 606 | 5 259 | 385 | 814 | -5 | -35 |
| 192 | 273 | 2 | 1 | 869 | 9 183 | 658 | 1 467 | -5 | -35 |
| 202 | 283 | 2 | 1 | 606 | 5 259 | 385 | 814 | -5 | -35 |
| 202 | 283 | 2 | 1 | 869 | 9 184 | 658 | 1 467 | -5 | -35 |
| 212 | 303 | 2 | 1 | 617 | 6 055 | 396 | 873 | -5 | -38 |
| 212 | 303 | 2 | 1 | 888 | 10 629 | 678 | 1 577 | -5 | -38 |
| 234 | 333 | 2.5 | 1 | 626 | 7 839 | 406 | 973 | -5 | -45 |
| 234 | 333 | 2.5 | 1 | 905 | 8 208 | 695 | 1 468 | -5 | -31 |
| 254 | 353 | 2.5 | 1 | 651 | 9 162 | 431 | 1 077 | -5 | -48 |
| 254 | 353 | 2.5 | 1 | 947 | 12 542 | 740 | 1 781 | -5 | -40 |
| 278 | 391 | 3 | 1.5 | 1 076 | 2 325 | 540 | 702 | - | - |
| 278 | 391 | 3 | 1.5 | 2 012 | 10 091 | 1 008 | 1 742 | - | - |
| 318 | 451 | 3 | 1.5 | 2 505 | 5 838 | 756 | 1 011 | - | - |
| 318 | 451 | 3 | 1.5 | 4 678 | 10 874 | 1 408 | 1 876 | - | - |
| 382 | 530 | 4 | 2 | 2 801 | 6 524 | 845 | 1 129 | - | - |
| 382 | 530 | 4 | 2 | 5 231 | 12 157 | 1 575 | 2 096 | - | - |
| 402 | 550 | 4 | 2 | 2 982 | 6 945 | 899 | 1 201 | - | - |
| 402 | 550 | 4 | 2 | 5 569 | 12 942 | 1 676 | 2 231 | - | - |

For additional information:

- Dynamic equivalent load P193
- Static equivalent load P200
- Spacer Dimensions and Nozzle Position P239
- Recommended Grease Quantities P259

3. Angular Contact Thrust Ball Bearings Angular Contact Thrust Ball Bearings (NSKTAC F Series)

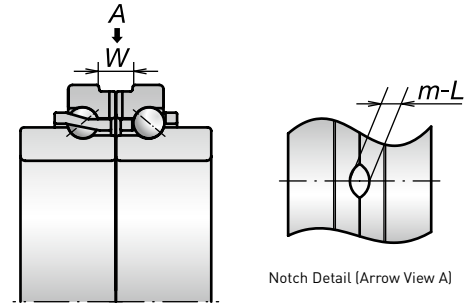
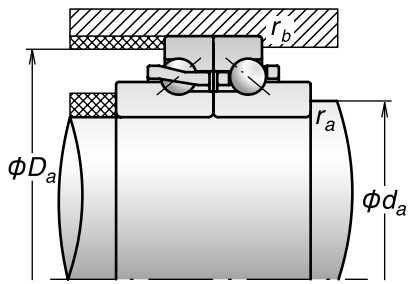
Bore Diameter 80-130 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Permissible Axial Load ⁽¹⁾ (kN) | Contact angle (Degree) | Mass (kg/row) (Reference) | Limiting Speeds ⁽²⁾ (min ⁻¹) | |
|---------------------|--------------------------|-----|----|----|----------|-----------------------|--------------------------|--------------------------|--|------------------------|---------------------------|---|-------|
| | d | D | T | C | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | Grease | Oil |
| 50TAC20F | 50 | 80 | 38 | 19 | 1 | 0.6 | 25.3 | 64.0 | 10.5 | 50 | 0.285 | 6 900 | 7 700 |
| 55TAC20F | 55 | 90 | 44 | 22 | 1.1 | 0.6 | 31.5 | 81.0 | 13.3 | 50 | 0.442 | 6 200 | 6 900 |
| 60TAC20F | 60 | 95 | 44 | 22 | 1.1 | 0.6 | 32.5 | 88.5 | 14.4 | 50 | 0.474 | 5 800 | 6 500 |
| 65TAC20F | 65 | 100 | 44 | 22 | 1.1 | 0.6 | 33.5 | 96.0 | 15.5 | 50 | 0.506 | 5 500 | 6 100 |
| 70TAC20F | 70 | 110 | 48 | 24 | 1.1 | 0.6 | 46.0 | 127 | 20.2 | 50 | 0.678 | 5 000 | 5 600 |
| 75TAC20F | 75 | 115 | 48 | 24 | 1.1 | 0.6 | 46.5 | 132 | 21.0 | 50 | 0.717 | 4 700 | 5 300 |
| 80TAC20F | 80 | 125 | 54 | 27 | 1.1 | 0.6 | 54.5 | 157 | 25.1 | 50 | 1.01 | 4 400 | 4 900 |
| 85TAC20F | 85 | 130 | 54 | 27 | 1.1 | 0.6 | 55.5 | 164 | 26.0 | 50 | 1.04 | 4 200 | 4 700 |
| 90TAC20F | 90 | 140 | 60 | 30 | 1.5 | 1 | 73.0 | 213 | 34.5 | 50 | 1.39 | 3 900 | 4 300 |
| 95TAC20F | 95 | 145 | 60 | 30 | 1.5 | 1 | 74.0 | 222 | 36.0 | 50 | 1.45 | 3 800 | 4 200 |
| 100TAC29F | 100 | 140 | 48 | 24 | 1.1 | 0.6 | 51.5 | 171 | 26.8 | 50 | 0.917 | 3 800 | 4 200 |
| 100TAC20F | 100 | 150 | 60 | 30 | 1.5 | 1 | 75.0 | 231 | 37.0 | 50 | 1.47 | 3 600 | 4 000 |
| 105TAC20F | 105 | 160 | 66 | 33 | 2 | 1 | 85.0 | 265 | 42.5 | 50 | 1.96 | 3 400 | 3 800 |
| 110TAC29F | 110 | 150 | 48 | 24 | 1.1 | 0.6 | 53.0 | 187 | 29.2 | 50 | 0.996 | 3 500 | 3 800 |
| 110TAC20F | 110 | 170 | 72 | 36 | 2 | 1 | 96.0 | 300 | 46.0 | 50 | 2.45 | 3 200 | 3 600 |
| 120TAC29F | 120 | 165 | 54 | 27 | 2 | 1 | 62.0 | 223 | 35.0 | 50 | 1.39 | 3 200 | 3 500 |
| 120TAC20F | 120 | 180 | 72 | 36 | 2 | 1 | 98.5 | 325 | 49.0 | 50 | 2.63 | 3 000 | 3 300 |
| 130TAC29F | 130 | 180 | 60 | 30 | 1.5 | 1 | 74.5 | 276 | 43.5 | 50 | 1.89 | 2 900 | 3 200 |
| 130TAC20F | 130 | 200 | 84 | 42 | 2 | 1 | 125 | 395 | 61.5 | 50 | 3.96 | 2 700 | 3 000 |

⁽¹⁾ For permissible axial load, please refer to Page 201.

⁽²⁾ For application of limiting speeds, please refer to Page 218. Limiting speeds listed on this page are based on a DB arrangement with extra light preload (EL). Adjust the limiting speed to 85% of the figure shown when a light preload (L) has been selected.



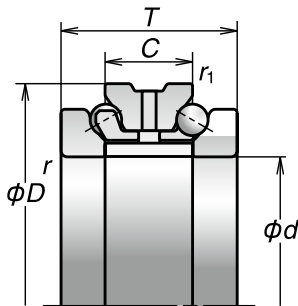
E44 Specification

| Abutment and Fillet Dimensions (mm) | | | | Preload (N) | | Axial Rigidity (N/ μ m) | | E44 Specification Lubrication Holes Dimensions (mm) | | |
|-------------------------------------|-------|--------------|--------------|-------------|-------|-----------------------------|-------|---|---------------|-------------------|
| d_a | D_a | r_a (max.) | r_b (max.) | EL | L | EL | L | Oil Groove Width W | Notch Width L | Number of Holes m |
| 62 | 75 | 1 | 0.6 | 549 | 2 335 | 530 | 876 | 8 | 3 | 4 |
| 69 | 84 | 1 | 0.6 | 580 | 2 485 | 565 | 934 | 8 | 3 | 4 |
| 74 | 89 | 1 | 0.6 | 619 | 2 677 | 609 | 1 010 | 8 | 3 | 4 |
| 79 | 94 | 1 | 0.6 | 658 | 2 868 | 652 | 1 086 | 8 | 3 | 4 |
| 87 | 104 | 1 | 0.6 | 648 | 2 814 | 641 | 1 062 | 10 | 4 | 4 |
| 92 | 109 | 1 | 0.6 | 670 | 2 920 | 665 | 1 104 | 10 | 4 | 4 |
| 99 | 117 | 1 | 0.6 | 806 | 3 236 | 733 | 1 181 | 12 | 5 | 4 |
| 104 | 122 | 1 | 0.6 | 829 | 3 348 | 758 | 1 225 | 12 | 5 | 4 |
| 110 | 131 | 1.5 | 1 | 847 | 3 428 | 778 | 1 254 | 12 | 5 | 4 |
| 115 | 136 | 1.5 | 1 | 872 | 3 548 | 805 | 1 301 | 12 | 5 | 4 |
| 117 | 134 | 1 | 0.6 | 931 | 3 839 | 871 | 1 418 | 10 | 4 | 4 |
| 120 | 141 | 1.5 | 1 | 897 | 3 667 | 833 | 1 348 | 12 | 5 | 4 |
| 127 | 150 | 2 | 1 | 925 | 3 802 | 864 | 1 400 | 12 | 6 | 4 |
| 127 | 144 | 1 | 0.6 | 996 | 4 157 | 944 | 1 543 | 10 | 4 | 4 |
| 134 | 158 | 2 | 1 | 952 | 3 933 | 894 | 1 451 | 14 | 6 | 4 |
| 139 | 157 | 2 | 1 | 1 036 | 4 351 | 989 | 1 619 | 10 | 5 | 4 |
| 144 | 168 | 2 | 1 | 1 005 | 4 189 | 954 | 1 551 | 14 | 6 | 4 |
| 150 | 170 | 1.5 | 1 | 1 102 | 4 666 | 1 062 | 1 741 | 10 | 5 | 4 |
| 160 | 187 | 2 | 1 | 956 | 3 946 | 898 | 1 453 | 14 | 6 | 4 |

For additional information:

- Dynamic equivalent loadP191
- Static equivalent loadP198
- Recommended Grease QuantitiesP257

3. Angular Contact Thrust Ball Bearings Bore Diameter 140-320 mm Double-Direction Angular Contact Thrust Ball Bearings (NSKTAC D Series)



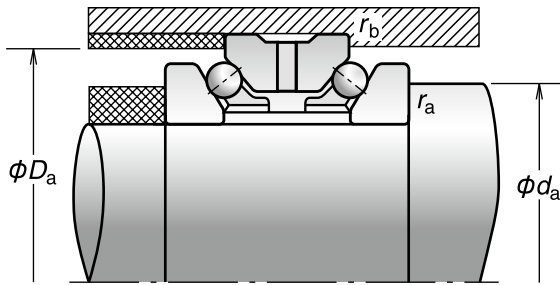
| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Permissible Axial Load ⁽²⁾ (kN) | Contact angle (Degree) | Mass (kg) (Reference) | Limiting Speeds ⁽³⁾ (min ⁻¹) | |
|---------------------|--------------------------|------------------|-----|----|----------|-----------------------|--------------------------|--------------------------|--|------------------------|-----------------------|---|-------|
| | d | D ⁽¹⁾ | T | C | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | Grease | Oil |
| 140TAC20X+L | 140 | 210 | 84 | 42 | 2 | 1 | 145 | 525 | 325 | 60 | 8.67 | 2 600 | 2 900 |
| 150TAC29D+L | 150 | 210 | 72 | 36 | 2 | 1 | 116 | 465 | 290 | 60 | 6.18 | 2 500 | 2 800 |
| 150TAC20X+L | 150 | 225 | 90 | 45 | 2.1 | 1.1 | 171 | 620 | 382 | 60 | 10.6 | 2 400 | 2 700 |
| 160TAC29D+L | 160 | 220 | 72 | 36 | 2 | 1 | 118 | 490 | 307 | 60 | 6.45 | 2 400 | 2 700 |
| 160TAC20X+L | 160 | 240 | 96 | 48 | 2.1 | 1.1 | 185 | 685 | 424 | 60 | 12.9 | 2 300 | 2 500 |
| 170TAC29D+L | 170 | 230 | 72 | 36 | 2 | 1 | 120 | 520 | 324 | 60 | 7.35 | 2 300 | 2 500 |
| 170TAC20X+L | 170 | 260 | 108 | 54 | 2.1 | 1.1 | 217 | 810 | 497 | 60 | 17.6 | 2 100 | 2 400 |
| 180TAC29D+L | 180 | 250 | 84 | 42 | 2 | 1 | 158 | 655 | 405 | 60 | 9.99 | 2 100 | 2 400 |
| 180TAC20X+L | 180 | 280 | 120 | 60 | 2.1 | 1.1 | 280 | 1 020 | 634 | 60 | 23.1 | 2 000 | 2 200 |
| 190TAC29D+L | 190 | 260 | 84 | 42 | 2 | 1 | 161 | 695 | 428 | 60 | 11.0 | 2 000 | 2 300 |
| 190TAC20D+L | 190 | 290 | 120 | 60 | 2.1 | 1.1 | 285 | 1 060 | 659 | 60 | 24.4 | 1 900 | 2 100 |
| 200TAC29D+L | 200 | 280 | 96 | 48 | 2.1 | 1.1 | 204 | 855 | 531 | 60 | 15.7 | 1 900 | 2 100 |
| 200TAC20D+L | 200 | 310 | 132 | 66 | 2.1 | 1.1 | 315 | 1 180 | 736 | 60 | 29.6 | 1 800 | 2 000 |
| 220TAC29D+L | 220 | 300 | 96 | 48 | 2.1 | 1.1 | 210 | 930 | 577 | 60 | 17.0 | 1 800 | 2 000 |
| 220TAC20D+L | 220 | 340 | 144 | 72 | 2.1 | 1.1 | 360 | 1 390 | 856 | 60 | 39.1 | 1 600 | 1 800 |
| 240TAC29D+L | 240 | 320 | 96 | 48 | 2.1 | 1.1 | 213 | 980 | 608 | 60 | 17.0 | 1 700 | 1 800 |
| 240TAC20D+L | 240 | 360 | 144 | 72 | 3 | 1.1 | 360 | 1 450 | 893 | 60 | 42.2 | 1 500 | 1 700 |
| 260TAC29D+L | 260 | 360 | 120 | 60 | 2.1 | 1.1 | 315 | 1 390 | 858 | 60 | 30.3 | 1 500 | 1 700 |
| 260TAC20D+L | 260 | 400 | 164 | 82 | 4 | 1.5 | 440 | 1 890 | 1 170 | 60 | 64.5 | 1 400 | 1 600 |
| 280TAC29D+L | 280 | 380 | 120 | 60 | 2.1 | 1.1 | 320 | 1 470 | 909 | 60 | 31.3 | 1 400 | 1 600 |
| 300TAC29D+L | 300 | 420 | 144 | 72 | 3 | 1.1 | 395 | 1 810 | 1 120 | 60 | 50.4 | 1 200 | 1 400 |
| 320TAC29D+L | 320 | 440 | 144 | 72 | 3 | 1.1 | 405 | 1 920 | 1 180 | 60 | 53.2 | 1 100 | 1 300 |

⁽¹⁾ Outer diameter tolerance is f6.

⁽²⁾ For permissible axial load, please refer to Page 201.

⁽³⁾ For application of limiting speeds, please refer to Page 218. Limiting speeds listed on this page are based on an extra light preload (C6).

Adjust the limiting speed to 85% of the figure shown when a light preload (C7) has been selected.



| Abutment and Fillet Dimensions (mm) | | | | Preload (N) | | | Axial Rigidity (N/ μm) | | |
|-------------------------------------|-------|--------------|--------------|-------------|-------|--------|------------------------------------|-------|-------|
| d_a | D_a | r_a (max.) | r_b (max.) | C6 | C7 | C8 | C6 | C7 | C8 |
| 167 | 198 | 2 | 1 | 925 | 3 675 | 9 343 | 1 194 | 1 898 | 2 603 |
| 172 | 200 | 2 | 1 | 196 | 4 116 | 7 085 | 775 | 2 152 | 2 587 |
| 178 | 213 | 2 | 1 | 934 | 4 725 | 9 467 | 1 210 | 2 086 | 2 639 |
| 182 | 210 | 2 | 1 | 196 | 4 309 | 7 432 | 803 | 2 263 | 2 722 |
| 191 | 228 | 2 | 1 | 1 277 | 4 837 | 11 088 | 1 368 | 2 140 | 2 833 |
| 192 | 219 | 2 | 1 | 196 | 4 502 | 7 780 | 830 | 2 374 | 2 857 |
| 206 | 245 | 2 | 1 | 2 078 | 6 745 | 13 736 | 1 650 | 2 451 | 3 119 |
| 207 | 238 | 2 | 1 | 1 063 | 4 409 | 9 795 | 1 439 | 2 319 | 3 038 |
| 220 | 264 | 2 | 1 | 2 982 | 6 811 | 15 473 | 1 876 | 2 476 | 3 268 |
| 217 | 247 | 2 | 1 | 1 102 | 4 617 | 10 284 | 1 508 | 2 439 | 3 198 |
| 230 | 274 | 2 | 1 | 3 074 | 7 039 | 18 620 | 1 941 | 2 565 | 3 564 |
| 230 | 267 | 2 | 1 | 1 098 | 4 597 | 11 866 | 1 502 | 2 427 | 3 344 |
| 245 | 291 | 2 | 1 | 3 083 | 7 714 | 18 677 | 1 947 | 2 650 | 3 575 |
| 250 | 287 | 2 | 1 | 1 160 | 4 933 | 12 790 | 1 613 | 2 621 | 3 616 |
| 272 | 320 | 2 | 1 | 3 247 | 4 331 | 19 791 | 2 063 | 2 273 | 3 794 |
| 270 | 307 | 2 | 1 | 1 202 | 5 156 | 13 405 | 1 688 | 2 750 | 3 798 |
| 290 | 341 | 2.5 | 1 | 3 345 | 9 161 | 20 465 | 2 133 | 2 993 | 3 927 |
| 300 | 344 | 2 | 1 | 1 193 | 8 859 | 13 254 | 1 671 | 3 274 | 3 750 |
| 316 | 375 | 3 | 1.5 | 4 232 | 8 420 | 22 437 | 2 461 | 3 101 | 4 315 |
| 320 | 364 | 2 | 1 | 1 239 | 9 313 | 13 947 | 1 754 | 3 451 | 3 954 |
| 348 | 399 | 2.5 | 1 | 1 717 | 9 403 | 16 124 | 1 970 | 3 485 | 4 179 |
| 368 | 419 | 2.5 | 1 | 1 789 | 9 885 | 20 384 | 2 071 | 3 673 | 4 689 |

For additional information:

- Dynamic equivalent load.....P191
- Static equivalent load.....P198
- Recommended Grease Quantities.....P257

4. Ball Screw Support Bearings



For High-Rigidity Applications

NSKTAC C Series



For High-Load Drive Applications

NSKTAC 03 Series



Double-Row Bearings

BSBD Series



Units

Units for Ball Screw Support

Ball Screw Support Bearings

Part 4

| | |
|---|---------|
| NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support | 146-155 |
| Features | |
| Designation System | |
| Bearing Tables | |
| For High-Rigidity Applications | |
| NSKTAC C Series | |
| For High-Load Drive Applications | |
| NSKTAC 03 Series | |
| Double-Row Bearings | |
| BSBD Series | |
| Units for Ball Screw Support | 156-157 |
| Features | |
| Designation System | |
| Support Unit Tables | |



4. Ball Screw Support Bearings

NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support

Features

NSKHPS:Reliability has been improved by focusing on material cleanliness, which has the biggest impact on bearing life, by employing NSK's proprietary material evaluation technology. The dynamic load rating has been improved by 5% compared with that of conventional bearings.

The NSKTAC C Series features high axial rigidity and is suitable for machine tool linear movement systems, while the NSKTAC 03 Series with its high axial load capacity is well suited for the support of large ball screws in high-load drive applications such as electric injection molding machines. With these series users can achieve much lower torque and higher accuracy than with roller bearings.

NSKTAC C Angular Contact Thrust Ball Bearings for Ball Screw Support in High-Rigidity Applications

A larger number of balls and a 60° contact angle provide high axial rigidity and make these bearings ideally suited for machine tool linear movement systems.

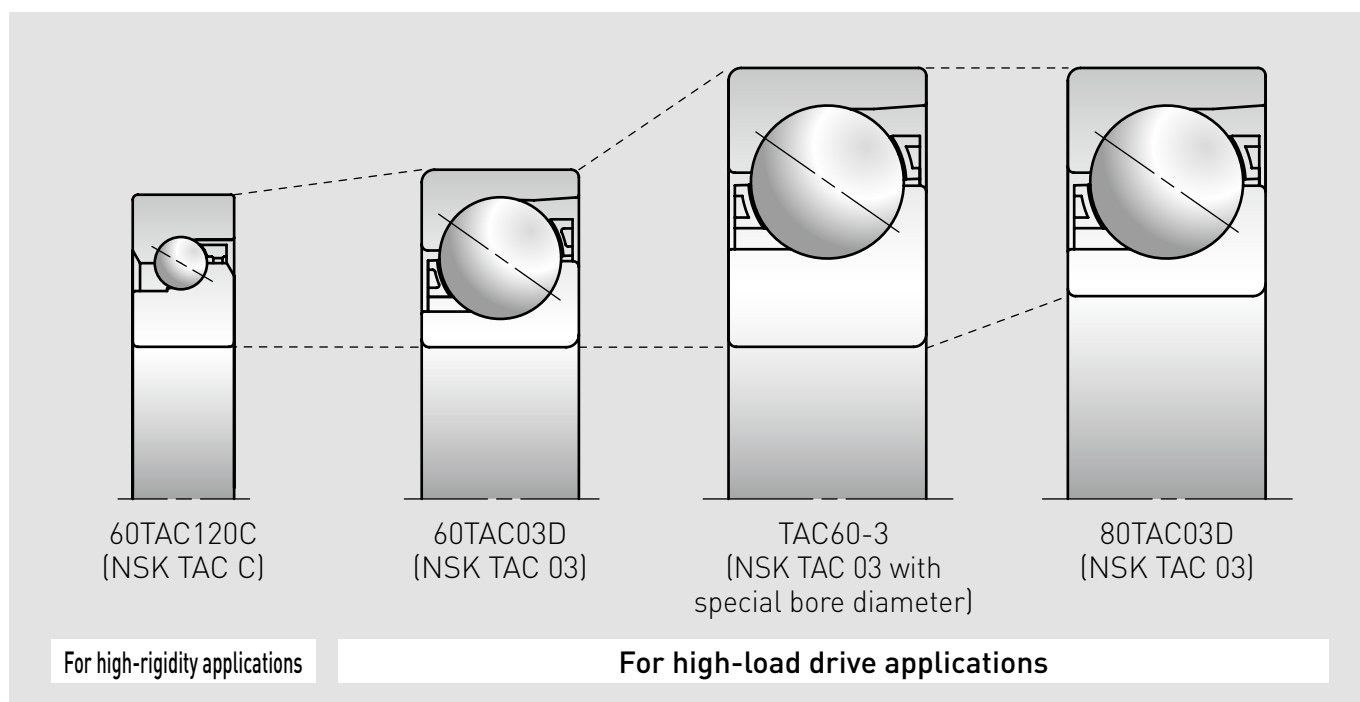
The "DDG" seals used for the sealed bearings of this series are light-contact seals for high-speed capability; a strong sealing effect is achieved by a labyrinth between the seal lip and the seal groove of the inner ring. This ensures that no foreign particles can get into the bearing and no grease can leak out, thus helping to keep the surrounding area clean. Some bearings from this series are also available as non-contact sealed bearings for even lower torque and lower heat generation.

For ease of handling and increased efficiency, NSKTAC C bearings is available with prepacked "WPH" grease that resists high temperatures and is less likely to soften and leak.

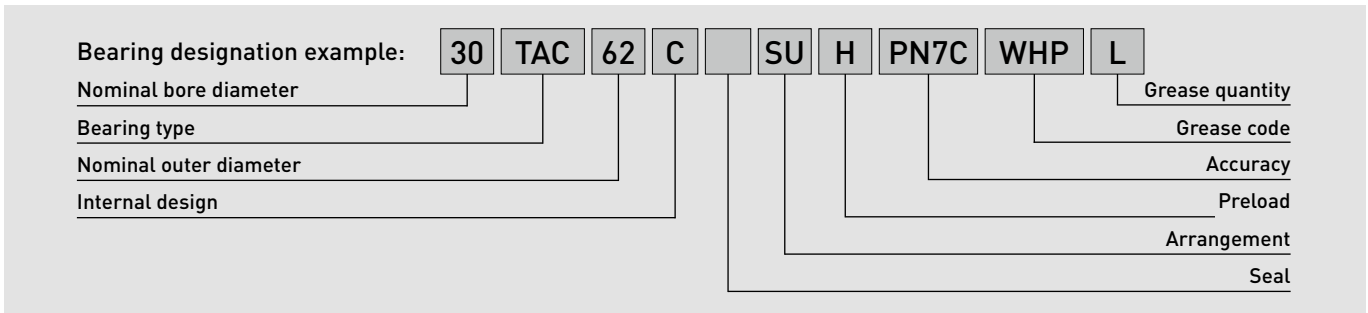
NSKTAC 03 Angular Contact Thrust Ball Bearings for Ball Screw Support in High-Load Drive Applications

Optimized internal design has led to a higher limiting axial load. The number of rows may be reduced, contributing to smaller sized devices. We also offer bearings with special bore diameters. That way, bearings with higher load capacity may be employed without any need to modify the shaft diameter, allowing for more compact screw shaft ends.

For the validity of this series for industries except Injection molding machines and machine tools, please ask NSK.

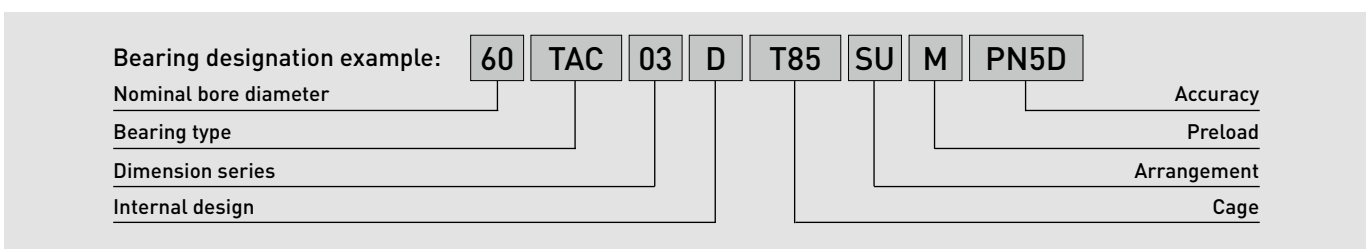


Designation System of NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support (for High-Rigidity Applications)



| | | | Reference pages |
|-------------|------------------------|--|-----------------|
| 30 | Nominal bore diameter | Bore diameter (mm) | 148-149 |
| TAC | Bearing type | Angular contact thrust ball bearing | 30, 146 |
| 62 | Nominal outer diameter | Outer diameter (mm) | 148-149 |
| C | Internal design | Contact angle 60° | — |
| | Seal | No symbol: Open type DDG: Contact rubber seal V1V: Non-contact rubber seal | 146 |
| SU | Arrangement | SU: Universal arrangement (single-row) | 202-207 |
| H | Preload | H: Heavy preload (standard in the HPS Series) | 148-149 |
| PN7C | Accuracy | PN7C: NES Class 7C (axial runout equivalent to P2) | 231 |

Designation System of NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support (for High-Load Drive Applications)

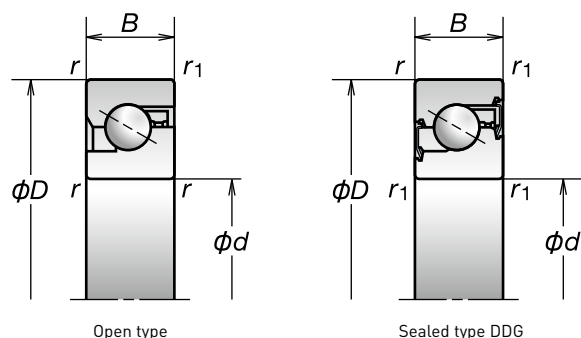


| | | | Reference pages |
|-------------|-----------------------|---|-----------------|
| 60 | Nominal bore diameter | Bore diameter (mm) | 150-151 |
| TAC | Bearing type | Angular contact thrust ball bearing | 32, 146 |
| 03 | Dimension series | 02: 02 Series 03: 03 Series | 146 |
| D | Internal design | Contact angle 55° | — |
| T85 | Cage | T85: Polyamide cage M: Brass Cage | — |
| SU | Arrangement | SU: Universal arrangement (single-row) | 202-207 |
| M | Preload | M: Medium preload EL: Extra light preload | 150-151 |
| PN5D | Accuracy | PN5D: Standard accuracy (equivalent to ISO Class 5) | 231 |

NSKHPS is not applicable for TAC160-3 and 180TAC03D.

4. Ball Screw Support Bearings for High-Rigidity

Bore Diameter 15-60 mm



(Open type)

| Bearing Designation | Boundary Dimensions (mm) | | | | | Abutment and Fillet Dimensions (mm) | | | | Recommended Grease Quantities (cc) | Contact angle (degree) | Limiting Speeds ⁽²⁾ (min ⁻¹) | | Mass (kg) (approx.) |
|---------------------|--------------------------|-----|----|----------|-----------------------|-------------------------------------|-----------------------|-----------------------|-----------------------|------------------------------------|------------------------|---|-------|---------------------|
| | d | D | B | r (min.) | r ₁ (min.) | D _b (max.) | d _a (min.) | D _a (max.) | d _b (min.) | | | Grease | Oil | |
| 15TAC47C | 15 | 47 | 15 | 1 | 0.6 | 42 | 19.5 | 41 | 19.5 | 2.2 | 60 | 6 900 | 9 200 | 0.146 |
| 17TAC47C | 17 | 47 | 15 | 1 | 0.6 | 42 | 23 | 41 | 23 | 2.2 | 60 | 6 900 | 9 200 | 0.140 |
| 20TAC47C | 20 | 47 | 15 | 1 | 0.6 | 42 | 25 | 41 | 25 | 2.2 | 60 | 6 900 | 9 200 | 0.135 |
| 25TAC62C | 25 | 62 | 15 | 1 | 0.6 | 57 | 31 | 56 | 31 | 3.0 | 60 | 5 200 | 6 900 | 0.252 |
| 30TAC62C | 30 | 62 | 15 | 1 | 0.6 | 57 | 36 | 56 | 36 | 3.2 | 60 | 4 900 | 6 400 | 0.224 |
| 30TAC72C | 30 | 72 | 19 | 1 | 0.6 | 67 | 36 | 66 | 36 | 3.8 | 60 | 4 100 | 5 800 | 0.427 |
| 35TAC72C | 35 | 72 | 15 | 1 | 0.6 | 67 | 42 | 66 | 42 | 3.8 | 60 | 4 100 | 5 800 | 0.310 |
| 40TAC72C | 40 | 72 | 15 | 1 | 0.6 | 67 | 47 | 66 | 47 | 3.9 | 60 | 4 100 | 5 500 | 0.275 |
| 40TAC90C | 40 | 90 | 20 | 1 | 0.6 | 85 | 48 | 84 | 48 | 8.8 | 60 | 3 500 | 4 600 | 0.674 |
| 45TAC75C | 45 | 75 | 15 | 1 | 0.6 | 68 | 54 | 67 | 54 | 4.2 | 60 | 3 700 | 4 900 | 0.270 |
| 45TAC100C | 45 | 100 | 20 | 1 | 0.6 | 93 | 55 | 92 | 55 | 9.7 | 60 | 3 000 | 4 100 | 0.842 |
| 50TAC100C | 50 | 100 | 20 | 1 | 0.6 | 92 | 60 | 91 | 60 | 10.2 | 60 | 3 000 | 3 900 | 0.778 |
| 55TAC100C | 55 | 100 | 20 | 1 | 0.6 | 92 | 63 | 91 | 63 | 10.2 | 60 | 3 000 | 3 900 | 0.714 |
| 55TAC120C | 55 | 120 | 20 | 1 | 0.6 | 112 | 63 | 111 | 63 | 12 | 60 | 2 500 | 3 500 | 1.23 |
| 60TAC120C | 60 | 120 | 20 | 1 | 0.6 | 112 | 70 | 111 | 70 | 12 | 60 | 2 500 | 3 500 | 1.16 |

(Sealed type)

| Bearing Designation ⁽¹⁾ | Boundary Dimensions (mm) | | | | | Abutment and Fillet Dimensions (mm) | | | | Contact angle (degree) | Limiting Speeds ⁽²⁾ (min ⁻¹) | | Mass (kg) (approx.) |
|------------------------------------|--------------------------|-----|----|----------|-----------------------|-------------------------------------|-----------------------|-----------------------|-----------------------|------------------------|---|-------|---------------------|
| | d | D | B | r (min.) | r ₁ (min.) | D _b (max.) | d _a (min.) | D _a (max.) | d _b (min.) | | Grease | Oil | |
| * 15TAC47CDDG | 15 | 47 | 15 | 1 | 0.6 | 42 | 19.5 | 41 | 19.5 | 60 | 6 900 | 9 200 | 0.146 |
| * 17TAC47CDDG | 17 | 47 | 15 | 1 | 0.6 | 42 | 22 | 41 | 22 | 60 | 6 900 | 9 200 | 0.140 |
| * 20TAC47CDDG | 20 | 47 | 15 | 1 | 0.6 | 42 | 25 | 41 | 25 | 60 | 6 900 | 9 200 | 0.135 |
| * 25TAC62CDDG | 25 | 62 | 15 | 1 | 0.6 | 57 | 30 | 56 | 30 | 60 | 5 200 | 6 900 | 0.252 |
| 30TAC62CDDG | 30 | 62 | 15 | 1 | 0.6 | 57 | 36 | 56 | 36 | 60 | 4 900 | 6 400 | 0.224 |
| 35TAC72CDDG | 35 | 72 | 15 | 1 | 0.6 | 67 | 41 | 66 | 41 | 60 | 4 100 | 5 800 | 0.310 |
| 40TAC72CDDG | 40 | 72 | 15 | 1 | 0.6 | 67 | 46 | 66 | 46 | 60 | 4 100 | 5 500 | 0.275 |
| 40TAC90CDDG | 40 | 90 | 20 | 1 | 0.6 | 85 | 47 | 84 | 47 | 60 | 3 500 | 4 600 | 0.674 |
| 45TAC100CDDG | 45 | 100 | 20 | 1 | 0.6 | 93 | 54 | 92 | 54 | 60 | 3 000 | 4 100 | 0.842 |
| 50TAC100CDDG | 50 | 100 | 20 | 1 | 0.6 | 92 | 59 | 91 | 59 | 60 | 3 000 | 3 900 | 0.778 |
| 55TAC100CDDG | 55 | 100 | 20 | 1 | 0.6 | 92 | 63 | 91 | 63 | 60 | 3 000 | 3 900 | 0.714 |

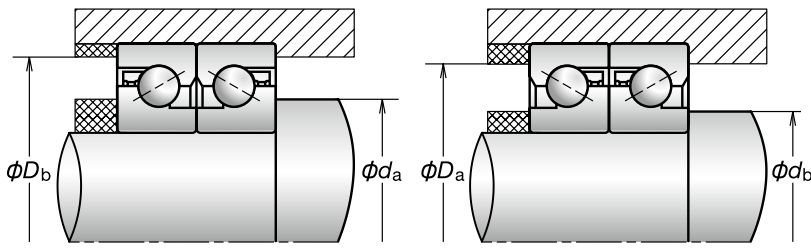
⁽¹⁾ An asterisk (*) indicates bearings that are also available as non-contact sealed bearings.

⁽²⁾ Limiting speeds are based on high preload (H). The values shown are valid for all types of bearing arrangement.

⁽³⁾ To calculate permissible axial load, multiply limiting axial load by 0.7.

⁽⁴⁾ The starting torque values in the table apply to grease lubricated bearings. Contact seal torque is not included. For oil lubricated bearings, multiply by 1.4.

⁽⁵⁾ Abutment and fillet dimensions are recommendable values for the use of standard Machine tool applications. For heavy load applications, please ask NSK



Calculation of preload, axial rigidity and starting torque for bearing arrangements
Multiply by factors in table B.

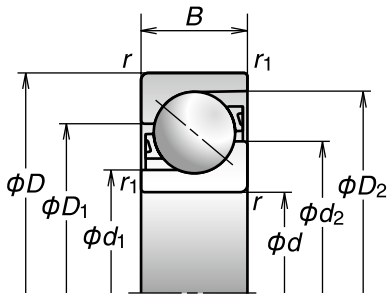
| | DFD ⊗⊗⊗ | DFF ⊗⊗⊗⊗ | DFT ⊗⊗⊗⊗ |
|-----------------|------------|-------------|-------------|
| | DBD ⊗⊗⊗ | DBB ⊗⊗⊗⊗ | DBT ⊗⊗⊗⊗ |
| Preload factor | 1.36 | 2.0 | 1.57 |
| Axial rigidity | 1.49 | 2.0 | 1.89 |
| Starting torque | 1.35 | 2.0 | 1.55 |

| Preload (DB and DF Arrangement) (N) | Axial Rigidity (DB and DF Arrangement) (N/μm) | Starting Torque (DB and DF Arrangement) ⁽⁴⁾ (N·m) (reference) | Basic dynamic load rating Ca by number of rows sustaining Fa | | | Limiting static axial load by number of rows sustaining Fa ⁽³⁾ | | |
|-------------------------------------|---|--|--|-------------|-------------|---|-------------|-------------|
| | | | 1 row (kN) | 2 rows (kN) | 3 rows (kN) | 1 row (kN) | 2 rows (kN) | 3 rows (kN) |
| H | H | H | | | | | | |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 2 280 | 850 | 0.15 | 29.9 | 48.5 | 64.5 | 40.5 | 81.5 | 122 |
| 2 400 | 890 | 0.16 | 30.5 | 50.0 | 66.0 | 43.0 | 86.0 | 129 |
| 2 750 | 1 030 | 0.18 | 32.5 | 53.0 | 70.5 | 50.0 | 100 | 150 |
| 2 750 | 1 030 | 0.18 | 32.5 | 53.0 | 70.5 | 50.0 | 100 | 150 |
| 2 860 | 1 080 | 0.19 | 33.5 | 54.0 | 72.0 | 52.0 | 104 | 157 |
| 3 450 | 1 150 | 0.29 | 62.0 | 101 | 134 | 89.5 | 179 | 269 |
| 3 100 | 1 170 | 0.20 | 34.5 | 56.0 | 74.5 | 57.0 | 114 | 170 |
| 4 440 | 1 340 | 0.40 | 64.5 | 105 | 140 | 99.0 | 198 | 298 |
| 4 650 | 1 410 | 0.42 | 66.0 | 107 | 142 | 104 | 208 | 310 |
| 4 650 | 1 410 | 0.42 | 66.0 | 107 | 142 | 104 | 208 | 310 |
| 5 450 | 1 660 | 0.49 | 70.5 | 115 | 153 | 123 | 246 | 370 |
| 5 450 | 1 660 | 0.49 | 70.5 | 115 | 153 | 123 | 246 | 370 |

| Preload (DB and DF Arrangement) (N) | Axial Rigidity (DB and DF Arrangement) (N/μm) | Starting Torque (DB and DF Arrangement) ⁽⁴⁾ (N·m) (reference) | Basic dynamic load rating Ca by number of rows sustaining Fa | | | Limiting static axial load by number of rows sustaining Fa ⁽³⁾ | | |
|-------------------------------------|---|--|--|-------------|-------------|---|-------------|-------------|
| | | | 1 row (kN) | 2 rows (kN) | 3 rows (kN) | 1 row (kN) | 2 rows (kN) | 3 rows (kN) |
| H | H | H | | | | | | |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 1 450 | 630 | 0.09 | 23.0 | 37.5 | 49.5 | 26.6 | 53.0 | 79.5 |
| 2 280 | 850 | 0.15 | 29.9 | 48.5 | 64.5 | 40.5 | 81.5 | 122 |
| 2 400 | 890 | 0.16 | 30.5 | 50.0 | 66.0 | 43.0 | 86.0 | 129 |
| 2 750 | 1 030 | 0.18 | 32.5 | 53.0 | 70.5 | 50.0 | 100 | 150 |
| 2 860 | 1 080 | 0.19 | 33.5 | 54.0 | 72.0 | 52.0 | 104 | 157 |
| 3 450 | 1 150 | 0.29 | 62.0 | 101 | 134 | 89.5 | 179 | 269 |
| 4 440 | 1 340 | 0.40 | 64.5 | 105 | 140 | 99.0 | 198 | 298 |
| 4 650 | 1 410 | 0.42 | 66.0 | 107 | 142 | 104 | 208 | 310 |
| 4 650 | 1 410 | 0.42 | 66.0 | 107 | 142 | 104 | 208 | 310 |

4. Ball Screw Support Bearings for High-Load Drive Applications

Bore Diameter 15-180 mm



| Bearing Designation ⁽¹⁾ | Boundary Dimensions (mm) | | | | | Reference Dimensions (mm) | | | | Recommended Grease Quantities (cc/row) | Contact angle (degree) | Limiting Speeds ⁽²⁾ (min ⁻¹) | | Mass (kg) (approx.) |
|------------------------------------|--------------------------|-----|----|----------|-----------------------|---------------------------|----------------|----------------|----------------|--|------------------------|---|--------|---------------------|
| | d | D | B | r (min.) | r ₁ (min.) | d ₁ | d ₂ | D ₁ | D ₂ | | | Grease | Oil | |
| 15TAC02D | 15 | 35 | 11 | 0.6 | 0.3 | 19.1 | 24.5 | 26 | 31.9 | 1 | 55 | 12 000 | 14 800 | 0.047 |
| 20TAC03D | 20 | 52 | 15 | 1.1 | 0.6 | 27.2 | 35.3 | 37.5 | 46.1 | 2.7 | 55 | 8 300 | 10 300 | 0.155 |
| 25TAC02D | 25 | 52 | 15 | 1 | 0.6 | 30.8 | 38.1 | 39.6 | 47.3 | 3 | 55 | 7 700 | 9 700 | 0.137 |
| TAC35-3 | 35 | 90 | 23 | 1.5 | 1 | 50.4 | 64.2 | 67.1 | 81.7 | 14 | 55 | 4 600 | 5 700 | 0.712 |
| 40TAC03D | 40 | 90 | 23 | 1.5 | 1 | 50.4 | 64.2 | 67.1 | 81.7 | 14 | 55 | 4 600 | 5 700 | 0.659 |
| TAC40-3 | 40 | 110 | 27 | 2 | 1 | 62 | 79.1 | 82.4 | 100.6 | 25 | 55 | 3 700 | 4 700 | 1.28 |
| 45TAC03D | 45 | 100 | 25 | 1.5 | 1 | 56.5 | 71.7 | 74.7 | 90.8 | 18 | 55 | 4 100 | 5 200 | 0.877 |
| TAC45-3 | 45 | 110 | 27 | 2 | 1 | 62 | 79.1 | 82.4 | 100.6 | 25 | 55 | 3 700 | 4 700 | 1.21 |
| 50TAC03D | 50 | 110 | 27 | 2 | 1 | 62 | 79.1 | 82.4 | 100.6 | 25 | 55 | 3 700 | 4 700 | 1.14 |
| TAC50-3 | 50 | 130 | 31 | 2.1 | 1.1 | 73.9 | 93.8 | 98 | 119 | 40 | 55 | 3 100 | 3 900 | 2.00 |
| 55TAC03D | 55 | 120 | 29 | 2 | 1 | 68 | 86.4 | 90.2 | 109.7 | 32 | 55 | 3 400 | 4 300 | 1.44 |
| 60TAC03D | 60 | 130 | 31 | 2.1 | 1.1 | 73.9 | 93.8 | 98 | 119 | 40 | 55 | 3 100 | 3 900 | 1.80 |
| TAC60-3 | 60 | 170 | 39 | 2.1 | 1.1 | 98.5 | 123.6 | 128.7 | 157.5 | 85 | 55 | 2 400 | 3 000 | 4.47 |
| 70TAC03D | 70 | 150 | 35 | 2.1 | 1.1 | 86.3 | 108.6 | 113.4 | 137.8 | 59 | 55 | 2 700 | 3 400 | 2.67 |
| 75TAC03D | 75 | 160 | 37 | 2.1 | 1.1 | 92.4 | 116.2 | 121 | 146.2 | 67 | 55 | 2 500 | 3 200 | 3.20 |
| 80TAC03D | 80 | 170 | 39 | 2.1 | 1.1 | 98.5 | 123.6 | 128.7 | 157.5 | 85 | 55 | 2 400 | 3 000 | 3.80 |
| TAC80-3 | 80 | 215 | 47 | 3 | 1.1 | 124 | 154.9 | 160.4 | 194.5 | 156 | 55 | 1 900 | 2 400 | 8.66 |
| 100TAC03D | 100 | 215 | 47 | 3 | 1.1 | 124 | 154.9 | 160.4 | 194.5 | 156 | 55 | 1 900 | 2 400 | 7.54 |
| TAC100-3 | 100 | 260 | 55 | 3 | 1.1 | 150.5 | 186.9 | 193.4 | 231.7 | 254 | 55 | 1 500 | 2 000 | 14.8 |
| 120TAC03D | 120 | 260 | 55 | 3 | 1.1 | 150.5 | 186.9 | 193.4 | 231.7 | 254 | 55 | 1 500 | 2 000 | 13.3 |
| * TAC120-3M | 120 | 300 | 62 | 4 | 1.5 | 174.3 | 215.3 | 224.1 | 268.3 | 336 | 55 | 1 300 | 1 700 | 24.4 |
| * 140TAC03DM | 140 | 300 | 62 | 4 | 1.5 | 174.3 | 215.3 | 224.1 | 268.3 | 336 | 55 | 1 300 | 1 700 | 22.4 |
| * TAC140-3M | 140 | 340 | 68 | 4 | 1.5 | 201.2 | 246.2 | 254.3 | 301.6 | 442 | 55 | 1 200 | 1 500 | 34.1 |
| * 160TAC03DM | 160 | 340 | 68 | 4 | 1.5 | 201.2 | 246.2 | 254.3 | 301.6 | 442 | 55 | 1 200 | 1 500 | 31.6 |
| * TAC160-3M | 160 | 380 | 75 | 4 | 1.5 | 225.1 | 275.6 | 284.9 | 338.8 | 624 | 55 | 1 000 | 1 400 | 47.0 |
| * 180TAC03DM | 180 | 380 | 75 | 4 | 1.5 | 225.1 | 275.6 | 284.9 | 338.8 | 624 | 55 | 1 000 | 1 400 | 43.8 |

⁽¹⁾ An asterisk (*) indicates bearings that are also available equipped with screw holes for mounting bolts.

⁽²⁾ Limiting speeds are based on the standard preload of each bearing. The values shown are valid for all types of bearing arrangement.

⁽³⁾ Preload values for bearings with a bore diameter of 100mm or more as well as for TAC80-3 are based on EL preload.

⁽⁴⁾ The starting torque values in the table apply to grease lubrication.

⁽⁵⁾ To calculate permissible axial load, multiply limiting axial load by 0.7.

Calculation of preload, axial rigidity and starting torque for bearing arrangements
 Multiply by factors in table B.

| Table B Number of load-sustaining rows | 2 rows | | 3 rows | | | 4 rows | | 5 rows |
|---|------------|-------------|-------------|---------------|----------------|---------------|----------------|-----------------|
| | DFD ⊗⊗⊗ | DFB ⊗⊗⊗⊗ | DFT ⊗⊗⊗⊗ | DFFD ⊗⊗⊗⊗⊗ | DFFF ⊗⊗⊗⊗⊗⊗ | DFTD ⊗⊗⊗⊗⊗ | DFFT ⊗⊗⊗⊗⊗⊗ | DFTT ⊗⊗⊗⊗⊗⊗⊗ |
| | DBD ⊗⊗⊗ | DBB ⊗⊗⊗⊗ | DBT ⊗⊗⊗⊗ | DBBD ⊗⊗⊗⊗⊗ | DBBB ⊗⊗⊗⊗⊗⊗ | DBTD ⊗⊗⊗⊗⊗ | DBBT ⊗⊗⊗⊗⊗⊗ | DBTT ⊗⊗⊗⊗⊗⊗⊗ |
| Preload factor | 1.36 | 2.0 | 1.57 | 2.42 | 3.0 | 1.72 | 2.72 | 1.83 |
| Axial rigidity | 1.49 | 2.0 | 1.89 | 2.51 | 3.0 | 2.24 | 2.97 | 2.57 |
| Starting torque | 1.35 | 2.0 | 1.55 | 2.41 | 3.0 | 1.68 | 2.71 | 1.73 |

| Preload ⁽³⁾ (DB and DF Arrangement) (N) | Axial Rigidity ⁽³⁾ (DB and DF Arrangement) (N/μm) | Starting Torque ⁽⁴⁾ (DB and DF Arrangement) (N·m) | Basic dynamic load rating Ca by number of rows sustaining Fa | | | | | Limiting static axial load by number of rows sustaining Fa ⁽⁵⁾ | | | | |
|--|--|--|--|-------------|-------------|-------------|-------------|---|-------------|-------------|-------------|-------------|
| | | | 1 row (kN) | 2 rows (kN) | 3 rows (kN) | 4 rows (kN) | 5 rows (kN) | 1 row (kN) | 2 rows (kN) | 3 rows (kN) | 4 rows (kN) | 5 rows (kN) |
| 400 | 290 | 0.017 | 21.0 | 34.0 | 45.0 | 55.5 | 64.5 | 18.6 | 37.5 | 56.0 | 74.5 | 93.0 |
| 830 | 430 | 0.026 | 42.5 | 69.5 | 92.0 | 113 | 132 | 38.5 | 77.0 | 116 | 154 | 193 |
| 690 | 430 | 0.036 | 37.0 | 60.0 | 79.5 | 97.5 | 114 | 36.0 | 72.5 | 109 | 145 | 181 |
| 2 500 | 780 | 0.26 | 113 | 184 | 244 | 299 | 350 | 118 | 235 | 355 | 470 | 590 |
| 2 500 | 780 | 0.26 | 113 | 184 | 244 | 299 | 350 | 118 | 235 | 355 | 470 | 590 |
| 3 900 | 970 | 0.50 | 166 | 270 | 360 | 440 | 515 | 181 | 360 | 540 | 720 | 905 |
| 2 800 | 830 | 0.31 | 133 | 216 | 287 | 350 | 410 | 142 | 283 | 425 | 565 | 710 |
| 3 900 | 970 | 0.50 | 166 | 270 | 360 | 440 | 515 | 181 | 360 | 540 | 720 | 905 |
| 3 900 | 970 | 0.50 | 166 | 270 | 360 | 440 | 515 | 181 | 360 | 540 | 720 | 905 |
| 5 200 | 1 120 | 0.78 | 218 | 355 | 470 | 575 | 670 | 242 | 485 | 725 | 965 | 1 210 |
| 4 280 | 1 060 | 0.68 | 190 | 310 | 410 | 500 | 585 | 210 | 420 | 630 | 840 | 1 050 |
| 5 200 | 1 120 | 0.78 | 218 | 355 | 470 | 575 | 670 | 242 | 485 | 725 | 965 | 1 210 |
| 8 050 | 1 400 | 1.5 | 305 | 495 | 660 | 805 | 940 | 390 | 775 | 1 170 | 1 550 | 1 940 |
| 6 400 | 1 250 | 1.1 | 262 | 425 | 565 | 690 | 810 | 305 | 615 | 920 | 1 230 | 1 530 |
| 7 230 | 1 330 | 1.3 | 283 | 460 | 610 | 750 | 875 | 345 | 690 | 1 040 | 1 380 | 1 730 |
| 8 050 | 1 400 | 1.5 | 305 | 495 | 660 | 805 | 940 | 390 | 775 | 1 170 | 1 550 | 1 940 |
| 1 240 | 880 | 0.15 | 420 | 685 | 910 | 1 110 | 1 300 | 510 | 1 020 | 1 530 | 2 040 | 2 550 |
| 1 240 | 880 | 0.15 | 420 | 685 | 910 | 1 110 | 1 300 | 510 | 1 020 | 1 530 | 2 040 | 2 550 |
| 1 620 | 1 050 | 0.21 | 520 | 850 | 1 130 | 1 380 | 1 610 | 680 | 1 360 | 2 040 | 2 720 | 3 400 |
| 1 620 | 1 050 | 0.21 | 520 | 850 | 1 130 | 1 380 | 1 610 | 680 | 1 360 | 2 040 | 2 720 | 3 400 |
| 1 710 | 1 130 | 0.24 | 640 | 1 040 | 1 380 | 1 680 | 1 970 | 794 | 1 590 | 2 380 | 3 200 | 3 950 |
| 1 710 | 1 130 | 0.24 | 640 | 1 040 | 1 380 | 1 680 | 1 970 | 794 | 1 590 | 2 380 | 3 200 | 3 950 |
| 1 850 | 1 240 | 0.27 | 725 | 1 180 | 1 570 | 1 920 | 2 240 | 1 040 | 2 080 | 3 100 | 4 150 | 5 200 |
| 1 850 | 1 240 | 0.27 | 725 | 1 180 | 1 570 | 1 920 | 2 240 | 1 040 | 2 080 | 3 100 | 4 150 | 5 200 |
| 1 940 | 1 310 | 0.30 | 815 | 1 330 | 1 760 | 2 150 | 2 520 | 1 360 | 2 720 | 4 100 | 5 450 | 6 800 |
| 1 940 | 1 310 | 0.30 | 815 | 1 330 | 1 760 | 2 150 | 2 520 | 1 360 | 2 720 | 4 100 | 5 450 | 6 800 |

4. Ball Screw Support Bearings

NSKHPS BSBD Series

Modern machine tools require ball screws that can accurately position a work piece or machine component, quickly and efficiently. The BSN / BSF range of bearings are support bearings designed to specifically meet these demanding requirements.

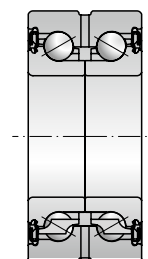


Features

The bearings of this series are double-row angular contact thrust ball bearings with a 60° contact angle and a single outer ring. The specifications are the same as those of the NSKTAC bearings, both series being optimized for the support of ball screws in machine tools. All BSBD Series bearings are equipped with a rubber contact seal and prepacked with high performance grease.

■ BSN Type

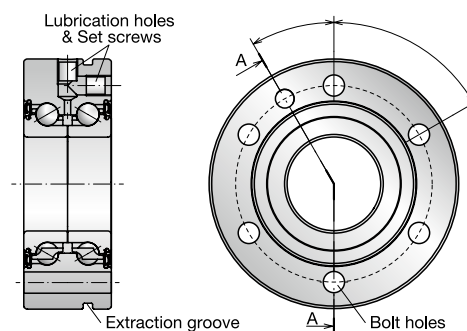
The BSN series of ball screw support bearings are double-row angular contact thrust ball bearings in a back-to-back arrangement, with a single outer ring. The bearings are prepacked with high performance grease. Lubrication holes allow for relubrication during operation if necessary. The contact seal offers minimized friction and temperature rise while providing excellent sealing performance.



■ BSF Type

The BSF series of bearings is equivalent to the BSN range of bearings, with bolt holes on the outer ring for easy direct mounting. Two lubrication holes – one in the outer surface and one in the face of the outer ring – allow for relubrication during operation if required. If not used, these holes are closed off with set screws. An extraction groove on the outer surface of the outer ring aids removal of the bearing.

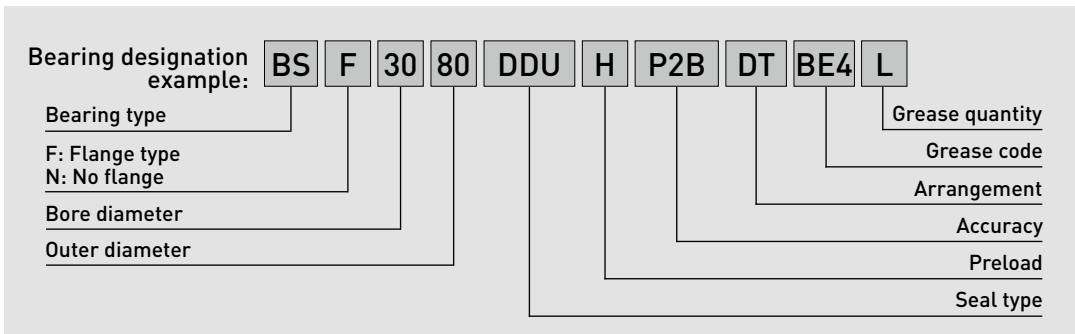
Note: BSF series bearings are supplied with seal and set screws included. Mounting bolts are not included.



BSN Type Single product

| Bearing Designation | Boundary Dimensions (mm) | | | | | Abutment and Fillet Dimensions (mm) | | Contact angle (Degree) | Basic Load Ratings (kN) | | Limiting static axial load (1) (kN) | Preload (N) | Axial Rigidity (N/μm) | Mass (kg) | Limiting Speeds (min ⁻¹) | Starting Torque (N·m) | Recommended Clamping Force (N) |
|---------------------|--------------------------|-----|----|----------|-----------------------|-------------------------------------|-----------------------|------------------------|--------------------------|--------------------------|-------------------------------------|-------------|-----------------------|-----------|--------------------------------------|-----------------------|--------------------------------|
| | d | D | B | r (min.) | r ₁ (min.) | d _a (min.) | D _b (max.) | | C _a (Dynamic) | C _{0a} (Static) | | | | | Grease | H (?) | |
| BSN1242 | 12 | 42 | 25 | 0.6 | 0.3 | 15 | 33 | 60 | 18.5 | 24.0 | 17.6 | 720 | 375 | 0.20 | 8 000 | 0.038 | 4 030 |
| BSN1545 | 15 | 45 | 25 | 0.6 | 0.3 | 19 | 35 | 60 | 19.4 | 26.9 | 19.4 | 675 | 400 | 0.22 | 7 100 | 0.034 | 4 050 |
| BSN1747 | 17 | 47 | 25 | 0.6 | 0.6 | 21 | 37 | 60 | 20.3 | 29.7 | 21.2 | 880 | 450 | 0.23 | 6 700 | 0.05 | 4 400 |
| BSN2052 | 20 | 52 | 28 | 0.6 | 0.6 | 24 | 43 | 60 | 26.4 | 41.0 | 29.3 | 1 885 | 650 | 0.31 | 5 800 | 0.13 | 7 600 |
| BSN2557 | 25 | 57 | 28 | 0.6 | 0.6 | 29 | 48 | 60 | 28.3 | 48.0 | 34.0 | 2 245 | 750 | 0.36 | 5 100 | 0.16 | 8 100 |
| BSN3062 | 30 | 62 | 28 | 0.6 | 0.6 | 34 | 53 | 60 | 30.0 | 55.5 | 38.5 | 2 625 | 850 | 0.40 | 4 500 | 0.19 | 8 600 |
| BSN3072 | 30 | 72 | 38 | 0.6 | 0.6 | 35 | 64 | 60 | 60.5 | 94.0 | 66.5 | 4 855 | 950 | 0.74 | 3 900 | 0.59 | 11 100 |
| BSN3572 | 35 | 72 | 34 | 0.6 | 0.6 | 40 | 62 | 60 | 42.0 | 77.5 | 52.0 | 2 630 | 900 | 0.66 | 3 800 | 0.21 | 13 500 |
| BSN4075 | 40 | 75 | 34 | 0.6 | 0.6 | 46 | 67 | 60 | 44.5 | 88.0 | 58.5 | 3 065 | 1 000 | 0.65 | 3 500 | 0.24 | 14 100 |
| BSN4090 | 40 | 90 | 46 | 0.6 | 0.6 | 46 | 80 | 60 | 78.5 | 135 | 91.0 | 7 220 | 1 200 | 1.38 | 3 100 | 1.02 | 18 700 |
| BSN5090 | 50 | 90 | 34 | 0.6 | 0.6 | 56 | 82 | 60 | 48.0 | 110 | 71.5 | 4 020 | 1 250 | 0.93 | 2 800 | 0.33 | 15 400 |
| BSN50110 | 50 | 110 | 54 | 0.6 | 0.6 | 57 | 98 | 60 | 116 | 219 | 149 | 7 435 | 1 400 | 2.46 | 2 500 | 1.06 | 19 100 |
| BSN60110 | 60 | 110 | 45 | 0.6 | 0.6 | 68 | 100 | 60 | 86.5 | 187 | 126 | 4 780 | 1 300 | 1.82 | 2 400 | 0.50 | 20 900 |

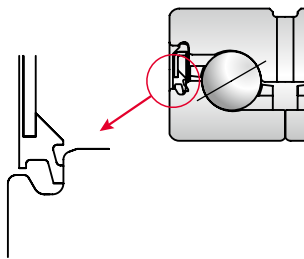
NSKHPS BSBD Series



Note:
P2B is an accuracy class specific to the BSBD Series, indicating the following:
Running accuracy: ISO Class 2
Others: NSK-specific

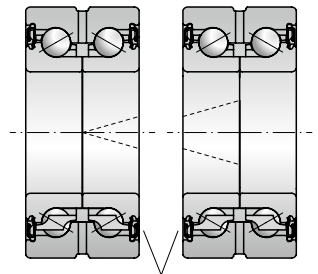
Seal

Rubber contact seal on both sides. Triple lip structure provides high grease sealing performance and dust resistance.

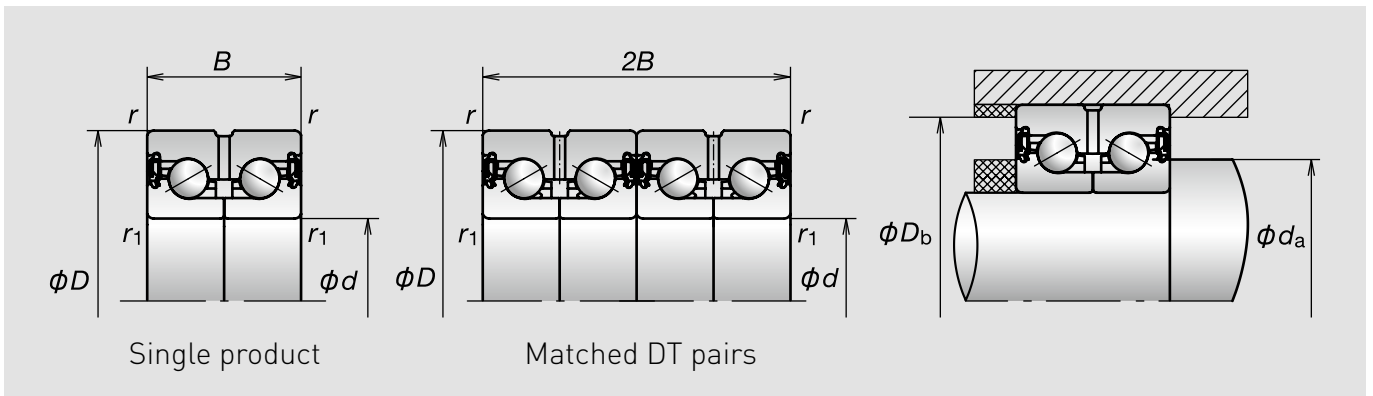


Matched DT pairs

BSBD bearings are available in matched DT pairs for applications with large external loads or where high rigidity and long life are required. The mating surfaces of the 2-row bearing set are controlled for offset, so as to have no impact on the preload of each individual bearing.



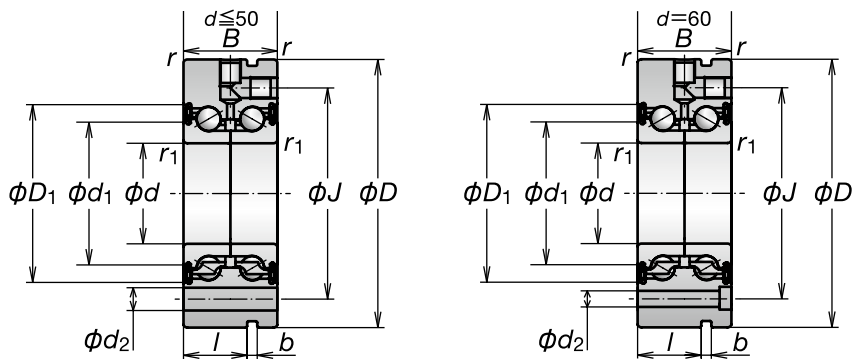
Mating surfaces controlled for offset



BSN Type Matched DT pairs

| Bearing Designation | Boundary Dimensions (mm) | | | | | Abutment and Fillet Dimensions (mm) | | Contact angle (Degree) | Basic Load Ratings (kN) | | Limiting static axial load (1) (kN) | Axial Rigidity (N/μm) | Mass (kg) | Limiting Speeds (min ⁻¹) | Starting Torque (N·m) | Recommended Clamping Force (N) |
|---------------------|--------------------------|-----|-----|----------|-----------------------|-------------------------------------|-----------------------|------------------------|--------------------------|--------------------------|-------------------------------------|-----------------------|-----------|--------------------------------------|-----------------------|--------------------------------|
| | d | D | 2B | r (min.) | r ₁ (min.) | d _a (min.) | D _b (max.) | | C _a (Dynamic) | C _{0a} (Static) | | | | Grease | H (2) | |
| BSN1747-DT | 17 | 47 | 50 | 0.6 | 0.6 | 21 | 37 | 60 | 33.0 | 59.5 | 42.5 | 790 | 0.46 | 6 700 | 0.10 | 4 400 |
| BSN2052-DT | 20 | 52 | 56 | 0.6 | 0.6 | 24 | 43 | 60 | 43.0 | 82.0 | 58.5 | 1 180 | 0.62 | 5 800 | 0.26 | 7 600 |
| BSN2557-DT | 25 | 57 | 56 | 0.6 | 0.6 | 29 | 48 | 60 | 46.0 | 96.0 | 68.0 | 1 370 | 0.71 | 5 100 | 0.32 | 8 100 |
| BSN3062-DT | 30 | 62 | 56 | 0.6 | 0.6 | 34 | 53 | 60 | 49.0 | 111 | 77.0 | 1 580 | 0.80 | 4 500 | 0.37 | 8 600 |
| BSN3072-DT | 30 | 72 | 76 | 0.6 | 0.6 | 35 | 64 | 60 | 98.0 | 188 | 133 | 1 800 | 1.47 | 3 900 | 1.17 | 11 100 |
| BSN3572-DT | 35 | 72 | 68 | 0.6 | 0.6 | 40 | 62 | 60 | 68.0 | 155 | 104 | 1 630 | 1.32 | 3 800 | 0.41 | 13 500 |
| BSN4075-DT | 40 | 75 | 68 | 0.6 | 0.6 | 46 | 67 | 60 | 72.0 | 176 | 117 | 1 850 | 1.30 | 3 500 | 0.49 | 14 100 |
| BSN4090-DT | 40 | 90 | 92 | 0.6 | 0.6 | 46 | 80 | 60 | 128 | 269 | 182 | 2 300 | 2.76 | 3 100 | 2.03 | 18 700 |
| BSN5090-DT | 50 | 90 | 68 | 0.6 | 0.6 | 56 | 82 | 60 | 78.0 | 220 | 143 | 2 330 | 1.86 | 2 800 | 0.66 | 15 400 |
| BSN50110-DT | 50 | 110 | 108 | 0.6 | 0.6 | 57 | 98 | 60 | 188 | 440 | 299 | 2 690 | 4.92 | 2 500 | 2.11 | 19 100 |

4. Ball Screw Support Bearings NSKHPS BSBD Series



BSF Type Single product

| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings (kN) | | Limiting static axial load ⁽¹⁾ (kN) | Axial Rigidity (N/μm) | Mass (kg) | Limiting Speeds (min ⁻¹) |
|---------------------|--------------------------|-----|----|----------|-----------------------|--------------------------|--------------------------|--|-----------------------|-----------|--------------------------------------|
| | d | D | B | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | Grease |
| BSF1255 | 12 | 55 | 25 | 0.6 | 0.3 | 18.5 | 24.0 | 17.6 | 375 | 0.37 | 8 000 |
| BSF1560 | 15 | 60 | 25 | 0.6 | 0.3 | 19.4 | 26.9 | 19.4 | 400 | 0.44 | 7 100 |
| BSF1762 | 17 | 62 | 25 | 0.6 | 0.6 | 20.3 | 29.7 | 21.2 | 450 | 0.46 | 6 700 |
| BSF2068 | 20 | 68 | 28 | 0.6 | 0.6 | 26.4 | 41.0 | 29.3 | 650 | 0.61 | 5 800 |
| BSF2575 | 25 | 75 | 28 | 0.6 | 0.6 | 28.3 | 48.0 | 34.0 | 750 | 0.73 | 5 100 |
| BSF3080 | 30 | 80 | 28 | 0.6 | 0.6 | 30.0 | 55.5 | 38.5 | 850 | 0.79 | 4 500 |
| BSF30100 | 30 | 100 | 38 | 0.6 | 0.6 | 60.5 | 94.0 | 66.5 | 950 | 1.71 | 3 900 |
| BSF3590 | 35 | 90 | 34 | 0.6 | 0.6 | 42.0 | 77.5 | 52.0 | 900 | 1.20 | 3 800 |
| BSF40100 | 40 | 100 | 34 | 0.6 | 0.6 | 44.5 | 88.0 | 58.5 | 1 000 | 1.49 | 3 500 |
| BSF40115 | 40 | 115 | 46 | 0.6 | 0.6 | 78.5 | 135 | 91.0 | 1 200 | 2.56 | 3 100 |
| BSF50115 | 50 | 115 | 34 | 0.6 | 0.6 | 48.0 | 110 | 71.5 | 1 250 | 1.89 | 2 800 |
| BSF50140 | 50 | 140 | 54 | 0.6 | 0.6 | 116 | 219 | 149 | 1 400 | 4.46 | 2 500 |
| BSF60145 | 60 | 145 | 45 | 0.6 | 0.6 | 86.5 | 187 | 126 | 1 300 | 4.06 | 2 400 |

BSF Type Matched DT pairs

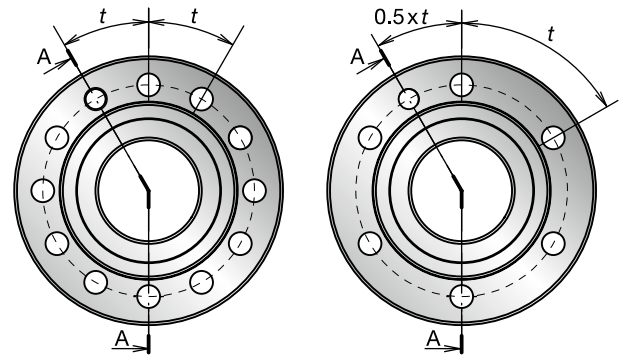
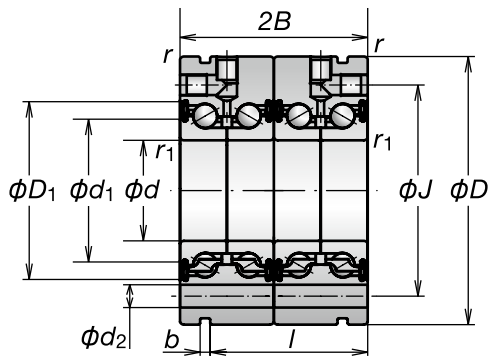
| Bearing Designation | Boundary Dimensions (mm) | | | | | Basic Load Ratings (kN) | | Limiting static axial load ⁽¹⁾ (kN) | Axial Rigidity (N/μm) | Mass (kg) | Limiting Speeds (min ⁻¹) |
|---------------------|--------------------------|-----|-----|----------|-----------------------|--------------------------|--------------------------|--|-----------------------|-----------|--------------------------------------|
| | d | D | 2B | r (min.) | r ₁ (min.) | C _a (Dynamic) | C _{oa} (Static) | | | | Grease |
| BSF1762-DT | 17 | 62 | 50 | 0.6 | 0.6 | 33.0 | 59.5 | 42.5 | 790 | 0.890 | 6 700 |
| BSF2068-DT | 20 | 68 | 56 | 0.6 | 0.6 | 43.0 | 82.0 | 58.5 | 1 180 | 1.17 | 5 800 |
| BSF2575-DT | 25 | 75 | 56 | 0.6 | 0.6 | 46.0 | 96.0 | 68.0 | 1 370 | 1.46 | 5 100 |
| BSF3080-DT | 30 | 80 | 56 | 0.6 | 0.6 | 49.0 | 111 | 77.0 | 1 580 | 1.58 | 4 500 |
| BSF30100-DT | 30 | 100 | 76 | 0.6 | 0.6 | 98.0 | 188 | 133 | 1 800 | 3.41 | 3 900 |
| BSF3590-DT | 35 | 90 | 68 | 0.6 | 0.6 | 68.0 | 155 | 104 | 1 630 | 2.30 | 3 800 |
| BSF40100-DT | 40 | 100 | 68 | 0.6 | 0.6 | 72.0 | 176 | 117 | 1 850 | 2.88 | 3 500 |
| BSF40115-DT | 40 | 115 | 92 | 0.6 | 0.6 | 128 | 269 | 182 | 2 300 | 5.12 | 3 100 |
| BSF50115-DT | 50 | 115 | 68 | 0.6 | 0.6 | 78.0 | 220 | 143 | 2 330 | 3.78 | 2 800 |
| BSF50140-DT | 50 | 140 | 108 | 0.6 | 0.6 | 188 | 440 | 299 | 2 690 | 8.92 | 2 500 |

⁽¹⁾ Permissible axial load equals 0.7 times of limiting axial load.

To calculate permissible axial load, multiply limiting axial load by 0.7. The values refer to the limiting load of the bearing only, without taking the mounting bolts into account.

⁽²⁾ The values indicate starting torque of preloaded bearings, not including seal torque.

⁽³⁾ Inner rings can be separable easily. Please push or pull bearings by clamping inner ring at mounting and dismounting.



| Reference Dimensions (mm) | | | | | | | Type | Mounting Bolts | | Preload (N) | Starting Torque ^[2] (N·m) | Recommended Clamping Force (N) |
|---------------------------|----------------|-----|----------------|----|---|----------|------|----------------|-----------------|-------------|--------------------------------------|--------------------------------|
| d ₁ | D ₁ | J | d ₂ | l | b | t | | Bolt Dia. | Number of Bolts | | | |
| 23.7 | 32.7 | 42 | 6.8 | 17 | 3 | 3 x 120° | II | M6 | 3 | 720 | 0.038 | 4 030 |
| 26.7 | 35.7 | 46 | 6.8 | 17 | 3 | 3 x 120° | II | M6 | 3 | 675 | 0.034 | 4 050 |
| 28.1 | 37.7 | 48 | 6.8 | 17 | 3 | 3 x 120° | II | M6 | 3 | 890 | 0.05 | 4 400 |
| 32.6 | 43 | 53 | 6.8 | 19 | 3 | 4 x 90° | II | M6 | 4 | 1 885 | 0.13 | 7 600 |
| 37.6 | 48 | 58 | 6.8 | 19 | 3 | 4 x 90° | II | M6 | 4 | 2 245 | 0.16 | 8 100 |
| 42.6 | 53 | 63 | 6.8 | 19 | 3 | 6 x 60° | II | M6 | 6 | 2 625 | 0.19 | 8 600 |
| 49.1 | 64.4 | 80 | 8.8 | 30 | 3 | 8 x 45° | II | M8 | 8 | 4 855 | 0.59 | 11 100 |
| 53.1 | 62.2 | 75 | 8.8 | 25 | 3 | 4 x 90° | II | M8 | 4 | 2 630 | 0.21 | 13 500 |
| 55.1 | 67.2 | 80 | 8.8 | 25 | 3 | 4 x 90° | II | M8 | 4 | 3 065 | 0.24 | 14 100 |
| 63.1 | 80.1 | 94 | 8.8 | 36 | 3 | 12 x 30° | II | M8 | 12 | 7 220 | 1.02 | 18 700 |
| 70.1 | 82.2 | 94 | 8.8 | 25 | 3 | 6 x 60° | II | M8 | 6 | 4 020 | 0.33 | 15 400 |
| 78.1 | 97.5 | 113 | 11 | 45 | 3 | 12 x 30° | II | M10 | 12 | 7 435 | 1.06 | 19 100 |
| 83.1 | 99.3 | 120 | 8.8 | 35 | 3 | 8 x 45° | II | M8 | 8 | 4 780 | 0.50 | 20 900 |

| Reference Dimensions (mm) | | | | | | | Type | Mounting Bolts | | Starting Torque ^[2] (N·m) | Recommended Clamping Force (N) |
|---------------------------|----------------|-----|----------------|----|---|----------|------|----------------|-----------------|--------------------------------------|--------------------------------|
| d ₁ | D ₁ | J | d ₂ | l | b | t | | Bolt Dia. | Number of Bolts | | |
| 28.1 | 37.7 | 48 | 6.8 | 42 | 3 | 6 x 60° | II | M6 | 5 | 0.10 | 4 400 |
| 32.6 | 43 | 53 | 6.8 | 47 | 3 | 8 x 45° | II | M6 | 7 | 0.26 | 7 600 |
| 37.6 | 48 | 58 | 6.8 | 47 | 3 | 8 x 45° | II | M6 | 7 | 0.32 | 8 100 |
| 42.6 | 53 | 63 | 6.8 | 47 | 3 | 12 x 30° | II | M6 | 11 | 0.37 | 8 600 |
| 49.1 | 64.4 | 80 | 8.8 | 68 | 3 | 8 x 45° | II | M8 | 8 | 1.17 | 11 100 |
| 53.1 | 62.2 | 75 | 8.8 | 59 | 3 | 8 x 45° | II | M8 | 7 | 0.41 | 13 500 |
| 55.1 | 67.2 | 80 | 8.8 | 59 | 3 | 8 x 45° | II | M8 | 7 | 0.49 | 14 100 |
| 63.1 | 80.1 | 94 | 8.8 | 82 | 3 | 12 x 30° | II | M8 | 12 | 2.03 | 18 700 |
| 70.1 | 82.2 | 94 | 8.8 | 59 | 3 | 12 x 30° | II | M8 | 11 | 0.66 | 15 400 |
| 78.1 | 97.5 | 113 | 11 | 99 | 3 | 12 x 30° | II | M10 | 12 | 2.11 | 19 100 |

4. Ball Screw Support Bearings

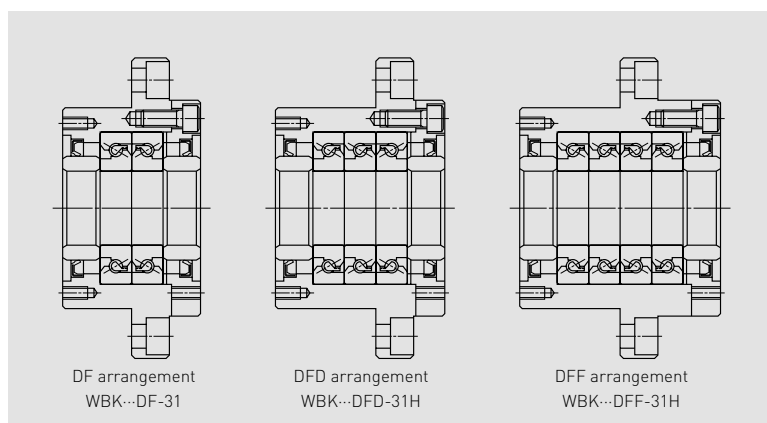
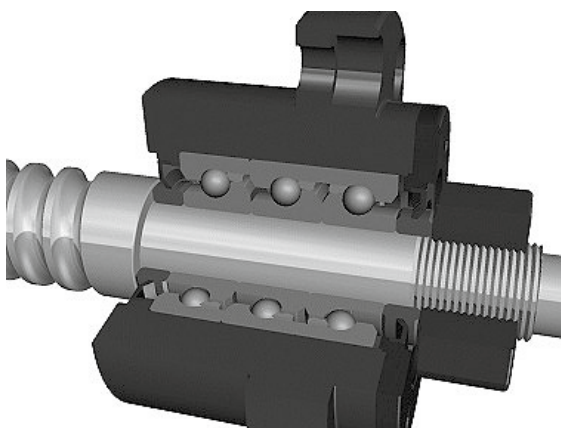
Ball Screw Support Units



This unit for ball screw support in heavy-load and machine tool applications features NSK/TAC C Series high-accuracy, high-rigidity angular contact thrust ball bearings. Three types of arrangement are available, as shown below.

Features

- The dust-resistant unit allows the user to easily design the support side of the ball screw.
- Preload-controlled and ready-mounted bearings eliminate the need for on-site mounting of bearings.



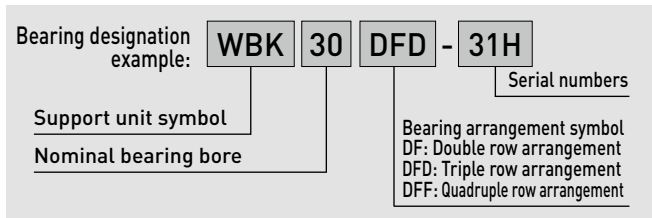
| Support Unit Designation | Support Unit Parts (mm) | | | | | | | | | | | | | | | | |
|--------------------------|-------------------------|----|----------------|----------------|----|----------------|----------------|-----|-----|----|------|-----|------------------|----|----|----|----|
| | d | D | D ₁ | D ₂ | L | L ₁ | L ₂ | A | W | X | Y | Z | d ₁ * | l* | V* | P* | Q* |
| WBK17DF-31H | 17 | 70 | 106 | 72 | 60 | 32 | 15 | 80 | 88 | 9 | 14 | 8.5 | 45 | 3 | 58 | M5 | 10 |
| WBK20DF-31H | 20 | 70 | 106 | 72 | 60 | 32 | 15 | 80 | 88 | 9 | 14 | 8.5 | 45 | 3 | 58 | M5 | 10 |
| WBK25DF-31H | 25 | 85 | 130 | 90 | 66 | 33 | 18 | 100 | 110 | 11 | 17.5 | 11 | 57 | 4 | 70 | M6 | 12 |
| WBK25DFD-31H | 25 | 85 | 130 | 90 | 81 | 48 | 18 | 100 | 110 | 11 | 17.5 | 11 | 57 | 4 | 70 | M6 | 12 |
| WBK30DF-31H | 30 | 85 | 130 | 90 | 66 | 33 | 18 | 100 | 110 | 11 | 17.5 | 11 | 57 | 4 | 70 | M6 | 12 |
| WBK30DFD-31H | 30 | 85 | 130 | 90 | 81 | 48 | 18 | 100 | 110 | 11 | 17.5 | 11 | 57 | 4 | 70 | M6 | 12 |
| WBK35DF-31H | 35 | 95 | 142 | 102 | 66 | 33 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |
| WBK35DFD-31H | 35 | 95 | 142 | 102 | 81 | 48 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |
| WBK35DFF-31H | 35 | 95 | 142 | 102 | 96 | 48 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |
| WBK40DF-31H | 40 | 95 | 142 | 102 | 66 | 33 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |
| WBK40DFD-31H | 40 | 95 | 142 | 102 | 81 | 48 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |
| WBK40DFF-31H | 40 | 95 | 142 | 102 | 96 | 48 | 18 | 106 | 121 | 11 | 17.5 | 11 | 69 | 4 | 80 | M6 | 12 |

[1] Rigidity: Rigidity values in the table are theoretical values calculated from elastic displacement between grooves and steel balls.

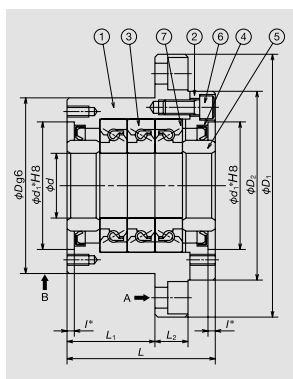
[2] Starting torque: The values indicate starting torque of preloaded bearings, not including seal torque.

[3] Tolerance of shaft outer diameter at bearing seat; h5 Class is recommended for the shaft outer diameter at the support unit's bearing seat.

Designation system of support units



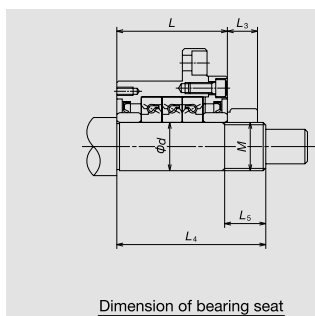
Components of support unit



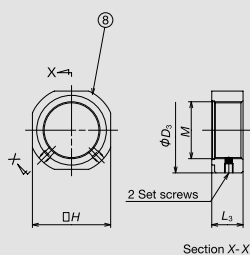
| Part No. | Name of Part | Quantities |
|----------|---|------------|
| ① | Housing | 1 |
| ② | Retaining cover | 1 |
| ③ | Angular contact thrust ball bearings for Ball Screw Support | 1 set |
| ④ | Dust seal | 2 |
| ⑤ | Collar | 2 |
| ⑥ | Preload securing bolt | 6 or 8 |
| ⑦ | Shim | 1 set |
| ⑧ | Locknut | 1 |

1. Use datum faces A and B to mount the support unit to a machine base.
2. Do not try to disassemble the NSK Support Unit because its preload is adjusted with high precision and the components ①, ②, ③, ④, ⑥ and ⑦ are integrated into a single piece.
3. The bearings are prepacked with grease.
4. Locknut ⑧ is designed specifically for ball screws with its perpendicularities controlled against the triangular thread of the screw. Tighten the set screws to prevent loosening of the locknut.

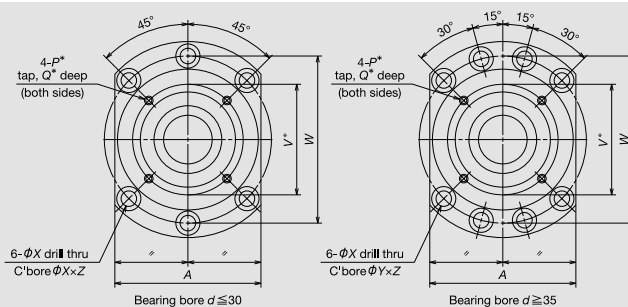
The locknut is also available separately. For further information on angular contact thrust ball bearings for ball screw support (NSKTAC C Series), please refer to Page 146.



Dimension of bearing seat



Lock nut



| Basic Dynamic Load Rating Ca [N] | Limiting axial load [N] | Preload [N] | Axial Rigidity [N/μm] | Starting Torque [N·cm] | Locknut | | | | | Tightening torque [N·cm] (Ref.) | Bearing seat for unit [mm] | | | Limiting Speeds [min ⁻¹] | Mass [kg] | | | |
|----------------------------------|-------------------------|-------------|-----------------------|------------------------|---------------------------|----|----------------|----------------|--------|---------------------------------|----------------------------|----------------|----------------|--------------------------------------|-----------|---|----------------|----------------|
| | | | | | Reference Dimensions [mm] | | | | M | | H | D ₃ | L ₃ | | | d | L ₄ | L ₅ |
| | | | | | M | H | D ₃ | L ₃ | | | | | | | | | | |
| 23 000 | 26 600 | 1 450 | 630 | 14 | M17×1.0 | 32 | 37 | 18 | 4 100 | 17 | 81 | 23 | 6 900 | 1.9 | | | | |
| 23 000 | 26 600 | 1 450 | 630 | 14 | M20×1.0 | 36 | 40 | 18 | 4 500 | 20 | 81 | 23 | 6 900 | 1.9 | | | | |
| 29 900 | 40 500 | 2 280 | 850 | 21 | M25×1.5 | 41 | 45 | 20 | 8 500 | 25 | 89 | 26 | 5 200 | 3.1 | | | | |
| 48 500 | 81 500 | 3 100 | 1 250 | 28 | M25×1.5 | 41 | 45 | 20 | 8 500 | 25 | 89 | 26 | 5 200 | 3.4 | | | | |
| 30 500 | 43 000 | 2 400 | 890 | 23 | M30×1.5 | 46 | 50 | 20 | 10 100 | 30 | 89 | 26 | 4 900 | 3.0 | | | | |
| 50 000 | 86 000 | 3 260 | 1 310 | 30 | M30×1.5 | 46 | 50 | 20 | 10 100 | 30 | 89 | 26 | 4 900 | 3.3 | | | | |
| 32 500 | 50 000 | 2 750 | 1 030 | 27 | M35×1.5 | 50 | 55 | 22 | 13 800 | 35 | 92 | 30 | 4 100 | 3.4 | | | | |
| 53 000 | 100 000 | 3 740 | 1 500 | 34 | M35×1.5 | 50 | 55 | 22 | 13 800 | 35 | 107 | 30 | 4 100 | 4.3 | | | | |
| 53 000 | 100 000 | 5 490 | 2 060 | 43 | M35×1.5 | 50 | 55 | 22 | 13 800 | 35 | 122 | 30 | 4 100 | 5.0 | | | | |
| 33 500 | 52 000 | 2 860 | 1 080 | 28 | M40×1.5 | 55 | 60 | 22 | 15 500 | 40 | 92 | 30 | 4 100 | 3.6 | | | | |
| 54 000 | 104 000 | 3 900 | 1 590 | 36 | M40×1.5 | 55 | 60 | 22 | 15 500 | 40 | 107 | 30 | 4 100 | 4.2 | | | | |
| 54 000 | 104 000 | 5 730 | 2 150 | 46 | M40×1.5 | 55 | 60 | 22 | 15 500 | 40 | 122 | 30 | 4 100 | 4.7 | | | | |

(4) Dimensions marked with * : The spigot and screw parts marked with * are used for mounting a seal unit for the NSK standard hollow ball screw shaft as well as for mounting a dust cover and damper.

(5) As bearings are prepacked with grease, the unit can be used immediately as is.

(6) To calculate permissible axial load, multiply limiting axial load by 0.7.

5. Tapered Roller Bearings



Tapered Roller Bearings

Tapered Roller Bearings

Part 4

Tapered Roller Bearings 160-163

Features

Designation System

Bearing Tables



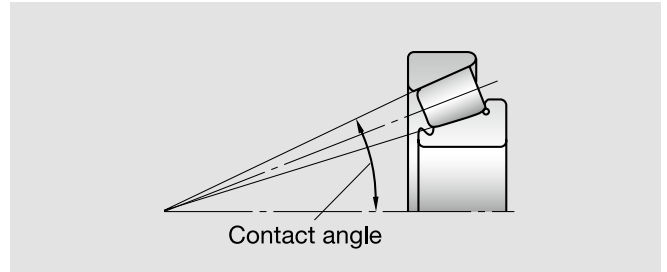
5. Tapered Roller Bearings

Tapered Roller Bearings

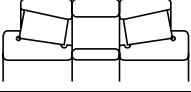
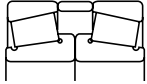
Design, Types and Features

Tapered roller bearings are designed so that the apices of the cones formed by the raceways of the cone and cup and the conical rollers all coincide at one point on the central axis of the bearing. When a radial load is imposed, an axial force also occurs; therefore, it is necessary to use two bearings in opposition or some other multiple arrangement.

The suffix J after the basic number of some high load capacity bearings (HR series) indicates that the cup back face raceway diameter, cup width, and contact angle conform to ISO specifications. Therefore, the cone assembly and cup of bearings with the same basic number suffixed with J are internationally interchangeable.



Design and Features of Combinations of Tapered Roller Bearings

| Figure | Arrangement | Examples of Bearing No. | Features |
|---|--------------|-------------------------|--|
|  | Back-to-back | HR32920JDB+KLR30 | Two standard bearings are combined. The bearing clearances are adjusted by cone spacers or cup spacers. The cones, cups and spacers are marked with serial numbers as well as symbols for matching. Components with the same serial number need to be assembled with regard to these matching symbols. |
|  | Face-to-face | HR32920JDF+KR | |

Dimensions Related to Mounting

The dimensions related to mounting tapered roller bearings are listed in the bearing tables. Since the cages protrude from the ring faces of tapered roller bearings, please use care when designing shafts and housings.

When heavy axial loads are imposed, the shaft shoulder dimensions and strength must be sufficient to support the cone rib.

Permissible Misalignment

The permissible misalignment angle for tapered roller bearings is approximately 0.0009 radian (3').

Limiting Speeds

The limiting speeds listed in the bearing tables should be adjusted depending on the bearing load conditions. For more details, please contact NSK.

Bearing designation example:

HR 3 29 20 J P5

NSK symbol

Bearing type symbol

Dimension series symbol

Accuracy symbol

Internal design symbol

Bore number

HR

NSK symbol

HR: High load capacity

3

Bearing type

3: Tapered roller bearing

29

Dimension series

20: 20 Series 29: 29 Series

20

Bore number

Bearing bore = Bore number × 5 (mm)

J

Internal design

X: Bearing boundary dimensions conform to ISO specifications (20 Series)
J: Cup back face raceway diameter, cup width, and contact angle conform to ISO specifications

P5

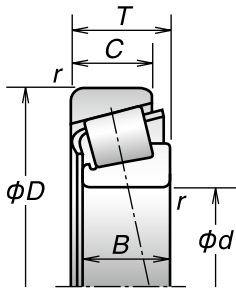
Accuracy

P5: ISO Class 5, P4: ISO Class 4

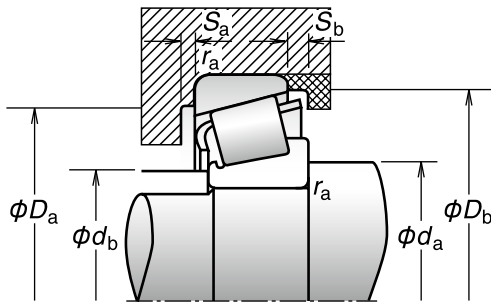
5. Tapered Roller Bearings

Single-Row Tapered Roller Bearings

Bore Diameter 100-360 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | | | | Basic Load Ratings (kN) | | Effective Load Center (mm) a | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | |
|---------------------|--------------------------|-----|------|------|----|----------|-----|--------------------------|--------------------------|------------------------------|---------------------|--------------------------------------|-------|
| | d | D | T | B | C | Cone | Cup | C _r (Dynamic) | C _{0r} (Static) | | | Grease | Oil |
| | | | | | | r (min.) | | | | | | | |
| HR32020XJ | 100 | 150 | 32 | 32 | 24 | 2 | 1.5 | 176 | 294 | 32.5 | 1.95 | 2 200 | 3 000 |
| HR32920J | 100 | 140 | 25 | 25 | 20 | 1.5 | 1.5 | 117 | 205 | 24.2 | 1.18 | 2 200 | 3 200 |
| HR32021XJ | 105 | 160 | 35 | 35 | 26 | 2.5 | 2 | 204 | 340 | 34.3 | 2.48 | 2 000 | 2 800 |
| HR32921J | 105 | 145 | 25 | 25 | 20 | 1.5 | 1.5 | 119 | 212 | 25.3 | 1.23 | 2 200 | 3 000 |
| HR32022XJ | 110 | 170 | 38 | 38 | 29 | 2.5 | 2 | 236 | 390 | 35.9 | 3.09 | 2 000 | 2 600 |
| HR32922J | 110 | 150 | 25 | 25 | 20 | 1.5 | 1.5 | 123 | 224 | 26.5 | 1.29 | 2 200 | 2 800 |
| HR32024XJ | 120 | 180 | 38 | 38 | 29 | 2.5 | 2 | 242 | 405 | 39.7 | 3.27 | 1 800 | 2 400 |
| HR32924J | 120 | 165 | 29 | 29 | 23 | 1.5 | 1.5 | 161 | 291 | 29.2 | 1.8 | 1 900 | 2 600 |
| HR32026XJ | 130 | 200 | 45 | 45 | 34 | 2.5 | 2 | 320 | 535 | 43.9 | 5.06 | 1 600 | 2 200 |
| HR32028XJ | 140 | 210 | 45 | 45 | 34 | 2.5 | 2 | 325 | 555 | 46.6 | 5.32 | 1 600 | 2 200 |
| HR32928J | 140 | 190 | 32 | 32 | 25 | 2 | 1.5 | 206 | 390 | 33.6 | 2.64 | 1 700 | 2 200 |
| HR32030XJ | 150 | 225 | 48 | 48 | 36 | 3 | 2.5 | 375 | 650 | 49.8 | 6.6 | 1 400 | 2 000 |
| HR32032XJ | 160 | 240 | 51 | 51 | 38 | 3 | 2.5 | 425 | 750 | 53.0 | 7.93 | 1 300 | 1 800 |
| HR32932J | 160 | 220 | 38 | 38 | 30 | 2.5 | 2 | 296 | 570 | 38.7 | 4.32 | 1 400 | 1 900 |
| HR32034XJ | 170 | 260 | 57 | 57 | 43 | 3 | 2.5 | 505 | 890 | 56.6 | 10.6 | 1 200 | 1 700 |
| HR32934J | 170 | 230 | 38 | 38 | 30 | 2.5 | 2 | 294 | 560 | 41.7 | 4.44 | 1 400 | 1 800 |
| HR32036XJ | 180 | 280 | 64 | 64 | 48 | 3 | 2.5 | 640 | 1 130 | 60.4 | 14.3 | 1 200 | 1 600 |
| HR32936J | 180 | 250 | 45 | 45 | 34 | 2.5 | 2 | 350 | 685 | 53.9 | 6.56 | 1 300 | 1 700 |
| HR32038XJ | 190 | 290 | 64 | 64 | 48 | 3 | 2.5 | 650 | 1 170 | 63.4 | 14.9 | 1 100 | 1 500 |
| HR32938J | 190 | 260 | 45 | 45 | 34 | 2.5 | 2 | 365 | 715 | 55.3 | 6.83 | 1 200 | 1 600 |
| HR32040XJ | 200 | 310 | 70 | 70 | 53 | 3 | 2.5 | 760 | 1 370 | 67.4 | 18.9 | 1 000 | 1 400 |
| HR32940J | 200 | 280 | 51 | 51 | 39 | 3 | 2.5 | 480 | 935 | 54.2 | 9.65 | 1 100 | 1 500 |
| HR32044XJ | 220 | 340 | 76 | 76 | 57 | 4 | 3 | 885 | 1 610 | 73.6 | 24.4 | 950 | 1 300 |
| HR32944J | 220 | 300 | 51 | 51 | 39 | 3 | 2.5 | 490 | 990 | 59.2 | 10.3 | 1 000 | 1 400 |
| HR32048XJ | 240 | 360 | 76 | 76 | 57 | 4 | 3 | 920 | 1 730 | 79.1 | 26.2 | 850 | 1 200 |
| HR32948J | 240 | 320 | 51 | 51 | 39 | 3 | 2.5 | 500 | 1 040 | 65.1 | 11.1 | 950 | 1 300 |
| HR32052XJ | 260 | 400 | 87 | 87 | 65 | 5 | 4 | 1 160 | 2 160 | 86.3 | 38.5 | 800 | 1 100 |
| HR32952J | 260 | 360 | 63.5 | 63.5 | 48 | 3 | 2.5 | 730 | 1 450 | 69.8 | 18.6 | 850 | 1 100 |
| HR32056XJ | 280 | 420 | 87 | 87 | 65 | 5 | 4 | 1 180 | 2 240 | 91.6 | 40.6 | 710 | 1 000 |
| HR32956J | 280 | 380 | 63.5 | 63.5 | 48 | 3 | 2.5 | 765 | 1 580 | 75.3 | 20 | 800 | 1 100 |
| HR32060XJ | 300 | 460 | 100 | 100 | 74 | 5 | 4 | 1 440 | 2 700 | 98.4 | 56.6 | 670 | 900 |
| HR32960J | 300 | 420 | 76 | 76 | 57 | 4 | 3 | 1 010 | 2 100 | 79.9 | 31.4 | 710 | 950 |
| HR32064XJ | 320 | 480 | 100 | 100 | 74 | 5 | 4 | 1 510 | 2 910 | 104.5 | 60 | 630 | 850 |
| HR32972J | 360 | 480 | 76 | 76 | 57 | 4 | 3 | 1 080 | 2 340 | 96.8 | 36.1 | 560 | 800 |



Dynamic Equivalent Load

$$P = XF_r + YF_a$$

| $F_a/F_r \leq e$ | | $F_a/F_r > e$ | |
|------------------|---|---------------|-------|
| X | Y | X | Y |
| 1 | 0 | 0.4 | Y_1 |

Static Equivalent Load

$$P_0 = 0.5 F_r + Y_0 F_a$$

When $F_r > 0.5 F_r + Y_0 F_a$,
use $P_0 = F_r$

The values of e , Y_1 and Y_0 given in the table below.

| Constant e | Axial Load Factors | | Abutment and Fillet Dimensions (mm) | | | | | | | | |
|--------------|--------------------|--------|-------------------------------------|-----------------|-------|-----|-----------------|-----------------|-----------------|----------------------------|----------------------------|
| | | | d_a (min.) | d_b (max.) | D_a | | D_b (min.) | S_a (min.) | S_b (min.) | Inner Ring r_a (max.) | Outer Ring r_a (max.) |
| | (max.) | (min.) | | | | | | | | | |
| 0.46 | 1.3 | 0.72 | 112 | 109 | 141 | 136 | 144 | 6 | 8 | 2 | 1.5 |
| 0.33 | 1.8 | 1.0 | 111 | 109 | 132 | 132 | 134 | 5 | 5 | 1.5 | 1.5 |
| 0.44 | 1.4 | 0.74 | 120 | 115 | 150 | 144 | 154 | 6 | 9 | 2 | 2 |
| 0.34 | 1.8 | 0.96 | 116 | 114 | 137 | 137 | 140 | 5 | 5 | 1.5 | 1.5 |
| 0.43 | 1.4 | 0.77 | 125 | 121 | 160 | 153 | 163 | 7 | 9 | 2 | 2 |
| 0.36 | 1.7 | 0.93 | 121 | 119 | 142 | 142 | 145 | 5 | 5 | 1.5 | 1.5 |
| 0.46 | 1.3 | 0.72 | 135 | 131 | 170 | 162 | 173 | 7 | 9 | 2 | 2 |
| 0.35 | 1.7 | 0.95 | 131 | 129 | 156 | 155 | 160 | 6 | 6 | 1.5 | 1.5 |
| 0.43 | 1.4 | 0.76 | 145 | 144 | 190 | 179 | 192 | 8 | 11 | 2 | 2 |
| 0.46 | 1.3 | 0.72 | 155 | 152 | 200 | 189 | 202 | 8 | 11 | 2 | 2 |
| 0.36 | 1.7 | 0.92 | 152 | 150 | 180 | 178 | 184 | 6 | 7 | 2 | 1.5 |
| 0.46 | 1.3 | 0.72 | 168 | 164 | 213 | 202 | 216 | 8 | 12 | 2.5 | 2 |
| 0.46 | 1.3 | 0.72 | 178 | 175 | 228 | 216 | 231 | 8 | 13 | 2.5 | 2 |
| 0.35 | 1.7 | 0.95 | 175 | 173 | 208 | 206 | 212 | 7 | 8 | 2 | 2 |
| 0.44 | 1.4 | 0.74 | 188 | 187 | 248 | 232 | 249 | 10 | 14 | 2.5 | 2 |
| 0.38 | 1.6 | 0.86 | 185 | 180 | 218 | 215 | 222 | 7 | 8 | 2 | 2 |
| 0.42 | 1.4 | 0.78 | 198 | 199 | 268 | 248 | 267 | 10 | 16 | 2.5 | 2 |
| 0.48 | 1.3 | 0.69 | 195 | 192 | 240 | 227 | 241 | 8 | 11 | 2 | 2 |
| 0.44 | 1.4 | 0.75 | 208 | 209 | 278 | 258 | 279 | 10 | 16 | 2.5 | 2 |
| 0.48 | 1.3 | 0.69 | 205 | 201 | 250 | 237 | 251 | 8 | 11 | 2 | 2 |
| 0.43 | 1.4 | 0.77 | 218 | 221 | 298 | 277 | 297 | 11 | 17 | 2.5 | 2 |
| 0.39 | 1.5 | 0.84 | 218 | 216 | 268 | 258 | 271 | 9 | 12 | 2.5 | 2 |
| 0.43 | 1.4 | 0.77 | 241 | 244 | 326 | 303 | 326 | 12 | 19 | 3 | 2.5 |
| 0.43 | 1.4 | 0.78 | 238 | 235 | 288 | 278 | 293 | 9 | 12 | 2.5 | 2 |
| 0.46 | 1.3 | 0.72 | 261 | 262 | 346 | 321 | 346 | 12 | 19 | 3 | 2.5 |
| 0.46 | 1.3 | 0.72 | 258 | 255 | 308 | 297 | 314 | 9 | 12 | 2.5 | 2 |
| 0.43 | 1.4 | 0.76 | 287 | 287 | 382 | 357 | 383 | 14 | 22 | 4 | 3 |
| 0.41 | 1.5 | 0.81 | 278 | 278 | 348 | 333 | 347 | 11 | 15.5 | 2.5 | 2 |
| 0.46 | 1.3 | 0.72 | 307 | 305 | 402 | 374 | 402 | 14 | 22 | 4 | 3 |
| 0.43 | 1.4 | 0.76 | 298 | 297 | 368 | 352 | 368 | 12 | 15.5 | 2.5 | 2 |
| 0.43 | 1.4 | 0.76 | 327 | 330 | 442 | 408 | 439 | 15 | 26 | 4 | 3 |
| 0.39 | 1.5 | 0.84 | 321 | 324 | 406 | 387 | 405 | 13 | 19 | 3 | 2.5 |
| 0.46 | 1.3 | 0.72 | 347 | 350 | 462 | 430 | 461 | 15 | 26 | 4 | 3 |
| 0.46 | 1.3 | 0.72 | 381 | 381 | 466 | 445 | 466 | 13 | 19 | 3 | 2.5 |

6. Thrust Bearings



Single-Direction Thrust Ball Bearings

Thrust Cylindrical Roller Bearings



ROBUSTSLIM

Thrust Bearings

Part 4

Thrust Bearings..... 166-177

Features

Designation System

Bearing Tables

Single-Direction Thrust Ball Bearings

Thrust Cylindrical Roller Bearings

ROBUSTSLIM



6. Thrust Bearings

Thrust Bearings

Types and Features

Single-Direction Thrust Ball Bearings

Thrust ball bearings can sustain axial loads but no radial loads.

For single-direction thrust ball bearings, pressed steel cages and machined brass cages are usually used as shown in Table 6.1.

The basic load ratings listed in the bearing tables are based on the standard cage type shown in Table 6.1.

For identical bearing numbers, different cage types may imply a different number of balls; in such a case, the load rating will differ from the one listed in the bearing tables.

Table 6.1 Standard Cages for Thrust Ball Bearings

| | Flat seat | Pressed steel cage | Machined brass cage |
|------------------|-----------|--------------------|---------------------|
| Single-direction | 511 | 51106-51152X | 51156X-51180X |
| | 512 | 51206-51236X | 51238X-51280X |
| | 513 | 51306-51336X | 51338X-51340X |
| | 514 | 51406-51418X | 51420X-51436X |

Thrust Cylindrical Roller Bearings

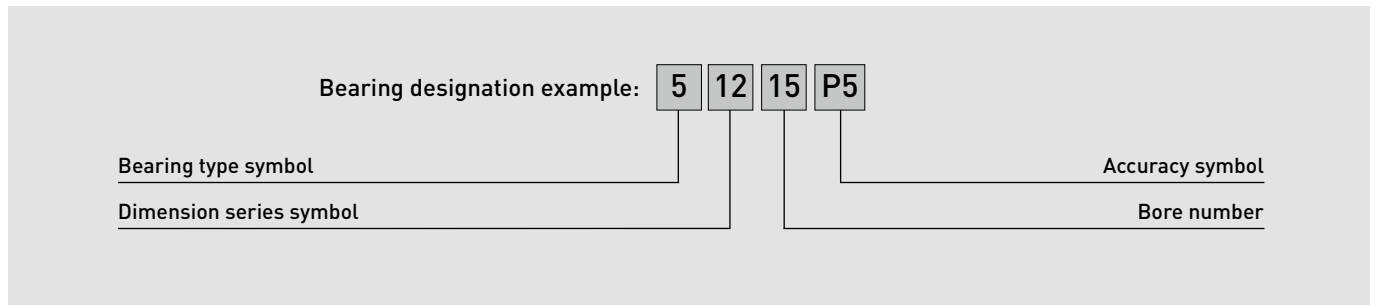
These are thrust bearings containing cylindrical rollers. They can sustain only axial loads, but they are suitable for heavy loads and have high axial rigidity.

The cages are machined brass.

Minimum Axial Load

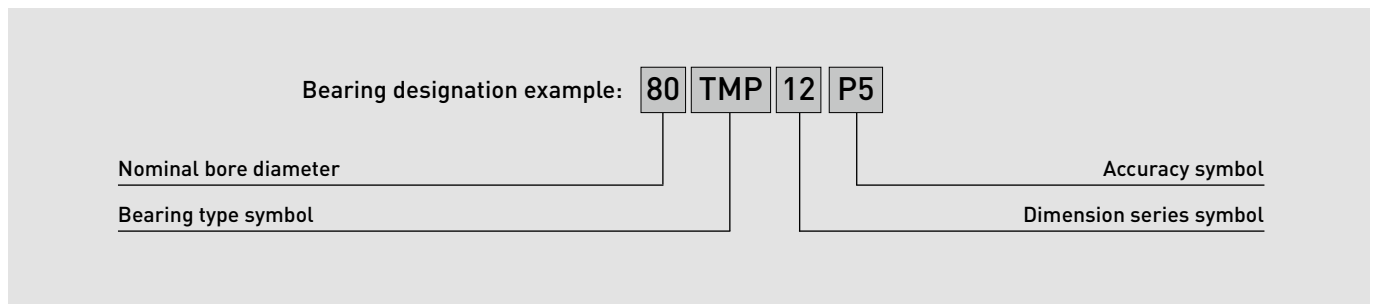
It is necessary to apply some axial load to thrust bearings to prevent slippage between the rolling elements and the raceways. For more details please refer to page 217.

Designation System of Single-Direction Thrust Ball Bearings



| | | |
|-----------|-------------------------|---|
| 5 | Bearing type | 5: Thrust ball bearing |
| 12 | Dimension series | 11: 11 Series 12: 12 Series 13: 13 Series 14: 14 Series |
| 15 | Bore number | Bearing bore = Bore number × 5 (mm) |
| P5 | Accuracy | P5: ISO Class 5, P4: ISO Class 4 |

Designation System of Thrust Cylindrical Roller Bearings

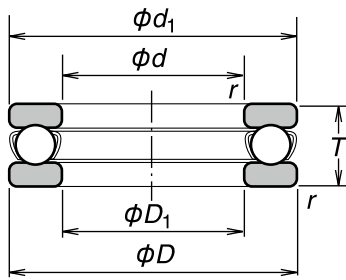


| | | |
|------------|------------------------------|---|
| 80 | Nominal bore diameter | Bore diameter (mm) |
| TMP | Bearing type | TMP: Thrust cylindrical roller bearing |
| 12 | Dimension series | 11: 11 Series 12: 12 Series 93: 93 Series |
| P5 | Accuracy | P5: Class 5, P4: Class 4 |

6. Thrust Bearings

Single-Direction Thrust Ball Bearings

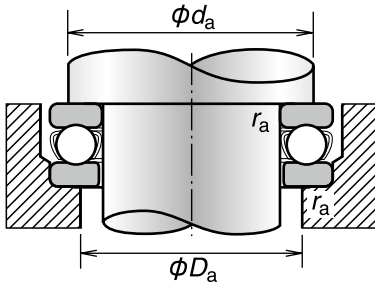
Bore Diameter 30-160 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor M (x10 ⁻⁶) | Abutment and Fillet Dimensions (2) (mm) | | |
|---------------------|--------------------------|-----|----|----------------|----------------|----------|--------------------------|--------------------------|---------------------|--------------------------------------|-------|--|---|-----------------------|-----------------------|
| | d | D | T | d ₁ | D ₁ | r (min.) | C _a (Dynamic) | C _{0a} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 51106 | 30 | 47 | 11 | 47 | 32 | 0.6 | 20.6 | 42 | 0.064 | 4 300 | 6 700 | 0.009 | 40 | 37 | 0.6 |
| 51206 | 30 | 52 | 16 | 52 | 32 | 0.6 | 29.5 | 58 | 0.137 | 3 400 | 5 300 | 0.018 | 43 | 39 | 0.6 |
| 51306 | 30 | 60 | 21 | 60 | 32 | 1 | 43 | 78.5 | 0.267 | 2 800 | 4 300 | 0.033 | 48 | 42 | 1 |
| 51406 | 30 | 70 | 28 | 70 | 32 | 1 | 73 | 126 | 0.519 | 2 200 | 3 400 | 0.082 | 54 | 46 | 1 |
| 51107 | 35 | 52 | 12 | 52 | 37 | 0.6 | 22.1 | 49.5 | 0.081 | 4 000 | 6 000 | 0.013 | 45 | 42 | 0.6 |
| 51207 | 35 | 62 | 18 | 62 | 37 | 1 | 39.5 | 78 | 0.210 | 3 000 | 4 500 | 0.033 | 51 | 46 | 1 |
| 51307 | 35 | 68 | 24 | 68 | 37 | 1 | 56 | 105 | 0.386 | 2 400 | 3 800 | 0.059 | 55 | 48 | 1 |
| 51407 | 35 | 80 | 32 | 80 | 37 | 1.1 | 87.5 | 155 | 0.769 | 2 000 | 3 000 | 0.13 | 62 | 53 | 1 |
| 51108 | 40 | 60 | 13 | 60 | 42 | 0.6 | 27.1 | 63 | 0.120 | 3 600 | 5 300 | 0.021 | 52 | 48 | 0.6 |
| 51208 | 40 | 68 | 19 | 68 | 42 | 1 | 47.5 | 98.5 | 0.270 | 2 800 | 4 300 | 0.050 | 57 | 51 | 1 |
| 51308 | 40 | 78 | 26 | 78 | 42 | 1 | 70 | 135 | 0.536 | 2 200 | 3 400 | 0.098 | 63 | 55 | 1 |
| 51209 | 45 | 73 | 20 | 73 | 47 | 1 | 48 | 105 | 0.310 | 2 600 | 4 000 | 0.059 | 62 | 56 | 1 |
| 51309 | 45 | 85 | 28 | 85 | 47 | 1 | 80.5 | 163 | 0.672 | 2 000 | 3 000 | 0.14 | 69 | 61 | 1 |
| 51110 | 50 | 70 | 14 | 70 | 52 | 0.6 | 29 | 75.5 | 0.153 | 3 200 | 4 800 | 0.030 | 62 | 58 | 0.6 |
| 51210 | 50 | 78 | 22 | 78 | 52 | 1 | 49 | 111 | 0.378 | 2 400 | 3 600 | 0.067 | 67 | 61 | 1 |
| 51310 | 50 | 95 | 31 | 95 | 52 | 1.1 | 97.5 | 202 | 0.931 | 1 800 | 2 800 | 0.21 | 77 | 68 | 1 |
| 51410 | 50 | 110 | 43 | 110 | 52 | 1.5 | 147 | 288 | 1.94 | 1 400 | 2 200 | 0.44 | 86 | 74 | 1.5 |
| 51111 | 55 | 78 | 16 | 78 | 57 | 0.6 | 35 | 93 | 0.227 | 2 800 | 4 300 | 0.045 | 69 | 64 | 0.6 |
| 51211 | 55 | 90 | 25 | 90 | 57 | 1 | 70 | 159 | 0.599 | 2 200 | 3 200 | 0.13 | 76 | 69 | 1 |
| 51311 | 55 | 105 | 35 | 105 | 57 | 1.1 | 115 | 244 | 1.31 | 1 600 | 2 400 | 0.31 | 85 | 75 | 1 |
| 51112 | 60 | 85 | 17 | 85 | 62 | 1 | 41.5 | 113 | 0.281 | 2 600 | 4 000 | 0.065 | 75 | 70 | 1 |
| 51212 | 60 | 95 | 26 | 95 | 62 | 1 | 71.5 | 169 | 0.673 | 2 000 | 3 000 | 0.15 | 81 | 74 | 1 |
| 51312 | 60 | 110 | 35 | 110 | 62 | 1.1 | 119 | 263 | 1.40 | 1 600 | 2 400 | 0.36 | 90 | 80 | 1 |
| 51113 | 65 | 90 | 18 | 90 | 67 | 1 | 42 | 117 | 0.324 | 2 400 | 3 800 | 0.073 | 80 | 75 | 1 |
| 51213 | 65 | 100 | 27 | 100 | 67 | 1 | 75.5 | 189 | 0.756 | 1 900 | 2 800 | 0.18 | 86 | 79 | 1 |
| 51313 | 65 | 115 | 36 | 115 | 67 | 1.1 | 123 | 282 | 1.54 | 1 500 | 2 400 | 0.41 | 95 | 85 | 1 |
| 51413 | 65 | 140 | 56 | 140 | 68 | 2 | 234 | 495 | 4.10 | 1 100 | 1 700 | 1.2 | 110 | 95 | 2 |
| 51214 | 70 | 105 | 27 | 105 | 72 | 1 | 74 | 189 | 0.793 | 1 900 | 2 800 | 0.19 | 91 | 84 | 1 |
| 51314 | 70 | 125 | 40 | 125 | 72 | 1.1 | 137 | 315 | 2.00 | 1 400 | 2 000 | 0.53 | 103 | 92 | 1 |
| 51115 | 75 | 100 | 19 | 100 | 77 | 1 | 43.5 | 131 | 0.389 | 2 200 | 3 400 | 0.092 | 90 | 85 | 1 |
| 51215 | 75 | 110 | 27 | 110 | 77 | 1 | 78 | 209 | 0.845 | 1 800 | 2 800 | 0.22 | 96 | 89 | 1 |
| 51415 | 75 | 160 | 65 | 160 | 78 | 2 | 254 | 560 | 6.15 | 950 | 1 400 | 1.8 | 125 | 110 | 2 |

(1) For more information on minimum load factors, please refer to page 217.

(2) Bearing numbers suffixed with X indicate that the outside diameter d₁ of the shaft washer is smaller than the outside diameter D of the housing washer.

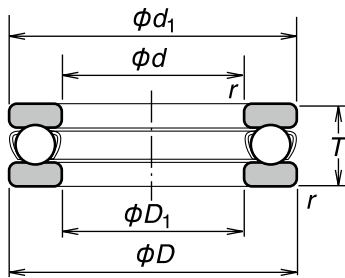


| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor (1) M (x10 ⁻⁶) | Abutment and Fillet Dimensions (2) (mm) | | |
|---------------------|--------------------------|-----|-----|----------------|----------------|----------|--------------------------|--------------------------|---------------------|--------------------------------------|-------|--|---|-----------------------|-----------------------|
| | d | D | T | d _i | D _i | r (min.) | C _a (Dynamic) | C _{oa} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 51116 | 80 | 105 | 19 | 105 | 82 | 1 | 45 | 141 | 0.417 | 2 200 | 3 400 | 0.10 | 95 | 90 | 1 |
| 51216 | 80 | 115 | 28 | 115 | 82 | 1 | 79 | 218 | 0.931 | 1 800 | 2 600 | 0.25 | 101 | 94 | 1 |
| 51316 | 80 | 140 | 44 | 140 | 82 | 1.5 | 164 | 395 | 2.74 | 1 300 | 1 900 | 0.82 | 116 | 104 | 1.5 |
| 51416 | 80 | 170 | 68 | 170 | 83 | 2.1 | 272 | 620 | 7.21 | 900 | 1 300 | 2.3 | 133 | 117 | 2 |
| 51117 | 85 | 110 | 19 | 110 | 87 | 1 | 46.5 | 150 | 0.440 | 2 200 | 3 200 | 0.12 | 100 | 95 | 1 |
| 51217 | 85 | 125 | 31 | 125 | 88 | 1 | 96 | 264 | 1.22 | 1 600 | 2 400 | 0.36 | 109 | 101 | 1 |
| 51118 | 90 | 120 | 22 | 120 | 92 | 1 | 60 | 190 | 0.646 | 1 900 | 3 000 | 0.19 | 108 | 102 | 1 |
| 51218 | 90 | 135 | 35 | 135 | 93 | 1.1 | 114 | 310 | 1.69 | 1 400 | 2 200 | 0.51 | 117 | 108 | 1 |
| 51318 | 90 | 155 | 50 | 155 | 93 | 1.5 | 214 | 525 | 3.83 | 1 100 | 1 700 | 1.4 | 129 | 116 | 1.5 |
| 51120 | 100 | 135 | 25 | 135 | 102 | 1 | 86 | 268 | 0.960 | 1 700 | 2 600 | 0.37 | 121 | 114 | 1 |
| 51220 | 100 | 150 | 38 | 150 | 103 | 1.1 | 135 | 375 | 2.25 | 1 300 | 2 000 | 0.75 | 130 | 120 | 1 |
| 51320 | 100 | 170 | 55 | 170 | 103 | 1.5 | 239 | 595 | 4.98 | 1 000 | 1 500 | 1.9 | 142 | 128 | 1.5 |
| 51420X | 100 | 210 | 85 | 205 | 103 | 3 | 370 | 985 | 14.8 | 710 | 1 100 | 5.3 | 165 | 145 | 2.5 |
| 51122 | 110 | 145 | 25 | 145 | 112 | 1 | 88 | 288 | 1.04 | 1 700 | 2 400 | 0.43 | 131 | 124 | 1 |
| 51222 | 110 | 160 | 38 | 160 | 113 | 1.1 | 136 | 395 | 2.42 | 1 300 | 1 900 | 0.85 | 140 | 130 | 1 |
| 51322X | 110 | 190 | 63 | 187 | 113 | 2 | 282 | 755 | 7.19 | 900 | 1 300 | 3.0 | 158 | 142 | 2 |
| 51124 | 120 | 155 | 25 | 155 | 122 | 1 | 90 | 310 | 1.12 | 1 600 | 2 400 | 0.49 | 141 | 134 | 1 |
| 51224 | 120 | 170 | 39 | 170 | 123 | 1.1 | 141 | 430 | 2.70 | 1 200 | 1 800 | 1.0 | 150 | 140 | 1 |
| 51424X | 120 | 250 | 102 | 245 | 123 | 4 | 480 | 1 400 | 26.2 | 600 | 900 | 11 | 196 | 174 | 3 |
| 51126 | 130 | 170 | 30 | 170 | 132 | 1 | 105 | 350 | 1.68 | 1 400 | 2 000 | 0.69 | 154 | 146 | 1 |
| 51226X | 130 | 190 | 45 | 187 | 133 | 1.5 | 183 | 550 | 3.95 | 1 100 | 1 600 | 1.7 | 166 | 154 | 1.5 |
| 51326X | 130 | 225 | 75 | 220 | 134 | 2.1 | 350 | 1 030 | 12.1 | 750 | 1 100 | 5.6 | 186 | 169 | 2 |
| 51128X | 140 | 180 | 31 | 178 | 142 | 1 | 107 | 375 | 1.83 | 1 300 | 2 000 | 0.79 | 164 | 156 | 1 |
| 51228X | 140 | 200 | 46 | 197 | 143 | 1.5 | 186 | 575 | 4.30 | 1 000 | 1 500 | 1.9 | 176 | 164 | 1.5 |
| 51328X | 140 | 240 | 80 | 235 | 144 | 2.1 | 370 | 1 130 | 14.2 | 670 | 1 000 | 6.8 | 199 | 181 | 2 |
| 51130X | 150 | 190 | 31 | 188 | 152 | 1 | 110 | 400 | 1.95 | 1 300 | 1 900 | 0.89 | 174 | 166 | 1 |
| 51230X | 150 | 215 | 50 | 212 | 153 | 1.5 | 238 | 735 | 5.52 | 950 | 1 400 | 2.9 | 189 | 176 | 1.5 |
| 51330X | 150 | 250 | 80 | 245 | 154 | 2.1 | 380 | 1 200 | 15.0 | 670 | 1 000 | 7.7 | 209 | 191 | 2 |
| 51430X | 150 | 300 | 120 | 295 | 154 | 4 | 620 | 2 010 | 43.5 | 480 | 710 | 24 | 238 | 212 | 3 |
| 51132X | 160 | 200 | 31 | 198 | 162 | 1 | 113 | 425 | 2.07 | 1 200 | 1 900 | 1.0 | 184 | 176 | 1 |
| 51332X | 160 | 270 | 87 | 265 | 164 | 3 | 475 | 1 570 | 19.6 | 600 | 900 | 13 | 225 | 205 | 2.5 |
| 51432X | 160 | 320 | 130 | 315 | 164 | 5 | 650 | 2 210 | 52.7 | 450 | 670 | 28 | 254 | 226 | 4 |

6. Thrust Bearings

Single-Direction Thrust Ball Bearings

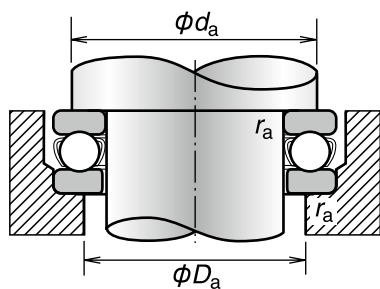
Bore Diameter 170-700 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor (1) M (x10 ⁻⁶) | Abutment and Fillet Dimensions (2) (mm) | | |
|---------------------|--------------------------|-----|-----|----------------|----------------|----------|--------------------------|--------------------------|---------------------|--------------------------------------|-------|---|---|-----------------------|-----------------------|
| | d | D | T | d ₁ | D ₁ | r (min.) | C _a (Dynamic) | C _{0a} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 51134X | 170 | 215 | 34 | 213 | 172 | 1.1 | 135 | 510 | 2.72 | 1 100 | 1 700 | 1.4 | 197 | 188 | 1 |
| 51234X | 170 | 240 | 55 | 237 | 173 | 1.5 | 280 | 915 | 7.41 | 850 | 1 300 | 4.4 | 212 | 198 | 1.5 |
| 51136X | 180 | 225 | 34 | 222 | 183 | 1.1 | 136 | 530 | 2.79 | 1 100 | 1 700 | 1.6 | 207 | 198 | 1 |
| 51236X | 180 | 250 | 56 | 247 | 183 | 1.5 | 284 | 955 | 7.94 | 800 | 1 200 | 4.8 | 222 | 208 | 1.5 |
| 51336X | 180 | 300 | 95 | 295 | 184 | 3 | 480 | 1 680 | 25.9 | 560 | 850 | 15 | 251 | 229 | 2.5 |
| 51138X | 190 | 240 | 37 | 237 | 193 | 1.1 | 172 | 655 | 3.60 | 1 000 | 1 600 | 2.4 | 220 | 210 | 1 |
| 51238X | 190 | 270 | 62 | 267 | 194 | 2 | 320 | 1 110 | 11.8 | 750 | 1 100 | 6.7 | 238 | 222 | 2 |
| 51140X | 200 | 250 | 37 | 247 | 203 | 1.1 | 173 | 675 | 3.75 | 1 000 | 1 500 | 2.5 | 230 | 220 | 1 |
| 51240X | 200 | 280 | 62 | 277 | 204 | 2 | 315 | 1 110 | 12.3 | 710 | 1 100 | 6.9 | 248 | 232 | 2 |
| 51144X | 220 | 270 | 37 | 267 | 223 | 1.1 | 179 | 740 | 4.09 | 950 | 1 500 | 3.0 | 250 | 240 | 1 |
| 51244X | 220 | 300 | 63 | 297 | 224 | 2 | 325 | 1 210 | 13.6 | 670 | 1 000 | 8.2 | 268 | 252 | 2 |
| 51148X | 240 | 300 | 45 | 297 | 243 | 1.5 | 229 | 935 | 6.55 | 850 | 1 200 | 4.9 | 276 | 264 | 1.5 |
| 51248X | 240 | 340 | 78 | 335 | 244 | 2.1 | 420 | 1 650 | 23.7 | 560 | 850 | 15 | 299 | 281 | 2 |
| 51448X | 240 | 440 | 160 | 435 | 245 | 6 | 915 | 3 900 | 115 | 320 | 500 | 85 | 359 | 321 | 5 |
| 51152X | 260 | 320 | 45 | 317 | 263 | 1.5 | 233 | 990 | 7.01 | 800 | 1 200 | 5.6 | 296 | 284 | 1.5 |
| 51252X | 260 | 360 | 79 | 355 | 264 | 2.1 | 435 | 1 800 | 25.1 | 560 | 850 | 18 | 319 | 301 | 2 |
| 51156X | 280 | 350 | 53 | 347 | 283 | 1.5 | 315 | 1 310 | 12.0 | 710 | 1 000 | 9.6 | 322 | 308 | 1.5 |
| 51256X | 280 | 380 | 80 | 375 | 284 | 2.1 | 450 | 1 950 | 27.1 | 530 | 800 | 21 | 339 | 321 | 2 |
| 51160X | 300 | 380 | 62 | 376 | 304 | 2 | 360 | 1 560 | 17.2 | 600 | 900 | 14 | 348 | 332 | 2 |
| 51360 | 300 | 480 | 140 | 480 | 305 | 5 | 860 | 3 950 | 103 | 340 | 500 | 90 | 407 | 375 | 4 |
| 51164X | 320 | 400 | 63 | 396 | 324 | 2 | 365 | 1 660 | 18.6 | 600 | 900 | 16 | 368 | 352 | 2 |
| 51264X | 320 | 440 | 95 | 435 | 325 | 3 | 585 | 2 680 | 45.0 | 450 | 670 | 41 | 391 | 369 | 2.5 |
| 51364 | 320 | 500 | 140 | 500 | 325 | 5 | 880 | 4 200 | 109 | 340 | 500 | 101 | 427 | 395 | 4 |
| 51168X | 340 | 420 | 64 | 416 | 344 | 2 | 375 | 1 760 | 19.9 | 560 | 850 | 18 | 388 | 372 | 2 |
| 51268X | 340 | 460 | 96 | 455 | 345 | 3 | 595 | 2 800 | 47.9 | 430 | 630 | 46 | 411 | 389 | 2.5 |
| 51172X | 360 | 440 | 65 | 436 | 364 | 2 | 385 | 1 860 | 21.5 | 560 | 800 | 19 | 408 | 392 | 2 |
| 51272X | 360 | 500 | 110 | 495 | 365 | 4 | 705 | 3 500 | 68.8 | 380 | 560 | 70 | 442 | 418 | 3 |
| 51176X | 380 | 460 | 65 | 456 | 384 | 2 | 385 | 1 910 | 22.4 | 540 | 800 | 21 | 427 | 413 | 2 |
| 51276 | 380 | 520 | 112 | 520 | 385 | 4 | 740 | 3 800 | 74.5 | 370 | 550 | 80 | 464 | 438 | 3 |
| 51180X | 400 | 480 | 65 | 476 | 404 | 2 | 395 | 2 010 | 23.5 | — | 790 | 23 | 447 | 433 | 2 |
| 51280X | 400 | 540 | 112 | 535 | 405 | 4 | 730 | 3 800 | 76.6 | — | 540 | 83 | 484 | 458 | 3 |

(1) For more information on minimum load factors, please refer to page 217.

(2) Bearing numbers suffixed with X indicate that the outside diameter d_1 of the shaft washer is smaller than the outside diameter D of the housing washer.

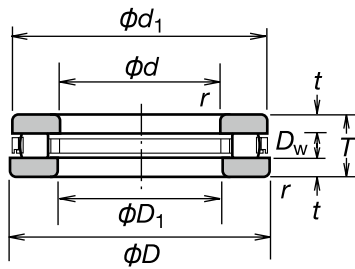


| Bearing Designation | Boundary Dimensions (mm) | | | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor (1) M (x10 ⁻⁶) | Abutment and Fillet Dimensions (2) (mm) | | |
|---------------------|--------------------------|-------|-----|----------------|----------------|----------|--------------------------|--------------------------|---------------------|--------------------------------------|-----|--|---|-----------------------|-----------------------|
| | d | D | T | d _i | D _i | r (min.) | C _a (Dynamic) | C _{0a} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 51184X | 420 | 500 | 65 | 495 | 424 | 2 | 400 | 2 110 | 24.4 | — | 770 | 25 | 467 | 453 | 2 |
| 51284 | 420 | 580 | 130 | 580 | 425 | 5 | 850 | 4 650 | 109 | — | 470 | 121 | 517 | 485 | 4 |
| 51188X | 440 | 540 | 80 | 535 | 444 | 2.1 | 515 | 2 850 | 40.5 | — | 650 | 45 | 498 | 482 | 2 |
| 51288 | 440 | 600 | 130 | 600 | 445 | 5 | 865 | 4 850 | 115 | — | 460 | 131 | 537 | 505 | 4 |
| 51192X | 460 | 560 | 80 | 555 | 464 | 2.1 | 520 | 2 930 | 42.0 | — | 640 | 48 | 518 | 502 | 2 |
| 51292 | 460 | 620 | 130 | 620 | 465 | 5 | 880 | 5 050 | 119 | — | 460 | 142 | 557 | 525 | 4 |
| 51392 | 460 | 710 | 195 | 710 | 465 | 6 | 1 200 | 7 150 | 291 | — | 330 | 292 | 606 | 566 | 5 |
| 51196X | 480 | 580 | 80 | 575 | 484 | 2.1 | 530 | 3 100 | 43.7 | — | 630 | 52 | 538 | 522 | 2 |
| 51296 | 480 | 650 | 135 | 650 | 485 | 5 | 890 | 5 250 | 137 | — | 430 | 155 | 582 | 550 | 4 |
| 511/500X | 500 | 600 | 80 | 595 | 504 | 2.1 | 560 | 3 300 | 45.4 | — | 620 | 60 | 554 | 546 | 2 |
| 511/530X | 530 | 640 | 85 | 635 | 534 | 3 | 640 | 3 900 | 56.7 | — | 570 | 86 | 597 | 575 | 2.5 |
| 512/530 | 530 | 710 | 140 | 710 | 535 | 5 | 1 010 | 6 200 | 165 | — | 400 | 224 | 637 | 605 | 4 |
| 511/560X | 560 | 670 | 85 | 665 | 564 | 3 | 655 | 4 100 | 59.6 | — | 560 | 95 | 625 | 605 | 2.5 |
| 512/560 | 560 | 750 | 150 | 750 | 565 | 5 | 1 200 | 7 800 | 200 | — | 370 | 328 | 672 | 640 | 4 |
| 511/600X | 600 | 710 | 85 | 705 | 605 | 3 | 675 | 4 400 | 63.3 | — | 540 | 109 | 665 | 645 | 2.5 |
| 511/630X | 630 | 750 | 95 | 745 | 634 | 3 | 685 | 4 600 | 83.0 | — | 490 | 120 | 700 | 680 | 2.5 |
| 511/670X | 670 | 800 | 105 | 795 | 675 | 4 | 760 | 5 350 | 104 | — | 440 | 160 | 742 | 728 | 3 |
| 511/750 | 750 | 900 | 120 | 900 | 755 | 4 | 910 | 6 850 | 156 | — | 380 | 262 | 834 | 818 | 3 |
| F980-1 | 980 | 1 120 | 120 | 1 115 | 985 | 5 | 1 010 | 8 900 | 186 | — | 330 | 435 | 1 059 | 1 041 | 4 |
| F1250-1 | 1 250 | 1 495 | 150 | 1 490 | 1 256 | 6 | 1 670 | 17 200 | 505 | — | 240 | 1 645 | 1 384 | 1 362 | 5 |
| F1400-7 | 1 400 | 1 570 | 100 | 1 570 | 1 404 | 4 | 1 090 | 11 800 | 246 | — | 300 | 813 | 1 494 | 1 478 | 3 |
| F1700-2 | 1 700 | 1 960 | 170 | 1 950 | 1 710 | 6 | 2 210 | 27 200 | 783 | — | 180 | 4 061 | 1 838 | 1 822 | 5 |

6. Thrust Bearings

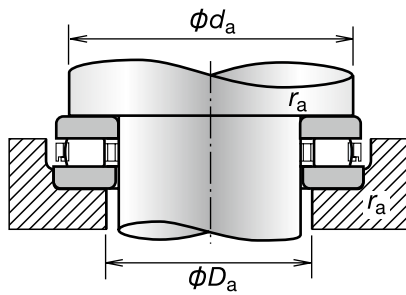
Thrust Cylindrical Roller Bearings

Bore Diameter 40-500 mm



| Bearing Designation | Boundary Dimensions (mm) | | | | Reference Dimensions (mm) | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor (1) M (x10 ⁻⁶) | Abutment and Fillet Dimensions (mm) | | |
|---------------------|--------------------------|-----|----|----------|---------------------------|----------------|----------------|------|--------------------------|--------------------------|---------------------|--------------------------------------|-------|---|-------------------------------------|-----------------------|-----------------------|
| | d | D | T | r (min.) | d ₁ | D ₁ | D _w | t | C _a (Dynamic) | C _{oa} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 40TMP93 | 40 | 78 | 22 | 1 | 78 | 42 | 8 | 7 | 63 | 194 | 0.525 | 1 200 | 3 600 | 0.0026 | 71 | 48 | 1 |
| 45TMP93 | 45 | 85 | 24 | 1 | 85 | 47 | 8 | 8 | 71 | 233 | 0.665 | 1 100 | 3 400 | 0.0038 | 78 | 53 | 1 |
| 50TMP93 | 50 | 95 | 27 | 1.1 | 93 | 52 | 11 | 8 | 113 | 350 | 0.942 | 1 000 | 3 000 | 0.0086 | 89 | 57 | 1 |
| 55TMP93 | 55 | 105 | 30 | 1.1 | 105 | 55.2 | 11 | 9.5 | 134 | 450 | 1.28 | 900 | 2 600 | 0.014 | 98 | 63 | 1 |
| 60TMP12 | 60 | 95 | 26 | 1 | 95 | 62 | 10 | 8 | 99 | 325 | 0.735 | 1 000 | 3 000 | 0.0095 | 88 | 67 | 1 |
| 60TMP93 | 60 | 110 | 30 | 1.1 | 110 | 62 | 11 | 9.5 | 139 | 480 | 1.36 | 850 | 2 600 | 0.016 | 103 | 68 | 1 |
| 65TMP12 | 65 | 100 | 27 | 1 | 100 | 67 | 12.5 | 7.25 | 110 | 325 | 0.805 | 950 | 2 800 | 0.0095 | 93 | 71 | 1 |
| 65TMP93 | 65 | 115 | 30 | 1.1 | 115 | 65.2 | 11 | 9.5 | 145 | 515 | 1.44 | 850 | 2 600 | 0.019 | 108 | 73 | 1 |
| 70TMP93 | 70 | 125 | 34 | 1.1 | 125 | 72 | 14 | 10 | 191 | 635 | 1.95 | 750 | 2 200 | 0.028 | 117 | 78 | 1 |
| 75TMP11 | 75 | 100 | 19 | 1 | 100 | 77 | 8 | 5.5 | 63.5 | 221 | 0.41 | 1 100 | 3 400 | 0.0068 | 96 | 79 | 1 |
| 75TMP93 | 75 | 135 | 36 | 1.5 | 135 | 77 | 14 | 11 | 209 | 735 | 2.42 | 710 | 2 200 | 0.038 | 125 | 84 | 1.5 |
| 80TMP12 | 80 | 115 | 28 | 1 | 115 | 82 | 11 | 8.5 | 120 | 420 | 1.02 | 900 | 2 600 | 0.016 | 109 | 86 | 1 |
| 80TMP93 | 80 | 140 | 36 | 1.5 | 138 | 82 | 14 | 11 | 208 | 740 | 2.54 | 710 | 2 000 | 0.038 | 130 | 91 | 1.5 |
| 85TMP11 | 85 | 110 | 19 | 1 | 110 | 87 | 7.5 | 5.75 | 75 | 298 | 0.46 | 1 100 | 3 200 | 0.012 | 105 | 89 | 1 |
| 85TMP12 | 85 | 125 | 31 | 1 | 125 | 88 | 14 | 8.5 | 151 | 485 | 1.36 | 800 | 2 400 | 0.021 | 118 | 92 | 1 |
| 85TMP93 | 85 | 150 | 39 | 1.5 | 148 | 87 | 14 | 12.5 | 257 | 995 | 3.2 | 630 | 1 900 | 0.069 | 140 | 95 | 1.5 |
| 90TMP11 | 90 | 120 | 22 | 1 | 119 | 91.5 | 9 | 6.5 | 96 | 370 | 0.725 | 950 | 3 000 | 0.019 | 114 | 95 | 1 |
| 90TMP93 | 90 | 155 | 39 | 1.5 | 155 | 90.2 | 16 | 11.5 | 250 | 885 | 3.3 | 630 | 1 900 | 0.055 | 144 | 101 | 1.5 |
| 100TMP93 | 100 | 170 | 42 | 1.5 | 170 | 103 | 16 | 13 | 292 | 1 110 | 4.25 | 560 | 1 700 | 0.086 | 159 | 110 | 1.5 |
| 110TMP12 | 110 | 160 | 38 | 1.1 | 160 | 113 | 15 | 11.5 | 228 | 855 | 2.66 | 630 | 1 900 | 0.066 | 150 | 119 | 1 |
| 120TMP12 | 120 | 170 | 39 | 1.1 | 170 | 123 | 15 | 12 | 233 | 895 | 2.93 | 600 | 1 800 | 0.072 | 160 | 129 | 1 |
| 130TMP12 | 130 | 190 | 45 | 1.5 | 187 | 133 | 19 | 13 | 300 | 1 090 | 4.5 | 530 | 1 600 | 0.11 | 177 | 142 | 1.5 |
| 130TMP93 | 130 | 225 | 58 | 2.1 | 225 | 133 | 22 | 18 | 585 | 2 370 | 10.4 | 430 | 1 300 | 0.39 | 214 | 140 | 2 |
| 140TMP93 | 140 | 240 | 60 | 2.1 | 240 | 143 | 25 | 17.5 | 610 | 2 360 | 12.2 | 400 | 1 200 | 0.39 | 226 | 154 | 2 |
| 150TMP12 | 150 | 215 | 50 | 2 | 215 | 153 | 19 | 15.5 | 375 | 1 500 | 6.15 | 480 | 1 400 | 0.20 | 202 | 163 | 2 |
| 150TMP93 | 150 | 250 | 60 | 2.1 | 250 | 153 | 25 | 17.5 | 635 | 2 510 | 12.8 | 400 | 1 200 | 0.44 | 236 | 165 | 2 |

(1) For more information on minimum load factors, please refer to page 217.

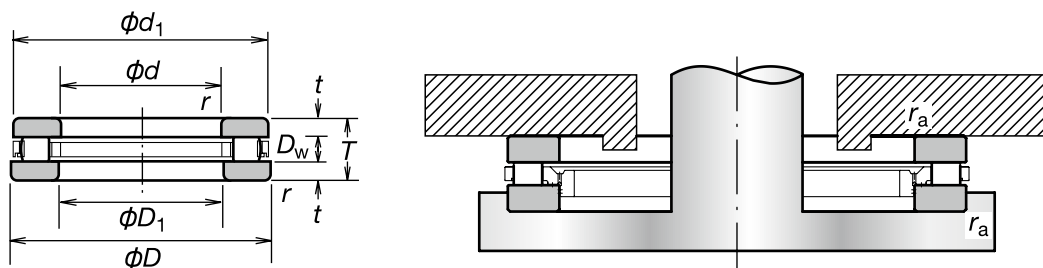


| Bearing Designation | Boundary Dimensions (mm) | | | | Reference Dimensions (mm) | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Limiting Speeds (min ⁻¹) | | Minimum Load Factor (1) M (x10 ⁻⁶) | Abutment and Fillet Dimensions (mm) | | |
|---------------------|--------------------------|-----|-----|----------|---------------------------|----------------|----------------|------|--------------------------|--------------------------|---------------------|--------------------------------------|-------|--|-------------------------------------|-----------------------|-----------------------|
| | d | D | T | r (min.) | d ₁ | D ₁ | D _w | t | C _a (Dynamic) | C _{oa} (Static) | | Grease | Oil | | d _a (min.) | D _a (max.) | r _a (max.) |
| 160TMP11 | 160 | 200 | 31 | 1 | 200 | 162 | 11 | 10 | 173 | 815 | 2.21 | 630 | 1 900 | 0.093 | 191 | 168 | 1 |
| 170TMP12 | 170 | 240 | 55 | 1.5 | 237 | 173 | 22 | 16.5 | 485 | 1 960 | 8.2 | 430 | 1 300 | 0.35 | 227 | 182 | 1.5 |
| 180TMP93 | 180 | 300 | 73 | 3 | 300 | 185 | 32 | 20.5 | 1 000 | 4 000 | 22.5 | 320 | 950 | 1.1 | 284 | 194 | 2.5 |
| 190TMP12 | 190 | 270 | 62 | 3 | 266 | 195 | 30 | 16 | 705 | 2 630 | 11.8 | 360 | 1 100 | 0.62 | 255 | 200 | 2.5 |
| 190TMP93 | 190 | 320 | 78 | 4 | 320 | 195 | 32 | 23 | 1 080 | 4 500 | 27.6 | 300 | 900 | 1.42 | 303 | 205 | 3 |
| 200TMP11 | 200 | 250 | 37 | 1.1 | 247 | 203 | 17 | 10 | 365 | 1 690 | 4.1 | 500 | 1 500 | 0.40 | 242 | 207 | 1 |
| 200TMP93 | 200 | 340 | 85 | 4 | 340 | 205 | 32 | 26.5 | 1 180 | 5 150 | 34.5 | 280 | 800 | 1.9 | 322 | 218 | 3 |
| 220TMP11 | 220 | 270 | 37 | 1.1 | 267 | 223 | 17 | 10 | 385 | 1 860 | 4.5 | 480 | 1 500 | 0.48 | 262 | 227 | 1 |
| 220TMP12 | 220 | 300 | 63 | 2 | 297 | 224 | 30 | 16.5 | 770 | 3 100 | 13.5 | 340 | 1 000 | 0.86 | 287 | 232 | 2 |
| 240TMP11 | 240 | 300 | 45 | 1.5 | 297 | 243 | 18 | 13.5 | 435 | 2 160 | 7.2 | 400 | 1 200 | 0.65 | 288 | 251 | 1.5 |
| 240TMP12 | 240 | 340 | 78 | 2.1 | 335 | 244 | 32 | 23 | 965 | 4 100 | 23.3 | 280 | 850 | 1.5 | 322 | 258 | 2 |
| 240TMP93 | 240 | 380 | 85 | 4 | 380 | 245 | 32 | 26.5 | 1 290 | 6 100 | 39.4 | 260 | 770 | 2.6 | 362 | 258 | 3 |
| 260TMP11 | 260 | 320 | 45 | 1.5 | 317 | 263 | 18 | 13.5 | 460 | 2 350 | 7.75 | 400 | 1 200 | 0.77 | 308 | 272 | 1.5 |
| 260TMP12 | 260 | 360 | 79 | 2.1 | 355 | 264 | 32 | 23.5 | 995 | 4 350 | 25.2 | 280 | 850 | 1.7 | 342 | 276 | 2 |
| 260TMP93 | 260 | 420 | 95 | 1.1 | 420 | 265 | 38 | 28.5 | 1 670 | 7 700 | 55.2 | 230 | 680 | 4.2 | 398 | 282 | 1 |
| 280TMP11 | 280 | 350 | 53 | 1.5 | 347 | 283 | 20 | 16.5 | 545 | 2 800 | 11.6 | 340 | 1 000 | 1.1 | 335 | 294 | 1.5 |
| 280TMP12 | 280 | 380 | 80 | 2.1 | 375 | 284 | 32 | 24 | 1 050 | 4 750 | 27.2 | 260 | 800 | 2.0 | 362 | 296 | 2 |
| 300TMP12 | 300 | 420 | 95 | 3 | 415 | 304 | 38 | 28.5 | 1 390 | 6 250 | 42 | 220 | 670 | 3.5 | 398 | 322 | 2.5 |
| 320TMP11 | 320 | 400 | 63 | 2 | 396 | 324 | 25 | 19 | 820 | 4 250 | 18 | 300 | 900 | 2.5 | 385 | 335 | 2 |
| 320TMP12 | 320 | 440 | 95 | 3 | 435 | 325 | 38 | 28.5 | 1 420 | 6 550 | 44.5 | 220 | 670 | 3.9 | 418 | 340 | 2.5 |
| 340TMP12 | 340 | 460 | 96 | 3 | 455 | 345 | 38 | 29 | 1 450 | 6 800 | 47.4 | 220 | 650 | 4.2 | 438 | 360 | 2.5 |
| 360TMP12 | 360 | 500 | 110 | 4 | 495 | 365 | 45 | 32.5 | 1 870 | 8 600 | 68.1 | 190 | 570 | 6.7 | 475 | 383 | 3 |
| 380TMP12 | 380 | 520 | 112 | 4 | 515 | 385 | 45 | 33.5 | 1 920 | 8 950 | 82.1 | 180 | 550 | 7.2 | 495 | 403 | 3 |
| 400TMP12 | 400 | 540 | 112 | 4 | 535 | 405 | 45 | 33.5 | 1 960 | 9 350 | 78.0 | — | 540 | 7.9 | 515 | 423 | 3 |
| 420TMP11 | 420 | 500 | 65 | 2 | 495 | 424 | 25 | 20 | 940 | 5 450 | 24.6 | — | 770 | 4.2 | 485 | 434 | 2 |
| 500TMP11 | 500 | 600 | 80 | 2.1 | 595 | 505 | 32 | 24 | 1 420 | 8 300 | 46.5 | — | 620 | 9.6 | 582 | 516 | 2 |

6. Thrust Bearings

Bore Diameter 560-2 530 mm

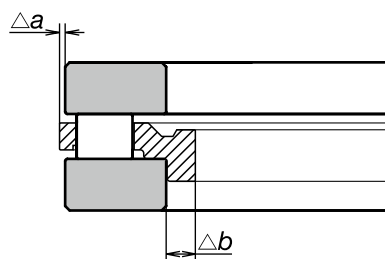
Cylindrical Roller Thrust Bearings for Vertical Lathe Table



| Bearing Designation | Boundary Dimensions (mm) | | | | Reference Dimensions (mm) | | | | Basic Load Ratings (kN) | | Mass (kg) (approx.) | Minimum Load Factor ⁽¹⁾ M ($\times 10^{-6}$) | Limiting Speeds (min^{-1}) | | Abutment and Fillet Dimensions ⁽²⁾ (mm) | |
|---------------------|--------------------------|-------|-----|----------|---------------------------|----------------|----------------|------|--------------------------|--------------------------|---------------------|---|---------------------------------------|-----------------------|--|--|
| | d | D | T | r (min.) | d ₁ | D ₁ | D _w | t | C _a (Dynamic) | C _{oa} (Static) | | | Oil | r _a (max.) | | |
| 560TMP7001 | 560 | 700 | 95 | 4 | 700 | 560 | 35 | 30 | 1 690 | 10 200 | 95.5 | 14.6 | 510 | 3 | | |
| 610TMP7102 | 610 | 710 | 65 | 4 | 710 | 610 | 25 | 20 | 1 080 | 7 300 | 46.5 | 7.5 | 630 | 3 | | |
| 860TMP1001 | 860 | 1 000 | 96 | 4 | 1 000 | 860 | 35 | 30.5 | 2 130 | 15 500 | 145 | 34 | 410 | 3 | | |
| 1240TMP1301 | 1 240 | 1 380 | 97 | 4 | 1 380 | 1 240 | 35 | 31 | 2 480 | 21 000 | 204 | 62 | 330 | 3 | | |
| 1400TMP1501 | 1 400 | 1 520 | 90 | 3 | 1 520 | 1 400 | 30 | 30 | 2 120 | 19 800 | 187 | 55 | 330 | 2.5 | | |
| 1690TMP1801 | 1 690 | 1 800 | 105 | 3 | 1 800 | 1 690 | 35 | 35 | 2 990 | 29 300 | 239 | 120 | 270 | 2.5 | | |
| 1930TMP2101 | 1 930 | 2 100 | 105 | 4 | 2 100 | 1 930 | 35 | 35 | 2 700 | 27 500 | 434 | 135 | 240 | 3 | | |
| 2270TMP2401 | 2 270 | 2 400 | 120 | 4 | 2 400 | 2 270 | 40 | 40 | 4 100 | 44 000 | 448 | 271 | 200 | 3 | | |
| 2530TMP2701 | 2 530 | 2 750 | 150 | 4 | 2 750 | 2 530 | 50 | 50 | 5 750 | 60 500 | 1 012 | 512 | 150 | 3 | | |

[¹] For more information on minimum load factors, please refer to page 217.

[²] Since the cages protrude from the ring faces of thrust cylindrical roller bearings, please use care when designing shafts and housings. For more details, please contact NSK.



6. Thrust Bearings

High-Accuracy Low-Profile Angular Contact Ball Bearings ROBUSTSLIM



Features

A series of angular contact ball bearings that has been designed specifically for swiveling spindle heads used in machine tools, and is suitable for high-precision processing with multi-axis machines. The ROBUSTSLIM series of high-accuracy low-profile angular contact ball bearings offer high rigidity and low torque.

Low Torque

Lower torque than roller bearings.

High Accuracy

NRRO (Non-repeatable runout) of 0.5 μ m or lower was archived with BRSA130 .

High Rigidity

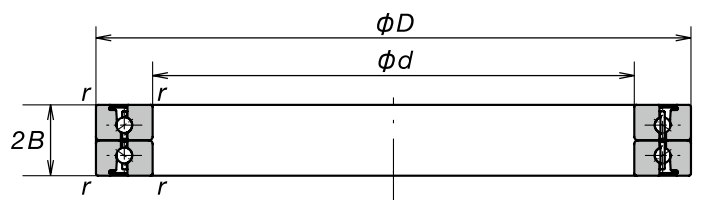
High moment stiffness on a par with crossed roller bearings.

Space-saving design

Bearing width reduced by 35% or more compared to standard bearings.

Bore Diameter **130-400 mm**

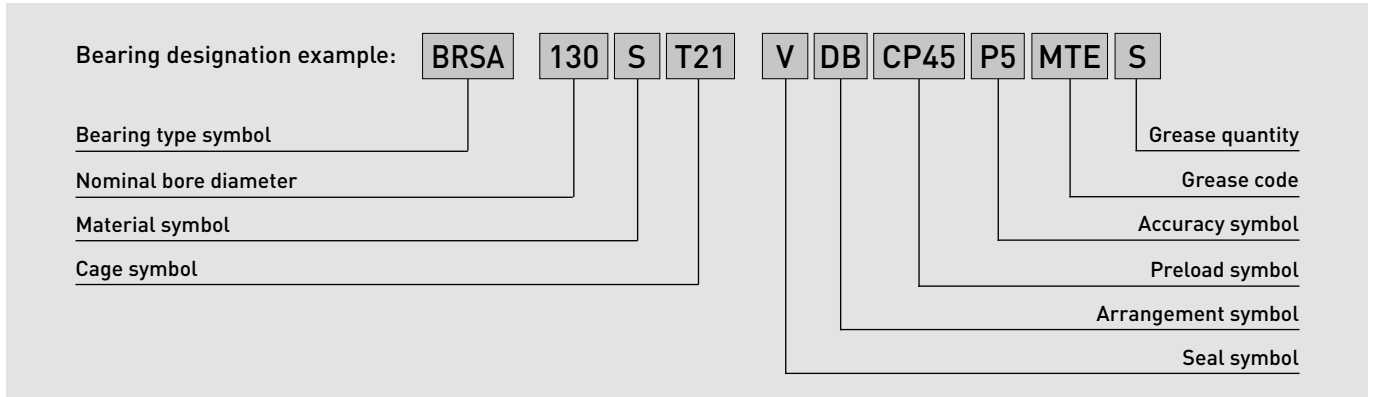
ROBUSTSLIM



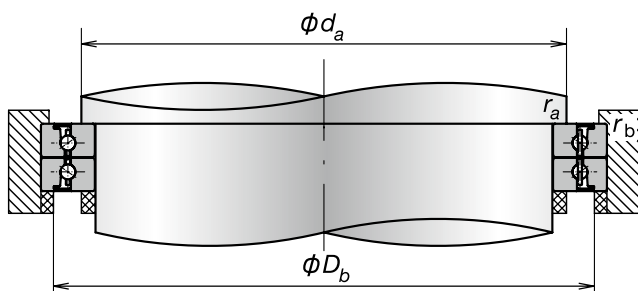
| Bearing Designation (1) | Boundary Dimensions (mm) | | | | Basic Load Ratings (kN) | | Permissible Axial Load (kN) | Contact angle ^a (degree) | Mass (kg/row) (reference) |
|-------------------------|--------------------------|-----|----|----------|--------------------------|--------------------------|-----------------------------|-------------------------------------|---------------------------|
| | d | D | 2B | r (min.) | C _a (Dynamic) | C _{oa} (Static) | | | |
| BRSA130ST21VDBCP45 | 130 | 165 | 22 | 0.6 | 20.2 | 91 | 28.5 | 35 | 0.6 |
| BRSA170ST21VDBCP55 | 170 | 215 | 27 | 0.6 | 34.5 | 166 | 47.5 | 35 | 1.2 |
| BRSA220ST21VDBCP62 | 220 | 270 | 31 | 1 | 45.5 | 243 | 63.5 | 35 | 2.0 |
| BRSA340SVDBCP95 | 340 | 420 | 50 | 1.1 | 97.5 | 560 | 150.9 | 35 | 8.2 |
| BRSA400SVDBCP100 | 400 | 500 | 62 | 1.1 | 139 | 830 | 221.6 | 35 | 15.4 |

Note: The values given in the table for preload, limiting speeds, axial rigidity, radial rigidity and moment rigidity are reference values based on the axial clearance specified in the "Bearing Designation" column.

Designation System of High-Accuracy Low-Profile Angular Contact Ball Bearings ROBUSTSLIM

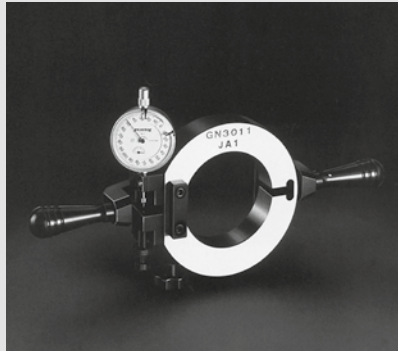


| | | | Reference pages |
|-------------|------------------------------|--|-----------------|
| BRSA | Bearing type | BRSA: contact angle 35° | 46-47 |
| 130 | Nominal bore diameter | Bore dimensions [mm]: 130, 170, 220, 340,400 | 176-177 |
| S | Material | S: Inner/outer ring SUJ2 or SUJ3, balls SUJ2 | 16-157 |
| T21 | Cage | T21: Ring guided resin cage No symbol: Ring guided machined brass cage | — |
| V | Seal | V: Non-contact rubber seal on one side | — |
| DB | Arrangement | DB: Back-to-back arrangement | 202-203 |
| CP45 | Preload | CP: Special preload gap | 212 |
| P5 | Accuracy | P5: Class 5 | 224-227 |



| Abutment and Fillet Dimensions (mm) | | | | Preload (kN) | Limiting Speeds (min ⁻¹) | Axial rigidity (kN/μm) | Radial rigidity (kN/μm) | Moment Rigidity (kN-m/mrad) |
|-------------------------------------|--------------|--------------|--------------|--------------|--------------------------------------|------------------------|-------------------------|-----------------------------|
| d_a (min.) | D_b (max.) | r_a (max.) | r_b (max.) | | | | | |
| 135 | 160 | 0.6 | 0.6 | 18 | 260 | 2.6 | 1.8 | 7.9 |
| 175 | 210 | 0.6 | 0.6 | 29 | 200 | 3.4 | 2.4 | 17.9 |
| 226 | 264 | 1 | 1 | 43 | 150 | 4.4 | 3.1 | 37.3 |
| 347 | 413 | 1 | 1 | 95 | 100 | 6.5 | 4.7 | 134 |
| 407 | 493 | 1 | 1 | 111 | 80 | 7.2 | 5.4 | 210 |

7. Peripheral Equipment



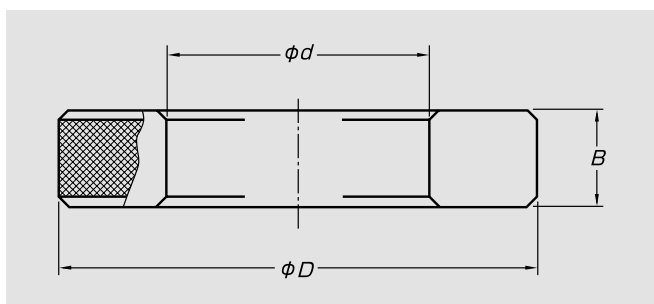
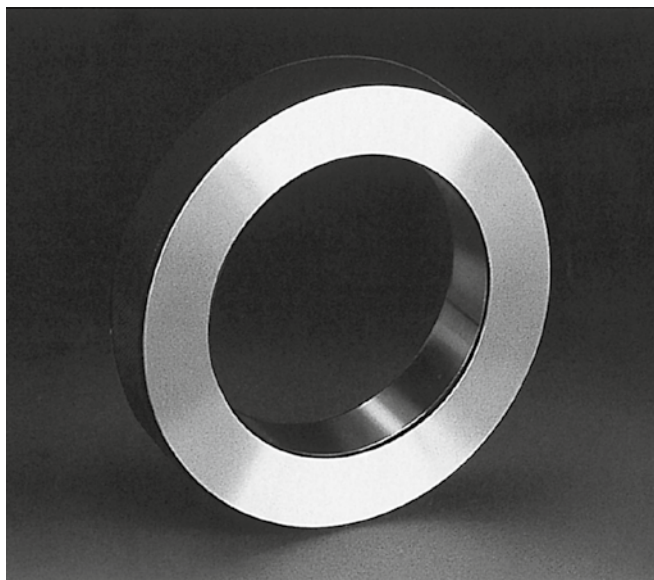
Peripheral Equipment

Part 4

| | |
|--|---------|
| Gauges | 180-183 |
| GR Gauges | |
| Features | |
| Designation System | |
| GN Gauges | |
| Features | |
| Designation System | |
| NSK Induction Bearing Heaters | 184-185 |
| Grease Replenishing System FINE-LUB II | 186-187 |
| High Speed Built-In Motor Spindle | 188-189 |

7. Peripheral Equipment

Ring Gauges GR Series Housing bore diameter precision measuring gauges



To obtain satisfactory performance of precision rolling bearings for machine tool spindles, it is important to have an accurate fit with the shaft and housing.

To achieve an accurate fit, it is necessary to measure the shaft outside diameter and housing bore exactly.

NSK Ring Gauges GR series are master gauges for measuring the bore diameters of housings within an accuracy of 0.001 mm.

Features

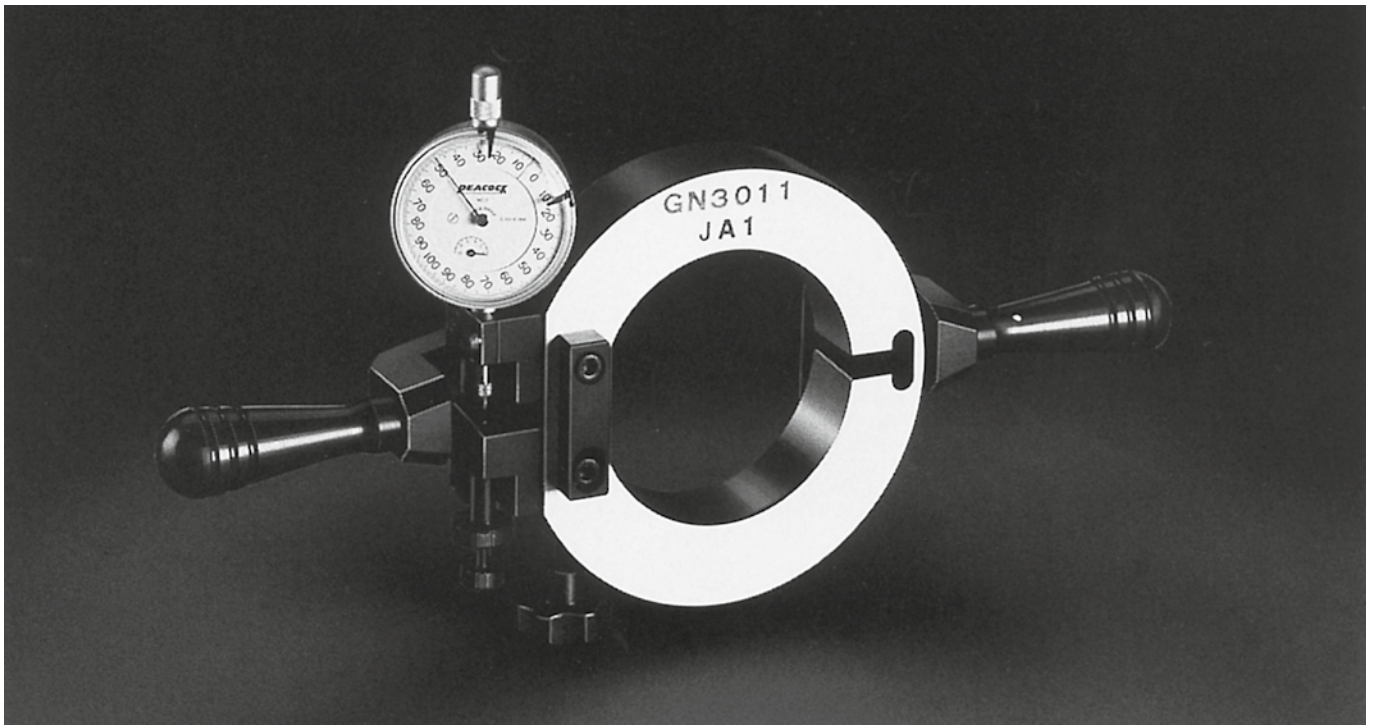
- Ring design enables reliable cylinder gauge settings.
- Ring thickness prevents any deformation caused by measuring pressure.
- Heat treatment during manufacturing of the ring negates any effects of aging on ring dimensions.
- Exact gauging is possible due to precisely measured dimensions that are marked on the gauges in 0.001 mm units in both the X and Y directions.

| Applicable Bearings | | | | | Gauge Numbers | Boundary Dimensions (mm) | | | Mass (kg) (approx.) |
|--------------------------|----------------|-------------------------|----------------|----------------|---------------|--------------------------|-----|----|---------------------|
| 79 69 NN39 NN49 | BNR19 BER19 | 70 60 N10 NN30 | BNR10 BER10 | 72 62 N2 | | d | D | B | |
| - | - | 00 | - | - | GR 26 | 26 | 75 | 20 | 0.6 |
| 02 | - | 01 | - | - | GR 28 | 28 | 75 | 20 | 0.6 |
| 03 | - | - | - | 00 | GR 30 | 30 | 80 | 20 | 0.7 |
| - | - | 02 | - | 01 | GR 32 | 32 | 80 | 20 | 0.7 |
| - | - | 03 | - | 02 | GR 35 | 35 | 85 | 20 | 0.7 |
| 04 | - | - | - | - | GR 37 | 37 | 85 | 20 | 0.7 |
| - | - | - | - | 03 | GR 40 | 40 | 90 | 20 | 0.8 |
| 05 | - | 04 | - | - | GR 42 | 42 | 95 | 20 | 0.9 |
| 06 | - | 05 | - | 04 | GR 47 | 47 | 95 | 20 | 0.8 |
| 07 | - | - | - | 05 | GR 52 | 52 | 100 | 20 | 0.9 |
| - | - | 06 | 30 | - | GR 55 | 55 | 100 | 20 | 0.9 |
| 08 | - | 07 | 35 | 06 | GR 62 | 62 | 100 | 20 | 0.8 |
| 09 | - | 08 | 40 | - | GR 68 | 68 | 110 | 20 | 0.9 |
| 10 | 50 | - | - | 07 | GR 72 | 72 | 115 | 20 | 1.0 |
| - | - | 09 | 45 | - | GR 75 | 75 | 115 | 20 | 0.9 |
| 11 | 55 | 10 | 50 | 08 | GR 80 | 80 | 120 | 25 | 1.2 |
| 12 | 60 | - | - | 09 | GR 85 | 85 | 130 | 25 | 1.5 |
| 13 | 65 | 11 | 55 | 10 | GR 90 | 90 | 135 | 25 | 1.5 |
| - | - | 12 | 60 | - | GR 95 | 95 | 140 | 25 | 1.6 |
| 14 | 70 | 13 | 65 | 11 | GR 100 | 100 | 145 | 25 | 1.7 |
| 15 | 75 | - | - | - | GR 105 | 105 | 150 | 25 | 1.8 |
| 16 | 80 | 14 | 70 | 12 | GR 110 | 110 | 160 | 25 | 2.1 |
| - | - | 15 | 75 | - | GR 115 | 115 | 165 | 25 | 2.1 |
| 17 | 85 | - | - | 13 | GR 120 | 120 | 170 | 25 | 2.2 |
| 18 | 90 | 16 | 80 | 14 | GR 125 | 125 | 175 | 25 | 2.3 |
| 19 | 95 | 17 | 85 | 15 | GR 130 | 130 | 180 | 25 | 2.4 |
| 20 | 100 | 18 | 90 | 16 | GR 140 | 140 | 190 | 25 | 2.5 |
| 21 | 105 | 19 | 95 | - | GR 145 | 145 | 200 | 30 | 3.5 |
| 22 | 110 | 20 | 100 | 17 | GR 150 | 150 | 205 | 30 | 3.6 |
| - | - | 21 | 105 | 18 | GR 160 | 160 | 215 | 30 | 3.8 |
| 24 | 120 | - | - | - | GR 165 | 165 | 220 | 30 | 3.9 |
| - | - | 22 | 110 | 19 | GR 170 | 170 | 225 | 30 | 4.0 |
| 26 | 130 | 24 | 120 | 20 | GR 180 | 180 | 230 | 30 | 3.8 |
| 28 | 140 | - | - | 21 | GR 190 | 190 | 240 | 30 | 4.0 |
| - | - | 26 | 130 | 22 | GR 200 | 200 | 250 | 30 | 4.1 |

7. Peripheral Equipment

GN Gauges GN30 Series

Precision measuring gauges for residual radial clearance of double-row cylindrical roller bearings (NN30XX)



When mounting a double-row cylindrical roller bearing with a tapered bore onto a shaft, it is important to accurately match the shaft taper with that of the bearing, and to ensure that the desired radial internal clearance is attained after mounting.

If there is excessive residual radial internal clearance, the spindle will have some play and machining accuracy will be adversely affected. If preload is too large, despite little or no change in rigidity, heat generation will become excessive and rolling fatigue life will be extremely shortened (See page 217).

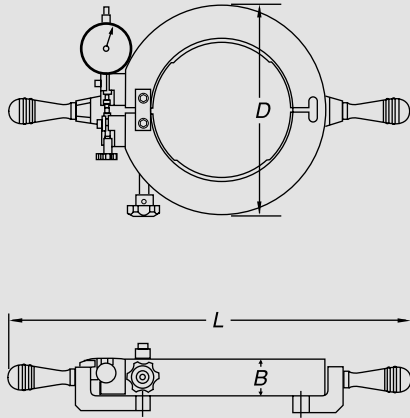
With the recent trends toward higher speed and higher precision, it is necessary to control residual radial internal clearance more carefully. In the past, radial clearance measuring methods were very difficult and required much skill. GN gauges developed by NSK for residual radial internal clearance measurements of double-row cylindrical roller bearings simplify bearing mounting and improve mounting accuracy. (Use of GN gauges also requires a bore measuring cylinder gauge.)

For details on how to use GN gauges, please refer to page 252.

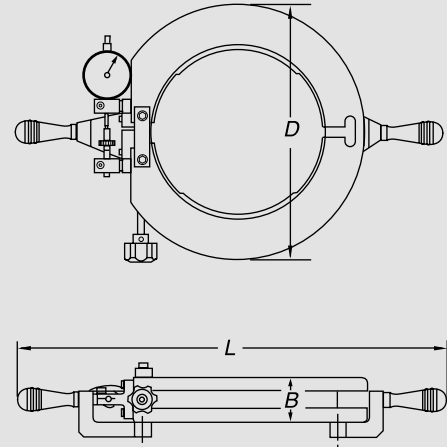
Features

- Reliable and accurate measurements made simple.
- No more complicated calculations for corrections based on interference of outer ring with housing.
- Both positive and negative clearance (preload) can be measured.
- Accurate measurements are obtained since all GN gauges are calibrated for measuring pressure.

Type I



Type II



| Applicable Bearings | Gauge Numbers | Types | Boundary dimensions (mm) | | | Mass (kg) (approx.) |
|---------------------|---------------|-------|--------------------------|----|-----|------------------------|
| | | | D | B | L | |
| NN3007 | GN3007 | I | 102 | 23 | 292 | 1.3 |
| NN3008 | GN3008 | I | 108 | 23 | 297 | 1.4 |
| NN3009 | GN3009 | I | 115 | 23 | 305 | 1.5 |
| NN3010 | GN3010 | I | 120 | 23 | 310 | 1.6 |
| NN3011 | GN3011 | I | 131 | 26 | 324 | 2.1 |
| NN3012 | GN3012 | I | 138 | 26 | 329 | 2.2 |
| NN3013 | GN3013 | I | 145 | 26 | 335 | 2.4 |
| NN3014 | GN3014 | I | 156 | 30 | 347 | 3.0 |
| NN3015 | GN3015 | I | 162 | 30 | 353 | 3.1 |
| NN3016 | GN3016 | I | 175 | 33 | 374 | 4.2 |
| NN3017 | GN3017 | I | 185 | 33 | 381 | 4.3 |
| NN3018 | GN3018 | I | 195 | 35 | 393 | 5.2 |
| NN3019 | GN3019 | I | 204 | 35 | 399 | 5.6 |
| NN3020 | GN3020 | I | 210 | 35 | 411 | 6.1 |
| NN3021 | GN3021 | I | 224 | 39 | 419 | 7.1 |
| NN3022 | GN3022 | I | 233 | 44 | 433 | 8.5 |
| NN3024 | GN3024 | II | 254 | 44 | 470 | 7.5 |
| NN3026 | GN3026 | II | 280 | 50 | 492 | 9.5 |
| NN3028 | GN3028 | II | 289 | 50 | 500 | 9.5 |
| NN3030 | GN3030 | II | 314 | 54 | 520 | 12 |
| NN3032 | GN3032 | II | 329 | 54 | 540 | 13 |

7. Peripheral Equipment

NSK Bearing Heater



A bearing heater heats a bearing evenly and quickly to fit the bearing on a spindle, thus enabling clean mounting without oil.

A bearing heater can be used to heat not only bearings but also ring-shaped metal parts, such as gears.

Features

- Rapid and even heating
- No heating oil is required, thus there is no greasy dirt.
- Suitable for shrink fitting of bearings as well as other ring-shaped metal parts.

User-friendly operation panel

In conjunction with an ultra-compact, highly sensitive temperature sensor, the heater indicates precise, real-time temperatures through digital display, irrespective of heating speed or detection area.

The heater starts or stops at the flick of a button.

The timer can be set for a maximum of 100 minutes.

*External input/output terminals for remote control on-line are featured as standard, enabling factory automation as well.

A superior level of safety

The heater automatically stops promptly if heat is applied without setting the temperature sensor or in the event of a device failure.

Suitable for various bore diameters

By selecting an I-type core that matches the bore of a bearing, one bearing heater can be used for bearings of various sizes.

■ Type/Capacity

| | | |
|----------------------|-----------|---|
| Model Number Example | IHE 01 10 | |
| | a | b |

Inverter Driven
NSK Bearing Heater

| a | b |
|------------------|------------------|
| Heating Capacity | Voltage Class |
| 01 : 1.0 kVA | 10 : 100 V Class |
| 03 : 3.3 kVA | 20 : 200 V Class |
| 06 : 6.6 kVA | 40 : 400 V Class |
| 11 : 11.8 kVA | |
| 23 : 23 kVA | |

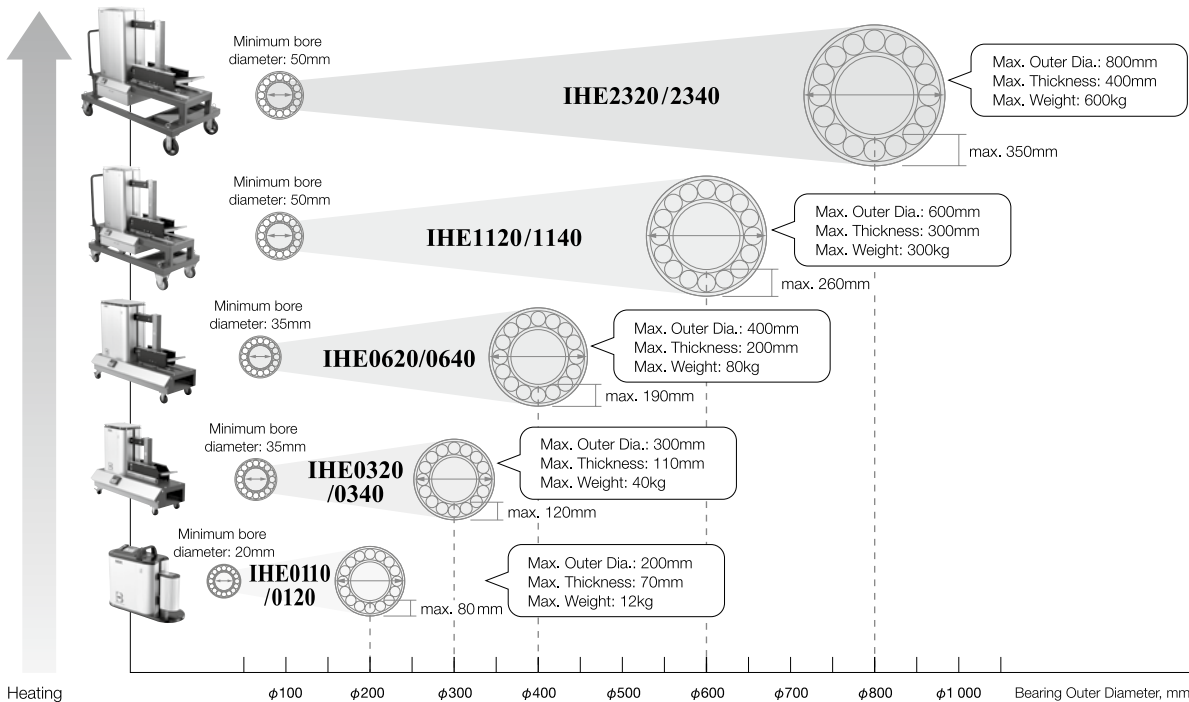
Automatic heating under optimal conditions

Electrical properties change depending on the type of bearing and I-type core used. The heater automatically detects these changes and thus always applies heat optimally.

Also, as the output is adjustable from 50% to 100% in increments of 10%, the heater is ideal for delicate bearings that require gradual heating.

■ Model Selection

This chart shows the applicable bearing sizes for each model. Please choose the model that corresponds to your bearing sizes.



Main Specifications

| Model | | IHE0110 | IHE0120 | IHE0320 | IHE0340 | IHE0620 | IHE0640 | IHE1120 | IHE1140 | IHE2320 | IHE2340 | |
|-------------------------|---------------------------------|--|---------------------|---------|---------|---------|---------|---------|---------|--------------------------------|---------|---|
| Heating Capacity (kVA) | | 1 | | 3.3 | | 6.6 | | 11.8 | | 23 | | |
| Applicable Bearing Size | Minimum Bore Diameter (mm) | 20 | | 35 | | 35 | | 50 | | 50 | | |
| | Maximum Outer Diameter (mm) | 200 | | 300 | | 400 | | 600 | | 800 | | |
| | Maximum Thickness (mm) | 70 | | 110 | | 200 | | 300 | | 400 | | |
| | Maximum Weight (kg) | 12 | | 40 | | 80 | | 300 | | 600 | | |
| Bearing Type | Can heat sealed bearings | Yes | | | | | | | | | | |
| | Can heat open type bearings | Yes | | | | | | | | | | |
| Power Supply | Phase | Single | | | | Three | | | | | | |
| | Voltage (V) | 100-120 | 200-240 | 200-240 | 380-400 | 200-230 | 380-440 | 200-230 | 380-440 | 200-220/50 Hz 200-230/60 Hz | 380-440 | |
| | Frequency (Hz) | 50/60 | | | | | | | | | | |
| | Input Current (A) | 7.2 | 4.0 | 5.3 | 2.7 | 8.1 | 4.0 | 13.2 | 6.6 | 27 | 13.5 | |
| Body Dimensions | H (mm) | 347 | | 565 | | 745 | | 1 200 | | 1 440 | | |
| | W (mm) | 175 | | 295 | | 380 | | 600 | | 850 | | |
| | L (mm) | 470 | | 755 | | 975 | | 1 250 | | 1 600 | | |
| | Main Body Weight (kg) | 14 | | 43 | | 81 | | 241 | | 335 | | |
| Control Specifications | Temperature Control Mode | Range | 35-250 °C | | | | | | | | | |
| | | Temp. Sensor Type | K-Type thermocouple | | | | | | | | | |
| | | Accuracy | 1 °C | | | | | | | | | |
| | Time Control Mode | Range (minutes) | 0-100 min | | | | | | | | | |
| | | Accuracy (seconds) | 1 sec | | | | | | | | | |
| | Power Adjustment (in 10%-steps) | 50-100 % | | | | | | | | | | |
| Demagnetization | 300 µT (3G) | | | | | | | | | | | |
| Heating Core Spec. | Maximum Flux | 1.5 T | | | | | | | | | | |
| Operation Spec. | Operation | Operator with LEDs | | | | | | | | | | |
| | Sequence Operation | Yes | | | | | | | | | | |
| Temp. Display | Celsius/Fahrenheit Changeover | Yes | | | | | | | | | | |
| Operating Environment | Location | Indoors; no corrosive gas, dust or direct sunlight | | | | | | | | | | |
| | Operating Temperature Range | -10°C to 35°C | | | | | | | | | | |
| | Operating Humidity Range | up to 92% | | | | | | | | | | |
| Accessories | I-Type Cores | N-CI-1815 (Bearing bore 20-35 mm) | ● | ● | | | | | | | | |
| | | N-CI-1825 (Bearing bore 35-50 mm) | ● | ● | | | | | | | | |
| | | N-CI-1835 (Bearing bore over 50 mm) | ● | ● | | | | | | | | |
| | | N-CI-2525 (Bearing bore 35-50 mm) | | | ● | ● | | | | | | |
| | | N-CI-2535 (Bearing bore 50-70 mm) | | | ● | ● | | | | | | |
| | | N-CI-2545 (Bearing bore over 70 mm) | | | ● | ● | | | | | | |
| | | N-CI-3725 (Bearing bore 35-50 mm) | | | | | ● | ● | | | | |
| | | N-CI-3735 (Bearing bore 50-80 mm) | | | | | ● | ● | | | | |
| | | N-CI-3755 (Bearing bore over 80 mm) | | | | | ● | ● | | | | |
| | | N-CI-5235 (Bearing bore 50-80 mm) | | | | | | | ● | ● | | |
| | | N-CI-5255 (Bearing bore 80-100 mm) | | | | | | | ● | ● | | |
| | | N-CI-5270 (Bearing bore over 100 mm) | | | | | | | ● | ● | | |
| | | N-CI-6735 (Bearing bore 50-80 mm) | | | | | | | | | ● | ● |
| | | N-CI-6755 (Bearing bore 80-130 mm) | | | | | | | | | ● | ● |
| | | N-CI-6785 (Bearing bore over 130 mm) | | | | | | | | | ● | ● |
| | Guides for I-Type Cores | N-CS-2525 for N-CI-2525 | | | ● | ● | | | | | | |
| | | N-CS-2535 for N-CI-2535 | | | ● | ● | | | | | | |
| | | N-CS-3725 for N-CI-3725 | | | | | ● | ● | | | | |
| | | N-CS-3735 for N-CI-3735 | | | | | ● | ● | | | | |
| | | N-CS-5235 for N-CI-5235 | | | | | | | ● | ● | | |
| | | N-CS-5255 for N-CI-5255 | | | | | | | ● | ● | | |
| | | N-CS-6735 for N-CI-6735 | | | | | | | | | ● | ● |
| | N-CS-6755 for N-CI-6755 | | | | | | | | | ● | ● | |
| | Lift-up Tool for I-Type Cores | N-CL-578 | | | | | | | ● | ● | ● | ● |
| | Temperature Sensors | N-CTC-300 Lead length 300 mm | ● | ● | | | | | | | | |
| | | N-CTC-500 Lead length 500 mm | | | ● | ● | ● | ● | | | | |
| | | N-CTC-1000 Lead length 1000 mm | | | | | | | ● | ● | ● | ● |

Product appearance or specifications as described in this catalogue may change without notice due to product development etc.

● = Accessories included as standard.

7. Peripheral Equipment

Grease Replenishing System FINE-LUB II



in the housing by means of an optimally shaped spacer. This revolutionary technology completely transforms the concept of grease lubrication. FINE-LUB II leads the way to a new type of grease lubrication, making it faster and more user-friendly.

Features

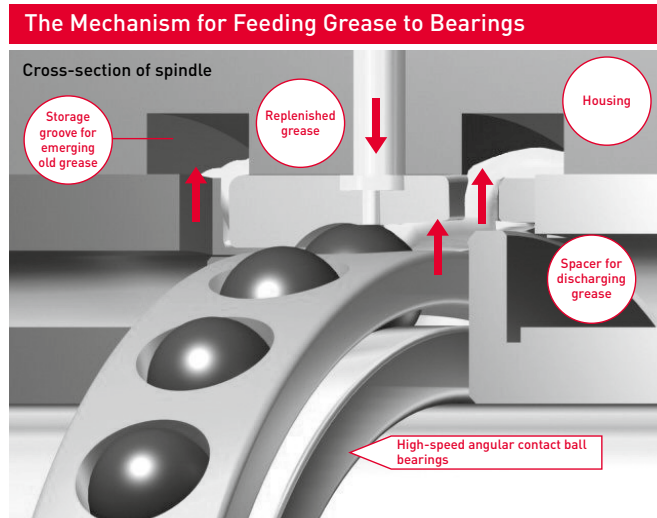
Extends operating life of lubricating grease

FINE-LUB II has been developed with the aim of feeding in an appropriate amount of grease according to the operating speed and bearing size to prevent seizure, thereby ensuring more than 10,000 hours of maintenance-free operation.

At speeds of 1.8 million $d_m n$ (#40 taper 20,000 min^{-1}), grease life drops to a few hundred hours. This renders high-speed operation with grease lubricated spindles impractical. Instead, oil-air and oil-mist lubrication have been used for high-speed applications. However, grease lubrication remains unrivalled in terms of environmental safety, energy conservation, a clean working environment, low noise and low atmospheric contamination.

In response to this demand, we at NSK have developed FINE-LUB II, the world's first grease replenishing system for high-speed machine tool spindles that provides stable long-term operation while maintaining a clean working environment.

FINE-LUB II intermittently feeds minimal amounts of grease into bearings during high-speed rotation. At the same time, used grease is discharged into a storage groove



Please contact NSK for further details.

Supplies optimized amounts of grease to prevent temperature increase

Feeding too much grease into a bearing can cause the temperature to increase due to grease churning. To prevent this, FINE-LUB II features a built-in device that ensures an appropriate amount of lubricant is fed into the bearing.



Bearing shape designed specifically for grease replenishing

● Grease replenishing method

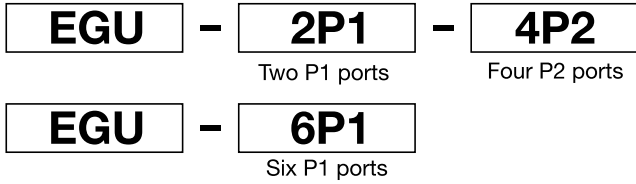
A small amount of grease is fed into a rotating bearing at regular intervals through a grease inlet located near the outer ring raceway.

The grease is fed in small amounts to prevent the bearing temperature from increasing.

● Grease discharging method

A specially shaped spacer for grease discharge, located at the counter-bore side of the bearing, directs old grease into a storage groove, preventing it from re-entering the inside of the bearing.

Model Designation

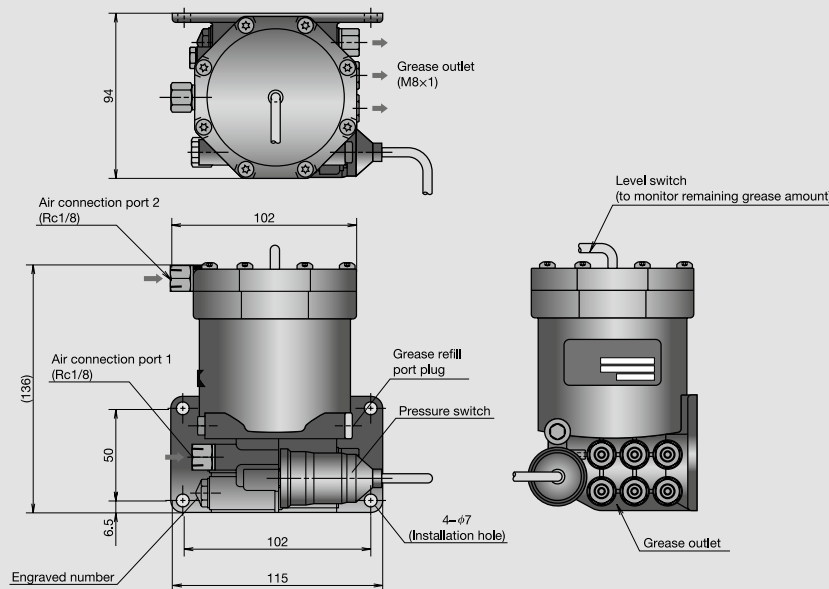


| Amount of fresh grease injected (cc/cycle) | Code number |
|--|-------------|
| 0.01 | P1 |
| 0.02 | P2 |

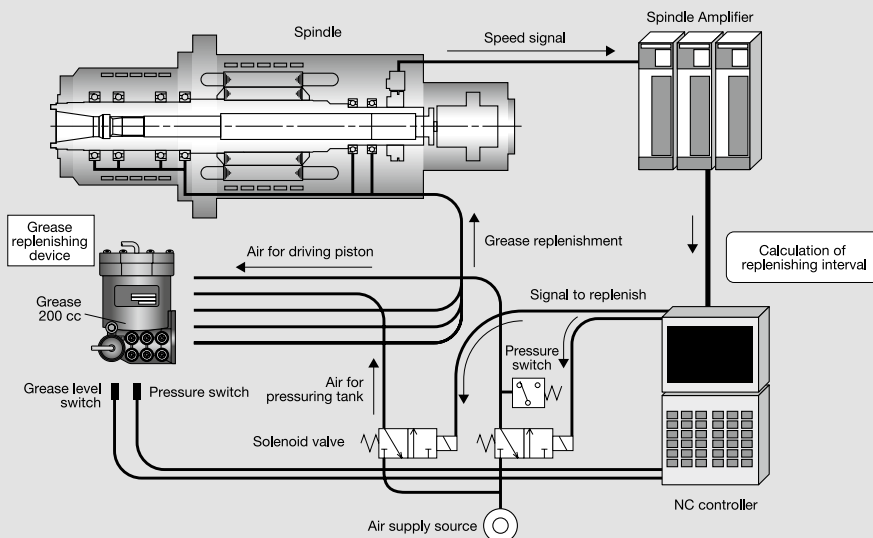
Specifications

| Item | Specification |
|---------------------------------|--|
| Air feeding pressure | 0.25 to 0.4 MPa |
| Amount of fresh grease injected | 0.01 or 0.02 cc/bearing row |
| Tank capacity | 200 cc |
| Monitoring function | Detection of remaining grease amount, detection of pressure (check of pressure increase) |
| Pipe length | 2.5 m or less |
| Grease type | MTE grease |

Dimensions



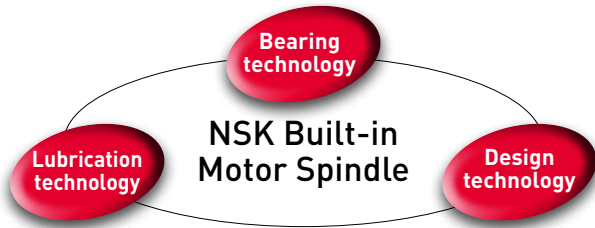
System Diagram



7. Peripheral Equipment

High-Speed Built-in Motor Spindle Series

Three technologies supporting NSK high-speed spindles



NSK's leading technologies in bearings, lubrication and design are combined in these high performance built-in motor spindles for machining centers. Their heavy cutting capability, ultra low noise and low environmental load far exceed those of conventional high-speed spindles.

This series establishes the highest standard in the world among BT40 taper built-in motor spindles with grease lubrication and has been thoroughly optimized for enhanced energy conservation and even quieter operation.

Features

Low noise and vibration

NSK's grease replenishing system eliminates the wind noise associated with oil-air lubrication. The direct drive without gears or couplings employs balance correction technologies that result in low noise and low vibration.

Low environmental load

The spindles of this series operate in a clean and energy-efficient way. Air and oil consumption for bearing lubrication are brought to zero, no oil particles are released into the atmosphere and there are no large quantities of oil dripping onto the work piece.

All-in-one concept with high variability

- Our grease replenishing system FINE-LUB II enabled us to develop this series of grease-lubricated high-speed spindles.
- Components such as bearings, motor, tool clamping parts etc. have been integrated in to a single unit. This reduces production lead time and cuts maintenance costs.
- The standard type spindles of this series allow customers to select between BT40 or HSK-A63, S- or L-type, grease replenishing or packed grease, etc. In addition, various options such as through-spindle coolant or flood coolant specification are available.

A wide variety of peripheral devices are offered in an all-in-one format for "plug-and-play" ease of use.

Extremely easy maintenance

All-in-one cartridge structure for spindle components significantly shortens downtime.

Tool clamping unit

Equipped with a spindle disc spring to maintain balance, and a monitor switch for checking tool presence.

Tool releasing cylinder

Equipped with switches for upper and lower position limits.

Flood coolant nozzle*

Nozzles mounted in six locations. Primarily effective for horizontal machining centers.

Tool holder

BT40/HSK-A63

Completely prevents coolant intrusion

Quadruple structure consists of the labyrinth seal, the sealing spacer, the air seal, and the slinger seal.

Rotary union*

Supplies through-spindle coolant under high pressure (7 MPa). Also suitable for MQL processing

*Optional feature

Specifications of High-Speed Built-in Motor Spindle

Reference numbers will be included in the specification drawings of supplied products. When ordering, please provide the reference number for the product you would like to purchase.

Reference number example: W- **B** **11** 00- **0** **4** **1** **3** **3** **0**

Spindle type B: Standard / High-Speed Type
S: High-Rigidity, High-Power Type
F: High-Speed, High-Power Type

Mounting dimensions 11: S-type
12: L-type / High-Rigidity, High-Power Type / High-Speed, High-Power Type

Flange 0: Standard position

Spindle taper / speed 0: BT40/15 000/12 000 1: BT40/20 000
2: HSK-A63/15 000/12 000 4: HSK-A63/20 000/25000

Bearing lubrication 0: Grease 1: Grease replenishing

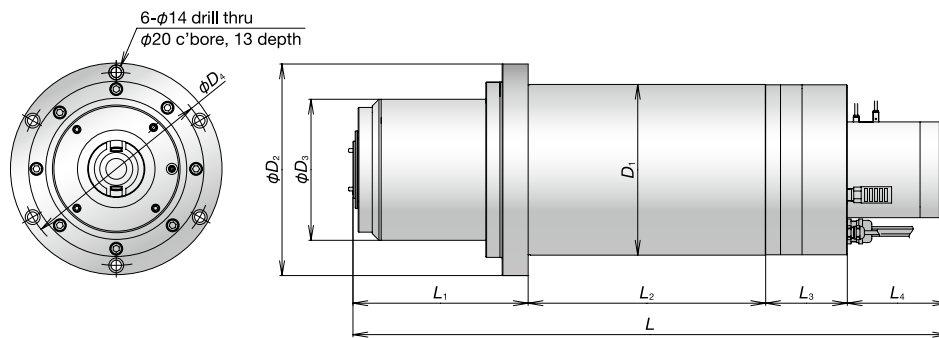
Seal 0: Standard seal

Monitor switch 3: Tool presence / Upper and lower position limits of the tool releasing cylinder

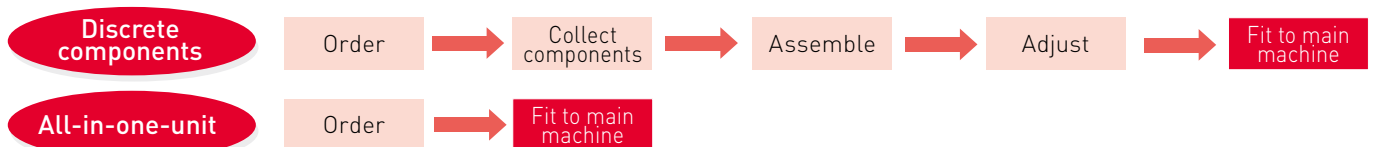
Coolant (Option) 0: None 1: Through-spindle coolant
2: Flood coolant nozzle
3: Through-spindle coolant / Flood coolant nozzle

Note: Flood coolant specification not available for High-Speed, High-Power Type

Dimensions



| | Item | Unit | S-type | | L-type | | High-rigidity, high-power | High-speed, high-power |
|---------------------|--------------------------------|----------------------|------------------|---------------------|------------------|---------------------|---------------------------|------------------------|
| | | | Standard | High-speed | Standard | High-speed | | |
| Main specification | Bearing bore | (mm) | φ70 | φ70 | φ70 | φ70 | φ80 | φ70 |
| | Speed | (min ⁻¹) | 15 000 | 20 000 | 15 000 | 20 000 | 12 000 | 25 000 |
| | Tool shank | — | BT40 HSK-A63 | ← | BT40 HSK-A63 | ← | BT40 HSK-A63 | HSK-A63 |
| | Bearing lubrication | — | grease | grease replenishing | grease | grease replenishing | grease replenishing | grease replenishing |
| | Output (short-time/continuous) | (kW) | 18.5 (10min) /11 | ← | 22 (15min) /18.5 | ← | 25 (15min) /22 | 30 (25%ED) /22 |
| | Torque | (N) | 60 | ← | 118 | ← | 156 | 68 |
| Boundary dimensions | D1 | (mm) | 210 | ← | 230 | ← | 230 | 230 |
| | D2 | (mm) | 265 | ← | 285 | ← | 285 | 285 |
| | D3 | (mm) | 170 | ← | 170 | ← | 190 | 180 |
| | D4 | (mm) | 240 | ← | 260 | ← | 260 | 260 |
| | L | (mm) | 670 | ← | 800 | ← | 801 | 670 |
| | L1 | (mm) | 235 | ← | 235 | ← | 236 | 140 |
| | L2 | (mm) | 190 | ← | 320 | ← | 320 | 270 |
| | L3 | (mm) | 110 | ← | 110 | ← | 110 | 125 |
| L4 | (mm) | 135 | ← | 135 | ← | 135 | 135 | |



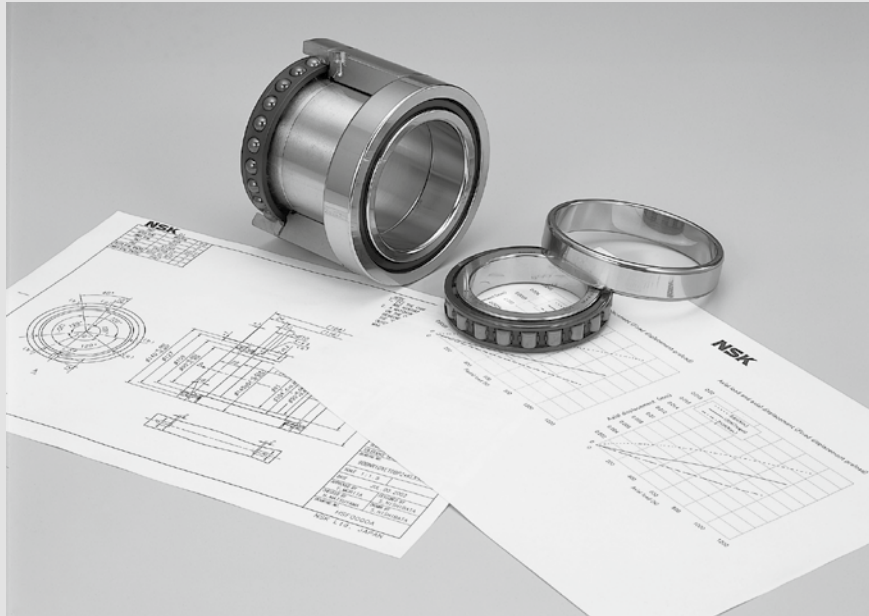
Reduced production lead time

- Significantly reduces time from order to completion of spindle adjustment.
- Also reduces running stock.

Carbs maintenance costs

- Spindles can be used for different machines in the factory.
- Reduces spare unit inventory.

Technical Guide



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1. Life

Rolling Fatigue Life and Basic Dynamic Load Rating

Bearing Life

The functions required of rolling bearings vary according to the bearing application, and these functions must be performed for a prolonged period. Even if bearings are properly mounted and correctly operated, they will eventually fail to perform satisfactorily due to an increase in noise and vibration, loss of running accuracy, deterioration of grease, or fatigue flaking of the rolling surfaces. In the broad sense of the term, bearing life refers to the period during which bearings continue to operate and satisfy their required functions. Depending on the cause of bearing failure, this bearing life may be defined as:

- noise life
- grease life
- rolling fatigue life

Besides natural deterioration, bearings may fail due to:

- heat seizure
- fracture or cracks
- wear
- rings becoming scored
- damaged seals

If the bearing fails for such reasons, this should not be interpreted as normal bearing life because these failures often occur as a result of selecting the wrong bearings, improper design or manufacture of the bearing surroundings, incorrect mounting, or insufficient maintenance.

Rolling Fatigue Life and Basic Rating Life

When rolling bearings are operated under load, the raceways of their inner and outer rings and rolling elements are subjected to repeated cyclic stress. The rolling contact surfaces of the raceways and rolling elements experience metal fatigue, and scaly particles may separate from the bearing material in a phenomenon called "flaking". Rolling fatigue life is represented by the total number of revolutions at which the bearing surface will start flaking due to stress. Rolling fatigue life is often also called "bearing life" when the term is used in a more narrow sense.

Even for seemingly identical bearings of the same type, size, and material that receive the same heat treatment and other processing, the rolling fatigue life varies greatly, even under identical operating conditions. This is because the flaking of materials due to fatigue is subject to many other variables. Consequently, the concept of "basic rating life", in which rolling fatigue life is treated as a statistical phenomenon, is used in preference to actual rolling fatigue life.

Suppose a number of bearings of the same type are operated individually under the same conditions. After a certain period, 10% of them will fail as a result of flaking caused by rolling fatigue. The total number of revolutions at this point is defined as the basic rating life. If the speed is constant, the basic rating life is often expressed by the total number of operating hours completed when 10% of the bearings become inoperable due to flaking.

In determining bearing life, basic rating life is often the only factor considered. However, other factors must also be taken into account. For example, it is possible to approximate the grease life of bearings prelubricated with grease. Since noise life and abrasion life are determined according to individual standards for different applications, specific values for noise or abrasion life have to be determined empirically.

Basic Dynamic Load Rating

The basic dynamic load rating applies to bearings with stationary outer rings and rotating inner rings. It is defined as the constant load that the bearing can endure for a rating life of one million revolutions (10^6 rev). For radial bearings, the basic dynamic load is given as a central radial load in a constant direction and magnitude, while the basic dynamic load rating of thrust bearings is given as an axial load of constant magnitude in the same direction as the central axis. The basic dynamic load ratings are listed in the bearing tables under C_r for radial bearings and C_a for thrust bearings.

The basic dynamic load rating of multi-row bearing arrangements can be calculated using the following formula:

$$\text{for ball bearings: } C_j = j^{0.7} \times C_1$$

$$\text{for roller bearings: } C_j = j^{7/9} \times C_1$$

where j : Number of rows ($j \geq 2$)

C_1 : Basic dynamic load rating for single-row bearings

C_j : Basic dynamic load rating for multi-row bearings

(where j is the number of rows)

Special care must be taken when calculating the basic dynamic load rating C_a for thrust bearings, as j refers to the number of rows sustaining axial load only. For example, only two rows sustain the axial load in a four-row DBB arrangement; thus $j = 2$.

Basic Rating Life

The following relationships exist between basic dynamic load rating, dynamic equivalent load, and basic rating life:

$$\text{for ball bearings: } L_{10} = \left(\frac{C}{P}\right)^3 (10^6 \text{ rev})$$

$$L_{10} = \frac{10^6}{60n} \left(\frac{C}{P}\right)^3 \text{ (h)}$$

$$\text{for roller bearings: } L_{10} = \left(\frac{C}{P}\right)^{10/3} (10^6 \text{ rev})$$

$$L_{10} = \frac{10^6}{60n} \left(\frac{C}{P}\right)^{10/3} \text{ (h)}$$

P : Dynamic equivalent load (N)
 C : Basic dynamic load rating (N)
 n : Rotational speed (min^{-1})

For bearings that run at a constant speed, it is convenient to express the fatigue life in terms of hours.

Dynamic Equivalent Load

In some cases, the loads applied on bearings are purely radial or axial loads; however, in most cases, the loads are a combination of both. In addition, such loads usually fluctuate in both magnitude and direction.

In such cases, the loads actually applied to bearings cannot be used for bearing life calculations; therefore, a hypothetical load should be estimated that has a constant magnitude, passes through the center of the bearing, and achieves the same bearing life as the bearing would attain under actual conditions of load and rotation. Such a hypothetical load is called the dynamic equivalent load.

Assuming the equivalent radial load as P_r , the radial load as F_r , the axial load as F_a , and the contact angle as α , the relationship between the equivalent radial load and bearing load can be approximated as follows:

$$P_r = XF_r + YF_a$$

where: X : Radial load factor } see Table 1.1
 Y : Axial load factor }

The axial load factor varies depending on the contact angle. For roller bearings, the contact angle remains the same regardless of the magnitude of the axial load. In the case of single-row deep groove ball bearings and angular contact ball bearings, the contact angle increases when the axial load is increased. Such change in the contact angle can be expressed by the ratio of the basic static load rating C_{0r} and the axial load F_a . Table 1.1 shows the axial load factor at the contact angle corresponding to this ratio. Regarding angular contact ball bearings, if the contact angle is 25° , 30° , or 40° , the effect of contact angle change on the load factor may be ignored under normal operating conditions.

For thrust bearings with contact angles of $\alpha \neq 90^\circ$ that receive both radial and axial loads simultaneously, the equivalent axial load P_a becomes as follows:

$$P_a = XF_r + YF_a$$

Relationship between Bearing Life and Contact Angle

When a load is applied to an angular contact ball bearing, the amount of stress at the contact point changes as a result of the varying load conditions of the balls, inner ring, and outer ring relative to the contact angle of the bearing.

Figure 1.1 illustrates loads acting on two rolling elements at a 30° contact angle and a 15° contact angle.

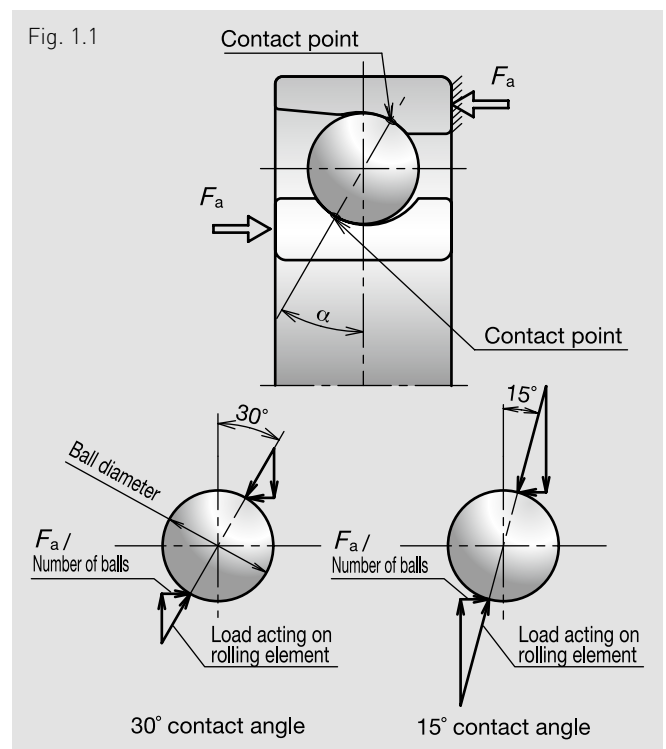
The relationship between an axial load applied to the bearing and the resulting load acting on the rolling element can be formulated as:

$$\text{Load on rolling element} = F_a / (\text{number of balls} \times \sin \alpha)$$

Therefore, the larger the contact angle, the smaller the load acting on the rolling element. The load at the contact point and its consequential deformation are reduced, thus resulting in longer life.

When a radial load is applied, the smaller the contact angle, the smaller the load acting on the rolling element. This results in reduced load at the contact point.

For these reasons, bearing life varies according to the contact angle under the same load conditions.



1. Life

Table 1.1 Value of Factors X and Y for Calculation of Equivalent Load $P = XF_r + YF_a$

| Bearing type | $\frac{if_a F_a}{C_{or}}$ | e | Single row (i=1) | | | | DB (i=2) | | | | | | | | | |
|---|--|------------------|------------------|---------------|-----------|------------------|-----------|---------------|-----------|------|----------|------|------|------|------|------|
| | | | DT (i=1) | | DTD (i=1) | | DF (i=2) | | DBB (i=2) | | | | | | | |
| | | | DTT (i=1) | | | | DFF (i=2) | | | | | | | | | |
| | | | DTT (i=1) | | | | DFF (i=2) | | | | | | | | | |
| | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | | | | | | | |
| | | X | Y | X | Y | X | Y | X | Y | | | | | | | |
| Angular contact ball bearings (C=C _r) | 15° | 0.178 | 0.38 | | | | 1.47 | | 1.65 | | 2.39 | | | | | |
| | | 0.357 | 0.40 | | | | 1.40 | | 1.57 | | 2.28 | | | | | |
| | | 0.714 | 0.43 | | | | 1.30 | | 1.46 | | 2.11 | | | | | |
| | | 1.07 | 0.46 | 1 | 0 | 0.44 | 1.23 | 1 | 1.38 | 0.72 | 2.00 | | | | | |
| | | 1.43 | 0.47 | | | | 1.19 | | 1.34 | | 1.93 | | | | | |
| | | 2.14 | 0.50 | | | | 1.12 | | 1.26 | | 1.82 | | | | | |
| | | 3.57 | 0.55 | | | | 1.02 | | 1.14 | | 1.66 | | | | | |
| | | 5.35 | 0.56 | | | | 1.00 | | 1.12 | | 1.63 | | | | | |
| | 0.181 | 0.44 | | | | | | | | | 1.30 | | 1.42 | | 2.11 | |
| | 0.363 | 0.46 | | | | | | | | | 1.25 | | 1.37 | | 2.03 | |
| | 0.726 | 0.48 | | | | | | | | | 1.18 | | 1.30 | | 1.92 | |
| | 18° | 1.09 | 0.50 | 1 | 0 | 0.43 | 1.14 | 1 | 1.25 | 0.70 | 1.85 | | | | | |
| | | 1.45 | 0.52 | | | | 1.10 | | 1.21 | | 1.79 | | | | | |
| | | 2.18 | 0.54 | | | | 1.05 | | 1.15 | | 1.70 | | | | | |
| | | 3.63 | 0.57 | | | | 1.00 | | 1.10 | | 1.63 | | | | | |
| | | — | 0.68 | | | | 1 | | 0 | | 0.41 | 0.87 | 1 | 0.92 | 0.67 | 1.41 |
| | | — | 0.80 | | | | 1 | | 0 | | 0.39 | 0.76 | 1 | 0.78 | 0.63 | 1.24 |
| | | — | 1.14 | | | | 1 | | 0 | | 0.35 | 0.57 | 1 | 0.55 | 0.57 | 0.93 |
| | Angular contact thrust ball bearings (C=C _a) | 30° | — | 0.72 | — | — | 0.48 | 1 | 0.74 | 0.55 | 0.48 | 1 | | | | |
| | | 40° | — | 1.05 | — | — | 0.60 | 1 | 1.01 | 0.64 | 0.60 | 1 | | | | |
| | | 55° | — | 1.79 | — | — | 0.81 | 1 | 1.60 | 0.60 | 0.81 | 1 | | | | |
| 60° | | — | 2.17 | — | — | 0.92 | 1 | 1.90 | 0.56 | 0.92 | 1 | | | | | |
| Tapered roller bearings (1) | | — | 1.5tanα | 1 | 0 | 0.4 | 0.4cotα | 1 | 0.45cotα | 0.67 | 0.67cotα | | | | | |

| Bearing type | | e | DBBD | | | | | DFFD | | | | |
|--|-----|------|--------------------------------|------|---------------|---|------|--------------------------------|------|---------------|--|--|
| | | | Axial load supported by 3 rows | | | | | Axial load supported by 2 rows | | | | |
| | | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | |
| | | | X | Y | X | Y | X | Y | X | Y | | |
| Angular contact thrust ball bearings (C=C _a) | 30° | 0.72 | 0.84 | 0.64 | 0.48 | 1 | 0.63 | 0.64 | 0.48 | 1 | | |
| | 40° | 1.05 | 1.15 | 0.60 | 0.60 | 1 | 0.87 | 0.60 | 0.60 | 1 | | |
| | 55° | 1.79 | 1.82 | 0.56 | 0.81 | 1 | 1.37 | 0.56 | 0.81 | 1 | | |
| | 60° | 2.17 | 2.15 | 0.55 | 0.92 | 1 | 1.62 | 0.55 | 0.92 | 1 | | |

Note: For tapered roller bearings, please also refer to the values listed in the bearing tables on pages 162 and 163.

| DBD DFD | | | | | | | | | | DBT DFT | | | | | | | | | |
|--------------------------------|------------------|------|---------------|------|-------------------------------|------------------|------|---------------|------|--------------------------------|------------------|------|---------------|------|-------------------------------|------------------|------|---------------|------|
| Axial load supported by 2 rows | | | | | Axial load supported by 1 row | | | | | Axial load supported by 3 rows | | | | | Axial load supported by 1 row | | | | |
| i | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | i | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | i | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | i | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | |
| | X | Y | X | Y | | X | Y | X | Y | | X | Y | X | Y | | X | Y | X | Y |
| $\frac{3}{2}$ | 1 | 0.87 | | 1.97 | 3 | 1 | 3.07 | | 3.19 | $\frac{4}{3}$ | 1 | 0.59 | | 1.81 | 4 | 1 | 4.35 | | 3.90 |
| | | 0.83 | | 1.86 | | | 2.91 | | 3.02 | | | 0.56 | | 1.71 | | | 4.12 | | 3.70 |
| | | 0.77 | | 1.73 | | | 2.71 | | 2.82 | | | 0.52 | | 1.60 | | | 3.84 | | 3.45 |
| | | 0.73 | 0.59 | 1.65 | | | 2.58 | 0.95 | 2.68 | | | 0.50 | 0.54 | 1.52 | | | 3.65 | 1.17 | 3.28 |
| | | 0.70 | | 1.58 | | | 2.48 | | 2.57 | | | 0.48 | | 1.46 | | | 3.51 | | 3.15 |
| | | 0.66 | | 1.49 | | | 2.33 | | 2.42 | | | 0.45 | | 1.37 | | | 3.30 | | 2.96 |
| | | 0.61 | | 1.37 | | | 2.14 | | 2.22 | | | 0.41 | | 1.26 | | | 3.02 | | 2.71 |
| | | 0.56 | | 1.27 | | | 1.98 | | 2.06 | | | 0.40 | | 1.22 | | | 2.94 | | 2.64 |
| $\frac{3}{2}$ | 1 | 0.75 | | 1.72 | 3 | 1 | 2.63 | | 2.80 | $\frac{4}{3}$ | 1 | 0.51 | | 1.57 | 4 | 1 | 3.73 | | 3.38 |
| | | 0.72 | | 1.66 | | | 2.53 | | 2.69 | | | 0.49 | | 1.51 | | | 3.59 | | 3.26 |
| | | 0.68 | | 1.57 | | | 2.40 | | 2.55 | | | 0.46 | | 1.43 | | | 3.41 | | 3.09 |
| | | 0.65 | 0.57 | 1.51 | | | 2.31 | 0.93 | 2.45 | | | 0.45 | 0.53 | 1.38 | | | 3.28 | 1.15 | 2.97 |
| | | 0.63 | | 1.46 | | | 2.24 | | 2.38 | | | 0.43 | | 1.34 | | | 3.18 | | 2.88 |
| | | 0.60 | | 1.39 | | | 2.12 | | 2.26 | | | 0.41 | | 1.27 | | | 3.02 | | 2.74 |
| | | 0.56 | | 1.29 | | | 1.97 | | 2.10 | | | 0.40 | | 1.22 | | | 2.91 | | 2.64 |
| | | — | 1 | 0.48 | | | 0.54 | 1.16 | — | | | 1 | 1.71 | 0.89 | | | 1.88 | — | 1 |
| — | 1 | 0.41 | 0.52 | 1.01 | — | 1 | 1.45 | 0.84 | 1.64 | — | 1 | 0.28 | 0.48 | 0.93 | — | 1 | 2.05 | 1.03 | 2.01 |
| — | 1 | 0.29 | 0.46 | 0.76 | — | 1 | 1.02 | 0.76 | 1.23 | — | 1 | 0.20 | 0.42 | 0.71 | — | 1 | 1.46 | 0.92 | 1.54 |
| — | 0.91 | 0.41 | 0.48 | 1 | — | 0.56 | 0.89 | 0.48 | 1 | — | 0.98 | 0.30 | 0.48 | 1 | — | 0.46 | 1.04 | 0.48 | 1 |
| — | 1.24 | 0.39 | 0.60 | 1 | — | 0.76 | 0.84 | 0.60 | 1 | — | 1.35 | 0.29 | 0.60 | 1 | — | 0.62 | 0.98 | 0.60 | 1 |
| — | 1.95 | 0.36 | 0.81 | 1 | — | 1.20 | 0.78 | 0.81 | 1 | — | 2.12 | 0.27 | 0.81 | 1 | — | 0.98 | 0.90 | 0.81 | 1 |
| — | 2.32 | 0.35 | 0.92 | 1 | — | 1.43 | 0.76 | 0.92 | 1 | — | 2.52 | 0.26 | 0.92 | 1 | — | 1.17 | 0.88 | 0.92 | 1 |

| DBTD DFTD | | | | | | | | DBTT DFTT | | | | | | | |
|--------------------------------|------|---------------|---|-------------------------------|------|---------------|---|--------------------------------|------|---------------|---|-------------------------------|------|---------------|---|
| Axial load supported by 4 rows | | | | Axial load supported by 1 row | | | | Axial load supported by 5 rows | | | | Axial load supported by 1 row | | | |
| $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | | $F_a/F_r \leq e$ | | $F_a/F_r > e$ | |
| X | Y | X | Y | X | Y | X | Y | X | Y | X | Y | X | Y | X | Y |
| 1.03 | 0.64 | 0.48 | 1 | 0.39 | 0.64 | 0.48 | 1 | 1.06 | 0.64 | 0.48 | 1 | 0.34 | 0.64 | 0.48 | 1 |
| 1.41 | 0.60 | 0.60 | 1 | 0.53 | 0.60 | 0.60 | 1 | 1.45 | 0.60 | 0.60 | 1 | 0.47 | 0.60 | 0.60 | 1 |
| 2.22 | 0.56 | 0.81 | 1 | 0.84 | 0.56 | 0.81 | 1 | 2.28 | 0.56 | 0.81 | 1 | 0.74 | 0.56 | 0.81 | 1 |
| 2.63 | 0.55 | 0.92 | 1 | 1.00 | 0.55 | 0.92 | 1 | 2.71 | 0.55 | 0.92 | 1 | 0.88 | 0.55 | 0.92 | 1 |

1. Life

New Life Theory

Introduction

The conventional life calculation formula based on the theories of G. Lundberg and A. Palmgren addresses only subsurface-originated flaking. This phenomenon occurs from cracks due to dynamic shear stress immediately below the rolling surface that progressively reach the surface in the form of flaking.

$$\ln \frac{1}{S} \propto \frac{\tau_0 \cdot N^e \cdot V}{Z_0^h} \dots [1]$$

In recent years, bearing technology has advanced considerably, particularly in the areas of dimensional accuracy and material cleanliness. In addition, progress has been made in bearing-related technology such as lubrication cleanliness and filtration. As a result, bearings can now have a longer rolling fatigue life in a cleaner environment than the life obtained by the traditional ISO life calculation formula.

NSK's new life calculation formula theorizes that rolling fatigue life is the sum total of the combined effects of both subsurface-originated flaking and surface-originated flaking occurring simultaneously.

Composition of NSK's New Life Calculation Formula

(1) Subsurface-originated flaking

Before examining subsurface-originated flaking, contact of the rolling elements with the raceway surface must have a sufficient and continuous, clean oil-film.

Fig. 1.2 plots the L_{10} life for each test condition regarding the maximum surface contact pressure (P_{max}) along the y-axis and the number of repeated stress cycles applied along the x-axis.

In the figure, line L_{10} theoretical is obtained using the conventional life calculation formula. As maximum surface contact pressure decreases, the line representing actual life separates from the conventional line and moves towards longer life. This separation suggests the presence of a fatigue load limit P_u below which no rolling fatigue occurs. This is better illustrated in Fig. 1.3. The following equation introduces a fatigue limit for subsurface-originated flaking into the Lundberg-Palmgren theory:

$$\ln \frac{1}{S} \propto N^e \int_V \frac{(\tau - \tau_U)^c}{Z_0^h} dV \dots [2]$$

Fig. 1.2 Life Test Results Under Clean Lubrication Conditions

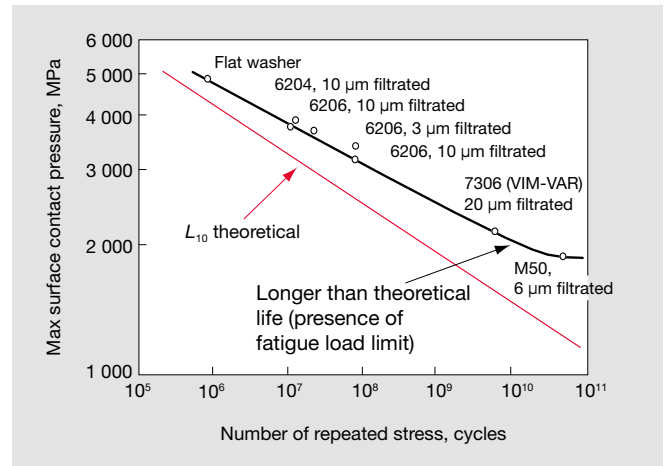
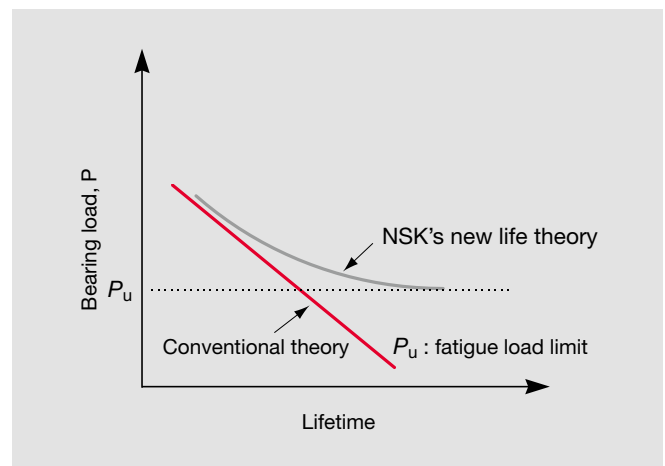


Fig. 1.3 NSK's New Life Theory That Considers Fatigue Limit



(2) Surface-originated flaking

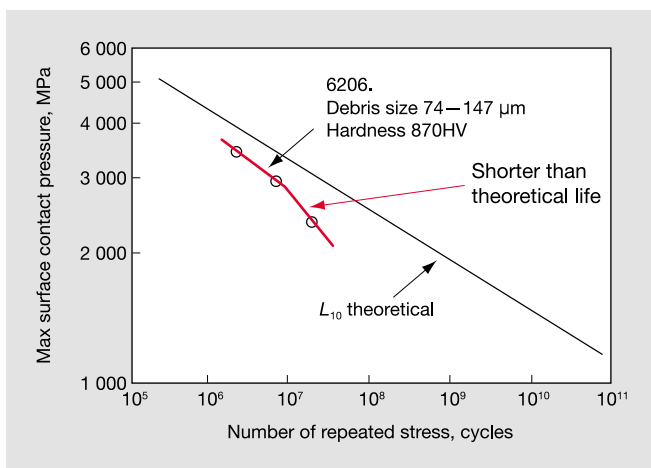
Under actual bearing operation, the lubricant is often contaminated with foreign objects such as metal chips, burrs, casting sand, and so on.

When foreign particles are mixed in the lubricant, the particles become pressed onto the raceways by the rolling elements, and dents occur on the surfaces of the raceways and rolling elements. Stress concentration occurs at the edges of the dents, generating fine cracks that over time propagate into flaking of the raceways and rolling elements. As shown in Fig. 1.4, the actual life is shorter than conventionally calculated life when lubrication is contaminated at low maximum surface pressure. The line representing actual life separates from the line created by theoretical life calculations and moves towards a shorter life. This shows that actual life under contaminated lubrication is further shortened because of the decrease in maximum surface contact pressure.

Table 1.2 Value of Contamination Coefficient a_c

| | Very clean | Clean | Normal | Contaminated | Heavily contaminated |
|---|--|---|--|---|--|
| a_c factor | 1 | 0.8 | 0.5 | 0.4–0.1 | 0.05 |
| Application guide /Degree of filtration | <10 μm | 10–30 μm | 30–100 μm | Greater than 100 μm or no filtration (oil bath, circulating lubrication, etc.) | No filtration, presence of many fine particles |
| Application examples | Sealed, grease-lubricated bearings for electrical appliances, information technology equipment, etc. | Sealed, grease-lubricated bearings for electric motors Sealed, grease-lubricated bearings for railway axle boxes Bearings for machine tools, etc. | Normal usage Automotive hub unit bearings, etc. | Bearings for automotive transmission, industrial gearboxes; construction machines, etc. | — |

Fig. 1.4 Life Test Results Under Contaminated Lubrication Conditions



NSK's new life calculation formula accounts for trends in the results of the life test in a clean environment and at low load. Therefore, the new equation is a function of $(P-P_v)/C$. This function is affected by specific lubrication conditions identified by a lubrication parameter. In addition, it is assumed that the effects of different types and shapes of foreign particles are strongly influenced by the bearing load and lubrication conditions present and that such a relationship can be expressed as a function of the load parameter. This load parameter is defined in the new life calculation formula as $(P-P_v)/C \cdot 1/a_c$.

Based on the above concept, the calculation formula for surface-originated flaking is as follows:

$$\ln \frac{1}{S} \propto N^e \int_V \frac{(\tau - \tau_0)^c}{Z_0^h} dV \times \left\{ \frac{1}{f(a_c, a_L)} - 1 \right\} \dots (3)$$

(3) Calculation of contamination coefficient a_c

Test results on ball and roller bearings with grease lubrication and clean filtration show that bearing life is a number of times longer than the conventionally calculated life. However, if a foreign particle is harder than HV350, hardness becomes a factor and a dent will appear on the raceway. Fatigue damage from these dents can progress to flaking in a short time. Test results on ball and roller bearings with foreign object contamination show that they have no more than 1/3 to 1/10 of the conventionally calculated bearing life.

Based on these test results, we have adopted contamination coefficient a_c as a basic concept for NSK's new life theory. The contamination coefficient a_c is classified into five stages, as shown in Table 1.2.

1. Life

(4) New Life Calculation Formula L_{able}

Adding the formulas for subsurface-originated flaking (2) and surface-originated flaking (3) yields a formula that can be expressed as:

$$\ln \frac{1}{S} \propto N^e \int_V \frac{(\tau - \tau_u)^c}{Z_0^h} dV \times \left\{ \frac{1}{f(a_c, a_L)} - 1 \right\} \dots (4)$$

From this equation (4), another equation (5) can be derived:

$$L_{able} = a_1 \cdot a_{NSK} \cdot L_{10} \dots (5)$$

Reliability factor a_1 is shown in Table 1.3. The theory also utilizes viscosity ratio $K (K = V/V_1$ where V is the operational viscosity and V_1 is the required viscosity). The lubrication parameter a_L is a function of K . The theory indicates that the better the lubrication conditions (the higher the K value), the longer the life.

As shown in equation (6), correction factor a_{NSK} is a function of lubrication parameter a_L and load parameter $(P - P_u)/C \cdot 1/a_c$.

$$a_{NSK} \propto F \left\{ \frac{P - P_u}{C} \cdot \frac{1}{a_c} \cdot a_L \right\} \dots (6)$$

Figures 1.5 and 1.6 chart the correction factor a_{NSK} of the new life calculation formula as a function.

Based on test results, the new life calculation formula considers ball bearings and roller bearings separately.

Table 1.3 Reliability Factor a_1

| | | | | | | |
|--------------------|------|------|------|------|------|------|
| Reliability (%) | 90 | 95 | 96 | 97 | 98 | 99 |
| Reliability Factor | 1.00 | 0.62 | 0.53 | 0.44 | 0.33 | 0.21 |

List of symbols used:

- S : Probability that flaking does not occur after stress has been repeated N times
- N : Number of repeated stresses
- τ : Internal stress
- τ_u : Internal stress at fatigue limit
- V : Stress volume
- Z_0 : Depth at which maximum shear stress occurs
- a_c : Contamination coefficient
- a_L : Lubrication parameter (a function of viscosity ratio κ)
- P : Load applied to bearing
- P_u : Fatigue load limit
- C : Basic dynamic load rating
- e, c, h : Constants

Fig. 1.5 New Life Calculation Graph for Ball Bearings

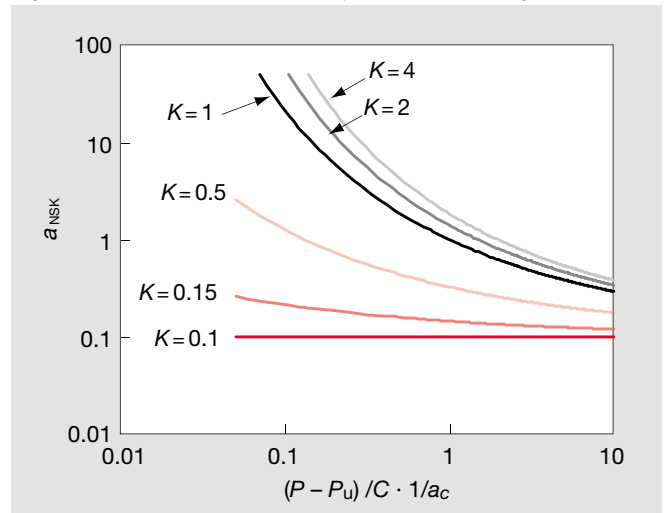
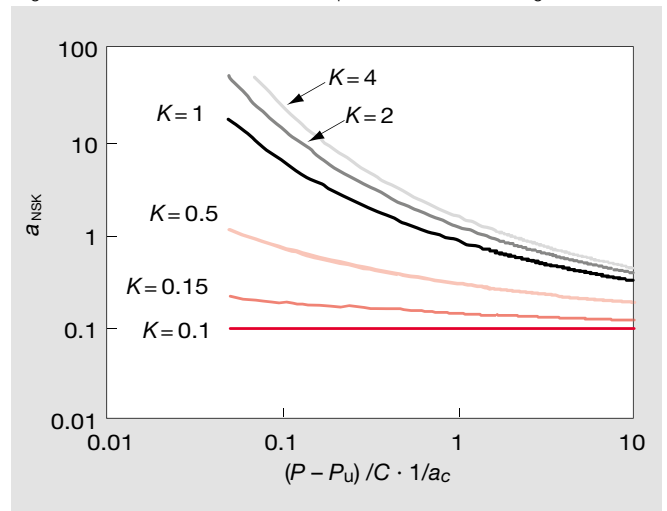


Fig. 1.6 New Life Calculation Graph for Roller Bearings



Life of High-Speed Bearings

When bearings are operated at high speed, the effect of centrifugal force acting on the rolling elements must be considered (Fig. 1.7). In the basic rating life equation on page 192, a ratio of basic dynamic load rating and external load was used, and the internal load generated by centrifugal force was not taken into account.

NSK employs specific software to perform convergence calculations that obtain a balance of the forces acting on rolling elements, including centrifugal force and various other elements. An example result of such a calculation regarding bearing life in high-speed operation is given in Fig. 1.8.

Please contact NSK for life calculations regarding bearings used in high-speed applications.

Note: Bearing life as mentioned above indicates rolling fatigue life, which does not include bearing failure caused by seizure, wear, or the like. It is difficult to calculate how long a bearing will perform until a bearing failure takes place. Please refer to page 192 for details on the definition of bearing life.

Life of Ceramic Hybrid Bearings

As ceramic balls have a lower density than steel balls, the increase in internal load due to centrifugal force in high-speed operation is less than with steel balls. Thus, the life calculation will show a longer life.

ISO 281 does not define static load ratings and dynamic load ratings for bearings with ceramic balls. Therefore, the load rating values listed in the bearing tables from page 50 onward are reference values calculated with the same formula that applies to steel ball bearings.

Fig. 1.7 Change in Contact Angle Due to Centrifugal Force

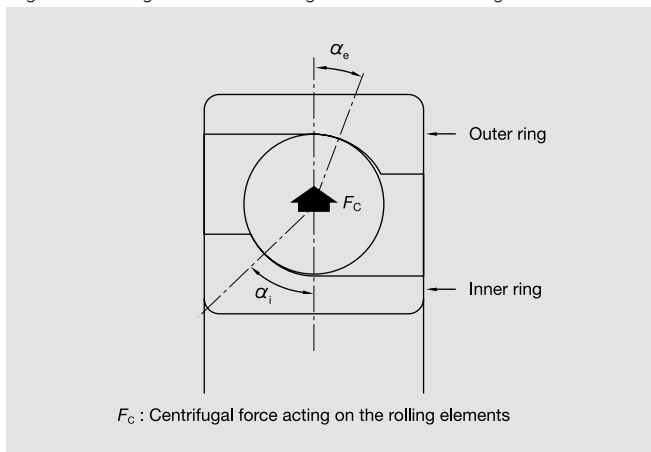
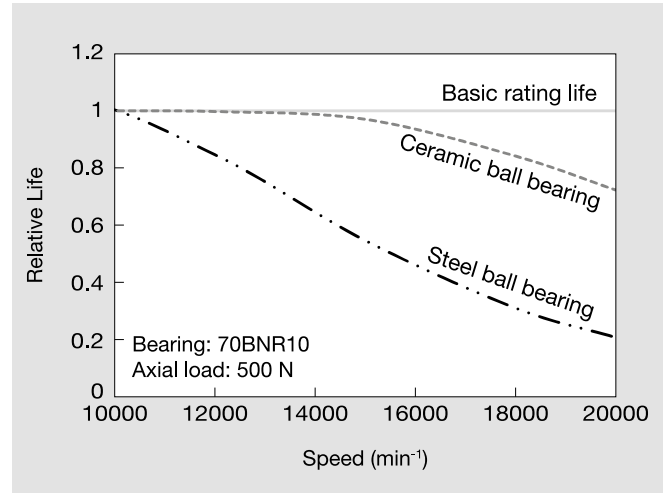


Fig. 1.8 Example Calculated Life Considering Centrifugal Force



Life Calculation for Multiple Bearings as a Group

When multiple rolling bearings are used in one machine, the fatigue life of individual bearings can be determined if the load acting on individual bearings is known. In general however, the machine becomes inoperative if a bearing in any part fails. It may therefore be necessary in certain cases to know the fatigue life of a group of bearings used in one machine.

The fatigue life of bearings varies greatly, and our fatigue life calculation equation $L_{10} = \left(\frac{C}{P}\right)^p$ (where $p=3$ for ball bearings and $p=\frac{10}{3}$ for roller bearings) applies to the 90% life, or "basic rating life". This refers to either the number of revolutions or hours that 90% of bearings of the same type operated under the same conditions can reach.

In other words, the calculated fatigue life for one bearing has a probability of 90%. Since the endurance probability of a group of multiple bearings for a certain period is a product of the endurance probability of individual bearings for the same period, the basic rating life of a group of multiple bearings is not determined solely from the shortest basic rating life among the individual bearings. In fact, the group life is much shorter than the life of the bearing with the shortest fatigue life.

Defining the basic rating life of individual bearings as $L_1, L_2, L_3 \dots$ and the basic rating life of the entire group of bearings as L , the relationship may be expressed by the following equation:

$$L = \frac{1}{\left(\frac{1}{L_1^{1.1}} + \frac{1}{L_2^{1.1}} + \frac{1}{L_3^{1.1}} + \dots\right)^{\frac{1}{1.1}}}$$

2. Static Load Ratings and Static Equivalent Loads

Basic Static Load Rating

When subjected to an excessive load or a strong shock load, rolling bearings may incur a local, permanent deformation of the rolling elements and raceway surface. This deformation increases in area and depth as the load increases, and when the load exceeds a certain limit, the smooth running of the bearing is impeded.

The basic static load rating produces the following calculated contact stress at the center of the contact area between the raceway surface and the rolling element subjected to the maximum stress:

for ball bearings : 4 200MPa
for roller bearings : 4 000MPa

In this most heavily contacted area, the sum of the permanent deformation of the rolling element and that of the raceway is approximately 0.0001 times the rolling element's diameter. The basic static load rating value C_0 is listed in the bearing tables as C_{0r} for radial bearings and C_{0a} for thrust bearings.

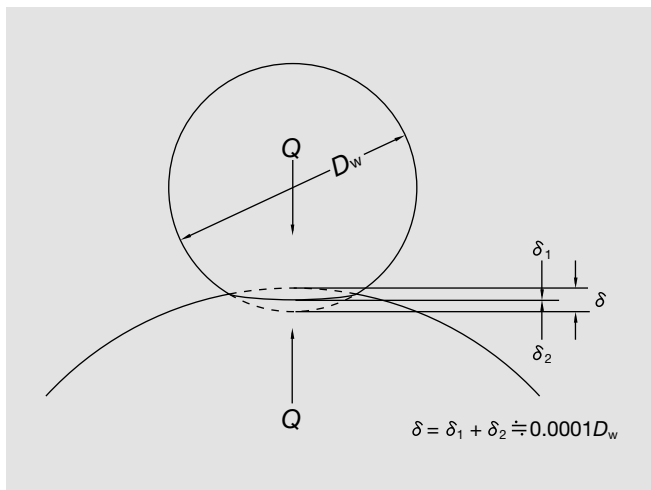
The basic static load rating of multi-row bearing arrangements may be calculated using the following formula:

$$C_j = j \times C_1$$

where j : Number of rows
 C_1 : Basic static load rating for a single-row bearing
 C_j : Basic static load rating for a multi-row bearing
(where j refers to the number of rows)

However, when calculating the basic static load rating for thrust bearings C_{0a} , j refers only to the number of rows that sustain an axial load.

Fig. 2.1 The Relation between Indentations and Basic Static Load Rating



Static Equivalent Load

The static equivalent load is a hypothetical load that produces a contact stress equal to the maximum contact stress the bearing is subjected to under actual load conditions while stationary in the area of contact between the most heavily stressed rolling element and the bearing raceway.

For radial bearings, the radial load passing through the bearing center is used as the static equivalent load. For thrust bearings, the axial load in the direction coinciding with the central axis is used as the static equivalent load.

(a) Static equivalent loads for radial bearings

The greater of the two values calculated from the following equations should be adopted as the static equivalent load on radial bearings:

$$P_0 = X_0 F_r + Y_0 F_a \dots\dots\dots(1)$$

$$P_0 = F_r \dots\dots\dots(2)$$

where P_0 : Static equivalent load (N)
 F_r : Radial load (N)
 F_a : Axial load (N)
 X_0 : Static radial load factor
 Y_0 : Static axial load factor

(b) Static equivalent loads for thrust bearings

$$P_0 = X_0 F_r + F_a \quad \alpha \neq 90^\circ \dots\dots\dots(3)$$

where P_0 : Static equivalent load (N)
 α : Nominal contact angle

Note that the accuracy of this equation decreases when $F_a < X_0 F_r$.

The values X_0 and Y_0 of equations (1) and (3) are shown in Table 2.1.

Note that $P_0 = F_a$ for thrust bearings with $\alpha = 90^\circ$.

Table 2.1 Static Equivalent Loads

| Bearing type | | Single row | | Double row | |
|-------------------------------|------------------------|--------------------------------------|--------------------|------------|--------------------|
| | | X_0 | Y_0 | X_0 | Y_0 |
| Angular contact ball bearings | $\alpha=15^\circ$ | 0.5 | 0.46 | 1 | 0.92 |
| | $\alpha=18^\circ$ | 0.5 | 0.46 | 1 | 0.92 |
| | $\alpha=25^\circ$ | 0.5 | 0.38 | 1 | 0.76 |
| | $\alpha=30^\circ$ | 0.5 | 0.33 | 1 | 0.66 |
| Tapered roller bearings | $\alpha \neq 0$ | 0.5 | $0.22 \cot \alpha$ | 1 | $0.44 \cot \alpha$ |
| Cylindrical roller bearings | $\alpha=0$ | $P_0 = F_r$ | | | |
| Thrust ball bearings | $\alpha=90^\circ$ | $P_{0a} = F_a$ | | | |
| Thrust roller bearings | $\alpha=90^\circ$ | $P_{0a} = F_a$ | | | |
| Thrust ball bearings | $\alpha \neq 90^\circ$ | $P_{0a} = F_a + 2.3 F_r \tan \alpha$ | | | |
| Thrust roller bearings | $\alpha \neq 90^\circ$ | (where $F_a > 2.3 F_r \tan \alpha$) | | | |

Permissible Static Load Factor

The permissible static equivalent load on bearings varies depending on their basic static load rating, their application, and operating conditions.

The permissible static load factor f_s is a safety factor that is applied to the basic static load rating, and it is defined by the ratio in the equation below:

$$f_s = [C_0/P_0]$$

where C_0 : Basic static load rating
 P_0 : Static equivalent load

Table 2.2 lists the generally recommended values for the permissible static load factor f_s .

Table 2.2 Values of Permissible Static Load Factor f_s

| Operating conditions | Lower limit of f_s | |
|---|----------------------|-----------------|
| | Ball bearings | Roller bearings |
| Low-noise applications | 2.0 | 3.0 |
| Bearings subjected to vibration and shock loads | 1.5 | 2.0 |
| Standard operating conditions | 1.0 | 1.5 |

Permissible Axial Load for Angular Contact Ball Bearings

NSK has defined the limiting static axial load as the smaller of the two values listed below:

1. Limiting axial load that prevents shoulder override
 The limiting load at which the contact ellipse generated between the ball and the raceway does not override the shoulder of the raceway groove (Fig. 2.2)
2. Limiting axial load in terms of surface pressure
 The limiting load at which the contact stress at the center of the contact area between the ball and the raceway groove reaches a level that leaves an indentation of max. 0.01% of the ball diameter as defined in the basic static load rating (Fig. 2.3)

To maintain optimal bearing performance, NSK has defined permissible static axial load values by applying a safety factor to the limiting axial load based on many years of experience.

The formula for calculating the basic static axial load rating C_{0a} does not take the shoulder height of the raceway groove into account. Therefore, in some cases the C_{0a} value may exceed the limiting axial load that produces shoulder override. In such cases, the maximum load that the bearing can sustain is lower than the C_{0a} value, making the C_{0a} value unsuitable (Fig. 2.4). Therefore, instead of C_{0a} values, we have listed limiting axial load values in the bearing tables where necessary, particularly for angular contact thrust ball bearings as they are usually used to support heavy axial loads.

Fig. 2.2 Limiting Axial Load that prevents Shoulder Override

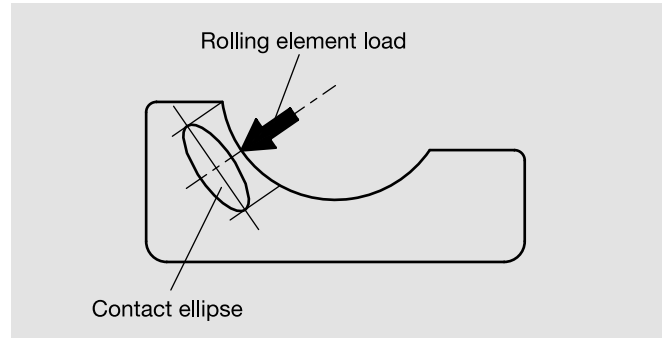


Fig. 2.3 Limiting Axial Load in Terms of Surface Pressure

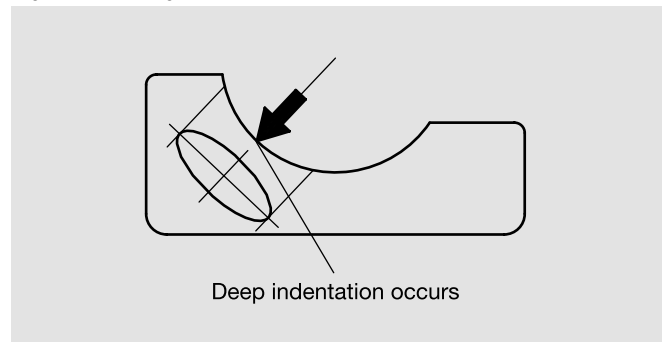
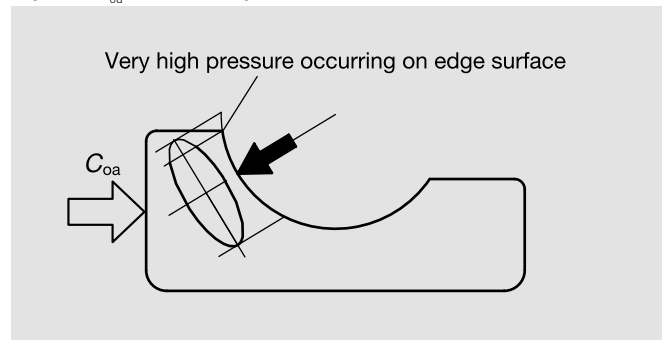


Fig. 2.4 C_{0a} and Limiting Axial Load



3. Angular Contact Ball Bearing Combinations

Angular Contact Ball Bearing Combinations

The combinations of angular contact ball bearings used for the fixed end of spindles are usually 2 row (DB), 3 row (DBD), and 4 row (DBB) sets. However, in 3 row combinations the preload is unevenly distributed between the bearings, resulting in a very limited optimum range of preload which makes them unsuitable for high-speed applications.

Matched bearings are manufactured as sets, so when they are mounted adjacent to each other, the specified preload is automatically achieved. The variation of bore and outer diameter within each set of matched bearings is adjusted to less than 1/3 of the permissible tolerance.

Table 3.1 Features of Each Combination

◎Excellent ◎Very good ○Good △Fair →One direction only ↔Two directions

| | DB | DF | DT | DBD | DBB |
|---------------------|----|----|----|-----|-----|
| Load direction | ↔ | ↔ | → | ↔ | ↔ |
| Moment stiffness | ◎ | ○ | △ | ◎ | ◎ |
| Speed capability | ◎ | ◎ | ◎ | △ | ○ |
| Low heat generation | ◎ | ◎ | ◎ | △ | ○ |
| Stiffness | ○ | ○ | △ | ◎ | ◎ |

Features of Each Combination

- Back-to-back Arrangement, DB
Axial loads in both directions and radial loads can be sustained. Since the distance between the effective load centers is large, this type is suitable if moments are applied. However, in case of insufficient housing accuracy or shaft misalignment, internal load of the bearings could be large enough to possibly cause premature failure due to the high level of moment stiffness.
- Face-to-face Arrangement, DF
Compared with the DB type, the distance between the effective load centers is small, so the capacity to sustain moments is inferior to the DB type. On the other hand, this type is suitable for use with housings that have less accuracy or larger shaft deflections due to enabling lower bending stiffness of the shaft.
- Tandem Arrangement, DT
Axial loads in one direction and radial loads can be sustained. Since axial stiffness of this type is twice the value of a single row type, this arrangement is used when the axial load in one direction is heavy.
If preload is required, it needs to be applied externally, e.g. by using a spring.
- 3 Row Arrangement, DBD
Axial loads in both directions and radial loads can be sustained. However, the preload distribution to each bearing is not equal, and preload on the counter side (single side) is twice that of the other side. Consequently, this type is unsuitable for high-speed operation because of the large increase of internal load on the single side, which could lead to bearing failure.
- 4 Row Arrangement, DBB
Axial loads in both directions and radial loads can be sustained. In situations that have the same axial clearance

as DB arrangement, preload and stiffness are twice that of the DB arrangement. Also, the permissible axial load of a 4 row arrangement is larger than that of a DB arrangement.

Fig. 3.1 The Distance between the Effective Load Centers of Back-to-back and Face-to-face Arrangements

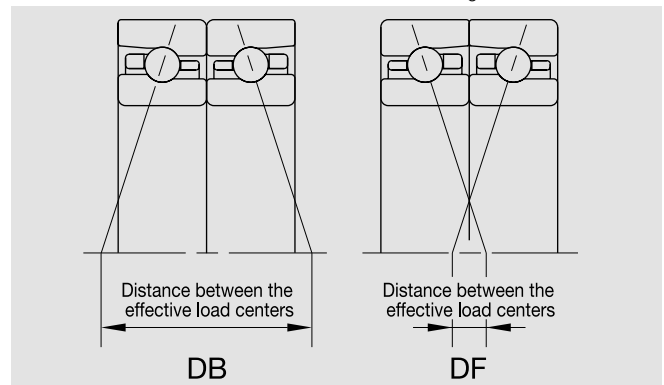


Fig. 3.2 Load Application Direction in Back-to-Back and Tandem Arrangements

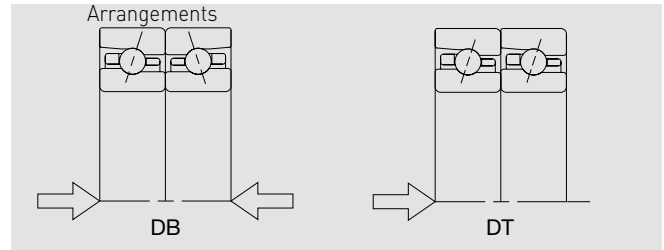
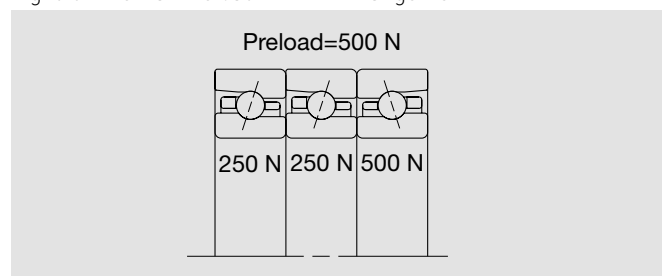


Fig. 3.3 Internal Preload in DBD Arrangement



Shaft Bending Comparison between Back-to-back and Face-to-face Arrangements

Moment stiffness is different between back-to-back and face-to-face arrangements. We have calculated typical shaft deflections for the spindle structure shown in Fig. 3.4. In this example, angular contact ball bearings (75BNR10) are used at the front end and shaft deflections are shown for both DB and DF configurations. A radial load of 1 000 N applied to the spindle nose will cause the following radial deflection of the spindle nose:

$$\delta_{DB} = 2.4079 \times 10^{-2} \text{ (mm)}$$

$$\delta_{DF} = 2.9853 \times 10^{-2} \text{ (mm)}$$

This demonstrates the effect the distance between effective load centers has on spindle bending.

Mounting Instructions for Matched Angular Contact Ball Bearings

Direction of Matching

For matched bearings, the mounting order and load application direction are very important. As shown in Fig. 3.6, marks on the outer ring surfaces of the bearings form a "V" when the bearings are properly matched and aligned.

Radial Run-out Mark

On the inner ring face side of the bearing back side the symbol "○" is marked to indicate the position of maximum radial run-out. Optimum accuracy is achieved when the bearing is mounted that "○" symbol is placed directly opposite the point of maximum shaft eccentricity.

Fig. 3.5 The Symbol for the Position of Maximum Radial Runout of the Inner Ring

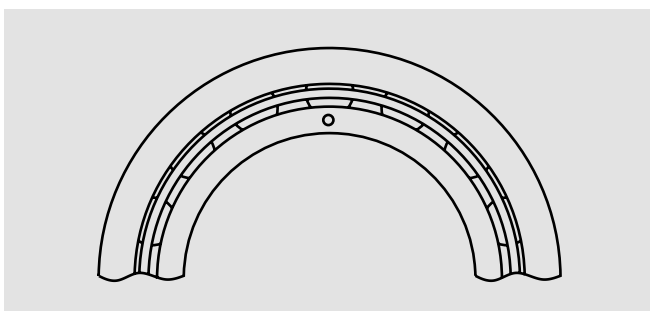


Fig. 3.4 Spindle Deflection Curve

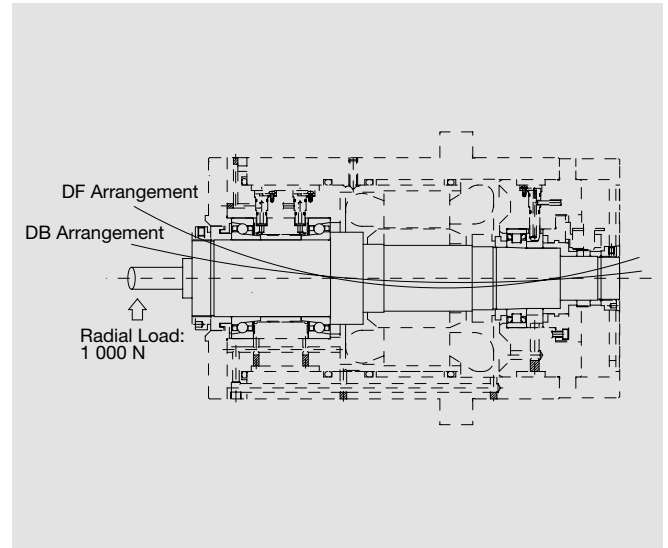
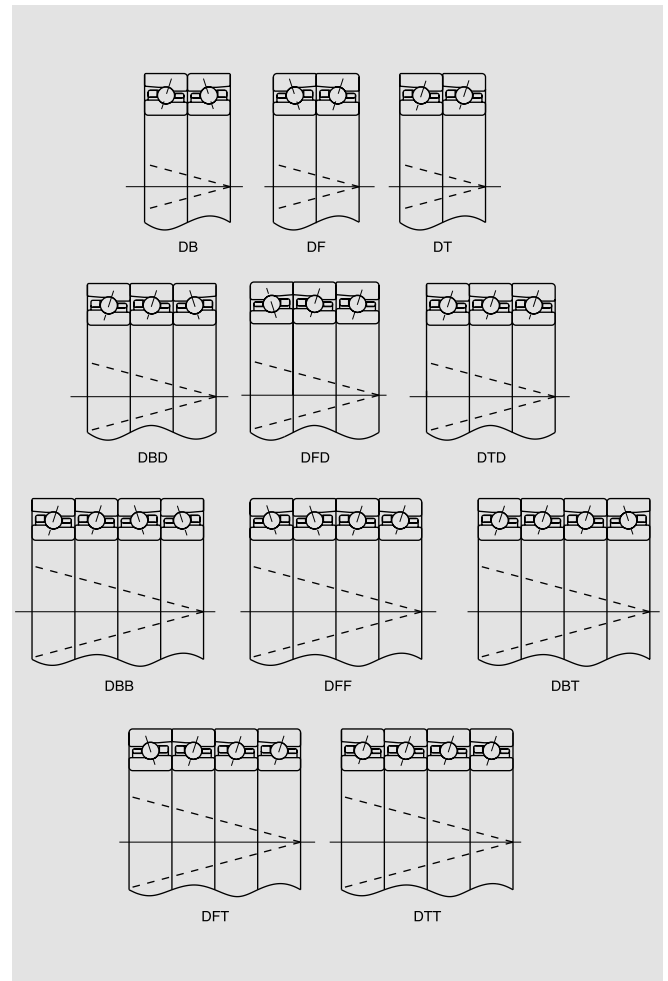


Fig. 3.6 Combinations of Angular Contact Ball Bearings



3. Angular Contact Ball Bearing Combinations

Important Points to Consider When Using Matched Bearings

The preload (stand-out) of each bearing in a set of matched bearings (DB, DT, DFD etc.) has been adjusted and controlled, so that the specified amount for each standard preload is achieved when the bearings are arranged in the order indicated by the marks on the surface of their outer rings. These marks form a "V" when the bearings have been correctly mounted. Thus, as long as the bearing direction and the order of the bearings are not altered, bearing axial clearance or preload gap is controlled even if some bearings are selected from a bearing set. In this case the marks on the outer rings will also form continuous straight lines.

Should the direction or order of matched bearings be changed, the clearance adjustment of mating surfaces will be lost and the resulting clearance values will be unknown. If used this way, problems may arise due to excessive or insufficient preload and uneven load distribution. Therefore, in order to use matched bearings in other than the prescribed directions and order, it is necessary to measure the protrusion (axial off-set) of each individual bearing and use spacers to adjust the axial clearance according to these measurements.

We do not recommend machining the bearings themselves to the desired offset, as debris from grinding may remain inside the bearing.

To customers who wish to use the same bearings on various machines, we recommend stocking universal combination bearings rather than sets of matched bearings prepared for specific arrangements. Universal combination bearings are ready for use in different arrangements. For more information on universal combination bearings, please refer to page 206.

Fig. 3.7 DT Combination

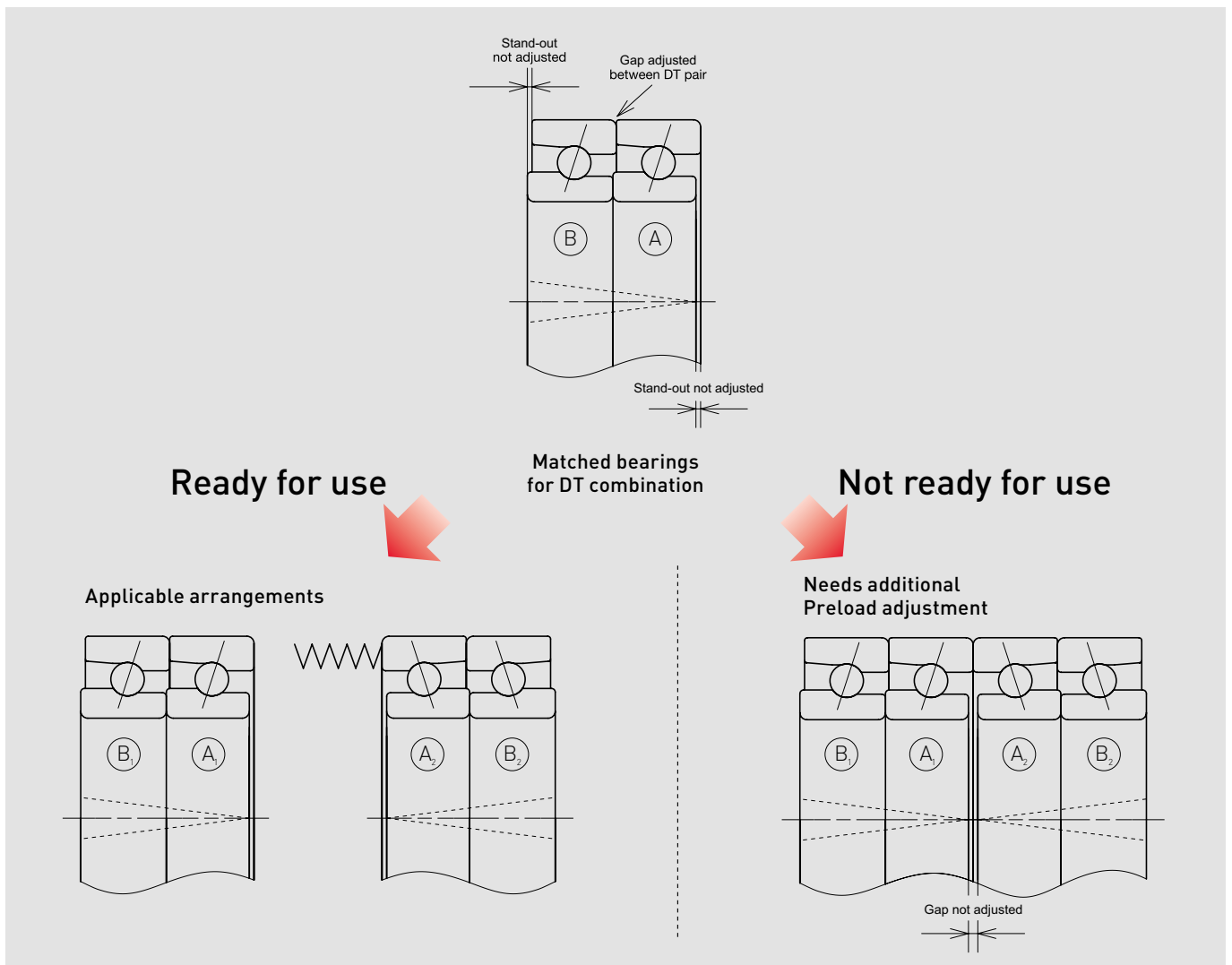
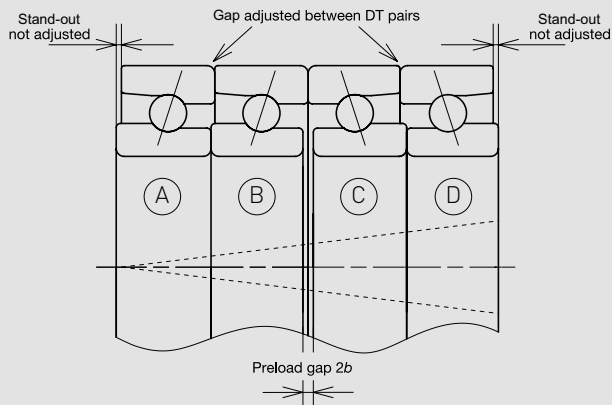


Fig. 3.8 DBB Combination

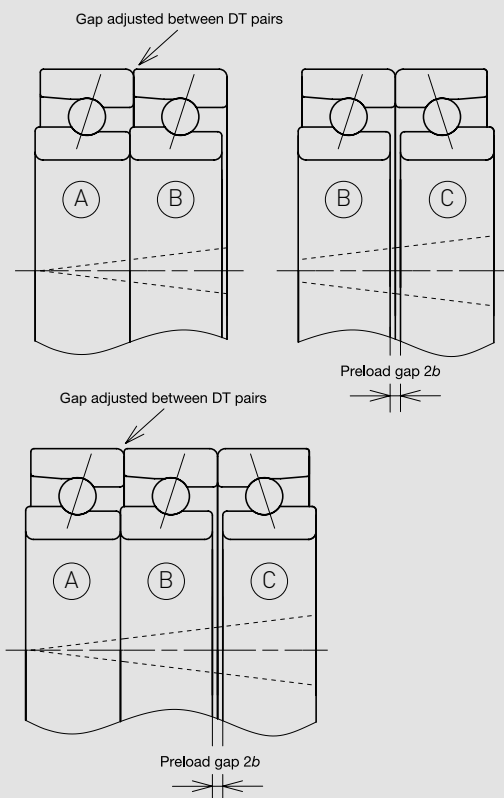


Ready for use

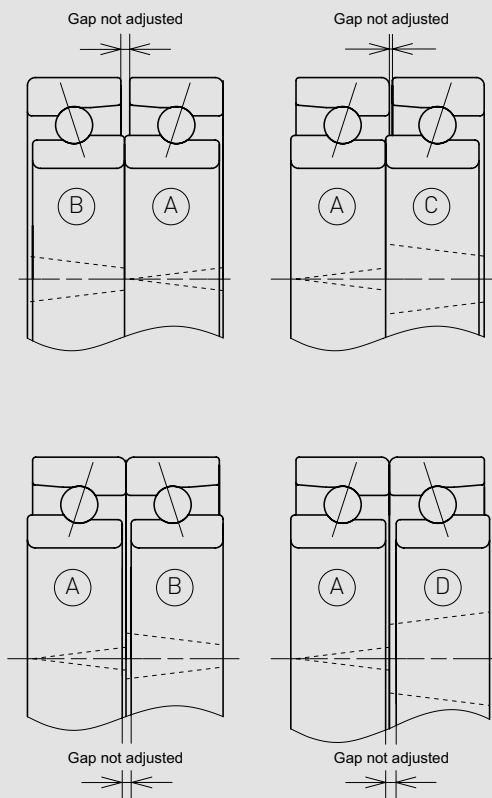
Matched bearings
for DBB combination

Not ready for use

Examples of applicable arrangements



Needs additional Preload adjustment

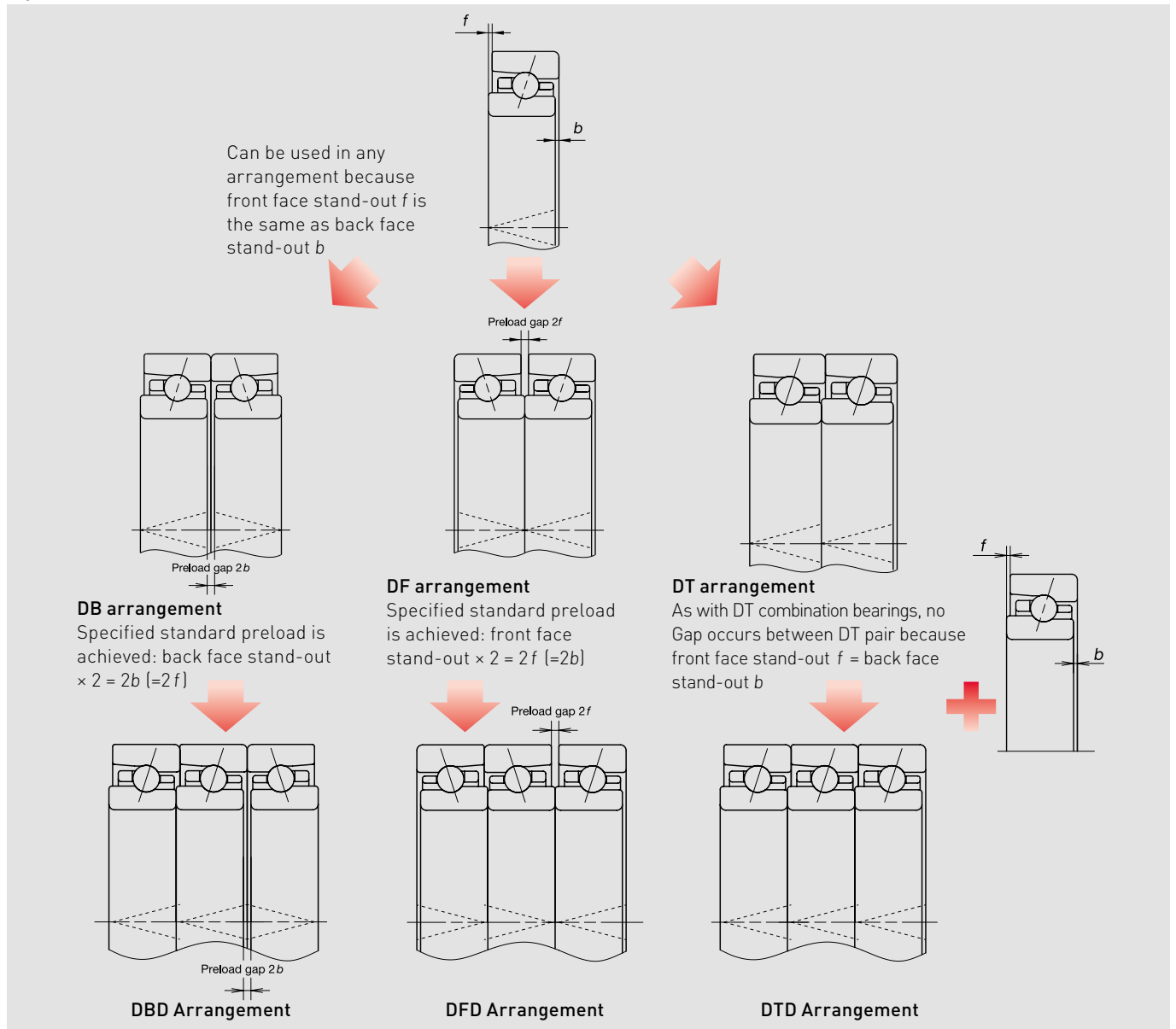


3. Angular Contact Ball Bearing Combinations

Universal Combination Bearings

NSK manufactures universal combination bearings which have been controlled to have the same amount of stand-out (offset) on their front and back faces. That way, for bearings with the same bearing number, users will achieve the specified amount for each standard preload, regardless of which combination they chose. Each universal combination bearing comes with a V-shaped mark on the surface of the outer ring to simplify identification of the correct direction when mounting and to ensure that the correct combination is achieved. The V-shaped mark points to the direction of the axial load that the inner ring supports (contact angle).

Fig. 3.9 Universal Combination



Types of Universal Combination Bearings

NSK supplies four types of universal combination bearings, as shown in Table 3.2. Variation of bore and outer diameter are controlled for multiple-row universal combination bearings.

Table 3.2 Types of Universal Combination Bearings and Their Features

| | SU | DU | DUD | QU |
|--------------------------------------|----|--|-----|----|
| Number of rows | 1 | 2 | 3 | 4 |
| Variation of bore and outer diameter | — | Controlled to be within 1/3 of tolerance | | |

Note: Variation control for P4Y class bearings is the same as for P4 class bearings.

Notice for the Use of Single Universal (SU) Bearings

- In the case of bearing sets (DB, DU etc.), the variations of bore and outer diameter within each set are controlled. However, when using single row universal combination bearings (SU), users should check the actual bore/outer diameter variation printed on the box of each bearing and make sure variation of these tolerances is low. Otherwise variations in housing or shaft fit may occur that result in imbalances of internal load, which may cause damage to the bearings.
- One way of keeping the variation of bore and outer diameter of SU bearings low is to choose the P4Y accuracy class that NSK provides. P4Y rated bearings have a running accuracy of ISO Class 4. As bore diameter and outer diameter are strictly controlled, these bearings are suitable for random matching.

Fig. 3.10 Tolerances of P4 and P4Y Accuracy

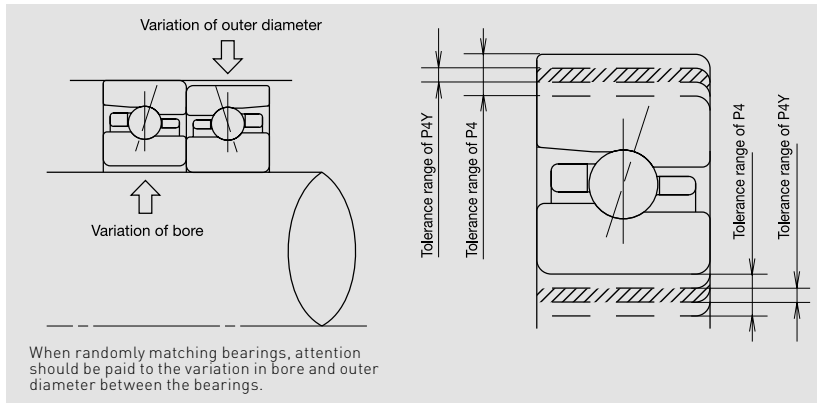
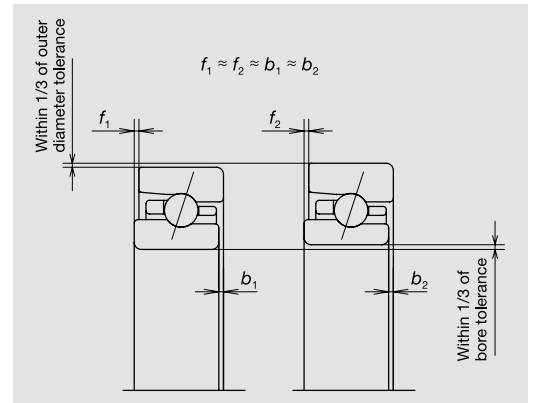
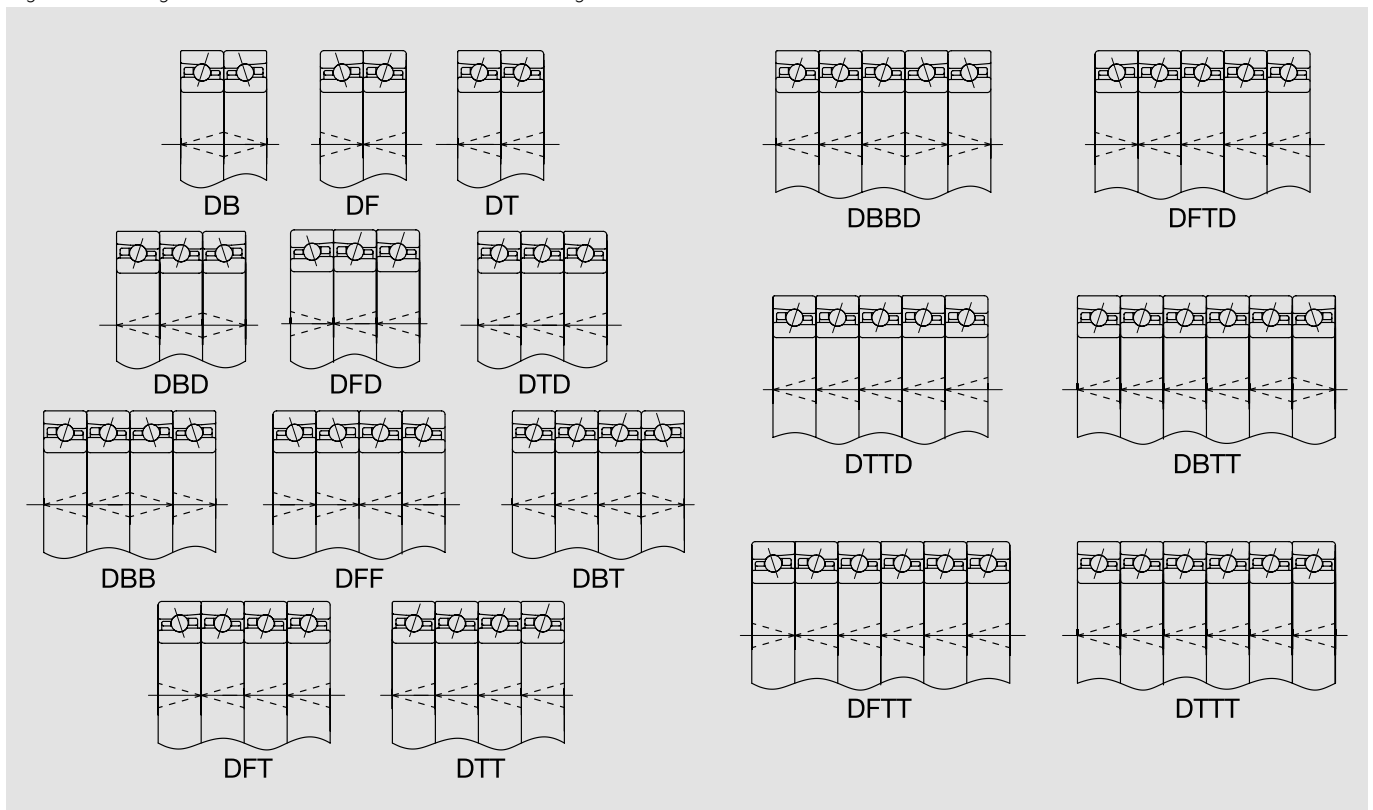


Fig. 3.11 DU Combination



Combination Mark and Matching Method for Universal Combination Bearings

Fig. 3.12 Arrangements of Universal Combination Bearings



4. Preload and Rigidity

Regarding the rigidity of machine tool spindles, it is possible to think of the bearings as being springs. When an axial load is applied to the spindle, axial displacement of the spindle is determined by the axial rigidity of the fixed end bearings.

Radial loads applied to the spindle end will cause radial deflection. While shaft deformation will account for most of this deflection, bearing deflection is also a factor that may not be ignored.

When high radial rigidity is required, cylindrical roller bearings are generally used. In this case, axial loads are usually sustained by angular contact thrust ball bearings. The bigger the contact angle of an angular contact ball bearing, the higher its axial rigidity.

Normally, preload is applied to bearings in order to increase the rigidity of machine tool spindles. However, excessively high preload may cause seizure and flaking. Many users increase rigidity by using a combination of two or more angular contact ball bearings. This is especially true for ball screw support bearings, where high rigidity is required, contact angle is as large as possible, and preload is higher than that for a spindle.

Purpose

The main purposes of applying preload to bearings in machine tool spindles are as follows:

- To improve the running accuracy of the spindle.
- To increase spindle rigidity.
- To minimize noise due to spindle vibration.
- To prevent abnormal wear due to oscillation and vibration
- To prevent sliding between the rolling elements and raceways

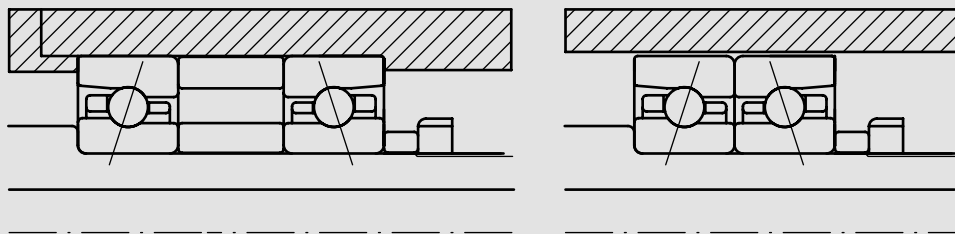
Usually a preload is applied to bearings by using two or more bearings in combination, such as angular contact ball bearings or tapered roller bearings. Cylindrical roller bearings can be preloaded by making the radial internal clearance negative.

(1) Position Preload

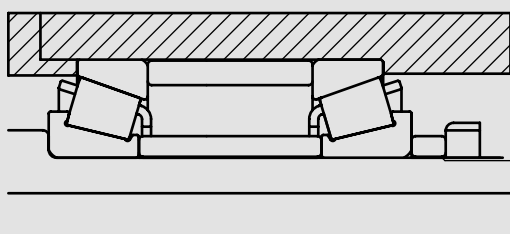
A position preload is achieved by fixing two axially opposed bearings so that their position relative to one another remains unchanged during operation. In practice, the following three methods are generally used to obtain a position preload.

1. By using a spacer or shim of proper size to obtain the required spacing and preload, as shown in Fig. 4.1(a) on the left, (b) and (c).
2. By installing a bearing set with previously adjusted stand-out dimensions and closed gap by preloading the inner rings, as shown in Fig. 4.1(a) on the right.
3. By utilizing bolts or nuts to allow adjustment of axial preload, as shown in Fig. 4.1(d). In this case, starting torque should be measured to verify proper preload. However, this method cannot be recommended for high precision machine tool spindles due to difficulty in verifying the proper preload, thus risking vertical displacement (tilting) of the bearing.

Fig 4.1 Position Preload Examples

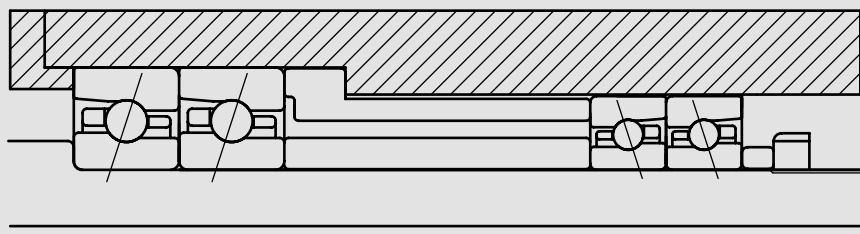


(a) Angular contact ball bearings in position preload

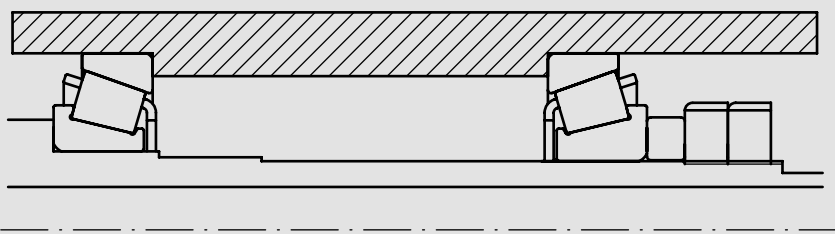


Note: The cages of tapered roller bearings usually protrude from the bearing's end faces. Customers who wish to reduce bearing span, please bear in mind the required minimum amount of spacer width.

(b) Tapered roller bearings in position preload



(c) Bearing combinations of differently sized bearings in position preload



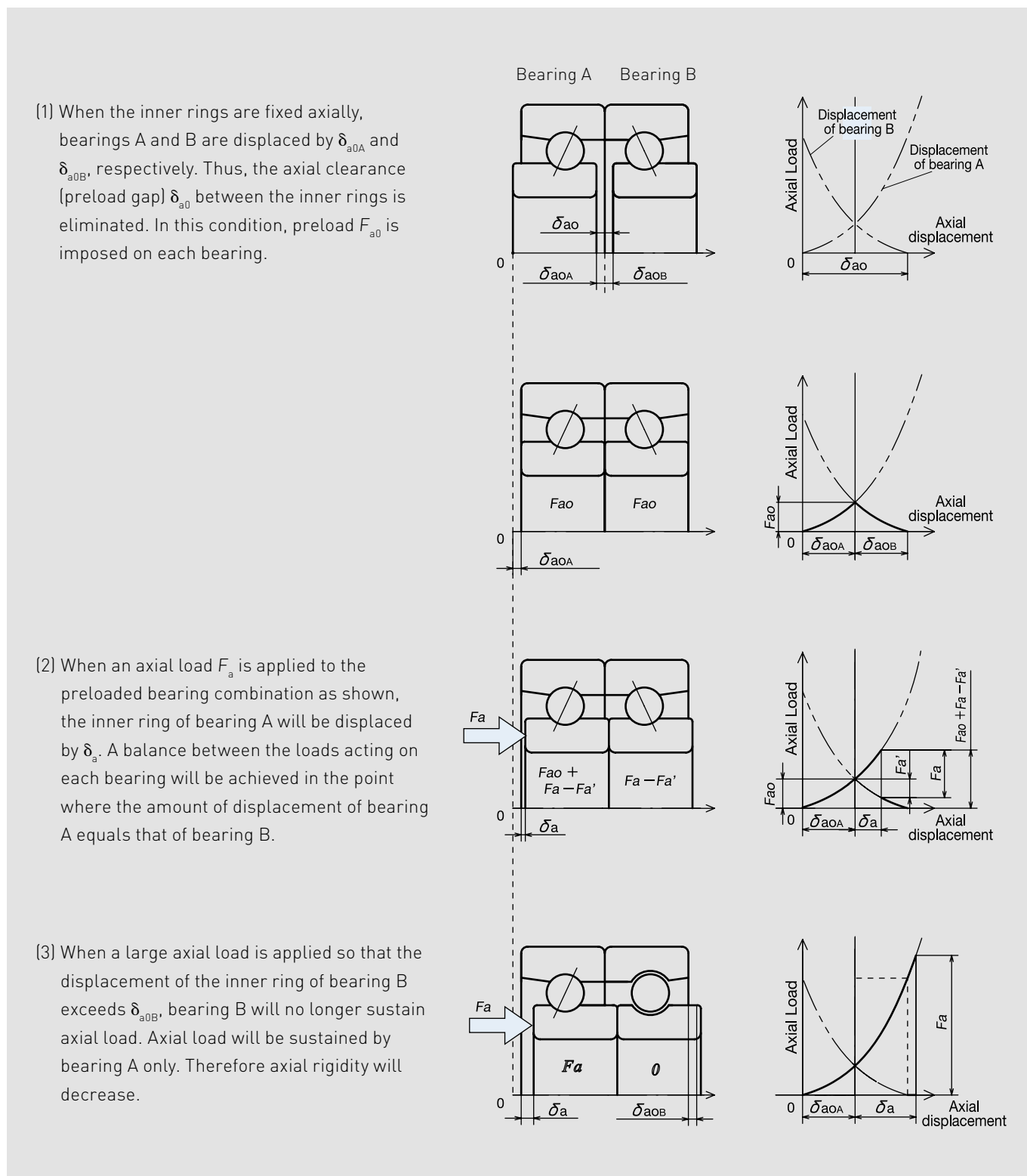
(d) Position preload without spacers

4. Preload and Rigidity

Axial Load and Displacement in Position Preload (DB Arrangement)

Fig 4.2 illustrates the mechanism of preload and axial load in bearing combinations.

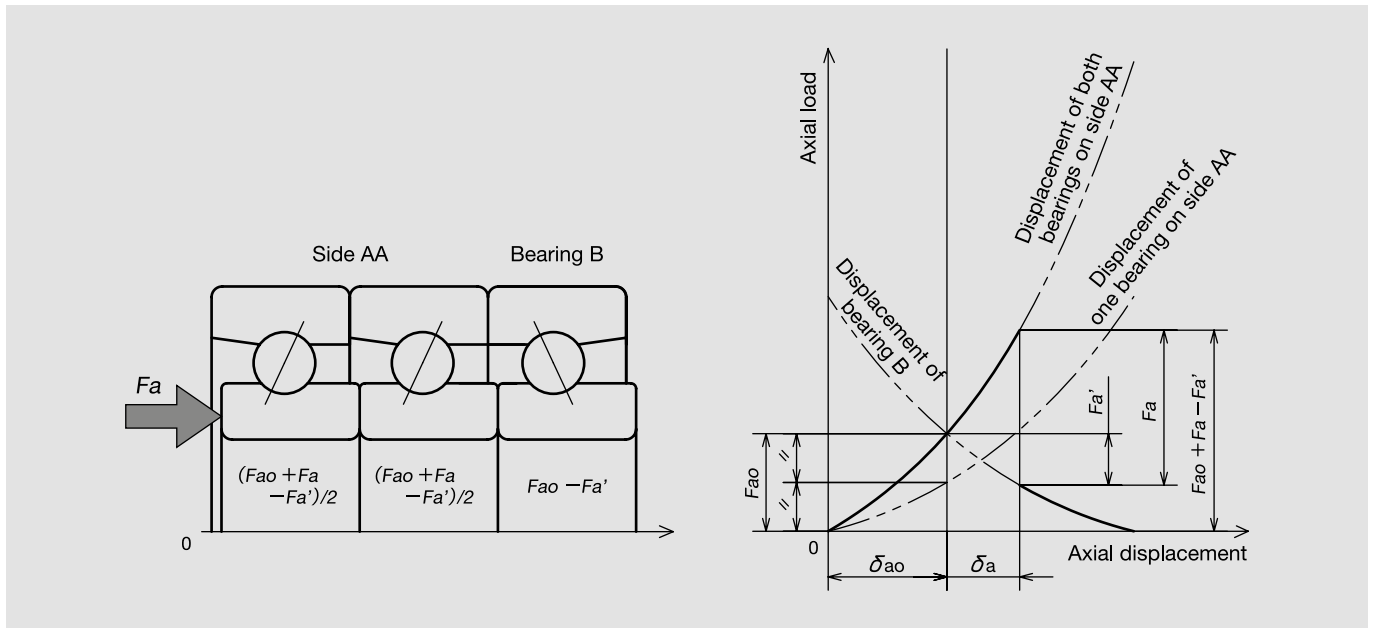
Fig 4.2 Axial Displacement in Position Preload (DB Arrangement)



Axial Load and Displacement in Position Preload (DBD Arrangement)

In DBD arrangements, one direction of axial load is divided equally between two bearings. Apart from that the basic concept is the same as with DB arrangements (shown in Fig 4.2.)

Fig 4.3 Axial Displacement in Position Preload (DBD Arrangement)



Unloading Force

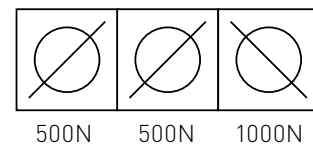
As shown in Fig 4.2 (3), when a large axial load is applied to preloaded bearings, the bearing opposite the side that experiences the thrust will be relieved of axial load. In such cases, sliding may occur between the rolling elements and the raceways. In high-speed rotation, this may lead to excessive wear or bearing damage.

Where bearings of the same type are used in combinations, the level of load that will cancel preload can be approximated as 3 times the preload of a single bearing in the case of angular contact ball bearings, and 2 times the preload of a single bearing for tapered roller bearings on Table 4.1 shows the factors for combinations of angular contact ball bearings and an example of a calculation of unloading force.

Table 4.1 Approximate Values of Unloading Forces

| Combination | Combination symbol | Direction of force | Unloading force factor (multiply with single row preload value) |
|-------------|--------------------|--------------------|---|
| | DB | | 3 |
| | | | 3 |
| | DBD | | 6 |
| | | | 2.1 |
| | DBB | | 6 |
| | | | 6 |
| | DBT | | 9 |
| | | | 1.8 |
| | DBBD | | 9 |
| | | | 2.3 |

Calculation Example



| Direction of force | Unloading force |
|--------------------|--------------------------------------|
| | $500 \times 6 = 3\ 000\text{N}$ |
| | $1\ 000 \times 2.1 = 2\ 100\text{N}$ |

4. Preload and Rigidity

Standard Clearance

NSK supplies matched angular contact ball bearings in four standard preload classes:

- EL: Extra light preload L: Light preload
- M: Medium preload H: Heavy preload

In addition, two special clearances are available for matched angular contact ball bearings and for tapered roller bearings:

- CA: Axial clearance ... (positive clearance in the axial direction)
- CP: Preload gap (preload is generated)

Preload Adjustment with Spacers

The measured axial clearance of each bearing is listed in the bearing tables in Part 4 of this catalogue. The listed values refer to DB and DF arrangements and do not include the influence of shaft and housing fit or nut clamping force.

When using spacers to adjust the preload (for example L→EL, L→M etc.), adjust the difference between measured axial clearance and target clearance value with a spacer. With DB arrangement, reduce the width of the inner-ring spacer to increase preload, and reduce the width of the outer-ring spacer to decrease preload.

In the case of universal combination bearings, the following applies:

When using a DB combination, the preload gap between the bearings equals the sum of the back face stand-out values of each bearing.

In a DF combination, the preload gap between the bearings equals the sum of the front face stand-out values.

Please adjust the difference to your required axial clearance with spacers. Table 4.2 shows measuring loads for measuring axial clearance. The values in the table indicate the amount of load necessary to obtain stable measurements.

Fig 4.4 Special Clearances

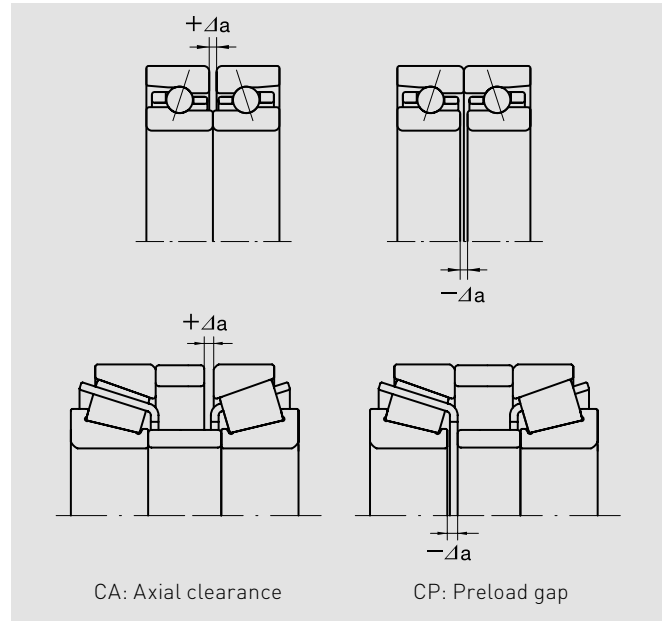


Fig 4.5 Adjustment of Axial Clearance with Spacers

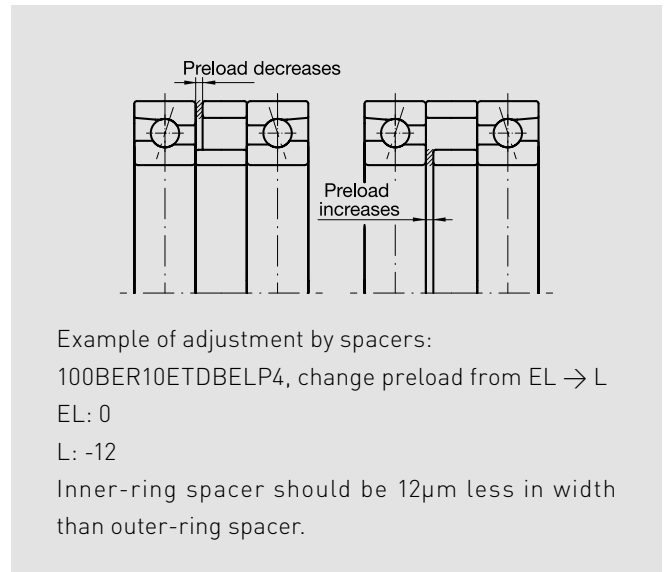


Table 4.2 Measuring Loads for Axial Clearance Measurement

| Nominal bearing outer diameter D (mm) | | Measuring load (N) |
|---------------------------------------|-------|--------------------|
| Larger than | Up to | |
| 10 ⁽¹⁾ | 50 | 24.5 |
| 50 | 120 | 49 |
| 120 | 200 | 98 |
| 200 | 400 | 196 |

⁽¹⁾ Outer diameter of 10mm is included in this range

Measuring Axial Clearance of Angular Contact Ball Bearing Combinations

In the case of a DB arrangement, place the bearing without the inner-ring spacer on the cradle as described in the figure below; then apply the measuring load to the inner ring. After the bearing is sufficiently stabilized, set the dial gauge to zero.

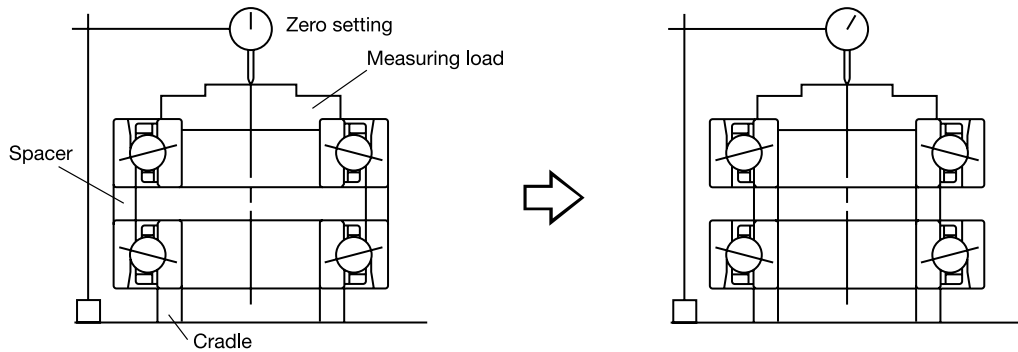
Next, after removing the outer-ring spacer, place the bearing with the inner-ring spacer on the cradle and apply measuring load in the same way as described above. The reading on the dial gauge now indicates the axial clearance. A positive reading signifies a CA clearance (positive clearance in axial direction). A negative reading signifies a CP clearance, which generates preload.

The axial clearance of a DF arrangement is measured in the same manner as with a DB arrangement, although the positions of spacers and cradles are different.

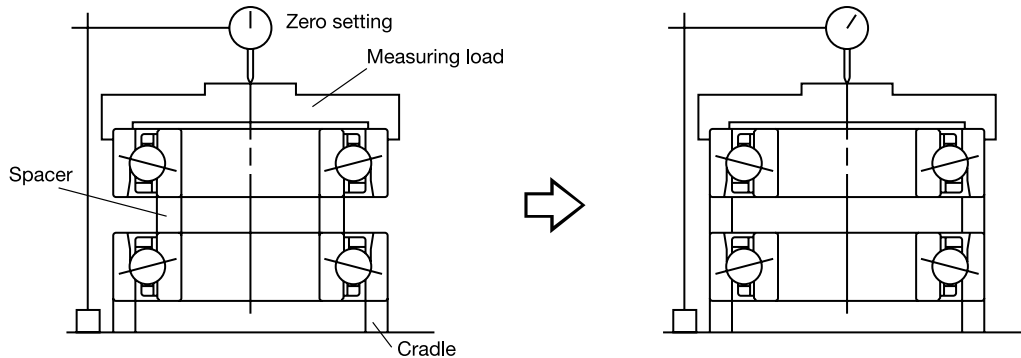
With a DT arrangement, the sum of front face stand-out and back face stand-out of the combined bearings at the mating surfaces should be zero.

For single-row bearings, axial clearance of a double-row arrangement can be obtained by adding the measured values of each bearing.

DB Arrangement

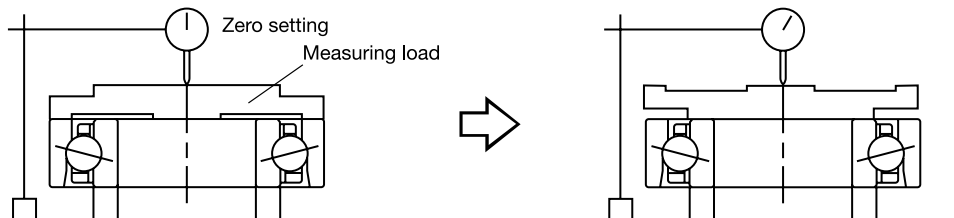


DF Arrangement

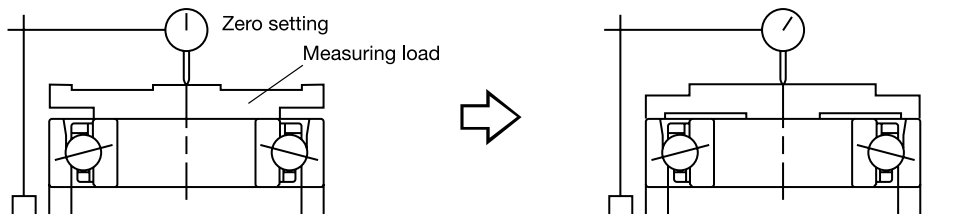


Single Row

Back face stand-out



Front face stand-out



4. Preload and Rigidity

Measuring Axial Clearance of Tapered Roller Bearing Combinations (Stand-out Measuring Method)

In the case of a DB arrangement, place a single row bearing on a cradle with the back face of the inner ring facing down. Turn the outer ring (at least 10 turns) to stabilize the rollers. Then measure inner ring width and assembled bearing width. Next, measure the inner ring width and assembled bearing width of the second bearing in the same way. Finally, measure widths K and L of the spacers.

Inserting these measurements into the equation below will obtain axial clearance Δ_a .

$$\Delta_a = (L-K) - (b_A + b_B) = (L-K) - [(T_A - B_A) + (T_B - B_B)]$$

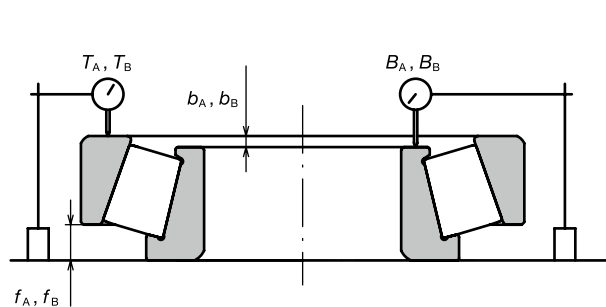
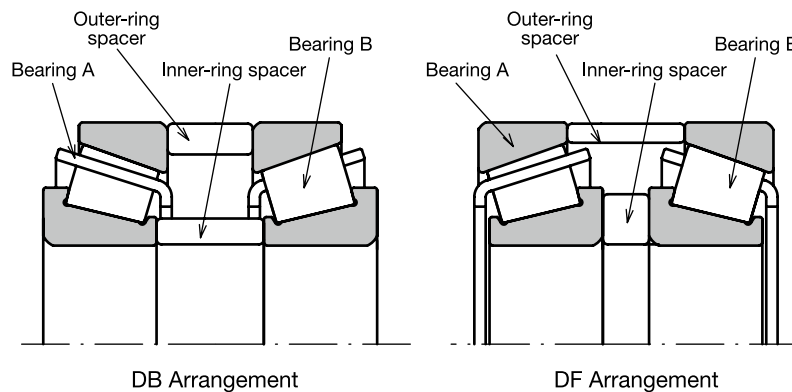
$\Delta_a < 0$ signifies a preload.

In the case of a DF arrangement, measure the outer ring instead of the inner ring. This gives the following equation for axial clearance:

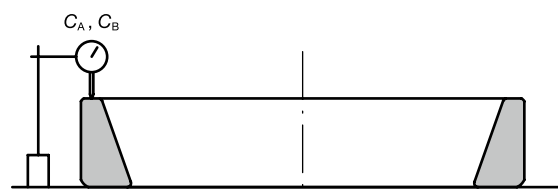
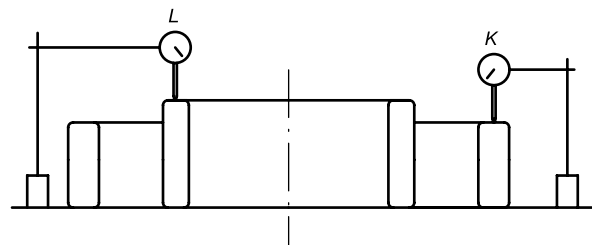
$$\Delta_a = (K-L) - (f_A + f_B) = (K-L) - [(T_A - C_A) + (T_B - C_B)]$$

Tapered roller bearings in DF arrangement are often operated without the use of an inner-ring spacer, so that the inner rings of both bearings touch directly. In this case, $L = 0$.

Since the cages protrude, please make sure you place the bearings with the correct side onto the cradle when measuring tapered roller bearings and take care to avoid mechanical interaction with other parts so as to prevent cage deformation.



- f : Front face stand-out
- b : Back face stand-out
- T : Assembled bearing width
- C : Outer ring width
- B : Inner ring width
- K : Outer-ring spacer width
- L : Inner-ring spacer width



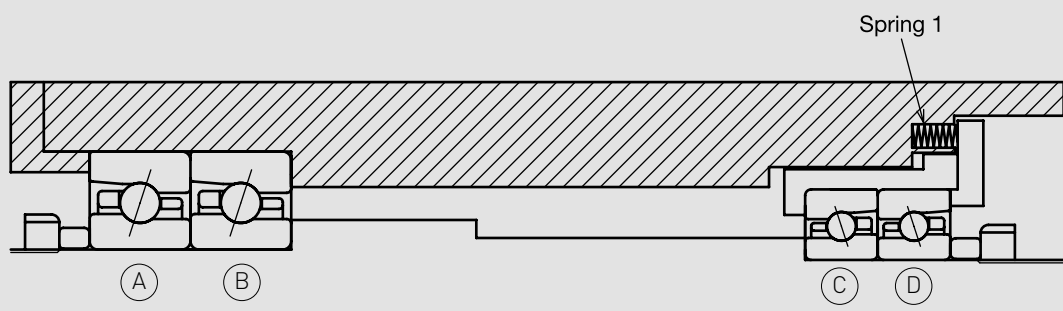
(2) Constant Pressure Preload

Constant pressure preload is achieved using a coil or disc spring. Even if the relative position of the bearings changes during operation, the magnitude of the preload remains relatively constant throughout all the various operation conditions. Therefore constant pressure preload is used for combinations of angular contact ball bearings in high-speed applications.

One example is shown in Fig. 4.6. Since spring rigidity is, as a rule, small compared with bearing rigidity, the change in spring preload due to bearing displacement is negligible. Thus, the preload applied to bearings C, D and E in the figure below will be approximately the same in both vertical shaft and horizontal shaft configurations.

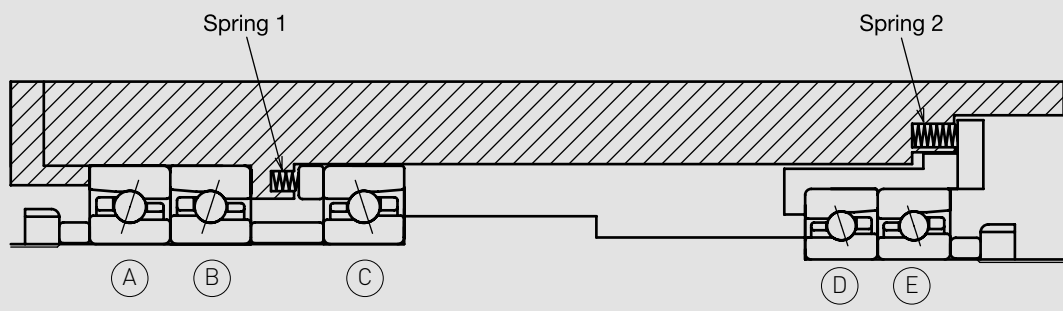
However, in addition to the forces of each spring, bearings A and B will also be affected by the dead weight of the shaft in vertical operation. Axial loads exerted from the free end towards the fixed end (from right to left in the figure below) will reduce preload of bearings A and B. It is necessary to consider these effects when setting preloads for bearings A and B so that they will not become unloaded.

Fig. 4.6 Distribution of Preload in Constant Pressure Preload



| | Preload (N) | | | |
|------------------|-------------|-----------|-----------|-----------|
| | Bearing A | Bearing B | Bearing C | Bearing D |
| Horizontal shaft | 250 | 250 | 250 | 250 |
| Vertical shaft | 200 | 200 | 250 | 250 |

(a) Shaft weight = 100 N, Spring 1 = 500 N



| | Preload (N) | | | | |
|------------------|-------------|-----------|-----------|-----------|-----------|
| | Bearing A | Bearing B | Bearing C | Bearing D | Bearing E |
| Horizontal shaft | 250 | 250 | 300 | 100 | 100 |
| Vertical shaft | 200 | 200 | 300 | 100 | 100 |

(b) Shaft weight = 100 N, Spring 1 = 300 N, Spring 2 = 200 N

4. Preload and Rigidity

Preload and Axial Rigidity

Generally, when an axial load F_a is applied to a bearing it is possible to calculate the axial displacement δ_a of the bearing using the following formula:

For angular contact ball bearings: $\delta_a = cF_a^{2/3}$

For tapered roller bearings: $\delta_a = cF_a^{0.9}$

Where c is a constant that depends on the bearing's internal design.

As the displacement is increased by axial load to the 0.9 for tapered roller bearings and the 2/3 for ball bearings, the effect of preload application to reduce displacement is stronger with ball bearings.

The above equation refers to elastic displacement between the rolling elements (balls, tapered rollers) and the inner and outer rings. Actual axial displacement will also depend on the material and the thickness of shaft and housing as well as on shaft fit and housing fit. For axial displacement that takes these mounting factors into account, please contact NSK.

Fig. 4.7 Axial Load and Axial Displacement in Single Row Bearings

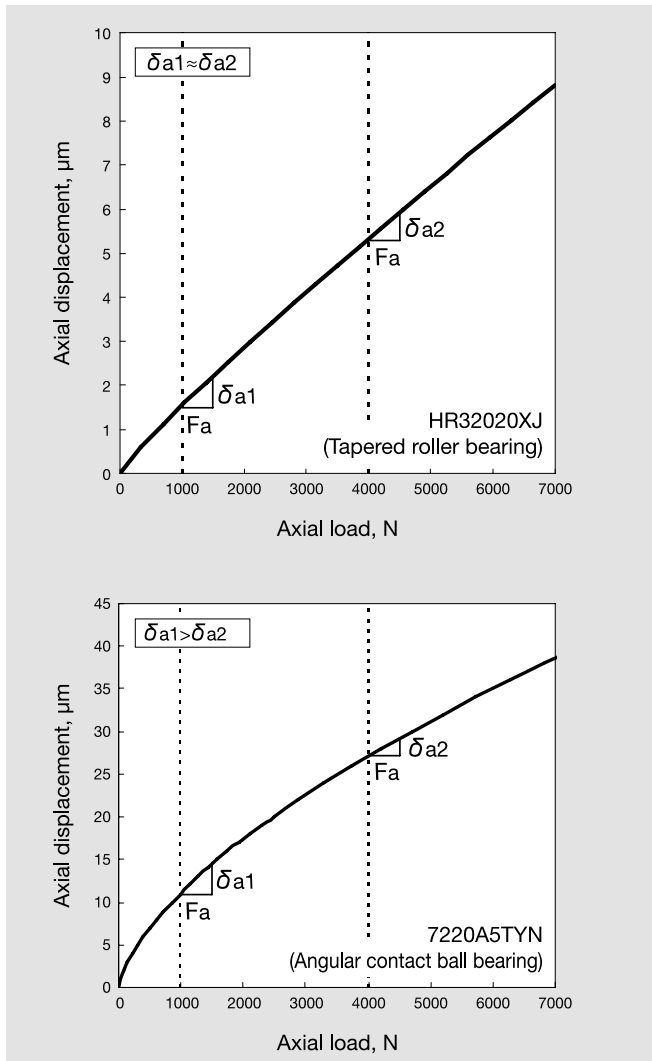
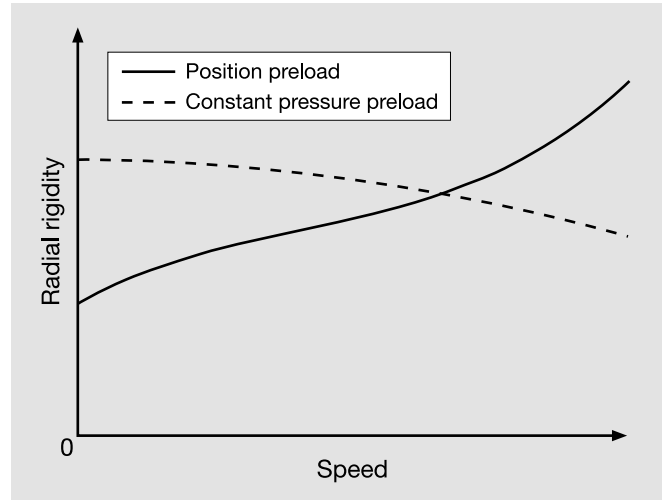


Fig. 4.8 Comparison of Rigidity under each Preloading Method



Comparison of Preloading Methods

Position preload and constant pressure preload can be compared as follows:

- (1) Position preload provides greater bearing rigidity than constant pressure preload at the same amount of preload. In other words, the deflection due to external loads is less for bearings with position preload.
- (2) Under position preload, the preload varies during operation depending on such factors as a difference in axial expansion due to a temperature difference between the shaft and the housing, a difference in radial expansion due to a temperature difference between the inner and outer rings, and the effect of centrifugal force acting on the rolling elements. Under constant pressure preload, the variation of spring load due to shaft expansion and contraction etc. is minimal, so its effect on preload is negligible.

With position preload, bearing rigidity will generally increase with spindle speed because preload increases during operation. In contrast, the preload level with constant pressure preload will remain constant. However, the contact angle will change due to centrifugal force acting on the balls (Fig. 1.7 on page 199) and result in a decrease of rigidity (Fig. 4.8).

Consequently, position preloads are generally preferred where increasing rigidity is desired, while constant pressure preloads are more suitable for high-speed applications, for applications where axial vibration needs to be prevented, for use with thrust bearings on horizontal shafts, etc.

Preloading Amount

A larger preload results in higher rigidity. However, increasing preload reduces fatigue life and increases heat generation. In extreme cases, excessive preload may result in abnormal wear or even seizure.

Therefore, the amount of preload needs to be carefully selected taking into consideration the type of application and the operating conditions, to avoid larger preload than necessary.

High-Speed Spindles and Preload

When bearings are operated at high speed, internal load increases as a result of the expansion of the inner ring due to centrifugal force, the effect centrifugal force has on balls, and the temperature difference between inner and outer ring. Then, surface contact pressure between the balls and the raceways of the inner and outer ring will increase. For bearings having a contact angle, such as angular contact ball bearings, pure rolling motion will be accompanied by sliding as a result of spin moments and gyroscopic moments on the balls. Sliding increases as bearing speed increases. As a result, the intensity of heat generated in the contact areas increases and the viscosity of the lubricating oil decreases. In some cases, a breakdown of the oil film occurs, which results in bearing seizure. This means that even if contact surface pressure were to remain unchanged from low-speed operation to high-speed operation, heat generation would still increase as speed increases due to sliding.

At NSK, we calculate contact surface pressure and slip rate generated during high-speed operation by computer. Based on our own abundant empirical test data as well as market results, we have established limiting factors according to the lubricating method and rotating speed; this is the foundation on which we determine preload. For applications exceeding $800,000 d_m n$, please contact NSK.

For high-speed bearings in constant pressure preload, a medium preload (M) per row is commonly chosen as a guideline value and then adjusted according to the required rigidity and the temperature rise in high-speed operation.

Preload for Thrust Bearings

Thrust bearings generally require an axial load in order to prevent slipping between the rolling elements and the washers.

The minimum axial load required to prevent rolling element slippage can be calculated using the equation below. In cases where shaft dead weight is insufficient, a preload needs to be added, e.g. by a spring.

For minimum axial load in the case of horizontal shafts, please contact NSK.

For thrust ball bearings: $F_{a \min} = Mn^2$

where $F_{a \min}$: Minimum axial load (kN)
 M : Minimum load factor (listed in bearing tables)
 n : Maximum speed during operation (min^{-1})

For thrust cylindrical roller bearings: $F_{a \min} = 0.0005C_{0a} + Mn^2$

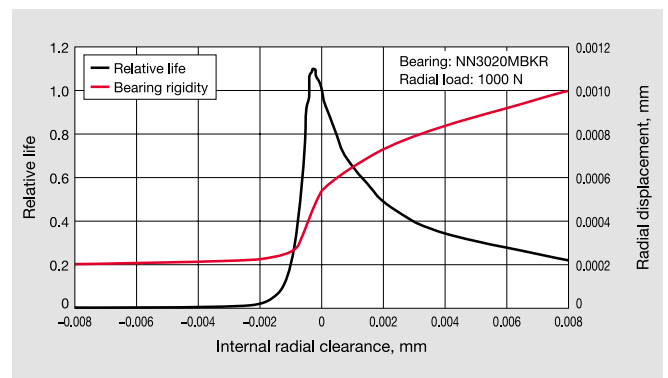
where $F_{a \min}$: Minimum axial load (kN)
 M : Minimum load factor (listed in bearing tables)
 C_{0a} : Basic static axial load rating (kN)
 n : Maximum speed during operation (min^{-1})

Internal Clearance in Cylindrical Roller Bearings

In order for machine tool spindles to have high running accuracy and rigidity, bearings are used with minimum internal clearance or preload after mounting. When using cylindrical roller bearings, bearings with tapered bores are usually used to allow easier adjustment of internal clearance. In general, cylindrical roller bearings for the front end (fixed end) of the spindle are adjusted upon mounting to have a preload during operation. Bearings for the rear end (free end) are adjusted upon mounting to produce a slight clearance during operation. The amount of internal radial clearance after mounting is determined based on several factors such as speed, load, lubricating method, bearing size, required rigidity, service life, etc.

Fig. 4.9 shows the relationship between internal radial clearance and rolling fatigue life as well as the relationship between internal radial clearance and radial elastic displacement for a cylindrical roller bearing (NN3020, bore diameter 100 mm, outside diameter 150 mm, width 37 mm).

Fig. 4.9 Influence of Internal Radial Clearance on Rolling Fatigue Life and Rigidity in a Double-Row Cylindrical Roller Bearing



5. Limiting Speeds

Limiting Speeds

The limiting speeds listed in the bearing tables are guideline values. They are applicable when all of the following criteria are met:

- A single bearing, appropriately preloaded using springs
- A spindle system controlled for unbalance
- Good heat dissipation
- Good lubrication
- Inner ring rotation

These values are not guaranteed for continuous operation over a prolonged period. Especially in the case of grease lubrication, it is recommended to choose suitable speeds taking grease life into consideration.

The limiting speeds with grease lubrication require appropriate amounts of high quality grease to be applied appropriately as well as sufficient run-in. Refer to page 258 for grease application procedures, page 270 for running-in.

Limiting speeds for oil lubrication are based on oil-air (or oil mist) lubrication. It is possible to achieve higher speeds in cases where oil serves to efficiently remove heat, as in jet lubrication.

In order to achieve high-speed operation, it is necessary to keep bearing load (including internal load), heat generation and temperature increase down. In addition to those mentioned, the following factors also exert an influence on limiting speeds:

(1) Preloading Method

Under position preload, internal preload increases when speed is increased. As a general rule, limiting speed with position preload will be lower than with constant pressure preload.

(2) Bearing Positioning and Arrangement

The number of rows in a combination of bearings affects load distribution. The limiting speed will be determined by the bearing operating under the most stress within a combination. In addition, even under the same preload, heat dissipation will be affected by the presence or absence of spacers and by spacer length.



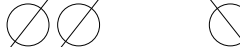

(3) Bearing Load

High speed and heavy load are difficult to combine. Load endurance is affected by speed.

(4) Drive Method

Spindle drive systems can be classified roughly into three groups: (a) coupling drives (b) built-in motor drives (c) belt or gear drives. (a) High eccentricity in coupling drives leads to shaft vibrations that result in lower limiting speeds. (b) With built-in motor drives, internal heat generation of the spindle is high; so it is especially bearings located near the motor that could be affected and damaged by heat. In spindles equipped with jacket cooling, the temperature difference between the inner ring and the outer ring of the bearing will

Table 5.1 Speed Factors for Position Preload

| | Arrangement | Preload after mounting | | | |
|------|--|------------------------|------|------|------|
| | | EL | L | M | H |
| DB |  | 0.85 | 0.80 | 0.65 | 0.55 |
| DBB |  | 0.80 | 0.75 | 0.60 | 0.45 |
| DBD |  | 0.75 | 0.70 | 0.55 | 0.40 |
| DBBD |  | 0.75 | 0.70 | 0.55 | 0.40 |

likely increase; in the case of position preload this results in the internal load increasing, which in turn means lower limiting speeds (Fig. 5.2). (c) In gear or belt drives, the driving force itself may have to be considered. Caution is required with high-torque spindles and high-speed spindles in particular.

(5) Mounting Conditions

In the case of position preload, the shaft fit will affect preload. Spacer length and tightening force also affect bearing clearance, thereby changing preload.

Housing fit conditions will greatly influence preload, particularly during operation. Too little clearance between bearing and housing will lead to an interference fit due to the difference in heat expansion between bearing and housing; this increases internal preload (Fig. 5.3).

If cylindrical roller bearings are mounted with excessive negative clearance, the limiting speed will decline due to rising heat generation. (page 48)

Speed Factors for Position Preload

The limiting speed of a combination of angular contact ball bearings is calculated by multiplying the limiting speed of a single bearing in the combination by the appropriate adjustment factor listed in Table 5.1. The preload classification in the table refers to the preload after the bearings have been attached to the spindle (i.e. preload after mounting).

Usually, preload after mounting is affected by shaft fit and spacer deformation and may exceed that resulting from initial axial clearance. For example, an EL preloaded bearing mounted with high interference, may have a preload after mounting that is equivalent to an M preload. It will be necessary to adjust axial clearance using spacers according to the conditions in which the bearings are used.

In order to maintain stable operation over time, it is advisable to reduce the values given in Table 5.1 further by a safety factor of 0.75.

Calculation example:

Target value for 70BNR10HTDB, EL preload after mounting, grease lubrication: (limiting speed) $20000 \times (\text{EL}) 0.85 \times (\text{safety factor}) 0.75 = 12750 \text{min}^{-1}$

Factors that Change Preload

Fig. 5.1 Preload Setting Study Flow

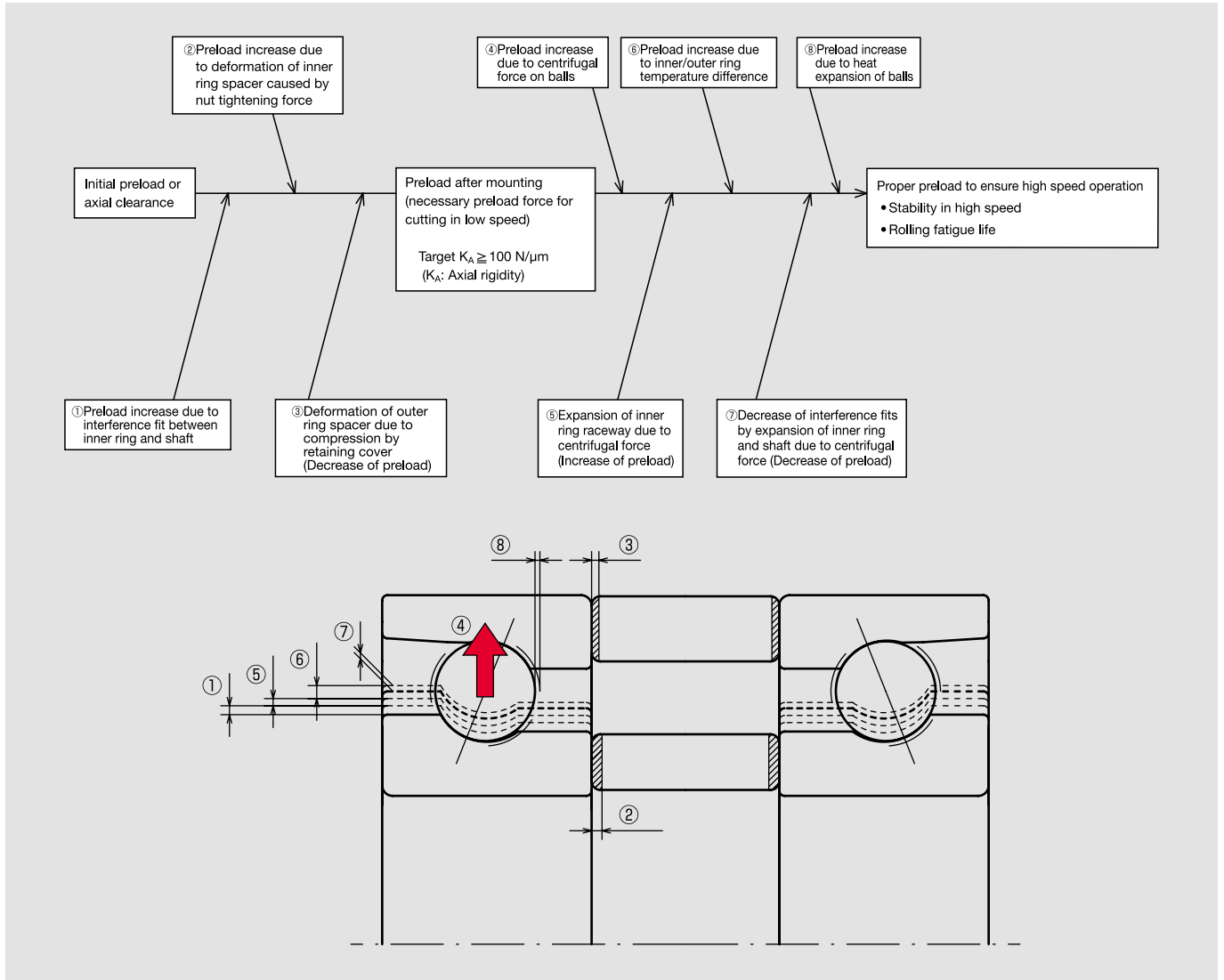


Fig. 5.2 The Influence of the Jacket Cooling on Limiting Speed

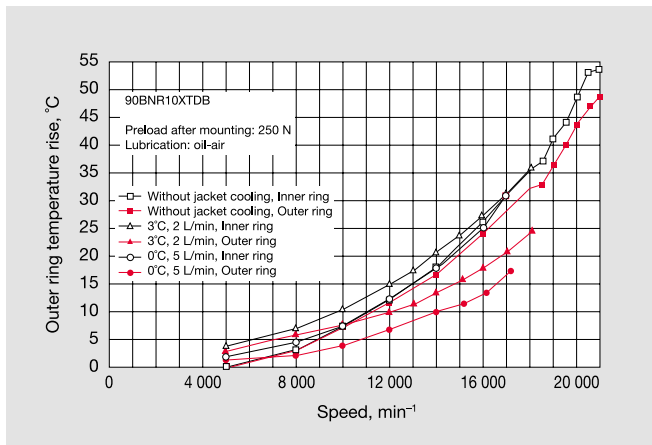
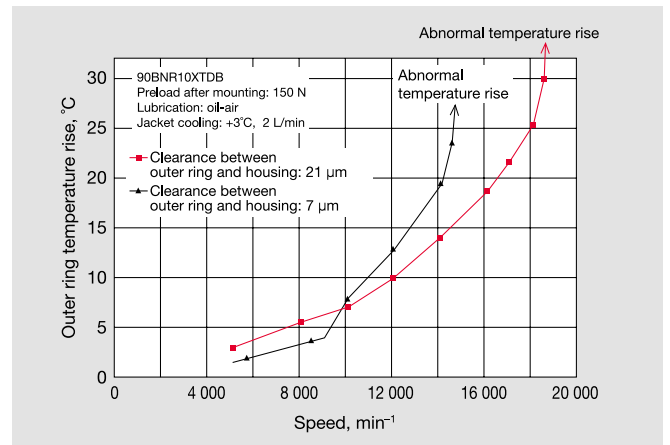


Fig. 5.3 The Influence of the Clearance between the Bearing & the Housing on Limiting Speed



6. Lubrication

Purposes of Lubrication

The main purpose of lubrication is to reduce friction and wear inside the bearing and thereby to prevent seizure. The effects of lubrication may be briefly explained as follows:

(1) Reduction of Friction and Wear

Direct metallic contact between the bearing rings, rolling elements, and cage, which are the basic parts of a bearing, is prevented by an oil film which reduces the friction and wear in the contact areas.

(2) Extension of Fatigue Life

Appropriate lubrication of the rolling contact surfaces extends the rolling fatigue life of bearings. This requires suitable viscosity of the lubricant. If the viscosity of the oil is too low so the film thickness is insufficient, rolling fatigue life will be shortened.

(3) Dissipation of Heat

Circulating lubrication may be employed to remove frictional heat or heat transferred to the bearing from the outside. This prevents the bearing from overheating and the lubricant itself from deteriorating.

(4) Others

Adequate lubrication also helps to prevent foreign material from entering the bearings and guards against corrosion or rusting.

Lubricating Methods

For machine tool spindles in which high accuracy is important, it is necessary to prevent excessive temperature rise of the spindle to reduce thermal deformation.

Bearing heat generation is divided into a load term determined by the bearing type and load, and a speed term determined by the lubricating method and speed.

Generally, the speed term is greater, but if a lubricating method resulting in a small speed term is selected, the influence of the load term cannot be disregarded. Therefore, it is important to select a low heat generating bearing (load term) and lubricating method (speed term).

Regarding heat generation, both the lubricating method and the quantity of lubricant have important effects. Lubrication using a small amount of grease is common since this method is economical, maintenance free, and there is little heat generation. The oil-air lubricating method requiring a minimum quantity of oil was developed to maintain a constant low temperature in conjunction with high speeds. Refer to Table 6.1. for a comparison of lubricating methods.

The relation between oil quantity and heat generation

(frictional loss) and temperature rise is already known as shown in Fig. 6.1. In zone A, oil is employed in the minimal quantity necessary. This minimizes agitation resistance and the amount of associated heat generation. However, caution is required since oil quantities lower than zone A pose the risk of insufficient lubrication causing heat increase and bearing failure.

In zone B, the oil quantity is higher which means more heat is generated due to oil agitation. However, once a certain quantity is exceeded, temperature decreases as the oil transports some of the heat away from the bearing.

In this case, the amount of oil needed depends on the oil drain features of the machine, allowable temperature, heat dissipation, and the heat generation characteristics of the oil due to agitation resistance. The adequate oil amount is thus often determined empirically.

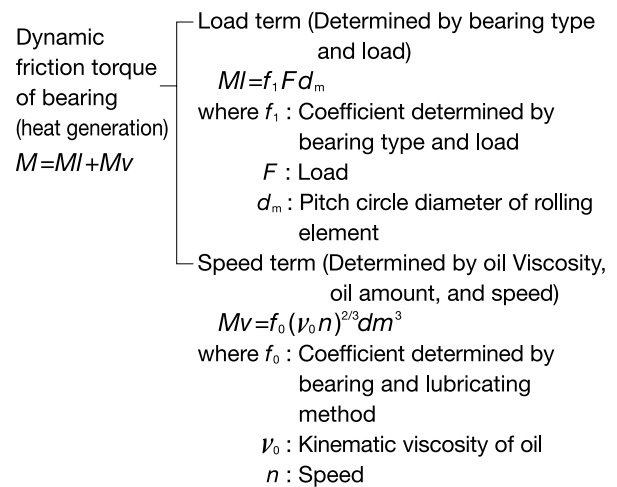


Fig. 6.1 Oil Quantity and Temperature Rise

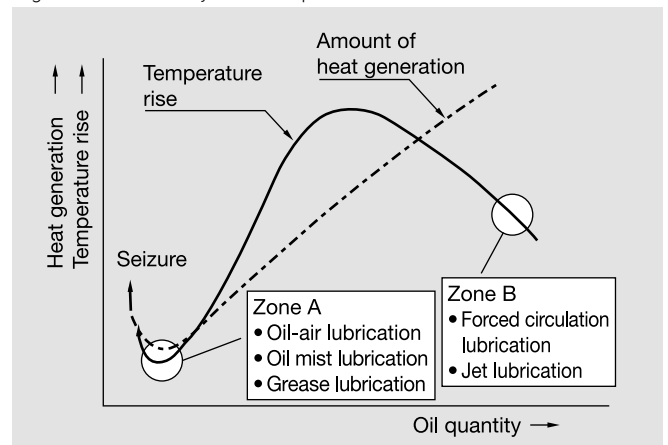


Table 6.1 Comparison of Lubricating Methods

| Lubricating Method | Advantages | Disadvantages |
|-----------------------------|---|---|
| Grease Lubrication | <ul style="list-style-type: none"> - Cost is low. - Limitation of temperature rise is possible. - Maintenance free. | <ul style="list-style-type: none"> - If packed grease deteriorates, seizure may occur. - May allow penetration of dust or cutting fluid. |
| Oil Mist Lubrication | <ul style="list-style-type: none"> - Since new oil is always fed, no fear of oil deterioration. - Dust and cutting fluid cannot easily enter. | <ul style="list-style-type: none"> - Pollution of environment. - Oil supply quantity varies depending on the oil viscosity and temperature, so control of a small flow rate is difficult. - It is difficult to confirm that oil is actually fed. |
| Oil-Air Lubrication | <ul style="list-style-type: none"> - Since oil quantity control is possible, the optimum quantity of oil is fed and heat generation is low. - Besides little heat-generation, there is a cooling effect of the air, so the temperature rise low. - Since new oil is always fed, no fear of oil deterioration. - Dust, cutting fluid cannot easily enter. - Environmental pollution mist is slight. | <ul style="list-style-type: none"> - Cost is rather high. - Confirmation of whether oil is actually fed to bearing is difficult. |
| Jet Lubrication | <ul style="list-style-type: none"> - Since the oil flow rate is high, dust and cutting fluid cannot enter and seizure hardly ever occurs. - Because of cooling by oil, the bearing temperature can be controlled to some degree. | <ul style="list-style-type: none"> - Frictional loss is high. - Since oil leaks, it is difficult to use for vertical spindles. - Cost is high. |

Grease Lubrication

(1) Recommended Greases

For grease lubrication of bearings in high-speed machine tool spindles that require low temperature rise and long life, a consistency class 2 or 3 (NLGI) grease with a synthetic base oil (diester, diester + mineral oil, etc.) is recommended.

Table 6.2 lists the brand names and properties of greases widely used in machine tool spindles and ball screw support bearings.

Grease life depends to a large degree upon operating temperature. Therefore, it is necessary to keep the temperature of the bearing (including atmospheric temperature) cool in order to extend grease life.

(2) Grease Quantities for High-Speed Spindle Bearings

To operate bearings at high speed with grease lubrication, the recommended quantity to be packed is 10% to 30% of

internal space. If too much grease is packed, abnormal heat generation occurs especially during running-in; this may cause the grease to deteriorate. To avoid such a risk, it is necessary to run in spindles for a sufficient time. Based on accumulated experience, NSK determines packing quantities that allow easy running in and will provide sufficient lubrication. These recommended grease quantities are listed in the table on page 259.

(3) Grease Quantities for Ball Screw Support Bearings

As bearings for ball screw support are usually operated at slow speed, under high load, and in intermittent operation, we recommend a grease quantity of 30% to 55% of internal space for increased reliability. Recommended grease quantities for each bearing are listed in the bearing tables for ball screw support bearings.

Table 6.2 Grease Brand Names and Properties

| Brand Name | Thickener | Base Oil | Base Oil Viscosity, mm ² /s (40°C) | Dropping Point (°C) | Working (1) Temperature Range (°C) | Main Applications |
|-------------------------------|----------------|---------------------------------|---|---------------------|------------------------------------|---|
| MTE Grease | Barium complex | Mineral oil + Ester oil (3) | 23 | >260 | -20 to +130 | Bearings for high-speed spindles |
| MTS Grease | Urea (2) | Poly-α-olefin+Ester oil (3) | 22 | >220 | -40 to +130 | Bearings for high-speed spindles |
| TURMOGREASE HIGHSPEED L252 | Lithium soap | Poly-α-olefin+Ester oil (3) | 25 | >250 | -50 to +120 | Bearings for high-speed spindles |
| ISOFLEX NBU15 | Barium complex | Mineral oil + Ester oil (3) | 23 | >260 | -20 to +120 | Bearings for spindles |
| STABURAGS NBU 8 EP | Barium complex | Mineral oil | 105 | >220 | -10 to +130 | Bearings for high load spindles |
| EA7 Grease | Urea (2) | Poly-α-olefin oil | 46 | >260 | -40 to +160 | Bearings for motors |
| ENS Grease | Urea (2) | Polyol ester oil (3) | 30.5 | >260 | -40 to +160 | Bearings for motors |
| Alvania S2 | Lithium | Mineral oil | 130 | 185 | -10 to +110 | Ball screw support bearings |
| WPH | Urea (2) | Poly-α-olefin oil | 95.8 | 259 | -40 to +150 | Ball screw support bearings |
| FS2 | Lithium soap | Mineral oil | 139 | 205 | -10 to +110 | Ball screw support bearings, heavy load applications |
| Multemp PS No. 2 | Lithium soap | Poly-α-olefin + Diester oil (3) | 15.9 | 190 | -50 to +110 | Ball screw support bearings, light load applications |
| Klüberplex BEM 41-132 | Lithium soap | Mineral oil + Poly-α-olefin oil | 120 | >250 | -40 to +150 | Ball screw support bearings (standard grease for BSBD Series) |

(1) For special application environments such as operating temperatures close to the low end or high end of the range or vacuum etc., please contact NSK.

(2) Caution: Grease containing urea thickener degrades fluorine-based materials.

(3) Caution: Ester oil-based grease causes acrylic materials to swell.

6. Lubrication

Oil Lubrication

For oil lubrication of bearings, highly purified mineral and synthetic oils with good anti-oxidative and anti-corrosive properties are used that perform well under high loads. The most important factor to consider when choosing lubricating oil is the viscosity it will exhibit at operating temperature. If viscosity is too low, the oil film will be insufficient which may cause abnormal wear and seizure. If viscosity is too high, the agitation resistance of the oil will generate more heat and lead to power loss. Oil film formation is also influenced by operating speed and load conditions. Generally, the higher the operating speed the lower the viscosity of the oil used. The higher the bearing load, or the larger the size of the bearing, the higher the viscosity of the oil used. Table 6.3 shows guideline values for oil viscosity at oil temperatures in the vicinity of operated bearings under normal operating conditions. To aid your selection of lubricating oil, Fig. 6.2 shows the relationship between oil temperature and viscosity.

(1) Oil Mist and Oil-Air Lubrication (Minimal Oil Quantity Lubrication)

Oil mist lubrication is a method of spraying oil by turning it into a mist using compressed air. Oil-air lubrication is a method of feeding oil continuously by injecting oil into a compressed air stream by means of a mixing valve that intermittently discharges the minimum quantity of oil using a constant-quantity piston. Fig. 6.3 shows the recommended oil quantity for these minimal oil quantity lubrication methods; each quantity is for one bearing. In the case of oil mist lubrication, it is necessary to adjust the oil

quantity to accommodate the effects of the branches in distribution tubing and leakage from the gaps around the spacers. For the position of the spray nozzle, please refer to pages 242-243.

Example of an oil-air lubrication system
Air supply

- Clean and dry compressed air
- Dew point 3°C or lower
- Air pressure: 0.2 to 0.5 MPa (0.4 to 0.45 recommended)

Lubricating oil

- Clean high-speed spindle oil, or turbine oil (With online filter, if needed)
- Viscosity: 22 to 68cst

Distributing tube for oil-air

- Length of distribution tubing: 1.5 to 5 m (3.5 to 5 m recommended)
- Inner diameter of distribution tubing: 2 to 2.5 mm (transparent urethane tube with 4mm outer diameter etc.)

Please refer to the instruction manual of your lubrication device manufacturer etc. for details.

Table 6.3 Required Viscosity of Lubricating Oil for Each Bearing Type

| Bearing Type | Kinematic Viscosity during Operation |
|--|--------------------------------------|
| Ball bearings, Cylindrical roller bearings | 13 cSt or higher |
| Tapered roller bearings | 20 cSt or higher |

Fig. 6.2 Relationship of Viscosity and Temperature of Lubricating Oil

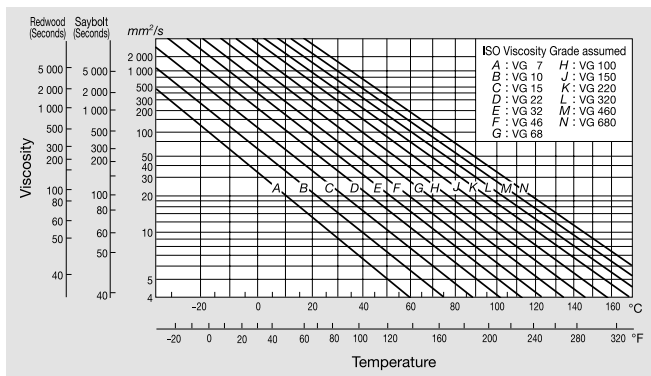


Fig. 6.3 Recommended Oil Quantity for Each Bore Size of Bearing (Minimal Oil Quantity Lubrication)

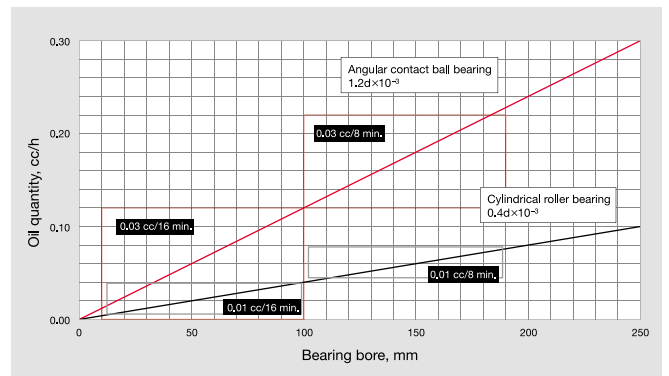
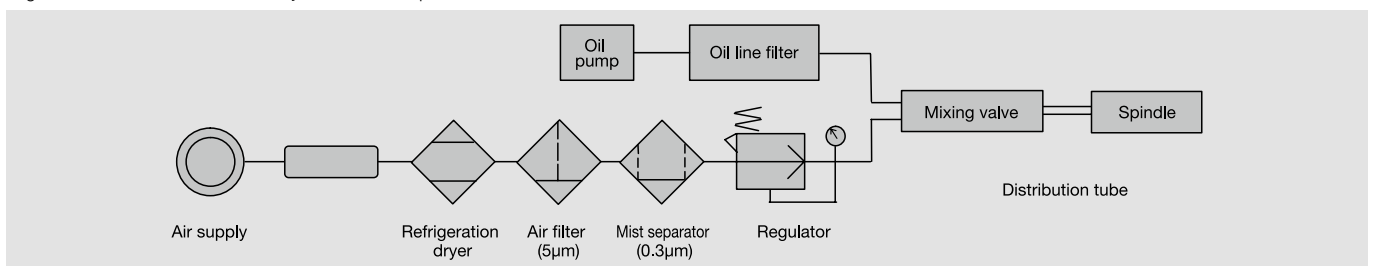


Fig. 6.4 Oil-air Lubrication System (Example)

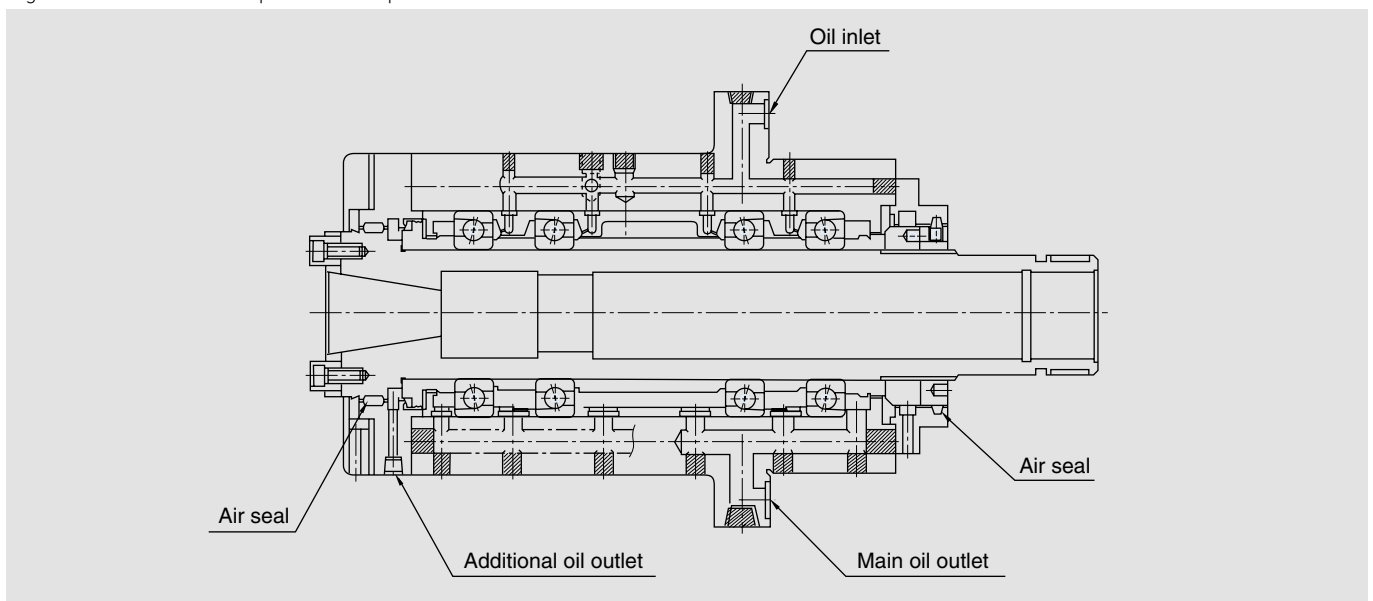


(2) Jet Lubrication

Jet lubrication is mainly used for high-speed bearings with a $d_m n$ value of more than 1.0×10^6 . Jets of lubricating oil pass through the bearings via one or several nozzles at a constant pressure. In high-speed applications, the air surrounding the bearing rotates together with the bearing and forms a wall of air. The speed of the jet from each nozzle must exceed the circumferential speed of the inner ring outside surface by at least 20%. To cool bearings and shaft down uniformly, it proves advantageous to increase the number of nozzles. Enlarging the oil discharge outlet or employing forced discharge should also be considered so as to improve heat removal.

Though it increases equipment size, this method is used for machine tool spindle bearings in some applications as a means of achieving stable operation at ultra-high speeds (see Fig. 6.5). For the position of the spray nozzle, please refer to pages 242-243.

Fig. 6.5 Jet Lubrication Spindle (Example)



Oil Amount in Forced-Circulation Lubrication

The empirical equation below can be used to estimate the amount of oil needed for a bearing with forced-circulation lubrication.

$$Q = \frac{0.19 \cdot 10^{-5}}{T_2 - T_1} d \cdot \mu \cdot n \cdot F \text{ (N)} \dots\dots\dots (1)$$

- where Q : Oil supply rate (liters/min)
- T_1 : Oil temperature at oil inlet (°C)
- T_2 : Oil temperature at oil outlet (°C)
- d : Bearing bore (mm)
- μ : Dynamic friction coefficient
(guideline value, determined by bearing type, see Table 6.4)
- n : Bearing speed (min⁻¹)
- F : Bearing load (N)

Table 6.4 Dynamic Friction Coefficient (Guideline Values)

| Bearing Type | Coefficient μ |
|------------------------------------|-------------------|
| Angular contact ball bearings | 0.0015 |
| Thrust ball bearings | 0.0011 |
| Cylindrical roller bearings | 0.0010 |
| Tapered roller bearings | 0.0022 |
| Thrust cylindrical roller bearings | 0.0040 |

The value calculated from equation (1) is a guideline only and may be modified after considering such factors as the restrictions on oil inlet and oil outlet bore sizes.

Note that the oil drain pipe and oil outlet bore must be designed large enough to prevent stagnation of the circulating oil in the housing.

The oil amount obtained from equation (1) is too large for large bearings (bore sizes of more than 200 mm) if they are exposed to heavy loads. In these cases a value of about 2/3 to 1/2 of the calculated value should be taken as a guideline and the final value determined after having been confirmed on the actual machine.

7. Bearing Tolerances

The tolerance for the boundary dimensions and running accuracy of NSK radial bearings are specified by the Accuracies of Rolling Bearings in ISO 492/199/582/1132-1, and Rolling Bearing Tolerances in JIS B 1514. In addition to the above tolerances, NSK manufactures angular contact ball bearings with precision classes ABEC 5, 7, and 9 as specified by American Bearing Manufacturers Association (ABMA) Standard 20.

Rough definitions of the items listed for running accuracy and their measuring methods are described in Table 7.1 and Fig 7.1. Further details are available in ISO 5593, Rolling Bearings Vocabulary in JIS B 0104, and Measuring Methods for Rolling Bearings in JIS B 1515.

Table 7.1

| Running Accuracy | | Inner Ring | Outer Ring | Dial Gauge |
|--|------------|--|------------|------------|
| Radial runout of inner ring of assembled bearing | K_{ia} | Rotating | Stationary | A |
| Radial runout of outer ring of assembled bearing | K_{ea} | Stationary | Rotating | A |
| Axial runout of inner ring of assembled bearing | S_{ia} | Rotating | Stationary | B_1 |
| Axial runout of outer ring of assembled bearing | S_{ea} | Stationary | Rotating | B_2 |
| Perpendicularity of inner ring face surface with respect to the bore | S_d | Rotating | Stationary | C |
| Perpendicularity of outer ring outside surface with respect to the face | S_D | — | Rotating | D |
| Variation in thickness between shaft washer (housing washer) raceway and back face | S_i, S_e | Only the shaft washer or the housing washer is to be rotated | | E |

Tolerances for Radial Bearings (excluding Tapered Roller Bearings)

Inner Ring

Table 7.2 Inner Ring (Class 5)

Unit: μm

| Nominal Bore Diameter d (mm) | | Deviation of Mean Bore Dia. in a single plane Δ_{dmp} [2] | | Bore Dia. Variation in a Single Radial Plane V_{dp} [2] | | Mean Bore Dia. Variation V_{dmp} [2] | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} [4] | Deviation of Single Inner Ring Width Δ_{Bs} | | | Inner Ring Width Variation V_{Bs} |
|--------------------------------|-------|--|-----|---|---------|--|--------------------------------------|-----------------------------------|--|--|------|------|-------------------------------------|
| Over | Incl. | High | Low | Diameter Series | | Max. | Max. | Max. | Max. | Max. | High | Low | Max. |
| | | | | 9 | 0, 2, 3 | | | | | | | | |
| 2.5 | 10 | 0 | -5 | 5 | 4 | 3 | 4 | 7 | 7 | 0 | -40 | -250 | 5 |
| 10 | 18 | 0 | -5 | 5 | 4 | 3 | 4 | 7 | 7 | 0 | -80 | -250 | 5 |
| 18 | 30 | 0 | -6 | 6 | 5 | 3 | 4 | 8 | 8 | 0 | -120 | -250 | 5 |
| 30 | 50 | 0 | -8 | 8 | 6 | 4 | 5 | 8 | 8 | 0 | -120 | -250 | 5 |
| 50 | 80 | 0 | -9 | 9 | 7 | 5 | 5 | 8 | 8 | 0 | -150 | -250 | 6 |
| 80 | 120 | 0 | -10 | 10 | 8 | 5 | 6 | 9 | 9 | 0 | -200 | -380 | 7 |
| 120 | 180 | 0 | -13 | 13 | 10 | 7 | 8 | 10 | 10 | 0 | -250 | -380 | 8 |
| 180 | 250 | 0 | -15 | 15 | 12 | 8 | 10 | 11 | 13 | 0 | -300 | -500 | 10 |
| 250 | 315 | 0 | -18 | 18 | 14 | 9 | 13 | 13 | 15 | 0 | -350 | -500 | 13 |
| 315 | 400 | 0 | -23 | 23 | 18 | 12 | 15 | 15 | 20 | 0 | -400 | -630 | 15 |

Table 7.3 Inner Ring (Class 4)

Unit: μm

| Nominal Bore Diameter d (mm) | | Single plane mean bore Dia. deviation Δ_{dmp} [2] | | Deviation of a Single Bore Dia. Δ_{ds} [2] | | Bore Dia. Variation in a Single Radial Plane V_{dp} [2] | | Mean Bore Dia. Variation V_{dmp} [2] | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} [4] | Deviation of Single Inner Ring Width Δ_{Bs} | | | Inner Ring Width Variation V_{Bs} |
|--------------------------------|-------|--|-----|---|-----|---|---------|--|--------------------------------------|-----------------------------------|--|--|------|------|-------------------------------------|
| Over | Incl. | High | Low | High | Low | Diameter Series | | Max. | Max. | Max. | Max. | High | Low | Max. | |
| | | | | | | 9 | 0, 2, 3 | | | | | | | | |
| 2.5 | 10 | 0 | -4 | 0 | -4 | 4 | 3 | 2 | 2.5 | 3 | 3 | 0 | -40 | -250 | 2.5 |
| 10 | 18 | 0 | -4 | 0 | -4 | 4 | 3 | 2 | 2.5 | 3 | 3 | 0 | -80 | -250 | 2.5 |
| 18 | 30 | 0 | -5 | 0 | -5 | 5 | 4 | 2.5 | 3 | 4 | 4 | 0 | -120 | -250 | 2.5 |
| 30 | 50 | 0 | -6 | 0 | -6 | 6 | 5 | 3 | 4 | 4 | 4 | 0 | -120 | -250 | 3 |
| 50 | 80 | 0 | -7 | 0 | -7 | 7 | 5 | 3.5 | 4 | 5 | 5 | 0 | -150 | -250 | 4 |
| 80 | 120 | 0 | -8 | 0 | -8 | 8 | 6 | 4 | 5 | 5 | 5 | 0 | -200 | -380 | 4 |
| 120 | 180 | 0 | -10 | 0 | -10 | 10 | 8 | 5 | 6 | 6 | 7 | 0 | -250 | -380 | 5 |
| 180 | 250 | 0 | -12 | 0 | -12 | 12 | 9 | 6 | 8 | 7 | 8 | 0 | -300 | -500 | 6 |

[1] Applicable to individual rings manufactured for combined bearings.

[2] Applicable to bearings with cylindrical bores.

[3] Class 3 is NSK's original accuracy. Tolerance of bearing bore diameter and outer ring outer diameter are Class 4. Other tolerances are Class 2.

[4] Applicable to ball bearings.

Remarks: 1. The bore diameter tolerance limit (High) for bearings with cylindrical bores, as specified in this table, is not necessarily applicable within a distance of 1.2 times the chamfer dimension r (Max.) from the ring face.

2. ABMA Standards ABEC5, ABEC7, and ABEC9 are equivalent to ISO (JIS) Classes 5, 4, and 2 respectively. ABMA Standards are applicable to angular contact ball bearings.

Fig. 7.1 Measuring Methods for Running Accuracy

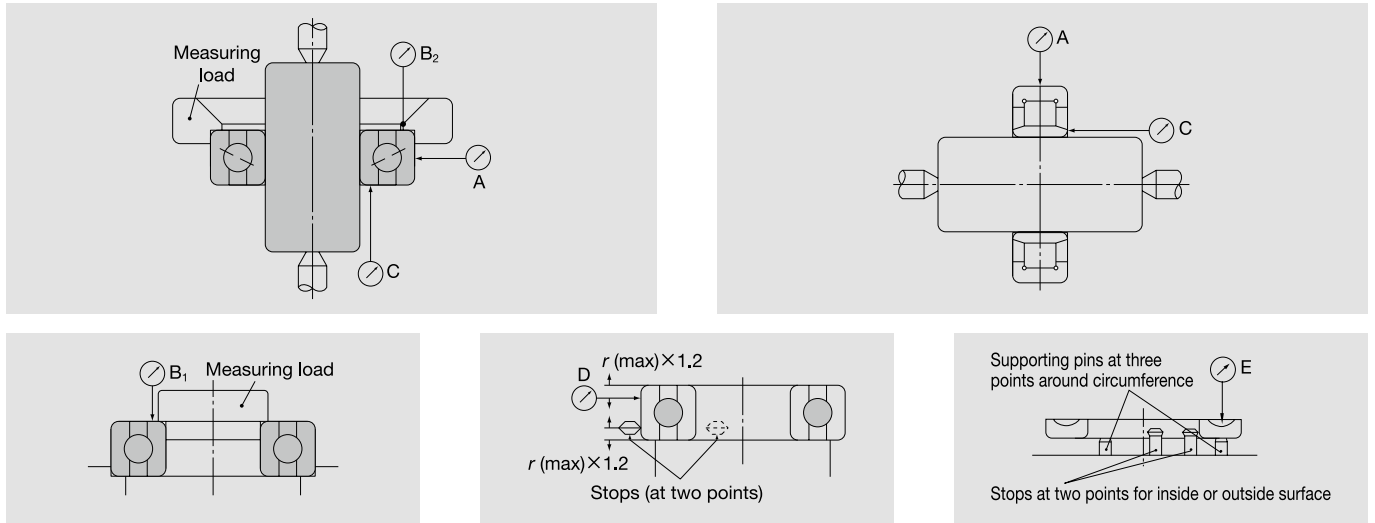


Table 7.4 Inner Ring (Class 3) ⁽³⁾

Unit: μm

| Nominal Bore Diameter d (mm) | | Single Plane Mean Bore Dia. Deviation Δ_{dmp} ⁽²⁾ | | Deviation of a Single Bore Dia. Δ_{ds} ⁽²⁾ | | Bore Dia. Variation in a Single Radial Plane V_{dp} ⁽²⁾ | Mean Bore Dia. Variation V_{dmp} ⁽²⁾ | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} ⁽⁴⁾ | Deviation of Single Inner Ring Width Δ_{Bs} | | | Inner Ring Width Variation V_{Bs} |
|--------------------------------|-------|---|-----|--|-----|--|---|--------------------------------------|-----------------------------------|---|--|----------------|---------------------------------|-------------------------------------|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. | Single Bearing | Single Bearing | Combined ⁽¹⁾ Bearing | Max. |
| 2.5 | 10 | 0 | -4 | 0 | -4 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0 | -40 | -250 | 1.5 |
| 10 | 18 | 0 | -4 | 0 | -4 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0 | -80 | -250 | 1.5 |
| 18 | 30 | 0 | -5 | 0 | -5 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 | 0 | -120 | -250 | 1.5 |
| 30 | 50 | 0 | -6 | 0 | -6 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 | 0 | -120 | -250 | 1.5 |
| 50 | 80 | 0 | -7 | 0 | -7 | 4 | 2 | 2.5 | 1.5 | 2.5 | 0 | -150 | -250 | 1.5 |
| 80 | 120 | 0 | -8 | 0 | -8 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | -200 | -380 | 2.5 |
| 120 | 150 | 0 | -10 | 0 | -10 | 7 | 3.5 | 2.5 | 2.5 | 2.5 | 0 | -250 | -380 | 2.5 |
| 150 | 180 | 0 | -10 | 0 | -10 | 7 | 3.5 | 5 | 4 | 5 | 0 | -250 | -380 | 4 |
| 180 | 250 | 0 | -12 | 0 | -12 | 8 | 4 | 5 | 5 | 5 | 0 | -300 | -500 | 5 |

Table 7.5 Inner Ring (Class 2)

Unit: μm

| Nominal Bore Diameter d (mm) | | Single Plane Mean Bore Dia. Deviation Δ_{dmp} ⁽²⁾ | | Deviation of a Single Bore Dia. Δ_{ds} ⁽²⁾ | | Bore Dia. Variation in a Single Radial Plane V_{dp} ⁽²⁾ | Mean Bore Dia. Variation V_{dmp} ⁽²⁾ | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} ⁽⁴⁾ | Deviation of Single Inner Ring Width Δ_{Bs} | | | Inner Ring Width Variation V_{Bs} |
|--------------------------------|-------|---|------|--|------|--|---|--------------------------------------|-----------------------------------|---|--|----------------|---------------------------------|-------------------------------------|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. | Single Bearing | Single Bearing | Combined ⁽¹⁾ Bearing | Max. |
| 2.5 | 10 | 0 | -2.5 | 0 | -2.5 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0 | -40 | -250 | 1.5 |
| 10 | 18 | 0 | -2.5 | 0 | -2.5 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0 | -80 | -250 | 1.5 |
| 18 | 30 | 0 | -2.5 | 0 | -2.5 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 | 0 | -120 | -250 | 1.5 |
| 30 | 50 | 0 | -2.5 | 0 | -2.5 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 | 0 | -120 | -250 | 1.5 |
| 50 | 80 | 0 | -4 | 0 | -4 | 4 | 2 | 2.5 | 1.5 | 2.5 | 0 | -150 | -250 | 1.5 |
| 80 | 120 | 0 | -5 | 0 | -5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | -200 | -380 | 2.5 |
| 120 | 150 | 0 | -7 | 0 | -7 | 7 | 3.5 | 2.5 | 2.5 | 2.5 | 0 | -250 | -380 | 2.5 |
| 150 | 180 | 0 | -7 | 0 | -7 | 7 | 3.5 | 5 | 4 | 5 | 0 | -250 | -380 | 4 |
| 180 | 250 | 0 | -8 | 0 | -8 | 8 | 4 | 5 | 5 | 5 | 0 | -300 | -500 | 5 |

Inner ring (Class 4Y)

Table 7.6 Tolerance of Bore Diameter of Inner Ring Unit: μm

| Bore diameter (mm) | | Class 4 | | Class 4Y (Controlled to medium value) | |
|--------------------|-------|---------|-----|---------------------------------------|-----|
| Over | Incl. | High | Low | High | Low |
| 30 | 50 | 0 | -6 | -1 | -3 |
| 50 | 80 | 0 | -7 | -2 | -5 |
| 80 | 120 | 0 | -8 | -3 | -6 |
| 120 | 150 | 0 | -10 | -3 | -7 |

* Class 4Y is NSK's proprietary accuracy standard, in which tolerance of bearing bore diameter and outer ring outer diameter are in a special class (controlled to medium value) and running accuracy is Class 4. Since variation of bearing bore diameter and outer ring outer diameter is minimized, P4Y is the most suitable accuracy class for universal combination bearings.

7. Bearing Tolerances

Tolerances for Radial Bearings (excluding Tapered Roller Bearings)

Outer Ring

Table 7.7 Outer Ring (Class 5)

Unit: μm

| Nominal Outside Diameter D (mm) | | Single Plane Mean Outside Dia. Deviation Δ_{Dmp} | | Outside Dia. Variation in a Single Radial Plane V_{Dp} | | | | Mean Outside Dia. Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} (1) | Deviation of Single Outer Ring Width Δ_{cs} | Outer Ring Width Variation V_{cs} | | |
|-----------------------------------|-------|---|-----|--|------|------|------|---------------------------------------|--------------------------------------|--|--|--|-------------------------------------|------|------|
| | | | | Diameter Series | | Max. | Max. | | | | | | | Max. | Max. |
| | | | | 9 | 0, 2 | | | | | | | | | | |
| Over | Incl. | High | Low | Max. | | Max. | Max. | Max. | Max. | Max. | Δ_{cs} | Max. | | | |
| 6 | 18 | 0 | -5 | 5 | 4 | 3 | 5 | 8 | 8 | Equal to the value of inner ring (Δ_{Bs}) of the same bearing number. | 5 | | | | |
| 18 | 30 | 0 | -6 | 6 | 5 | 3 | 6 | 8 | 8 | | 5 | | | | |
| 30 | 50 | 0 | -7 | 7 | 5 | 4 | 7 | 8 | 8 | | 5 | | | | |
| 50 | 80 | 0 | -9 | 9 | 7 | 5 | 8 | 8 | 10 | | 6 | | | | |
| 80 | 120 | 0 | -10 | 10 | 8 | 5 | 10 | 9 | 11 | | 8 | | | | |
| 120 | 150 | 0 | -11 | 11 | 8 | 6 | 11 | 10 | 13 | | 8 | | | | |
| 150 | 180 | 0 | -13 | 13 | 10 | 7 | 13 | 10 | 14 | | 8 | | | | |
| 180 | 250 | 0 | -15 | 15 | 11 | 8 | 15 | 11 | 15 | | 10 | | | | |
| 250 | 315 | 0 | -18 | 18 | 14 | 9 | 18 | 13 | 18 | | 11 | | | | |
| 315 | 400 | 0 | -20 | 20 | 15 | 10 | 20 | 13 | 20 | | 13 | | | | |
| 400 | 500 | 0 | -23 | 23 | 17 | 12 | 23 | 15 | 23 | | 15 | | | | |
| 500 | 630 | 0 | -28 | 28 | 21 | 14 | 25 | 18 | 25 | | 18 | | | | |
| 630 | 800 | 0 | -35 | 35 | 26 | 18 | 30 | 20 | 30 | | 20 | | | | |

Table 7.8 Outer Ring (Class 4)

Unit: μm

| Nominal Outside Diameter D (mm) | | Single Plane Mean Outside Dia. Deviation Δ_{Dmp} | | Deviation of Single Outside Dia. Δ_{Ds} | | | | Outside Dia. Variation in a Single Radial Plane V_{Dp} | | Mean Outside Dia. Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} (1) | Deviation of Single Outer Ring Width Δ_{cs} | Outer Ring Width Variation V_{cs} |
|-----------------------------------|-------|---|-----|--|-----|-----------------|------|--|------|---------------------------------------|--------------------------------------|--|--|--|-------------------------------------|
| | | | | High | Low | Diameter Series | | Max. | Max. | | | | | | |
| | | | | | | 9 | 0, 2 | | | | | | | | |
| Over | Incl. | High | Low | High | Low | Max. | | Max. | Max. | Max. | Max. | Max. | Δ_{cs} | Max. | |
| 6 | 18 | 0 | -4 | 0 | -4 | 4 | 3 | 2 | 3 | 4 | 5 | Equal to the value of inner ring (Δ_{Bs}) of the same bearing number. | 2.5 | | |
| 18 | 30 | 0 | -5 | 0 | -5 | 5 | 4 | 2.5 | 4 | 4 | 5 | | 2.5 | | |
| 30 | 50 | 0 | -6 | 0 | -6 | 6 | 5 | 3 | 5 | 4 | 5 | | 2.5 | | |
| 50 | 80 | 0 | -7 | 0 | -7 | 7 | 5 | 3.5 | 5 | 4 | 5 | | 3 | | |
| 80 | 120 | 0 | -8 | 0 | -8 | 8 | 6 | 4 | 6 | 5 | 6 | | 4 | | |
| 120 | 150 | 0 | -9 | 0 | -9 | 9 | 7 | 5 | 7 | 5 | 7 | | 5 | | |
| 150 | 180 | 0 | -10 | 0 | -10 | 10 | 8 | 5 | 8 | 5 | 8 | | 5 | | |
| 180 | 250 | 0 | -11 | 0 | -11 | 11 | 8 | 6 | 10 | 7 | 10 | | 7 | | |
| 250 | 315 | 0 | -13 | 0 | -13 | 13 | 10 | 7 | 11 | 8 | 10 | | 7 | | |
| 315 | 400 | 0 | -15 | 0 | -15 | 15 | 11 | 8 | 13 | 10 | 13 | 8 | | | |

(1) Applicable to ball bearings.

(2) NSK specification. Tolerance of bearing bore diameter and outer ring outer diameter are Class 4. Other tolerances are Class 2.

Remarks: 1. The outside diameter tolerance limit (Low) for bearings with cylindrical bores, as specified in this table, is not necessarily applicable within a distance of 1.2 times the chamfer dimension r (Max.) from the ring face.

2. ABMA Standards ABEC5, ABEC7, and ABEC9 are equivalent to ISO (JIS) Classes 5, 4, and 2 respectively. ABMA Standards are applicable to angular contact ball bearings.

Table 7.9 Outer Ring (Class 3) [2]

 Unit: μm

| Nominal Outside Diameter D (mm) | | Single Plane Mean Outside Dia. Deviation Δ_{Dmp} | | Deviation of Single Outside Dia. Δ_{Ds} | | Outside Dia. Variation in a Single Radial Plane V_{Dp} | Mean Outside Dia. Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} (') | Deviation of Single Outer Ring Width Δ_{Cs} | Outer Ring Width Variation V_{Cs} |
|-----------------------------------|-------|---|-----|--|-----|--|---------------------------------------|--------------------------------------|---|--|--|-------------------------------------|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. | | Max. |
| 6 | 18 | 0 | -4 | 0 | -4 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | Equal to the value of inner ring (Δ_{Bs}) of the same bearing number. | 1.5 |
| 18 | 30 | 0 | -5 | 0 | -5 | 4 | 2 | 2.5 | 1.5 | 2.5 | | 1.5 |
| 30 | 50 | 0 | -6 | 0 | -6 | 4 | 2 | 2.5 | 1.5 | 2.5 | | 1.5 |
| 50 | 80 | 0 | -7 | 0 | -7 | 4 | 2 | 4 | 1.5 | 4 | | 1.5 |
| 80 | 120 | 0 | -8 | 0 | -8 | 5 | 2.5 | 5 | 2.5 | 5 | | 2.5 |
| 120 | 150 | 0 | -9 | 0 | -9 | 5 | 2.5 | 5 | 2.5 | 5 | | 2.5 |
| 150 | 180 | 0 | -10 | 0 | -10 | 7 | 3.5 | 5 | 2.5 | 5 | | 2.5 |
| 180 | 250 | 0 | -11 | 0 | -11 | 8 | 4 | 7 | 4 | 7 | | 4 |
| 250 | 315 | 0 | -13 | 0 | -13 | 8 | 4 | 7 | 5 | 7 | | 5 |
| 315 | 400 | 0 | -15 | 0 | -15 | 10 | 5 | 8 | 7 | 8 | | 7 |

Table 7.10 Outer Ring (Class 2)

 Unit: μm

| Nominal Outside Diameter D (mm) | | Single Plane Mean Outside Dia. Deviation Δ_{Dmp} | | Deviation of Single Outside Dia. Δ_{Ds} | | Outside Dia. Variation in a Single Radial Plane V_{Dp} | Mean Outside Dia. Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} (') | Deviation of Single Outer Ring Width Δ_{Cs} | Outer Ring Width Variation V_{Cs} |
|-----------------------------------|-------|---|------|--|------|--|---------------------------------------|--------------------------------------|---|--|--|-------------------------------------|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. | | Max. |
| 6 | 18 | 0 | -2.5 | 0 | -2.5 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | Equal to the value of inner ring (Δ_{Bs}) of the same bearing number. | 1.5 |
| 18 | 30 | 0 | -4 | 0 | -4 | 4 | 2 | 2.5 | 1.5 | 2.5 | | 1.5 |
| 30 | 50 | 0 | -4 | 0 | -4 | 4 | 2 | 2.5 | 1.5 | 2.5 | | 1.5 |
| 50 | 80 | 0 | -4 | 0 | -4 | 4 | 2 | 4 | 1.5 | 4 | | 1.5 |
| 80 | 120 | 0 | -5 | 0 | -5 | 5 | 2.5 | 5 | 2.5 | 5 | | 2.5 |
| 120 | 150 | 0 | -5 | 0 | -5 | 5 | 2.5 | 5 | 2.5 | 5 | | 2.5 |
| 150 | 180 | 0 | -7 | 0 | -7 | 7 | 3.5 | 5 | 2.5 | 5 | | 2.5 |
| 180 | 250 | 0 | -8 | 0 | -8 | 8 | 4 | 7 | 4 | 7 | | 4 |
| 250 | 315 | 0 | -8 | 0 | -8 | 8 | 4 | 7 | 5 | 7 | | 5 |
| 315 | 400 | 0 | -10 | 0 | -10 | 10 | 5 | 8 | 7 | 8 | | 7 |

Outer Ring (Class 4Y)

Table 7.11 Tolerance of Outer Diameter of Outer Ring

 Unit: μm

| Outer diameter (mm) | | Class 4 | | Class 4Y (Controlled to medium value) | |
|---------------------|--------------|---------|-----|---------------------------------------|-----|
| Over | Incl. | High | Low | High | Low |
| 30 | 50 | 0 | -6 | -2 | -6 |
| 50 | 80 | 0 | -7 | -2 | -6 |
| 80 | 120 | 0 | -8 | -2 | -6 |
| 120 | 150 | 0 | -9 | -3 | -7 |
| 150 | 180 | 0 | -10 | -3 | -7 |
| 180 | 200 | 0 | -11 | -4 | -9 |
| 200 | 215 and less | 0 | -11 | -2 | -9 |

* Class 4Y is NSK's proprietary accuracy standard, in which tolerance of bearing bore diameter and outer ring outer diameter are in a special class (controlled to medium value) and running accuracy is Class 4. Since variation of bearing bore diameter and outer ring outer diameter is minimized, P4Y is the most suitable accuracy class for universal combination bearings.

7. Bearing Tolerances

Tolerances for Tapered Bores of Cylindrical Roller Bearings

Tolerances for Tapered Bores

The bore accuracy of tapered bore cylindrical roller bearings is specified by ISO. However, in this standard, the tolerances are rather wide. For super precision class cylindrical roller bearings, NSK has established its own narrower tolerance (see Fig. 7.2).

Fig. 7.2 Taper Angle Tolerances

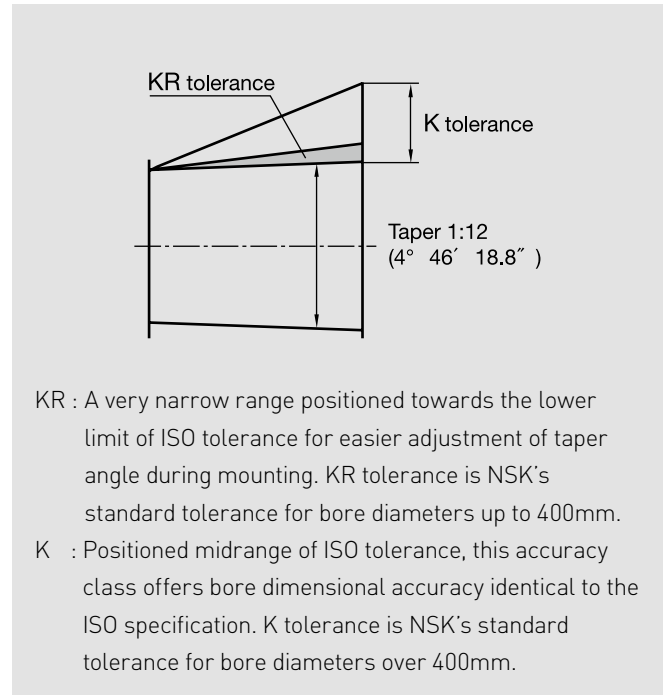


Fig. 7.3 Tapered Bore Tolerances

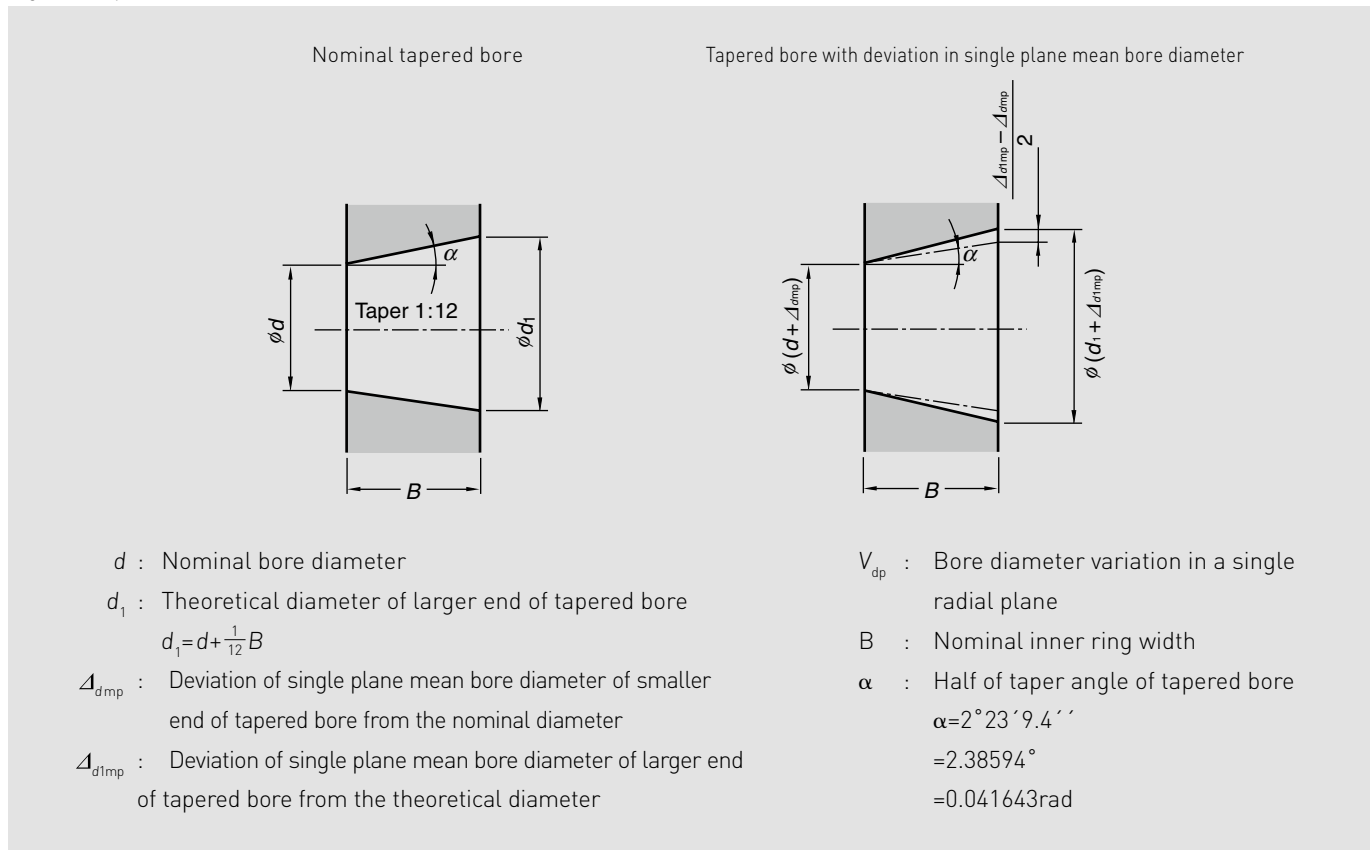


Table 7.12 KR Tapered Bores

Unit: μm

| d ⁽¹⁾ (mm) | | Δd_{mp} | | (Reference) ⁽³⁾ $\Delta d_{1mp} - \Delta d_{mp}$ | | V_{dp} ⁽²⁾ |
|----------------------------|-------|-----------------|-----|--|-----|-------------------------|
| Over | Incl. | High | Low | High | Low | Max. |
| 18 | 30 | + 13 | 0 | + 3 | 0 | 4 |
| 30 | 50 | + 16 | 0 | + 3 | 0 | 5 |
| 50 | 80 | + 19 | 0 | + 4 | 0 | 6 |
| 80 | 120 | + 22 | 0 | + 5 | 0 | 7 |
| 120 | 180 | + 25 | 0 | + 7 | 0 | 9 |
| 180 | 250 | + 29 | 0 | + 9 | 0 | 12 |
| 250 | 315 | + 32 | 0 | + 11 | 0 | 14 |
| 315 | 400 | + 36 | 0 | + 12 | 0 | 16 |

⁽¹⁾ For bearings with larger than 400mm bore, please contact NSK.

⁽²⁾ Bore diameter variation in a single radial plane, which is applicable to all radial planes of tapered bores.

⁽³⁾ Taper angular tolerance, $4^{\circ}46'18.8''_{-0}^{+25''}$

Table 7.13 K Tapered Bores

Unit: μm

| d (mm) | | Δd_{mp} | | $\Delta d_{1mp} - \Delta d_{mp}$ | | V_{dp} ⁽¹⁾ |
|-------------|-------|-----------------|-----|----------------------------------|-----|-------------------------|
| Over | Incl. | High | Low | High | Low | Max. |
| 18 | 30 | + 33 | 0 | + 21 | 0 | 13 |
| 30 | 50 | + 39 | 0 | + 25 | 0 | 16 |
| 50 | 80 | + 46 | 0 | + 30 | 0 | 19 |
| 80 | 120 | + 54 | 0 | + 35 | 0 | 22 |
| 120 | 180 | + 63 | 0 | + 40 | 0 | 40 |
| 180 | 250 | + 72 | 0 | + 46 | 0 | 46 |
| 250 | 315 | + 81 | 0 | + 52 | 0 | 52 |
| 315 | 400 | + 89 | 0 | + 57 | 0 | 57 |
| 400 | 500 | + 97 | 0 | + 63 | 0 | 63 |
| 500 | 630 | + 110 | 0 | + 70 | 0 | 70 |
| 630 | 800 | + 125 | 0 | + 80 | 0 | — |

⁽¹⁾ Bore diameter variation in a single radial plane, which is applicable to all radial planes of tapered bores.

7. Bearing Tolerances

Tolerances for Angular Contact Thrust Ball Bearings

Tolerances for angular contact thrust ball bearings (Class 4A ⁽¹⁾ of BAR, BTR, NSKTAC2xF types)

Table 7.14 Inner ring

Unit: μm

| Nominal Bore Diameter d (mm) | | Single Plane Mean Bore Dia. Deviation Δ_{dmp} | | Deviation of a Single Bore Dia. Δ_{ds} | | Bore Dia. Variation in a Single Radial Plane V_{dp} | | Mean Bore Dia. Variation V_{dmp} | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} | Inner Ring Width Variation V_{Bs} | Deviation of Single Inner Ring Width Δ_{Bs} | |
|--------------------------------------|-------|---|-----|--|-----|--|---|---------------------------------------|---|--------------------------------------|---|--|---|------|
| Over | Incl. | High | Low | High | Low | Diameter Series | | | | | | | Max. | Max. |
| | | | | | | 9 | 0 | | | | | | | |
| - | 50 | 0 | -6 | 0 | -6 | 6 | 5 | 3 | 4 | 4 | 4 | 3 | 0 | -250 |
| 50 | 80 | 0 | -7 | 0 | -7 | 7 | 5 | 3.5 | 4 | 5 | 5 | 4 | 0 | -250 |
| 80 | 120 | 0 | -8 | 0 | -8 | 8 | 6 | 4 | 5 | 5 | 5 | 4 | 0 | -380 |
| 120 | 150 | 0 | -10 | 0 | -10 | 10 | 8 | 5 | 6 | 6 | 7 | 5 | 0 | -380 |
| 150 | 180 | 0 | -10 | 0 | -10 | 10 | 8 | 5 | 6 | 6 | 7 | 5 | 0 | -500 |
| 180 | 250 | 0 | -12 | 0 | -12 | 12 | 9 | 6 | 8 | 7 | 8 | 6 | 0 | -500 |

Table 7.15 Outer ring

Unit: μm

| Nominal Outside Diameter D (mm) | | Single Plane Mean Outside Dia. Deviation Δ_{Dmp} | | Deviation of Single Outside Dia. Δ_{Ds} | | Outside Dia. Variation in a Single Radial Plane V_{Dp} | | Mean Outside Dia. Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} | Outer Ring Width Variation V_{Cs} | Deviation of Single Outer Ring Width Δ_{Cs} | |
|---|-------|--|-----|---|-----|---|----|--|---|--|---|--|--|------|
| Over | Incl. | High | Low | High | Low | Diameter Series | | | | | | | Max. | Max. |
| | | | | | | 9 | 0 | | | | | | | |
| - | 80 | -30 | -37 | -30 | -37 | 7 | 5 | 3.5 | 5 | 4 | 5 | 3 | Equal to the value of inner ring (Δ_{Bs}) of the same bearing number. | |
| 80 | 120 | -40 | -48 | -40 | -48 | 8 | 6 | 4 | 6 | 5 | 6 | 4 | | |
| 120 | 150 | -50 | -59 | -50 | -59 | 9 | 7 | 5 | 7 | 5 | 7 | 5 | | |
| 150 | 180 | -50 | -60 | -50 | -60 | 10 | 8 | 5 | 8 | 5 | 8 | 5 | | |
| 180 | 250 | -50 | -61 | -50 | -61 | 11 | 8 | 6 | 10 | 7 | 10 | 7 | | |
| 250 | 315 | -60 | -73 | -60 | -73 | 13 | 10 | 7 | 11 | 8 | 10 | 7 | | |
| 315 | 400 | -60 | -80 | -60 | -80 | 15 | 11 | 8 | 13 | 10 | 13 | 8 | | |

⁽¹⁾ NSK specification. Equivalent to ISO Class 4 except for tolerance of outer ring outside diameter.

Tolerances for double-direction angular contact thrust ball bearings (Class 7 ⁽²⁾ of NSKTAC2xD type)

Table 7.16 Tolerances of inner ring, outer ring, and bearing height

Unit: μm

| Nominal Bore Diameter d (mm) | | Single Plane Mean Bore Diameter Deviation Δ_{dmp} | | Deviation of the Actual Bearing Height Δ_{Ts} | | Radial Runout of Assembled Bearing Inner Ring (Outer Ring) K_{ia} (K_{ea}) | Inner Ring Runout with Bore S_d | Inner ring (Outer Ring) Face Runout with Raceway S_{ia} (S_{ea}) |
|--------------------------------------|-------|---|-----|---|-------|---|--------------------------------------|---|
| Over | Incl. | High | Low | High | Low | | | |
| - | 30 | 0 | -5 | 0 | -300 | 5 | 4 | 3 |
| 30 | 50 | 0 | -5 | 0 | -400 | 5 | 4 | 3 |
| 50 | 80 | 0 | -8 | 0 | -500 | 6 | 5 | 5 |
| 80 | 120 | 0 | -8 | 0 | -600 | 6 | 5 | 5 |
| 120 | 180 | 0 | -10 | 0 | -700 | 8 | 8 | 5 |
| 180 | 250 | 0 | -13 | 0 | -800 | 8 | 8 | 6 |
| 250 | 315 | 0 | -15 | 0 | -900 | 10 | 10 | 6 |
| 315 | 400 | 0 | -18 | 0 | -1200 | 10 | 12 | 7 |

⁽²⁾ NSK specification

Table 7.17 Tolerance of outer ring

Unit: μm

| Nominal Outside Diameter D (mm) | | Deviation of Single Outside Dia. Δ_{Ds} | |
|---|-------|---|------|
| Over | Incl. | High | Low |
| 30 | 50 | -25 | -41 |
| 50 | 80 | -30 | -49 |
| 80 | 120 | -36 | -58 |
| 120 | 180 | -43 | -68 |
| 180 | 250 | -50 | -79 |
| 250 | 315 | -56 | -88 |
| 315 | 400 | -62 | -98 |
| 400 | 500 | -68 | -108 |
| 500 | 630 | -76 | -120 |

Tolerances for Angular Contact Thrust Ball Bearings for Ball Screw Support

Tolerances for high-rigidity angular contact thrust ball bearings (Class PN7C ⁽³⁾ of NSKTACxxC type)

Table 7.18 NSKTAC C Series

Unit: μm

| Nominal Bore (Outer Ring) Diameter (mm) | | Single Plane Mean Bore Diameter Deviation Δd_{mp} | | Deviation of Single Bore Diameter Δd_s | | Single Plane Mean Outside Diameter Deviation ΔD_{mp} | | Deviation of Single Outside Diameter ΔD_s | | Deviation of Single Inner Ring Width ΔB_s | | Inner ring (Outer Ring) Face Runout with Raceway S_{ia} (S_{ea}) |
|---|-------|---|-----|--|-----|--|-----|---|-----|---|------|--|
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low | Max. |
| 10 | 18 | 0 | -4 | 0 | -4 | - | - | - | - | 0 | -120 | 2.5 |
| 18 | 30 | 0 | -5 | 0 | -5 | - | - | - | - | 0 | -120 | 2.5 |
| 30 | 50 | 0 | -6 | 0 | -6 | 0 | -6 | 0 | -6 | 0 | -120 | 2.5 |
| 50 | 80 | 0 | -7 | 0 | -7 | 0 | -7 | 0 | -7 | 0 | -150 | 2.5 |
| 80 | 120 | 0 | -8 | 0 | -8 | 0 | -8 | 0 | -8 | 0 | -200 | 2.5 |

⁽³⁾ NSK specification

Tolerances for angular contact thrust ball bearings for high-load drive applications (Class PN5D ⁽⁴⁾ of NSKTAC0xD and NSKTACxx-3 types)

Table 7.19 NSKTAC03 Series

Unit: μm

| Nominal Bore (Outer Ring) Diameter (mm) | | Single Plane Mean Bore Diameter Deviation Δd_{mp} | | Single Plane Mean Outside Diameter Deviation ΔD_{mp} | | Deviation of Single Inner Ring Width ΔB_s | | Inner ring (Outer Ring) Face Runout with Raceway S_{ia} (S_{ea}) |
|---|-------|---|-----|--|-----|---|------|--|
| Over | Incl. | High | Low | High | Low | High | Low | Max. |
| 10 | 18 | 0 | -5 | - | - | 0 | -80 | 5 |
| 18 | 30 | 0 | -6 | - | - | 0 | -120 | 5 |
| 30 | 50 | 0 | -8 | 0 | -7 | 0 | -120 | 5 |
| 50 | 80 | 0 | -9 | 0 | -9 | 0 | -150 | 8 |
| 80 | 120 | 0 | -10 | 0 | -10 | 0 | -200 | 8 |
| 120 | 150 | 0 | -13 | 0 | -11 | 0 | -250 | 10 |
| 150 | 180 | 0 | -13 | 0 | -13 | 0 | -250 | 10 |
| 180 | 250 | - | - | 0 | -15 | - | - | 10 |
| 250 | 315 | - | - | 0 | -18 | - | - | 11 |
| 315 | 400 | - | - | 0 | -20 | - | - | 13 |

⁽⁴⁾ NSK specification

Tolerances for BSB Series double-row bearings (Class P2B ⁽⁵⁾ of BSF and BSN types)

Table 7.20 BSB Series double-row bearings (BSF and BSN types)

Unit: μm

| Nominal Bore Diameter (mm) | | Single Plane Mean Bore Diameter Deviation Δd_{mp} | | Single Plane Mean Outside Diameter Deviation ΔD_{mp} | | Inner Ring Face Runout with Raceway S_{ia} | Radial Runout of Inner Ring K_{ia} | Width Tolerance | |
|----------------------------|-------|---|-----|--|-----|--|--------------------------------------|-----------------|------|
| Over | Incl. | High | Low | High | Low | Max. | Max. | High | Low |
| 10 | 18 | 0 | -5 | 0 | -10 | 1.5 | 1.5 | 0 | -250 |
| 18 | 30 | 0 | -5 | 0 | -10 | 2.5 | 2.5 | 0 | -250 |
| 30 | 50 | 0 | -5 | 0 | -10 | 2.5 | 2.5 | 0 | -250 |
| 50 | 80 | 0 | -8 | 0 | -15 | 2.5 | 2.5 | 0 | -250 |

⁽⁵⁾ NSK specification

7. Bearing Tolerances

Tolerances for Metric Design Tapered Roller Bearings Inner Ring

Table 7.21 Inner ring [Class 5]

Unit: μm

| Nominal Bore Diameter $d(\text{mm})$ | | Single Plane Mean Bore Diameter Deviation Δ_{dmp} | | Bore Diameter Variation in a Single Radial Plane V_{dp} | Mean Bore Diameter Variation V_{dmp} | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d |
|--------------------------------------|-------|--|-----|---|--|--------------------------------------|-----------------------------------|
| Over | Incl. | High | Low | Max. | Max. | Max. | Max. |
| 10 | 18 | 0 | -7 | 5 | 5 | 3.5 | 7 |
| 18 | 30 | 0 | -8 | 6 | 5 | 4 | 8 |
| 30 | 50 | 0 | -10 | 8 | 5 | 5 | 8 |
| 50 | 80 | 0 | -12 | 9 | 6 | 5 | 8 |
| 80 | 120 | 0 | -15 | 11 | 8 | 6 | 9 |
| 120 | 180 | 0 | -18 | 14 | 9 | 8 | 10 |
| 180 | 250 | 0 | -22 | 17 | 11 | 10 | 11 |
| 250 | 315 | 0 | -25 | — | — | 13 | 13 |
| 315 | 400 | 0 | -30 | — | — | 15 | 15 |
| 400 | 500 | 0 | -35 | — | — | 18 | 19 |

Table 7.22 Inner ring [Class 4]

Unit: μm

| Nominal Bore Diameter $d(\text{mm})$ | | Single Plane Mean Bore Diameter Deviation Δ_{dmp} | | Deviation of Single Bore Diameter Δ_{ds} | | Bore Diameter Variation in a Single Radial Plane V_{dp} | Mean Bore Diameter Variation V_{dmp} | Radial Runout of Inner Ring K_{ia} | Inner Ring Runout with Bore S_d | Inner Ring Face Runout with Raceway S_{ia} |
|--------------------------------------|-------|--|-----|---|-----|---|--|--------------------------------------|-----------------------------------|--|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. |
| 10 | 18 | 0 | -5 | 0 | -5 | 4 | 4 | 2.5 | 3 | 3 |
| 18 | 30 | 0 | -6 | 0 | -6 | 5 | 4 | 3 | 4 | 4 |
| 30 | 50 | 0 | -8 | 0 | -8 | 6 | 5 | 4 | 4 | 4 |
| 50 | 80 | 0 | -9 | 0 | -9 | 7 | 5 | 4 | 5 | 4 |
| 80 | 120 | 0 | -10 | 0 | -10 | 8 | 5 | 5 | 5 | 5 |
| 120 | 180 | 0 | -13 | 0 | -13 | 10 | 7 | 6 | 6 | 7 |
| 180 | 250 | 0 | -15 | 0 | -15 | 11 | 8 | 8 | 7 | 8 |
| 250 | 315 | 0 | -18 | 0 | -18 | — | — | 10 | 8 | 10 |
| 315 | 400 | 0 | -23 | 0 | -23 | — | — | 12 | 10 | 14 |
| 400 | 500 | 0 | -27 | 0 | -27 | — | — | 14 | 13 | 17 |

Remarks: 1. The outside diameter "no-go side" tolerances (low) specified in this table do not necessarily apply within a distance of 1.2 times the chamfer dimension r (max.) from the ring face.
2. Some of the tolerances refer to NSK's own specification.

Outer Ring

Table 7.23 Outer ring [Class 5]

Unit: μm

| Nominal Outside Diameter $D(\text{mm})$ | | Single Plane Mean Outside Diameter Deviation Δ_{Dmp} | | Outside Diameter Variation in a Single Radial Plane V_{Dp} | Mean Outside Diameter Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D |
|---|-------|---|-----|--|---|--------------------------------------|---|
| Over | Incl. | High | Low | Max. | Max. | Max. | Max. |
| 18 | 30 | 0 | -8 | 6 | 5 | 6 | 8 |
| 30 | 50 | 0 | -9 | 7 | 5 | 7 | 8 |
| 50 | 80 | 0 | -11 | 8 | 6 | 8 | 8 |
| 80 | 120 | 0 | -13 | 10 | 7 | 10 | 9 |
| 120 | 150 | 0 | -15 | 11 | 8 | 11 | 10 |
| 150 | 180 | 0 | -18 | 14 | 9 | 13 | 10 |
| 180 | 250 | 0 | -20 | 15 | 10 | 15 | 11 |
| 250 | 315 | 0 | -25 | 19 | 13 | 18 | 13 |
| 315 | 400 | 0 | -28 | 22 | 14 | 20 | 13 |
| 400 | 500 | 0 | -33 | — | — | 23 | 15 |
| 500 | 630 | 0 | -38 | — | — | 25 | 18 |

Table 7.24 Outer ring [Class 4]

Unit: μm

| Nominal Outside Diameter $D(\text{mm})$ | | Single Plane Mean Outside Diameter Deviation Δ_{Dmp} | | Deviation of Single Outside Diameter Δ_{Ds} | | Outside Diameter Variation in a Single Radial Plane V_{Dp} | Mean Outside Diameter Variation V_{Dmp} | Radial Runout of Outer Ring K_{ea} | Variation of Outside Surface Generatrix Inclination with Face S_D | Outer Ring Face Runout with Raceway S_{ea} |
|---|-------|---|-----|--|-----|--|---|--------------------------------------|---|--|
| Over | Incl. | High | Low | High | Low | Max. | Max. | Max. | Max. | Max. |
| 18 | 30 | 0 | -6 | 0 | -6 | 5 | 4 | 4 | 4 | 5 |
| 30 | 50 | 0 | -7 | 0 | -7 | 5 | 5 | 5 | 4 | 5 |
| 50 | 80 | 0 | -9 | 0 | -9 | 7 | 5 | 5 | 4 | 5 |
| 80 | 120 | 0 | -10 | 0 | -10 | 8 | 5 | 6 | 5 | 6 |
| 120 | 150 | 0 | -11 | 0 | -11 | 8 | 6 | 7 | 5 | 7 |
| 150 | 180 | 0 | -13 | 0 | -13 | 10 | 7 | 8 | 5 | 8 |
| 180 | 250 | 0 | -15 | 0 | -15 | 11 | 8 | 10 | 7 | 10 |
| 250 | 315 | 0 | -18 | 0 | -18 | 14 | 9 | 11 | 8 | 10 |
| 315 | 400 | 0 | -20 | 0 | -20 | 15 | 10 | 13 | 10 | 13 |
| 400 | 500 | 0 | -23 | 0 | -23 | — | — | 15 | 11 | 15 |
| 500 | 630 | 0 | -28 | 0 | -28 | — | — | 18 | 13 | 18 |

Remarks: 1. The cylindrical bore diameter "no-go side" tolerance limit (high) specified in this table does not necessarily apply within a distance of 1.2 times the chamfer dimension r (max.) from the ring face.
2. Some of the tolerances refer to NSK's own specification.

Tolerances for Thrust Ball Bearings Shaft Washer

Table 7.25 Shaft washer (Class 5)

Unit: μm

| Nominal Bore Diameter $d(\text{mm})$ | | Single Plane Mean Bore Diameter Deviation Δd_{mp} | | Bore Diameter Variation in a Single Radial Plane V_{dp} | Shaft Washer (Housing Washer) Raceway to Back Face Thickness Variation $S_i (S_e)$ | (Reference) Deviation of Bearing Height ΔT_s | |
|--------------------------------------|-------|---|-------|---|--|--|-------|
| Over | Incl. | High | Low | Max. | Max. | High | Low |
| 18 | 30 | 0 | - 10 | 8 | 3 | 0 | - 75 |
| 30 | 50 | 0 | - 12 | 9 | 3 | 0 | - 100 |
| 50 | 80 | 0 | - 15 | 11 | 4 | 0 | - 125 |
| 80 | 120 | 0 | - 20 | 15 | 4 | 0 | - 150 |
| 120 | 180 | 0 | - 25 | 19 | 5 | 0 | - 175 |
| 180 | 250 | 0 | - 30 | 23 | 5 | 0 | - 200 |
| 250 | 315 | 0 | - 35 | 26 | 7 | 0 | - 225 |
| 315 | 400 | 0 | - 40 | 30 | 7 | 0 | - 300 |
| 400 | 500 | 0 | - 45 | 34 | 9 | 0 | - 350 |
| 500 | 630 | 0 | - 50 | 38 | 11 | 0 | - 450 |
| 630 | 800 | 0 | - 75 | — | 13 | 0 | - 550 |
| 800 | 1000 | 0 | - 100 | — | 15 | 0 | - 700 |
| 1000 | 1250 | 0 | - 125 | — | 18 | 0 | - 900 |

Table 7.26 Shaft washer (Class 4)

Unit: μm

| Nominal Bore Diameter $d(\text{mm})$ | | Single Plane Mean Bore Diameter Deviation Δd_{mp} | | Bore Diameter Variation in a Single Radial Plane V_{dp} | Shaft Washer (Housing Washer) Raceway to Back Face Thickness Variation $S_i (S_e)$ | (Reference) Deviation of Bearing Height ΔT_s | |
|--------------------------------------|-------|---|------|---|--|--|-------|
| Over | Incl. | High | Low | Max. | Max. | High | Low |
| 18 | 30 | 0 | - 8 | 6 | 2 | 0 | - 75 |
| 30 | 50 | 0 | - 10 | 8 | 2 | 0 | - 100 |
| 50 | 80 | 0 | - 12 | 9 | 3 | 0 | - 125 |
| 80 | 120 | 0 | - 15 | 11 | 3 | 0 | - 150 |
| 120 | 180 | 0 | - 18 | 14 | 4 | 0 | - 175 |
| 180 | 250 | 0 | - 22 | 17 | 4 | 0 | - 200 |
| 250 | 315 | 0 | - 25 | 19 | 5 | 0 | - 225 |
| 315 | 400 | 0 | - 30 | 23 | 5 | 0 | - 300 |
| 400 | 500 | 0 | - 35 | 26 | 6 | 0 | - 350 |
| 500 | 630 | 0 | - 40 | 30 | 7 | 0 | - 450 |
| 630 | 800 | 0 | - 50 | — | 8 | 0 | - 550 |

Housing Washer

Table 7.27 Housing washer (Class 5)

Unit: μm

| Nominal Outside Diameter $D(\text{mm})$ | | Single Plane Mean Outside Diameter Deviation ΔD_{mp} | | Outside Diameter Variation in a Single Radial Plane V_{Dp} |
|---|-------|--|-------|--|
| Over | Incl. | High | Low | Max. |
| 30 | 50 | 0 | - 16 | 12 |
| 50 | 80 | 0 | - 19 | 14 |
| 80 | 120 | 0 | - 22 | 17 |
| 120 | 180 | 0 | - 25 | 19 |
| 180 | 250 | 0 | - 30 | 23 |
| 250 | 315 | 0 | - 35 | 26 |
| 315 | 400 | 0 | - 40 | 30 |
| 400 | 500 | 0 | - 45 | 34 |
| 500 | 630 | 0 | - 50 | 38 |
| 630 | 800 | 0 | - 75 | 55 |
| 800 | 1000 | 0 | - 100 | 75 |
| 1000 | 1250 | 0 | - 120 | — |
| 1250 | 1600 | 0 | - 160 | — |

Table 7.28 Housing washer (Class 4)

Unit: μm

| Nominal Outside Diameter $D(\text{mm})$ | | Single Plane Mean Outside Diameter Deviation ΔD_{mp} | | Outside Diameter Variation in a Single Radial Plane V_{Dp} |
|---|-------|--|------|--|
| Over | Incl. | High | Low | Max. |
| 30 | 50 | 0 | - 9 | 7 |
| 50 | 80 | 0 | - 11 | 8 |
| 80 | 120 | 0 | - 13 | 10 |
| 120 | 180 | 0 | - 15 | 11 |
| 180 | 250 | 0 | - 20 | 15 |
| 250 | 315 | 0 | - 25 | 19 |
| 315 | 400 | 0 | - 28 | 21 |
| 400 | 500 | 0 | - 33 | 25 |
| 500 | 630 | 0 | - 38 | 29 |
| 630 | 800 | 0 | - 45 | 34 |

8. Design of Shafts and Housings

Fitting of Shafts and Housings

In order to take full advantage of the capabilities of super precision bearings such as running accuracy, high-speed performance, and low heat generation, a high level of accuracy is required of shafts, housings and other surrounding parts as well.

When the inner ring or outer ring is mounted onto a shaft or into a housing with interference, the shape of the shaft or the housing (out-of-roundness) is transferred to the bearing raceway surfaces and will affect running accuracy. When multiple angular contact ball bearings are used in combination, cylindricity affects the distribution of preload between the bearings. Therefore, the parts that mate with bearing surfaces should be as accurate as possible. Inaccurate mating of parts may cause the formation of peaks or ridges along the shaft, which can affect the quality of finished work, especially in precision lathes etc.

Tables 8.1 through 8.4 list recommended interference values for bearings operated in standard conditions at speeds of less than $800\,000\,d_m n$ (Tables 8.1 and 8.2 refer to bearings for machine tool spindles, Tables 8.3 and 8.4 refer to ball screw support bearings).

For thrust cylindrical roller bearings and thrust ball bearings, we recommend a shaft fit of h6 and a housing fit of G7 as a target. Clearance fits are commonly used for both shaft washer and housing washer. However, particularly in the case of thrust ball bearings where alignment of both washers with the shaft is required, small values are preferable within the range that assembly allows.

Table 8.1 Fits on Shafts

| Bearing type | Shaft Outer diameter (mm) | | Tolerance of shaft outer diameter (mm) | | Target interference ⁽¹⁾ [⁽²⁾] (mm) | |
|------------------------------------|---------------------------|-------|--|-------|--|--------|
| | Over | Incl. | Min. | Max. | Min. | Max. |
| Bearings for machine tool spindles | 10 | 18 | - 0.003 | 0 | 0 | 0.002T |
| | 18 | 50 | - 0.004 | 0 | 0 | 0.003T |
| | 50 | 80 | - 0.005 | 0 | 0 | 0.003T |
| | 80 | 120 | - 0.003 | 0.003 | 0 | 0.004T |
| | 120 | 180 | - 0.004 | 0.004 | 0 | 0.006T |
| | 180 | 250 | - 0.005 | 0.005 | 0 | 0.008T |
| | 250 | 315 | - 0.008 | 0.008 | 0 | 0.010T |
| | 315 | 400 | - 0.009 | 0.009 | 0 | 0.013T |
| | 400 | 500 | - 0.010 | 0.010 | 0 | 0.015T |

⁽¹⁾ Use the target interference when the bearing can be matched to the shaft or housing. Otherwise, use the shaft outer diameter and housing bore minimum and maximum for random matching.

⁽²⁾ T=Interference or tight fit; L=Clearance or loose fit

⁽³⁾ Only applicable if outer ring is inserted into housing separately.

Table 8.2 Fits on Housings

| Bearing type | Housing Bore diameter (mm) | | Tolerance of housing bore (mm) | | Target interference (1)(2) (mm) | |
|--|----------------------------|-------|--------------------------------|--------|---------------------------------|--------|
| | Over | Incl. | Min. | Max. | Min. | Max. |
| Angular contact ball bearings (Fixed end) | 18 | 50 | - 0.002 | 0.002 | 0.002L | 0.005L |
| | 50 | 80 | - 0.0025 | 0.0025 | 0.002L | 0.005L |
| | 80 | 120 | - 0.003 | 0.003 | 0.002L | 0.006L |
| | 120 | 180 | - 0.004 | 0.004 | 0.003L | 0.009L |
| | 180 | 250 | - 0.005 | 0.005 | 0.004L | 0.012L |
| | 250 | 315 | - 0.006 | 0.006 | 0.005L | 0.015L |
| | 315 | 400 | - 0.007 | 0.007 | 0.007L | 0.02L |
| | 400 | 500 | - 0.008 | 0.008 | 0.008L | 0.023L |
| | 500 | 630 | - 0.008 | 0.008 | 0.008L | 0.024L |
| | 630 | 800 | - 0.009 | 0.009 | 0.009L | 0.027L |
| Angular contact thrust ball bearings (if used together with radial bearings) | 50 | 80 | - 0.005 | 0 | 0.025L | 0.037L |
| | 80 | 120 | - 0.007 | 0 | 0.033L | 0.047L |
| | 120 | 150 | - 0.008 | 0 | 0.042L | 0.059L |
| | 150 | 180 | - 0.011 | 0 | 0.039L | 0.059L |
| | 180 | 250 | - 0.012 | 0 | 0.038L | 0.061L |
| | 250 | 315 | - 0.013 | 0 | 0.047L | 0.073L |
| | 315 | 400 | - 0.015 | 0 | 0.045L | 0.080L |
| | 400 | 500 | - 0.016 | 0 | 0.054L | 0.091L |
| | 500 | 630 | - 0.018 | 0 | 0.052L | 0.094L |
| Angular contact ball bearings (Free end) | 18 | 50 | 0.004 | 0.007 | 0.006L | 0.009L |
| | 50 | 80 | 0.005 | 0.008 | 0.007L | 0.01L |
| | 80 | 120 | 0.006 | 0.010 | 0.008L | 0.012L |
| | 120 | 180 | 0.008 | 0.014 | 0.011L | 0.017L |
| | 180 | 250 | 0.010 | 0.018 | 0.014L | 0.022L |
| | 250 | 315 | 0.012 | 0.022 | 0.017L | 0.027L |
| | 315 | 400 | 0.013 | 0.026 | 0.021L | 0.034L |
| | 400 | 500 | 0.015 | 0.030 | 0.024L | 0.039L |
| | 500 | 630 | 0.016 | 0.032 | 0.026L | 0.042L |
| | 630 | 800 | 0.018 | 0.036 | 0.031L | 0.049L |
| Cylindrical roller bearings, Tapered roller bearings (3) | 50 | 80 | - 0.005 | 0 | 0.002L | 0.002T |
| | 80 | 120 | - 0.007 | 0 | 0.002L | 0.002T |
| | 120 | 180 | - 0.008 | 0 | 0.003L | 0.003T |
| | 180 | 250 | - 0.011 | 0 | 0.004L | 0.004T |
| | 250 | 315 | - 0.012 | 0 | 0.005L | 0.005T |
| | 315 | 400 | - 0.013 | 0 | 0.007L | 0.007T |
| | 400 | 500 | - 0.015 | 0 | 0.008L | 0.008T |
| | 500 | 630 | - 0.016 | 0 | 0.008L | 0.008T |
| | 630 | 800 | - 0.018 | 0 | 0.009L | 0.009T |

8. Design of Shafts and Housings

Recommended interference values for standard operating conditions of ball screws are listed in Tables 8.3 and 8.4.

When using angular contact thrust ball bearings for high-load drive ball screw support, in cases where a single end is supported and moment loads are high, it is advisable to increase shaft interference, for example by choosing k5 etc. as required.

For super precision class applications please make sure during designing and mounting that:

Misalignment in inclination is below $1/2000$ rad (target: below $1/5000$ rad)

Eccentricity is below 0.020mm

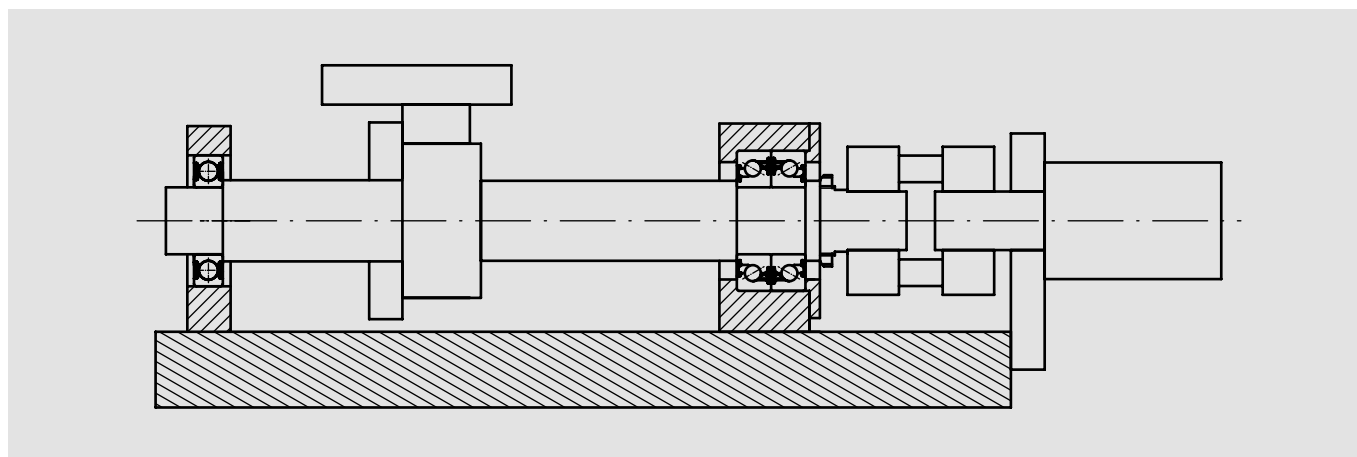
Table 8.3 Fits on Shafts

| Bearing type | Shaft Outer Diameter (mm) | | Tolerance of Shaft Outer Diameter (mm) | | |
|---|---------------------------|-------|--|----------|--------|
| | Over | Incl. | | Min. | Max. |
| Angular contact thrust ball bearings for ball screw support in machine tools | 10 | 18 | h5 | - 0.008 | 0 |
| | 18 | 30 | | - 0.009 | 0 |
| | 30 | 50 | | - 0.011 | 0 |
| | 50 | 80 | | - 0.013 | 0 |
| | 80 | 120 | | - 0.015 | 0 |
| Angular contact thrust ball bearings for ball screw support in high-load drive applications | 10 | 18 | js5 | - 0.004 | 0.004 |
| | 18 | 30 | | - 0.0045 | 0.0045 |
| | 30 | 50 | | - 0.0055 | 0.0055 |
| | 50 | 80 | | - 0.0065 | 0.0065 |
| | 80 | 120 | | - 0.0075 | 0.0075 |

Table 8.4 Fits on Housings

| Bearing type | Housing Bore Diameter (mm) | | Tolerance of Housing Bore Diameter (mm) | | |
|---|----------------------------|-------|---|------|-------|
| | Over | Incl. | | Min. | Max. |
| Angular contact thrust ball bearings for ball screw support | 30 | 50 | H6 | 0 | 0.016 |
| | 50 | 80 | | 0 | 0.019 |
| | 80 | 120 | | 0 | 0.022 |
| | 120 | 180 | | 0 | 0.025 |
| | 180 | 250 | | 0 | 0.029 |
| | 250 | 315 | | 0 | 0.032 |

Fig. 8.1 Arrangement of Ball Screw Support Bearings (Example)



Recommended accuracy and surface roughness for bearing seats in machine tool spindle applications are shown in the tables below. When using cylindrical roller bearings with tapered bores, if the taper of the inner ring does not match that of the shaft, misalignment of the inner ring groove will cause irregular movement of the rollers. With double-row cylindrical roller bearings, a difference in residual clearance between the rows will occur. Consequently, load will not be sustained equally, and rigidity will decline. We recommend that you gauge the tapered parts to be mated with bearings. Contact should cover more than 80% of the total surface area that is dyed blue. Please refer to page 250 for a description and details on the gauging of shaft tapers.

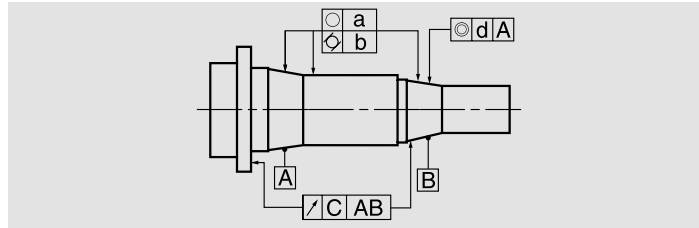


Table 8.5 Tolerance for and Mean Roughness of Shafts

| Shaft Diameter (mm) | | Tolerance Grades and Mean Roughness (µm) | | | | | | | |
|---------------------|-------|--|----------|----------------------|------------------|----------|------------------|----------|----------------------|
| | | Out-of-roundness (○) | | Cylindricity (⊙) | Runout (⤴) | | Coaxiality (◎) | | Roughness |
| | | a | | b | c | | d | | R _a |
| Over | Incl. | Bearing Accuracy | | Bearing Accuracy | Bearing Accuracy | | Bearing Accuracy | | Bearing Accuracy |
| | | P5 | P4,P3,P2 | All accuracy classes | P5 | P4,P3,P2 | P5 | P4,P3,P2 | All accuracy classes |
| - | 10 | 0.7 | 0.5 | 0.7 | 2 | 1.2 | 4 | 2.5 | 0.2 |
| 10 | 18 | 1 | 0.6 | 1 | 2.5 | 1.5 | 5 | 3 | 0.2 |
| 18 | 30 | 1.2 | 0.7 | 1.2 | 3 | 2 | 6 | 4 | 0.2 |
| 30 | 50 | 1.2 | 0.7 | 1.2 | 3.5 | 2 | 7 | 4 | 0.2 |
| 50 | 80 | 1.5 | 1 | 1.5 | 4 | 2.5 | 8 | 5 | 0.2 |
| 80 | 120 | 2 | 1.2 | 2 | 5 | 3 | 10 | 6 | 0.4 |
| 120 | 180 | 2.5 | 1.7 | 2.5 | 6 | 4 | 12 | 8 | 0.4 |
| 180 | 250 | 3.5 | 2.2 | 3.5 | 7 | 5 | 14 | 10 | 0.4 |
| 250 | 315 | 4 | 3 | 4 | 8 | 6 | 16 | 12 | 0.4 |
| 315 | 400 | 4.5 | 3.5 | 4.5 | 9 | 6.5 | 18 | 13 | 0.8 |
| 400 | 500 | 5 | 4 | 5 | 10 | 7.5 | 20 | 15 | 0.8 |

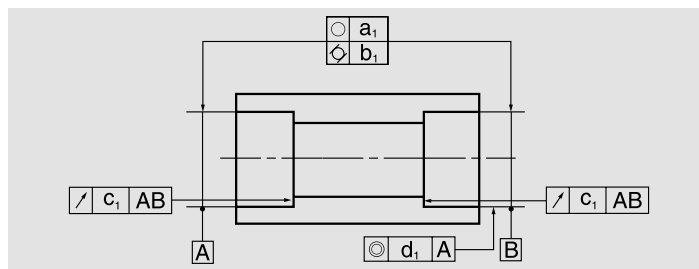


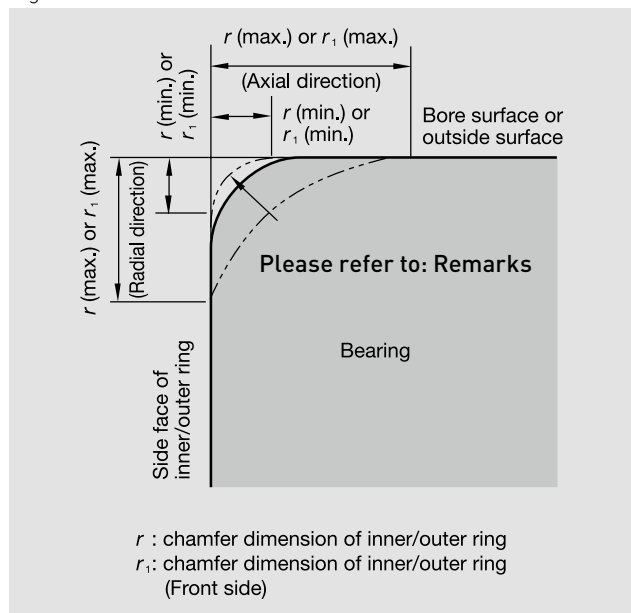
Table 8.6 Tolerance for and Mean Roughness of Housings

| Housing Bore Diameter (mm) | | Tolerance Grades and Mean Roughness (µm) | | | | | | | |
|----------------------------|-------|--|----------|----------------------|------------------|----------|------------------|----------|----------------------|
| | | Out-of-roundness (○) | | Cylindricity (⊙) | Runout (⤴) | | Coaxiality (◎) | | Roughness |
| | | a ₁ | | b ₁ | c ₁ | | d ₁ | | R _a |
| Over | Incl. | Bearing Accuracy | | Bearing Accuracy | Bearing Accuracy | | Bearing Accuracy | | Bearing Accuracy |
| | | P5 | P4,P3,P2 | All accuracy classes | P5 | P4,P3,P2 | P5 | P4,P3,P2 | All accuracy classes |
| 10 | 18 | 1 | 0.6 | 1 | 2.5 | 1.5 | 5 | 3 | 0.4 |
| 18 | 30 | 1.2 | 0.7 | 1.2 | 3 | 2 | 6 | 4 | 0.4 |
| 30 | 50 | 1.2 | 0.7 | 1.2 | 3.5 | 2 | 7 | 4 | 0.4 |
| 50 | 80 | 1.5 | 1 | 1.5 | 4 | 2.5 | 8 | 5 | 0.4 |
| 80 | 120 | 2 | 1.2 | 2 | 5 | 3 | 10 | 6 | 0.8 |
| 120 | 180 | 2.5 | 1.7 | 2.5 | 6 | 4 | 12 | 8 | 0.8 |
| 180 | 250 | 3.5 | 2.2 | 3.5 | 7 | 5 | 14 | 10 | 0.8 |
| 250 | 315 | 4 | 3 | 4 | 8 | 6 | 16 | 12 | 1.6 |
| 315 | 400 | 4.5 | 3.5 | 4.5 | 9 | 6.5 | 18 | 13 | 1.6 |
| 400 | 500 | 5 | 4 | 5 | 10 | 7.5 | 20 | 15 | 1.6 |
| 500 | 630 | 5.5 | 4.5 | 5.5 | 11 | 8 | 22 | 16 | 1.6 |
| 630 | 800 | 6.5 | 5 | 6.5 | 12.5 | 9 | 25 | 18 | 1.6 |

8. Design of Shafts and Housings

Chamfer Dimension Limits and Corner Radius of Shaft or Housing

Fig. 8.2 Chamfer Dimension



Remarks: The precise shape of chamfer surfaces has not been specified but its profile in the axial plane shall not intersect an arc of radius r (min.) or r_1 (min.) touching the side face of an inner ring and the bore surface, or the side face of an outer ring and the outside surface.

Table 8.7 Chamfer Dimension Limits for Radial Bearings (excluding Tapered Roller Bearings)

Unit: mm

| Smallest permissible chamfer dimension r (min.) or r_1 (min.) | Nominal bore diameter d | | Largest permissible chamfer dimension r (max.) or r_1 (max.) | | For reference |
|--|---------------------------|-------|---|---------------------|---|
| | Over | Incl. | Radial direction | Axial direction [°] | Corner radius of shaft or housing r_a Max. |
| 0.15 | — | — | 0.3 | 0.6 | 0.15 |
| 0.3 | — | 40 | 0.6 | 1 | 0.3 |
| 0.3 | 40 | — | 0.8 | 1 | 0.3 |
| 0.6 | — | 40 | 1 | 2 | 0.6 |
| 0.6 | 40 | — | 1.3 | 2 | 0.6 |
| 1 | — | 50 | 1.5 | 3 | 1 |
| 1 | 50 | — | 1.9 | 3 | 1 |
| 1.1 | — | 120 | 2 | 3.5 | 1 |
| 1.1 | 120 | — | 2.5 | 4 | 1 |
| 1.5 | — | 120 | 2.3 | 4 | 1.5 |
| 1.5 | 120 | — | 3 | 5 | 1.5 |
| 2 | — | 80 | 3 | 4.5 | 2 |
| 2 | 80 | 220 | 3.5 | 5 | 2 |
| 2 | 220 | — | 3.8 | 6 | 2 |
| 2.1 | — | 280 | 4 | 6.5 | 2 |
| 2.1 | 280 | — | 4.5 | 7 | 2 |
| 2.5 | — | 100 | 3.8 | 6 | 2 |
| 2.5 | 100 | 280 | 4.5 | 6 | 2 |
| 2.5 | 280 | — | 5 | 7 | 2 |
| 3 | — | 280 | 5 | 8 | 2.5 |
| 3 | 280 | — | 5.5 | 8 | 2.5 |
| 4 | — | — | 6.5 | 9 | 3 |
| 5 | — | — | 8 | 10 | 4 |
| 6 | — | — | 10 | 13 | 5 |

Table 8.8 Chamfer Dimension Limits for Tapered Roller Bearings

Unit: mm

| Smallest permissible chamfer dimension r (min.) | Nominal bore diameter or nominal outside diameter d or D | | Largest permissible chamfer dimension r (max.) | | For reference |
|--|--|-------|---|---------------------|---|
| | Over | Incl. | Radial direction | Axial direction [°] | Corner radius of shaft or housing r_a Max. |
| 0.6 | — | 40 | 1.1 | 1.7 | 0.6 |
| 0.6 | 40 | — | 1.3 | 2 | 0.6 |
| 1 | — | 50 | 1.6 | 2.5 | 1 |
| 1 | 50 | — | 1.9 | 3 | 1 |
| 1.5 | — | 120 | 2.3 | 3 | 1.5 |
| 1.5 | 120 | 250 | 2.8 | 3.5 | 1.5 |
| 1.5 | 250 | — | 3.5 | 4 | 1.5 |
| 2 | — | 120 | 2.8 | 4 | 2 |
| 2 | 120 | 250 | 3.5 | 4.5 | 2 |
| 2 | 250 | — | 4 | 5 | 2 |
| 2.5 | — | 120 | 3.5 | 5 | 2 |
| 2.5 | 120 | 250 | 4 | 5.5 | 2 |
| 2.5 | 250 | — | 4.5 | 6 | 2 |
| 3 | — | 120 | 4 | 5.5 | 2.5 |
| 3 | 120 | 250 | 4.5 | 6.5 | 2.5 |
| 3 | 250 | 400 | 5 | 7 | 2.5 |
| 3 | 400 | — | 5.5 | 7.5 | 2.5 |
| 4 | — | 120 | 5 | 7 | 3 |
| 4 | 120 | 250 | 5.5 | 7.5 | 3 |
| 4 | 250 | 400 | 6 | 8 | 3 |
| 4 | 400 | — | 6.5 | 8.5 | 3 |
| 5 | — | 180 | 6.5 | 8 | 4 |
| 5 | 180 | — | 7.5 | 9 | 4 |
| 6 | — | 180 | 7.5 | 10 | 5 |
| 6 | 180 | — | 9 | 11 | 5 |

Table 8.9 Chamfer Dimension Limits for Thrust Bearings

Unit: mm

| Smallest permissible chamfer dimension r (min.) or r_1 (min.) | Largest permissible chamfer dimension r (max.) | For reference |
|--|---|---|
| | | Corner radius of shaft or housing r_a Max. |
| 0.6 | 1.5 | 0.6 |
| 1 | 2.2 | 1 |
| 1.1 | 2.7 | 1 |
| 1.5 | 3.5 | 1.5 |
| 2 | 4 | 2 |
| 2.1 | 4.5 | 2 |
| 3 | 5.5 | 2.5 |
| 4 | 6.5 | 3 |
| 5 | 8 | 4 |
| 6 | 10 | 5 |
| 7.5 | 12.5 | 6 |
| 9.5 | 15 | 8 |
| 12 | 18 | 10 |
| 15 | 21 | 12 |
| 19 | 25 | 15 |

[°] For inner ring chamfer, locate d in "Over"/"Incl." columns; for outer ring chamfer, locate D in "Over"/"Incl." columns.

Spacer Dimensions

The dimensions of standard spacers for open type angular contact ball bearings (19, 29, 10, 20 and 02 Series) are listed below.

Additional information:

Material of spacer: Bearing steel or carbon steel

When using spacers, parallelism of spacer end surfaces should be:

Less than 0.003 mm (for spacers up to 300mm bore size)

Less than 0.004 mm (for spacers over 300mm bore size)

19 or 29 Series

Standard spacers for dimension series 19 or 29 (79, BNR19, BER19, BNR29, BER29, BSR19)

Unit: mm

| Bore number | Nominal bearing bore diameter d | Bearing outside diameter D | Outer ring spacer | | Inner ring spacer | | Spacer chamfer |
|-------------|---------------------------------|----------------------------|--------------------|-------|-------------------|----------|----------------|
| | | | Outer diameter (1) | Bore | Outer diameter | Bore (2) | |
| 00 | 10 | 22 | 21.5 | 17.5 | 14.5 | 10.5 | 0.2 |
| 01 | 12 | 24 | 23.5 | 19.5 | 16.5 | 12.5 | 0.2 |
| 02 | 15 | 28 | 27.5 | 23.5 | 19.5 | 15.5 | 0.2 |
| 03 | 17 | 30 | 29.5 | 25.5 | 21.5 | 17.5 | 0.2 |
| 04 | 20 | 37 | 36.5 | 31.5 | 26 | 20.5 | 0.2 |
| 05 | 25 | 42 | 41.5 | 36 | 31 | 25.5 | 0.2 |
| 06 | 30 | 47 | 46.5 | 41 | 36 | 30.5 | 0.2 |
| 07 | 35 | 55 | 54.5 | 48 | 42 | 35.5 | 0.3 |
| 08 | 40 | 62 | 61.5 | 54.5 | 47.5 | 40.5 | 0.3 |
| 09 | 45 | 68 | 67.5 | 60 | 53 | 45.5 | 0.3 |
| 10 | 50 | 72 | 71.5 | 66 | 56 | 50.5 | 0.3 |
| 11 | 55 | 80 | 79.5 | 72 | 64 | 55.5 | 0.5 |
| 12 | 60 | 85 | 84.5 | 77 | 68 | 60.5 | 0.5 |
| 13 | 65 | 90 | 89.5 | 82 | 73 | 65.5 | 0.5 |
| 14 | 70 | 100 | 99.5 | 91.5 | 79 | 70.5 | 0.5 |
| 15 | 75 | 105 | 104.5 | 96.5 | 84 | 75.5 | 0.5 |
| 16 | 80 | 110 | 109.5 | 101.5 | 89.5 | 80.5 | 0.5 |
| 17 | 85 | 120 | 119.5 | 110 | 95 | 85.5 | 0.5 |
| 18 | 90 | 125 | 124.2 | 116 | 100 | 90.5 | 0.5 |
| 19 | 95 | 130 | 129.2 | 120 | 106 | 95.5 | 0.5 |
| 20 | 100 | 140 | 139.2 | 129 | 112 | 100.5 | 0.5 |
| 21 | 105 | 145 | 144.2 | 133 | 117 | 105.5 | 0.5 |
| 22 | 110 | 150 | 149.2 | 138 | 122 | 110.5 | 0.5 |
| 24 | 120 | 165 | 164.2 | 152 | 133 | 120.5 | 0.5 |
| 26 | 130 | 180 | 179.2 | 166 | 144 | 130.8 | 0.8 |
| 28 | 140 | 190 | 189.2 | 176 | 154 | 140.8 | 0.8 |
| 30 | 150 | 210 | 209.2 | 193 | 167 | 150.8 | 1.0 |
| 32 | 160 | 220 | 219.2 | 203 | 175 | 160.8 | 1.0 |
| 34 | 170 | 230 | 229.2 | 214 | 188 | 170.8 | 1.0 |
| 36 | 180 | 250 | 249.2 | 231 | 200 | 180.8 | 1.0 |
| 38 | 190 | 260 | 259.2 | 242 | 206 | 190.8 | 1.0 |
| 40 | 200 | 280 | 279.2 | 255 | 225 | 200.8 | 1.0 |
| 44 | 220 | 300 | 299.2 | 275 | 245 | 220.8 | 1.2 |
| 48 | 240 | 320 | 319.2 | 297 | 263 | 240.8 | 1.2 |
| 52 | 260 | 360 | 359.2 | 322 | 290 | 260.8 | 1.2 |
| 56 | 280 | 380 | 379.2 | 348 | 312 | 280.8 | 1.2 |
| 60 | 300 | 420 | 419.2 | 386 | 335 | 300.8 | 1.2 |
| 64 | 320 | 440 | 439.2 | 400 | 360 | 320.8 | 1.2 |
| 68 | 340 | 460 | 459.2 | 425 | 375 | 340.8 | 1.2 |
| 72 | 360 | 480 | 479.2 | 441 | 399 | 360.8 | 1.2 |
| 76 | 380 | 520 | 519.2 | 475 | 425 | 380.8 | 1.5 |
| 80 | 400 | 540 | 539.2 | 494 | 446 | 400.8 | 1.5 |

(1) For outer ring spacers operated using oil mist lubrication or jet lubrication, we recommend that the outer diameter of the outer ring spacer is the same as the bearing outside diameter, with a tolerance of g5 or better.

(2) For high-speed operations exceeding 700 000 $d_m n$, we recommend that the bore diameter of the inner ring spacer is the same as the bearing bore diameter, with a tolerance of F6 or better.

9. Spacers

Additional information:

Material of spacer: Bearing steel or carbon steel

When using spacers, parallelism of spacer end surfaces should be:

Less than 0.003 mm (for spacers up to 300mm bore size)

Less than 0.004 mm (for spacers over 300mm bore size)

10 or 20 Series

Standard spacers for dimension series 10 or 20 (70, BNR10, BER10, BNR20, BER20, BSR10)

Unit: mm

| Bore number | Nominal bearing bore diameter d | Bearing outside diameter D | Outer ring spacer | | Inner ring spacer | | Spacer chamfer |
|-------------|---------------------------------|----------------------------|-------------------------------|-------|-------------------|---------------------|----------------|
| | | | Outer diameter ⁽¹⁾ | Bore | Outer diameter | Bore ⁽²⁾ | |
| 00 | 10 | 26 | 25.5 | 21.5 | 14.5 | 10.5 | 0.2 |
| 01 | 12 | 28 | 27.5 | 23.5 | 17 | 12.5 | 0.2 |
| 02 | 15 | 32 | 31.5 | 27 | 20 | 15.5 | 0.2 |
| 03 | 17 | 35 | 34.5 | 29.5 | 23 | 17.5 | 0.2 |
| 04 | 20 | 42 | 41.5 | 35 | 27 | 20.5 | 0.3 |
| 05 | 25 | 47 | 46.5 | 40.5 | 32 | 25.5 | 0.3 |
| 06 | 30 | 55 | 54.5 | 47.5 | 38 | 30.5 | 0.5 |
| 07 | 35 | 62 | 61.5 | 54 | 43 | 35.5 | 0.5 |
| 08 | 40 | 68 | 67.5 | 60 | 48 | 40.5 | 0.5 |
| 09 | 45 | 75 | 74.5 | 66 | 55 | 45.5 | 0.5 |
| 10 | 50 | 80 | 79.5 | 71 | 60 | 50.5 | 0.5 |
| 11 | 55 | 90 | 89.5 | 81 | 66 | 55.5 | 0.5 |
| 12 | 60 | 95 | 94.5 | 86 | 69 | 60.5 | 0.5 |
| 13 | 65 | 100 | 99.5 | 91 | 74 | 65.5 | 0.5 |
| 14 | 70 | 110 | 109.5 | 98 | 83 | 70.5 | 0.5 |
| 15 | 75 | 115 | 114.5 | 105 | 85 | 75.5 | 0.5 |
| 16 | 80 | 125 | 124.2 | 112 | 93 | 80.5 | 0.5 |
| 17 | 85 | 130 | 129.2 | 117 | 99 | 85.5 | 0.5 |
| 18 | 90 | 140 | 139.2 | 126 | 104 | 90.5 | 0.8 |
| 19 | 95 | 145 | 144.2 | 131 | 109 | 95.5 | 0.8 |
| 20 | 100 | 150 | 149.2 | 136 | 114 | 100.5 | 0.8 |
| 21 | 105 | 160 | 159.2 | 144 | 121 | 105.5 | 1.0 |
| 22 | 110 | 170 | 169.2 | 153 | 128 | 110.5 | 1.0 |
| 24 | 120 | 180 | 179.2 | 166 | 136 | 120.5 | 1.0 |
| 26 | 130 | 200 | 199.2 | 177 | 150 | 130.8 | 1.0 |
| 28 | 140 | 210 | 209.2 | 190 | 160 | 140.8 | 1.0 |
| 30 | 150 | 225 | 224.2 | 203 | 172 | 150.8 | 1.2 |
| 32 | 160 | 240 | 239.2 | 217 | 183 | 160.8 | 1.2 |
| 34 | 170 | 260 | 259.2 | 230.5 | 199.5 | 170.8 | 1.2 |
| 36 | 180 | 280 | 279.2 | 250 | 210 | 180.8 | 1.2 |
| 38 | 190 | 290 | 289.2 | 261 | 221 | 190.8 | 1.2 |
| 40 | 200 | 310 | 309.2 | 278 | 232 | 200.8 | 1.2 |
| 44 | 220 | 340 | 339.2 | 305 | 255 | 220.8 | 1.2 |
| 48 | 240 | 360 | 359.2 | 325 | 275 | 240.8 | 1.2 |
| 52 | 260 | 400 | 399.2 | 345 | 304 | 260.8 | 1.5 |
| 56 | 280 | 420 | 419.2 | 380 | 320 | 280.8 | 1.5 |
| 60 | 300 | 460 | 459.2 | 412 | 352 | 300.8 | 1.5 |
| 64 | 320 | 480 | 479.2 | 440 | 360 | 320.8 | 1.5 |
| 68 | 340 | 520 | 519.2 | 470 | 390 | 340.8 | 2.0 |
| 72 | 360 | 540 | 539.2 | 490 | 410 | 360.8 | 2.0 |
| 76 | 380 | 560 | 559.2 | 502 | 438 | 380.8 | 2.0 |
| 80 | 400 | 600 | 599.2 | 536 | 464 | 400.8 | 2.0 |

⁽¹⁾ For outer ring spacers operated using oil mist lubrication or jet lubrication, we recommend that the outer diameter of the outer ring spacer is the same as the bearing outside diameter, with a tolerance of g5 or better.

⁽²⁾ For high-speed operations exceeding $700\,000\,d_m n$, we recommend that the bore diameter of the inner ring spacer is the same as the bearing bore diameter, with a tolerance of F6 or better.

02 Series

Standard spacers for dimension series 02 (72, BSR02)

Unit: mm

| Bore number | Nominal bearing bore diameter d | Bearing outside diameter D | Outer ring spacer | | Inner ring spacer | | Spacer chamfer |
|-------------|---------------------------------|----------------------------|-------------------------------|------|-------------------|---------------------|----------------|
| | | | Outer diameter ⁽¹⁾ | Bore | Outer diameter | Bore ⁽²⁾ | |
| 00 | 10 | 30 | 29.5 | 25 | 17 | 10.5 | 0.3 |
| 01 | 12 | 32 | 31.5 | 27 | 18 | 12.5 | 0.3 |
| 02 | 15 | 35 | 34.5 | 29 | 21 | 15.5 | 0.3 |
| 03 | 17 | 40 | 39.5 | 33 | 24 | 17.5 | 0.3 |
| 04 | 20 | 47 | 46.5 | 39 | 28 | 20.5 | 0.5 |
| 05 | 25 | 52 | 51.5 | 44 | 33 | 25.5 | 0.5 |
| 06 | 30 | 62 | 61.5 | 53 | 40 | 30.5 | 0.5 |
| 07 | 35 | 72 | 71.5 | 62 | 46 | 35.5 | 0.5 |
| 08 | 40 | 80 | 79.5 | 68 | 52 | 40.5 | 0.5 |
| 09 | 45 | 85 | 84.5 | 75 | 56 | 45.5 | 0.5 |
| 10 | 50 | 90 | 89.5 | 80 | 60 | 50.5 | 0.5 |
| 11 | 55 | 100 | 99.5 | 90 | 65 | 55.5 | 0.8 |
| 12 | 60 | 110 | 109.5 | 95 | 75 | 60.5 | 0.8 |
| 13 | 65 | 120 | 119.5 | 105 | 80 | 65.5 | 0.8 |
| 14 | 70 | 125 | 124.2 | 110 | 85 | 70.5 | 0.8 |
| 15 | 75 | 130 | 129.2 | 115 | 90 | 75.5 | 0.8 |
| 16 | 80 | 140 | 139.2 | 125 | 95 | 80.5 | 1.0 |
| 17 | 85 | 150 | 149.2 | 135 | 105 | 85.5 | 1.0 |
| 18 | 90 | 160 | 159.2 | 140 | 110 | 90.5 | 1.0 |
| 19 | 95 | 170 | 169.2 | 150 | 115 | 95.5 | 1.0 |
| 20 | 100 | 180 | 179.2 | 160 | 125 | 100.5 | 1.0 |
| 21 | 105 | 190 | 189.2 | 170 | 132 | 105.5 | 1.0 |
| 22 | 110 | 200 | 199.2 | 175 | 135 | 110.5 | 1.0 |
| 24 | 120 | 215 | 214.2 | 190 | 145 | 120.5 | 1.0 |
| 26 | 130 | 230 | 229.2 | 203 | 157 | 130.8 | 1.2 |
| 28 | 140 | 250 | 249.2 | 220 | 170 | 140.8 | 1.2 |
| 30 | 150 | 270 | 269.2 | 233 | 189 | 150.8 | 1.2 |
| 32 | 160 | 290 | 289.2 | 255 | 195 | 160.8 | 1.2 |
| 34 | 170 | 310 | 309.2 | 270 | 210 | 170.8 | 1.5 |
| 36 | 180 | 320 | 319.2 | 277 | 223 | 180.8 | 1.5 |
| 38 | 190 | 340 | 339.2 | 300 | 235 | 190.8 | 1.5 |
| 40 | 200 | 360 | 359.2 | 320 | 250 | 200.8 | 1.5 |

⁽¹⁾ For outer ring spacers operated using oil mist lubrication or jet lubrication, we recommend that the outer diameter of the outer ring spacer is the same as the bearing outside diameter, with a tolerance of g5 or better.

⁽²⁾ For high-speed operations exceeding 700 000 $d_m n$, we recommend that the bore diameter of the inner ring spacer is the same as the bearing bore diameter, with a tolerance of F6 or better.

9. Spacers

Nozzle Position

The following table lists nozzle positions for oil-air, oil mist, and oil jet lubrication systems.

Unit: mm

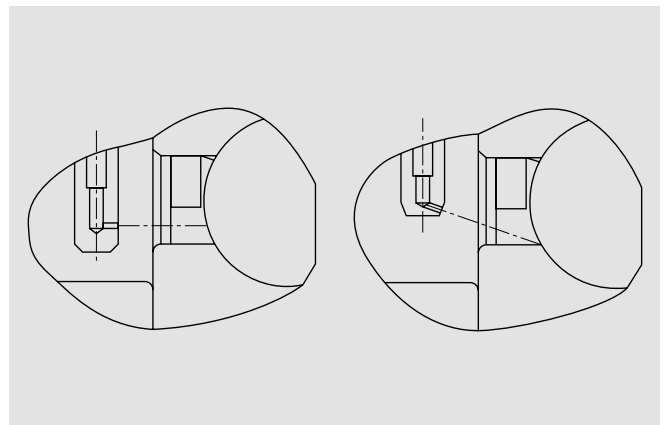
| Bore number | Nominal bearing bore | 79 Series | | 70 Series | | 72 Series | | N10XXMR (Standard Series) | | N10XXR (NSK ROBUST Series) | |
|-------------|----------------------|-----------|-----|-----------|-----|-----------|-----|---------------------------|-----|----------------------------|-----|
| | | ∅A (1) | B | ∅A (1) | B | ∅A | B | ∅A | B | ∅A | B |
| 00 | 10 | 14.5 | 0.4 | 16.1 | 0.5 | 18.1 | 0.5 | - | - | - | - |
| 01 | 12 | 16.5 | 0.4 | 18.3 | 0.5 | 19.6 | 0.5 | - | - | - | - |
| 02 | 15 | 20.0 | 0.5 | 21.3 | 0.5 | 22.6 | 0.7 | - | - | - | - |
| 03 | 17 | 21.8 | 0.5 | 23.5 | 1.0 | 25.9 | 0.7 | - | - | - | - |
| 04 | 20 | 26.1 | 0.5 | 28.2 | 1.0 | 30.5 | 1.0 | - | - | - | - |
| 05 | 25 | 31.1 | 0.5 | 32.9 | 1.0 | 35.5 | 1.0 | - | - | - | - |
| 06 | 30 | 36.1 | 0.5 | 39.5 | 1.0 | 41.8 | 1.0 | 39.7 | 1.2 | - | - |
| 07 | 35 | 42.6 | 0.5 | 44.6 | 1.0 | 48.6 | 0.7 | 45.4 | 1.5 | - | - |
| 08 | 40 | 47.9 | 0.5 | 50.0 | 1.0 | 54.6 | 0.7 | 50.6 | 1.5 | - | - |
| 09 | 45 | 53.4 | 0.5 | 55.6 | 1.0 | 59.4 | 0.7 | 56.5 | 2.0 | 60.0 | 1.2 |
| 10 | 50 | 57.9 | 0.5 | 60.6 | 1.0 | 64.4 | 1.0 | 61.5 | 2.0 | 64.5 | 1.3 |
| 11 | 55 | 64.0 | 0.5 | 67.3 | 1.0 | 70.8 | 1.0 | 69.2 | 2.5 | 71.0 | 1.2 |
| 12 | 60 | 69.0 | 0.5 | 72.5 | 1.0 | 77.4 | 0.7 | 74.3 | 2.5 | 76.5 | 1.2 |
| 13 | 65 | 74.0 | 0.5 | 77.5 | 1.0 | 84.6 | 0.7 | 79.2 | 2.5 | 81.5 | 1.2 |
| 14 | 70 | 80.9 | 0.7 | 83.7 | 1.0 | 89.4 | 0.7 | 86.6 | 3.0 | 89.0 | 1.5 |
| 15 | 75 | 85.5 | 0.7 | 89.4 | 1.0 | 94.5 | 0.7 | 90.0 | 2.5 | 94.5 | 1.5 |
| 16 | 80 | 90.5 | 0.7 | 96.5 | 1.0 | 101.4 | 0.7 | 98.5 | 3.0 | 101.0 | 2.0 |
| 17 | 85 | 98.8 | 0.7 | 101.5 | 1.0 | 109.8 | 1.0 | 103.5 | 3.0 | 106.0 | 2.0 |
| 18 | 90 | 102.8 | 0.7 | 108.6 | 1.0 | 116.7 | 1.0 | 109.0 | 3.0 | - | - |
| 19 | 95 | 107.7 | 0.7 | 113.3 | 1.0 | 123.6 | 1.0 | 115.5 | 2.5 | - | - |
| 20 | 100 | 116.0 | 0.7 | 118.6 | 1.0 | 130.6 | 1.0 | 119.0 | 2.5 | - | - |
| 21 | 105 | 119.5 | 0.7 | 125.1 | 0.7 | 137.4 | 1.0 | 125.5 | 3.0 | - | - |
| 22 | 110 | 124.5 | 0.7 | 131.9 | 0.7 | 144.4 | 1.0 | 134.0 | 3.0 | - | - |
| 24 | 120 | 136.3 | 0.7 | 142.3 | 0.7 | 156.3 | 1.0 | 142.0 | 3.0 | - | - |
| 26 | 130 | 149.3 | 0.7 | 156.2 | 1.0 | 168.9 | 1.0 | 156.1 | 4.5 | - | - |
| 28 | 140 | 158.1 | 0.7 | 165.7 | 2.5 | 182.6 | 1.0 | 168.0 | 4.5 | - | - |
| 30 | 150 | 171.8 | 0.7 | 178.1 | 2.5 | 196.5 | 1 | - | - | - | - |
| 32 | 160 | 181.8 | 0.7 | 190.4 | 2.5 | 210 | 1 | 190 | 5 | - | - |
| 34 | 170 | 191.8 | 0.7 | 203.4 | 2.5 | 223 | 1 | 203 | 5 | - | - |
| 36 | 180 | 205.6 | 0.7 | 217.1 | 2.5 | 233 | 1 | - | - | - | - |
| 38 | 190 | 215.4 | 0.7 | 227.1 | 2.5 | 248 | 1 | - | - | - | - |
| 40 | 200 | 229 | 0.7 | 240.9 | 2.5 | 262 | 1 | 242 | 6.5 | - | - |
| 44 | 220 | 249 | 0.7 | 264.3 | 5 | 290 | 1.5 | - | - | - | - |
| 48 | 240 | 271.4 | 0.7 | 287 | 5 | 320 | 2 | - | - | - | - |

(1) ∅A of 79 and 70 Series bearings are in compliance with DIN Standard 628-6.

Note

- Positioning the nozzle parallel to the spindle axis is sufficient for normal operating speeds. For bearings usually operated at high speeds, it is advantageous to position the nozzle bore so that the lubricant is directed into the bearing at an angle of about 15° to 20°.
- An appropriate oil drain is necessary to prevent oil from accumulating in the spindle which leads to increased heat in the sliding sections and damages bearings.
- We recommend filtering the oil to 5 micron or less before it enters the lubrication system. Refer to page 222 for an example of an oil-air lubrication system.

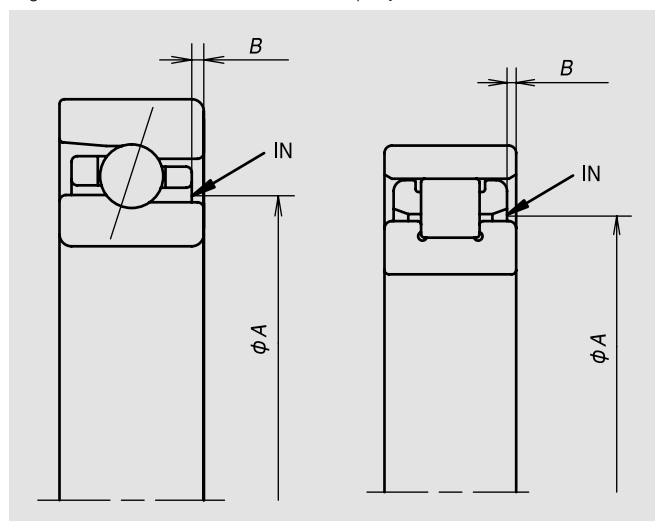
Fig. 9.1 Angle of Spray Nozzle



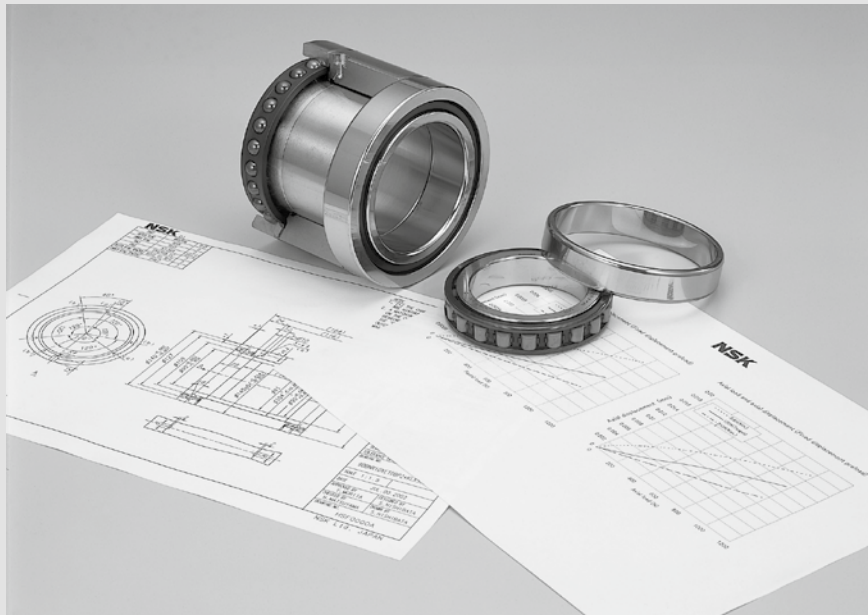
Unit: mm

| Nominal bearing bore | BNR19 BER19 | | BNR10 BER10 | | BSR19 | | BSR10 | | BSR02 | | BAR10 BTR10 | |
|----------------------|-------------|-----|-------------|-----|-------|-----|-------|-----|-------|-----|-------------|-----|
| | ∅A | B | ∅A | B | ∅A | B | ∅A | B | ∅A | B | ∅A | B |
| 6 | - | - | - | - | - | - | 9.0 | 0.4 | - | - | - | - |
| 7 | - | - | - | - | - | - | 10.5 | 0.4 | - | - | - | - |
| 8 | - | - | - | - | - | - | 12.0 | 0.5 | - | - | - | - |
| 10 | - | - | - | - | 13.5 | 0.4 | 14.5 | 0.5 | 17.0 | 1.0 | - | - |
| 12 | - | - | - | - | 15.5 | 0.4 | 16.5 | 0.5 | 18.0 | 0.5 | - | - |
| 15 | - | - | - | - | 18.5 | 0.5 | 20.0 | 1.0 | 21.0 | 1.0 | - | - |
| 17 | - | - | - | - | 20.5 | 0.5 | 22.5 | 1.5 | 24.0 | 0.5 | - | - |
| 20 | - | - | - | - | 25.0 | 0.8 | 26.5 | 0.8 | 28.3 | 0.5 | - | - |
| 25 | 31.0 | 0.5 | - | - | 30.0 | 0.8 | 31.5 | 0.8 | 33.2 | 1.0 | - | - |
| 30 | 35.5 | 0.5 | 39.0 | 1.0 | - | - | - | - | - | - | - | - |
| 35 | 42.0 | 0.5 | 44.5 | 1.2 | - | - | - | - | - | - | - | - |
| 40 | 48.0 | 0.5 | 50.0 | 1.5 | - | - | - | - | - | - | - | - |
| 45 | 53.0 | 0.5 | 55.5 | 1.7 | - | - | - | - | - | - | - | - |
| 50 | 57.5 | 0.5 | 60.5 | 1.7 | - | - | - | - | - | - | 60.5 | 0.9 |
| 55 | 63.5 | 0.5 | 67.5 | 1.5 | - | - | - | - | - | - | 67.5 | 0.7 |
| 60 | 68.5 | 0.5 | 73.0 | 1.5 | - | - | - | - | - | - | 73.5 | 0.7 |
| 65 | 73.5 | 0.5 | 77.5 | 1.5 | - | - | - | - | - | - | 77.5 | 0.7 |
| 70 | 80.5 | 0.7 | 84.0 | 1.7 | - | - | - | - | - | - | 84.0 | 0.7 |
| 75 | 85.0 | 0.7 | 89.0 | 1.7 | - | - | - | - | - | - | 89.0 | 0.7 |
| 80 | 90.5 | 0.7 | 96.0 | 1.7 | - | - | - | - | - | - | 96.0 | 0.9 |
| 85 | 98.5 | 0.7 | 102.0 | 1.7 | - | - | - | - | - | - | 102.0 | 0.9 |
| 90 | 102.0 | 0.7 | 109.0 | 1.7 | - | - | - | - | - | - | 108.5 | 1.2 |
| 95 | 107.0 | 0.7 | 112.0 | 1.7 | - | - | - | - | - | - | 112.5 | 1.2 |
| 100 | 113.5 | 0.7 | 118.5 | 2.5 | - | - | - | - | - | - | 118.5 | 1.7 |
| 105 | 119.0 | 0.7 | 125.0 | 1.7 | - | - | - | - | - | - | 126.0 | 1.4 |
| 110 | 124.0 | 0.7 | 132.5 | 1.7 | - | - | - | - | - | - | 132.5 | 1.2 |
| 120 | 136.0 | 0.7 | 143.0 | 1.7 | - | - | - | - | - | - | 142.5 | 1.2 |
| 130 | 149.0 | 0.7 | 156.5 | 1.7 | - | - | - | - | - | - | 155.5 | 1.7 |
| 140 | 157.5 | 0.7 | 166.0 | 1.7 | - | - | - | - | - | - | 167 | 1.7 |
| 150 | 171.5 | 0.7 | 178.5 | 1.7 | - | - | - | - | - | - | 179.5 | 1.9 |
| 160 | 181.8 | 0.7 | 190 | 2 | - | - | - | - | - | - | 190 | 2.0 |
| 170 | 191.8 | 0.7 | - | - | - | - | - | - | - | - | 205 | 1.7 |
| 180 | 205.6 | 0.7 | - | - | - | - | - | - | - | - | 218 | 2.0 |
| 190 | 215.4 | 0.7 | - | - | - | - | - | - | - | - | 228 | 2.0 |
| 200 | 229 | 0.7 | - | - | - | - | - | - | - | - | 242 | 2.2 |

Fig. 9.2 Position and Direction of Spray Nozzle



Bearing Handling



Bearing Handling

Part 6

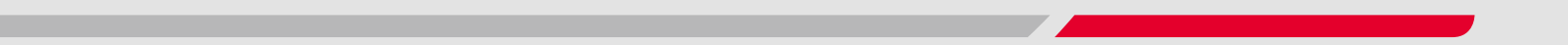
- 1. Mounting 246-267
 - 1. Cleaning the Bearings and Related Parts
 - 2. Checking Dimensions of Related Parts
 - 3. Mounting Procedures
 - 4. Inspection after Mounting
- 2. Operational Inspection 268-269
- 3. Running-in Procedures 270-271



Mounting

Operating Inspection

Running-in Procedures



1. Mounting

Mounting

The method of mounting rolling bearings strongly affects their accuracy, life, and performance. We recommended that designers and engineers fully analyze the handling procedures for bearings and establish standards with regard to the following procedures:

- (1) Cleaning the bearings and related parts
- (2) Checking the dimensions of related parts
- (3) Mounting procedures
- (4) Inspection after mounting

Precautions for Proper Handling of Bearings

Super precision bearings are highly accurate, high-quality machine parts and must be handled accordingly. Even if high-performance, high-accuracy bearings are used, their expected performance cannot be achieved if they are not handled properly. The main precautions to be observed are as follows:

- Keep bearings and surrounding area clean

Foreign particles, even if invisible to the naked eye, have harmful effects on bearings. Take care to prevent the ingress of dirt and debris into the bearing by maintaining a clean working environment.

- Handle bearings carefully

Avoid any heavy shocks during handling. Shock loads can scratch or dent a bearing, possibly resulting in failure. Excessive impacts may cause brinelling or cracks. Even very small damage can lead to noise and should be avoided.

- Use proper tools

Always use the proper equipment when handling bearings and avoid general-purpose tools.

- Prevent corrosion

Handling bearings with bare hands can corrode the bearing surfaces because of perspiration or various other contaminants on the skin. Wear gloves if possible. Take measures to prevent bearings rusting due to corrosive gasses.

Storage method

- Although bearings are coated with an anti-corrosion agent, and then wrapped and packed, it is impossible to completely avoid exposure to the air surrounding the bearings. Store the bearings in a dry location and avoid exposure to moisture and humidity.

- Bearings should be stored in a clean, dry, and well-ventilated location that also provides protection from direct sunlight. Store the bearings in a locker or on shelves that are at least 30 cm from the floor.

- When bearings are unpacked for acceptance inspection, take measures to prevent rusting and contamination. After inspection, follow the guidelines given above to ensure proper storage.

1. Cleaning the Bearings and Related Parts

Bearings should not be unpacked until immediately before mounting. Delivered bearings are coated with an anti-corrosion agent for dustproofing and rust prevention during transportation. In general, bearings for high-speed operation should be cleaned with clean filtered solvent to remove the anti-corrosion agent. That applies in particular to bearings that need packing with grease: anti-corrosion agent remaining on the raceway surfaces may lead to grease outflow. After the bearings are cleaned with filtered solvent, they should be protected to prevent corrosion. Refer to pages 248-249 for a detailed description of the cleaning process.

Some products such as bearings prepacked with grease or sealed bearings do not require cleaning. Instead wipe off the anti-corrosion agent from the outside surface with a clean cloth before assembly.

Shafts and housings should be cleaned and the mating surfaces (bearing seats, spacer seats) checked for flaws or burrs.

2. Checking the Dimensions of Related Parts

Inspection of shaft and housing

- Dimensions of the shafts and housing bores should be checked to confirm the required fit with the bearing bore and outer diameter will be achieved. Refer to pages 234-236 for recommended fits on shafts and housings.
- Measurements should be taken in a thermostatic chamber (this applies to mounting, as well). Once the parts have reached a constant and stable temperature, take measurements using a micrometer or cylinder gauge. Always take measurements at several different points and confirm there are no significant differences in measurement values. Recommended accuracy values for shafts and housings are listed on page 237.
- For spacers etc. to be arranged on a spindle, we recommend a parallelism of 0.003 mm or less (0.004 mm or less for bore sizes larger than 300 mm). Spacer parallelism exceeding this recommendation will tilt the bearings causing inaccuracies and bearing noise.
- To control radial clearance of cylindrical roller bearings with tapered bores, measure each dimension (before packing grease, in the case of grease lubrication) and prepare the spacers accordingly. Radial clearance measurement and clearance adjustment method are explained on page 251.

3. Mounting Procedures

When using grease lubrication, pack bearings with grease before mounting. With oil-air and oil mist lubrication, mount bearings after cleaning and degreasing.

Procedures for mounting vary according to the fit requirements of the inner and outer rings.

Primarily, it is the inner ring of a machine tool bearing that rotates: thus, bearings with cylindrical bores are usually mounted by heating them to expand the inner ring (shrink fit). Bearings with tapered bores can be mounted directly onto a tapered shaft.

Outer rings are usually mounted with some clearance. The housing can be heated to make mounting easier. In cases where outer rings are to be mounted with interference fit, press fitting is feasible and may be combined with the housing heating method.

4. Inspection after Mounting

After bearings have been mounted, check shaft runout and the amount of preload. Descriptions of each process start on page 265 and page 266, respectively.

After checking, follow the operating inspection such as balancing of shaft and running-in process.

There are two kinds of shaft unbalance; "static unbalance" and "dynamic unbalance". The outline is explained on page 268.

Static unbalance of a shaft can be checked by lying the shaft horizontally on jigs which have smooth surface; when there is an uneven distribution of mass, the shaft rotates by its own weight with heavier phase down. Static unbalance can be improved by adding compensating mass to the rotor at a prescribed location.

It needs to rotate the shaft to check dynamic unbalance. Using the special instrument for, the dynamic unbalance can be measured. Improving of the unbalance can be done by adjusting the weight at both front and rear side of the shaft.

Running-in procedure is very important, especially for grease lubricated spindle. This process distributes grease over bearing free internal space uniformly and expel the excess grease. This procedure is explained on page 270.

Typical irregularities of operating spindle and the countermeasures for them are listed on page 277.

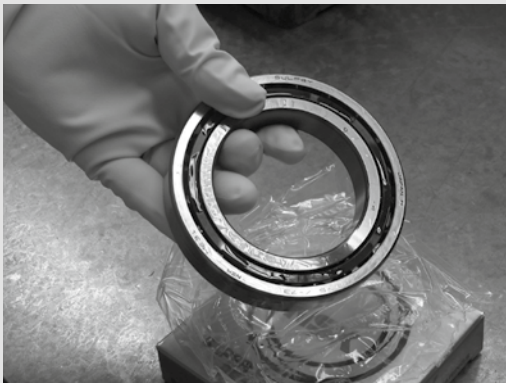
1. Mounting

1. Cleaning the Bearings and Related Parts

1.1 Cleaning with kerosene

This section provides information on the cleaning process and proper handling of bearings during cleaning as well as devices used for cleaning.

1 Take the bearing out of its package.



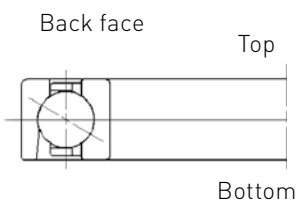
2 Without rotating it, pour cleaning oil over the bearing to remove anti-corrosion agent



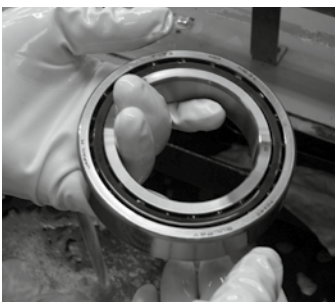
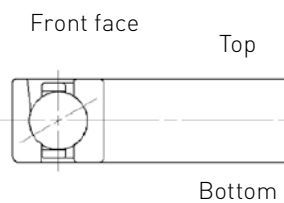
Handle bearings with care

The way you hold angular contact ball bearings is important: When holding the inner ring, make sure the bearing's back face is facing up. When holding the outer ring, make sure the bearing's front face is facing up.

When holding the inner ring



When holding the outer ring



Cleaning device and cleaning oil

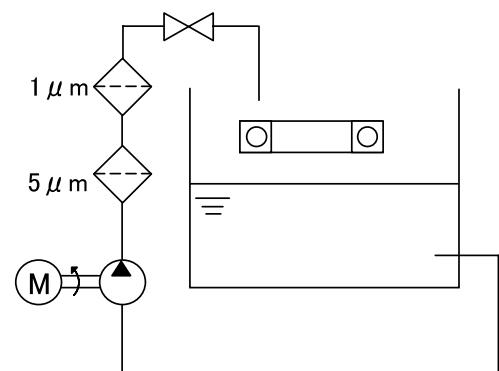
Always use a circulating filtration system to filter the cleaning fluid.

A pump is used to circulate the cleaning oil in the cleaning tank. The oil drain pipe is equipped with an oil filter that must be changed at regular intervals to prevent it becoming clogged.

Two-step filtration will efficiently remove larger and smaller particles and extend the service life of the filters.

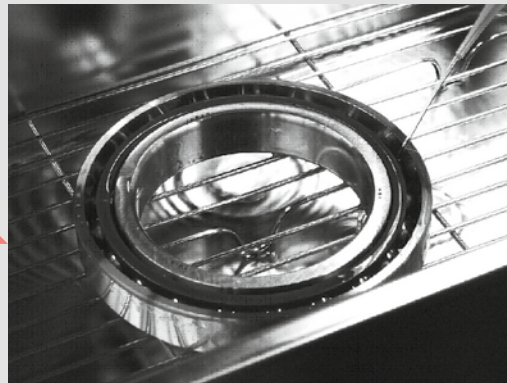
Replace the cleaning oil at regular intervals.

Circulating filtration system (Example)

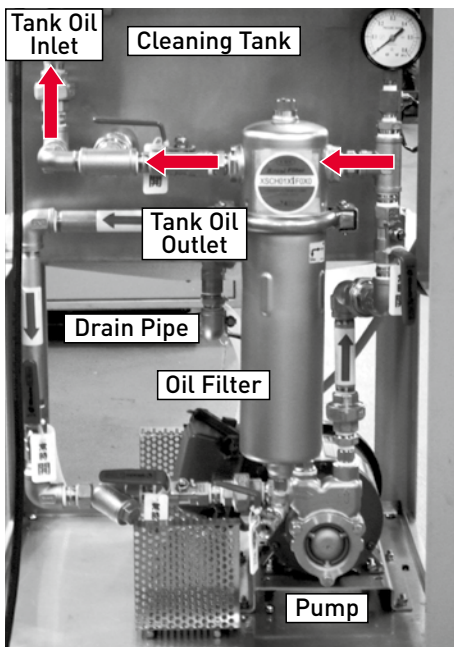


3 Rotate the bearing while allowing cleaning oil to flow between the inner and outer ring, thereby removing anti-corrosion agent from the bearing interior. Make sure the bearing runs smoothly after cleaning.

4 Degrease by rinsing the bearing with clean organic solvent.



Cleaning process is finished



Note: Shown here is an example of a filtration system with one oil filter.

Degrease with caution

- (1) After using organic solvent for degreasing, do not re-use the waste fluid.
- (2) Do not rotate bearings during and after contact with degreasing solvent as it might cause damage to the raceways and balls.
- (3) Avoid the use of compressed air as particles suspended in the surrounding air may penetrate into the bearing interior.
- (4) For grease lubrication, pack bearings with grease after degreasing. For oil lubrication, apply clean lubrication oil to the bearing interior prior to mounting. Alternatively, coat the bearing by rinsing with lubricating oil diluted with degreasing solvent (oil plating method).

Necessary caution for handling kerosene and organic solvents

When working with kerosene and organic solvents, be aware of the hazards of fire and toxicity. Always take appropriate measures in line with applicable industrial safety laws and regulations to prevent accidents. Examples: Ground the cleaning devices to prevent sparks from static electricity; ensure adequate ventilation, etc.

As this section illustrates only the cleaning process as such, please understand NSK cannot assume any responsibility for risks associated with the handling of cleaning agents.

1. Mounting

2. Checking the Dimensions of Related Parts

2.1 Gauging and adjusting tapered shafts

For precision cylindrical roller bearings to perform as expected, proper mounting onto a shaft and housing is essential.

If bearings are mounted with a mismatch between the taper angle of the bearing bore and the taper angle of the shaft, inner ring expansion will be uneven along the spindle axis, which will impede bearing performance during operation. This detrimental impact increases in the case of double-row cylindrical roller bearings due to their wider inner ring.

Fig 1.1 illustrates how uneven inner ring expansion during fitting caused by a mismatch of taper angle leads to a difference in radial clearance between the two rows. A large imbalance of load capacity ensues that results in lower rigidity; misaligned inner ring grooves result in irregular movement of the rollers, etc.

Even with single-row cylindrical roller bearings, misalignment of inner ring grooves causes unevenness of the contact points (running traces) of the rollers with the inner and outer ring, resulting in irregular roller motion.

Actual examples of such defects are discussed on page 274.

- Taper angle

Please refer to pages 228-229 for taper angle values of cylindrical roller bearings with tapered bore.

- Checking the shaft taper angle

We recommend you gauge the shaft taper with the bore taper of the actual bearing. Please follow these steps:

- Clean and degrease the tapered bore of the bearing and the tapered section of the shaft, then coat either of the tapers with blue dye very thinly and evenly.
- Push the bearing inner ring onto the shaft.
- Slightly rotate the inner ring, then withdraw the inner ring carefully from the shaft without rotating it (Fig. 1.2).
- Blue dye has rubbed off the tapered one onto another in places where both parts are in contact.
- The area of the tapered shaft that is dyed blue should cover at least 80% of the bearing width.
- If the contact area is insufficient, modify the shaft taper accordingly.
- Lead oxide may also be used instead of blue dye.

- Types of taper contact

A uniform taper contact along the complete bearing bore surface, confirmed by the method described above, is an ideal fit that is hard to achieve because of limits to machining accuracy. In practice, differences of contact are likely to occur.

In Fig. 1.3, the shade of blue indicates the intensity of contact between bearing bore and shaft.

Contact at the large end of the shaft taper (a) means that contact is strongest in the area where the inner ring is thinnest. Therefore, row A will expand to a larger degree, and row B to a smaller degree. The result is a large imbalance of radial clearance, as shown in Fig. 1.1.

We recommend contact at the small end of the shaft taper (b) since the thick wall of the inner ring means row B is less likely to expand and the effect of taper irregularity can be absorbed more easily.

Fig. 1.1 Unevenness of Radial Clearance Due to Taper Mismatch

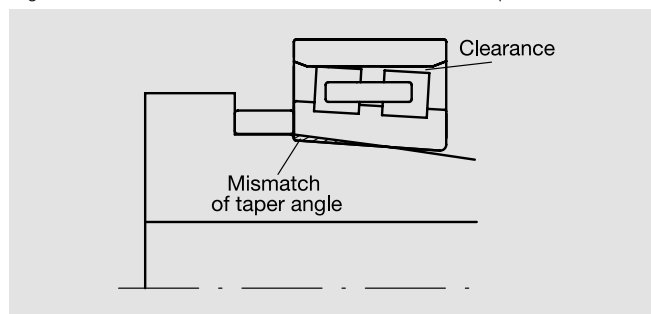


Fig. 1.2 Confirmation of Taper Angle with Coloured Paste

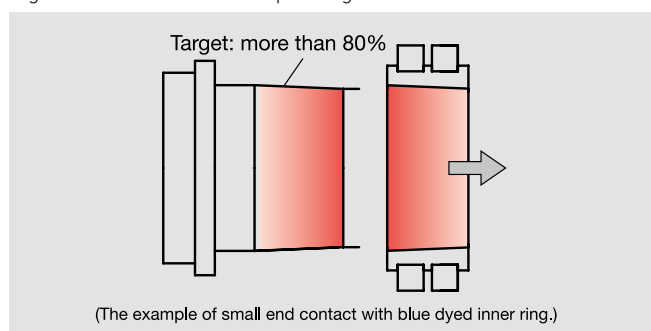
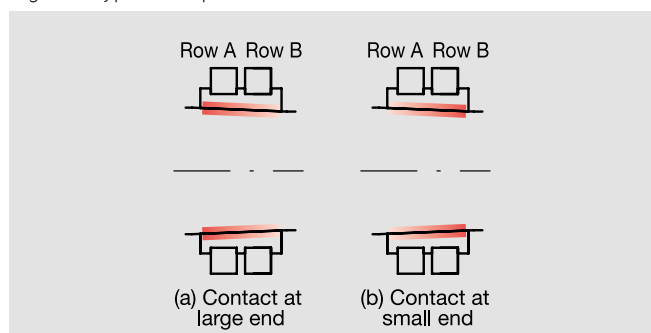


Fig. 1.3 Types of Taper Contact



2.2 Adjusting the radial clearance of cylindrical roller bearings

The internal radial clearance (preload) of cylindrical roller bearings is adjusted by pushing the inner ring up the tapered shaft, thereby expanding the inner ring. This process can be divided in four steps as explained below (Fig. 1.4).

- Step 1: Push inner ring onto tapered shaft
- Step 2: Measure radial clearance
- Step 3: Measure the distance between inner ring and shaft shoulder
- Step 4: Adjust spacer width as required to achieve target radial clearance

Step 1: Push inner ring onto tapered shaft

After cleaning and degreasing, slide the inner ring onto the shaft. Mount the inner ring by giving it a light impulse using a spacer (Fig. 1.5). Tighten the shaft locknut. For grease lubricated bearings, grease is not yet packed at this stage.

Please refer to pages 248-249 for details on the process of bearing cleaning.

Step 2: Measure radial clearance

Radial clearance is measured either (1) using a special instrument called a GN gauge or (2) without a GN gauge (calculation method). Descriptions of each measuring process start on page 252 and page 254, respectively.

Step 3: Measure the distance between inner ring and shaft shoulder

Using gauge blocks or feeler gauges etc., measure the distance L from the inner ring end face to the shaft shoulder (Fig. 1.6).

Take three or more measurements around the circumference and use the average in order to account for possible shaft misalignment during adjustment and for the accuracies of surrounding parts.

Step 4: Adjust spacer width as required to achieve target radial clearance

Based on the calculation of the width measured in step 3 and the other measurement values, determine the spacer width that will obtain the targeted radial clearance. Finish the spacer to this width.

Fig. 1.4 Adjusting the Radial Clearance of Cylindrical Roller Bearings

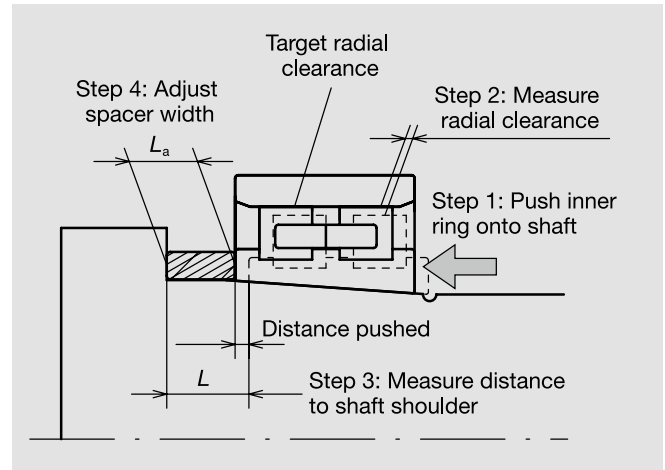


Fig. 1.5 Pushing the Inner Ring in Place

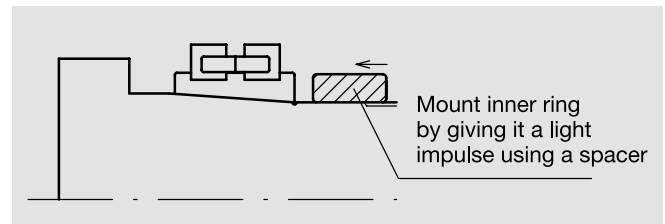
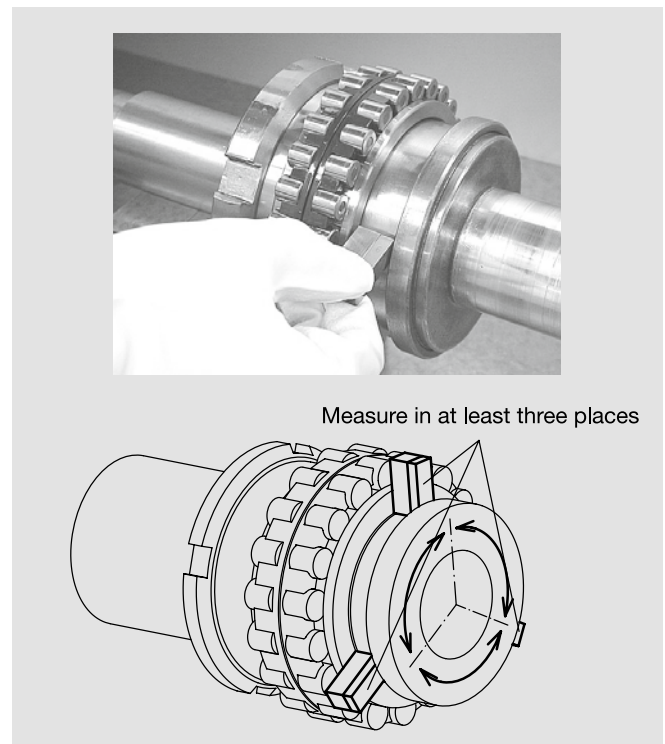


Fig. 1.6 Measuring the Required Spacer Width



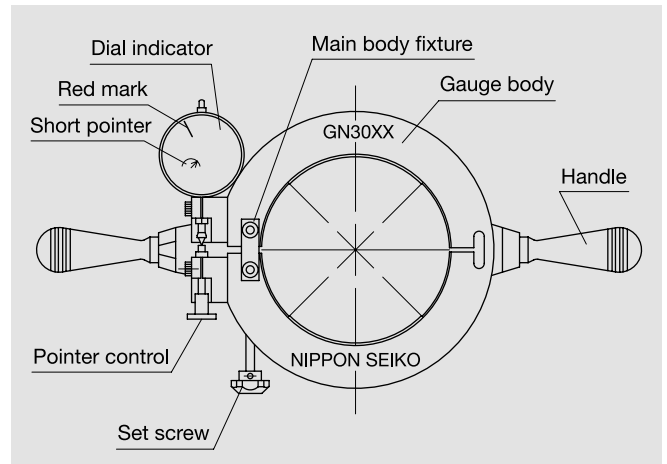
1. Mounting

(1) Measuring Radial Clearance of Cylindrical Roller Bearings (GN Gauge Method)

When mounting a cylindrical roller bearing with tapered bore onto a machine tool spindle, it is essential to accurately match the shaft taper with that of the bearing and to ensure that the desired radial internal clearance is attained after mounting. A GN gauge is a special instrument that allows precise measurement and control of mounted radial clearance during this process. GN gauges are especially effective when cylindrical roller bearings are used with radial preload.

Fig. 1.7 describes the components of GN gauges.

Fig. 1.7 Components of a GN Gauge



How to use a GN gauge

① Insert outer ring into housing

Recommended values for the fit between outer ring and housing are listed on page 235.

② Set cylinder gauge to zero

Ensure that the temperatures are the same for the outer ring (inserted into the housing), the inner ring, and the shaft. Then, measure the bore diameter of the outer ring at about four different locations using a cylinder gauge (dial bore gauge) and set the dial of the cylinder gauge to zero using the average value of the measurements (Fig. 1.8).

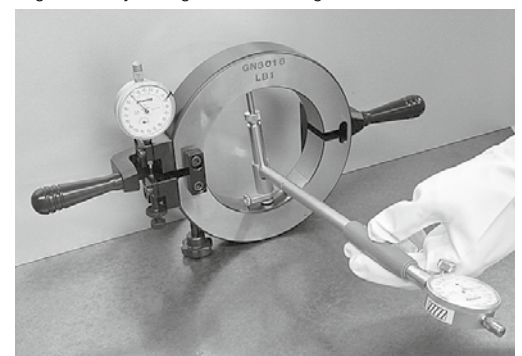
③ Adjust the bore diameter of the GN gauge

Loosen the bolt of the main body fixture on the GN gauge. Place the cylinder gauge in the bore of the GN gauge and adjust the setscrew until the dial on the cylinder gauge reads zero. The idea is to set the bore of the GN gauge to replicate that of the outer ring. Use the GN gauge in an upright position during this process to avoid inaccuracies in the cylindricity of the GN gauge bore due to its own weight (Fig 1.9).

Fig. 1.8 Setting the Cylinder Gauge to Zero



Fig. 1.9 Adjusting the GN Gauge Bore



④ Correct the GN gauge

Next, use the pointer control on the dial indicator to adjust the main pointer to the red mark for gauge correction, as shown in Fig. 1.10. Confirm that the short pointer is close to 2 on the secondary dial.

Gauge correction compensates for the elastic deformation of the rollers caused by the measuring pressure of the GN gauge. The amount of correction is different for each GN gauge. It is determined when the gauge is shipped.

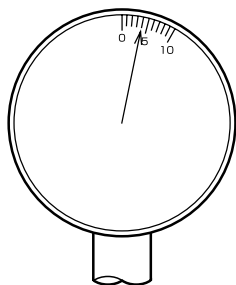
⑤ Set the GN gauge

Expand the GN gauge by adjusting the setscrew. Place centrally over the inner ring rollers (Fig 1.11) and release the setscrew to allow the GN gauge to spring closed over the rollers (so that contact deformation is applied to the rollers by the elasticity of the GN gauge only).

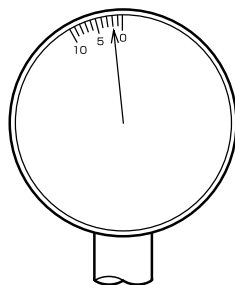
⑥ Read the dial

Read the main pointer on the dial indicator. The geometrical structure of the GN gauge (Fig 1.12) is such that a given deviation from zero in measuring point A produces twice that amount on the dial.

The actual amount of clearance or preload is $\frac{1}{2}$ the reading. Examples:



Example 1:
A reading of 4 (clockwise) indicates a radial clearance of $+2\mu\text{m}$



Example 2:
A reading of 2 (anti-clockwise) indicates a radial clearance of $-1\mu\text{m}$

⑦ Readjust the amount the inner ring is pushed up the shaft

As in ⑤, widen the GN gauge by turning the set screw until the dial shows play. Take the GN gauge off the inner ring. Tighten the shaft locknut. Then measure radial clearance again. Repeat these steps until the GN gauge indicates the target clearance value.

⑧ Measure the required spacer width

Take measurement of the distance between the inner ring end face and the shaft shoulder as described on page 251, step 3.

⑨ Adjust the spacer width

Finish the spacer width to the dimension obtained in ⑧.

Fig. 1.10 Correcting the GN Gauge



Fig. 1.11 Setting the GN Gauge

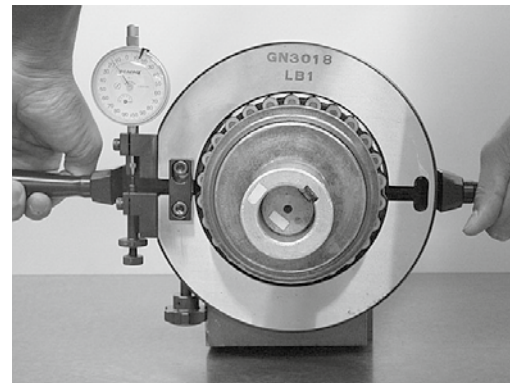
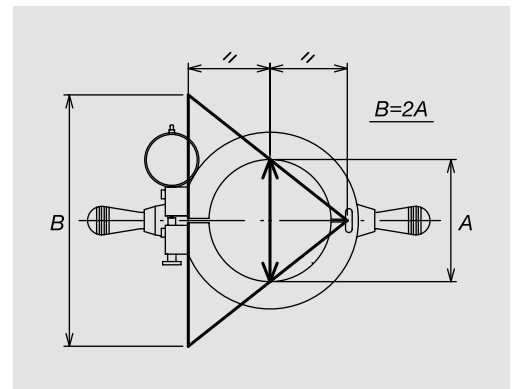


Fig. 1.11 Geometrical Structure of the GN Gauge



1. Mounting

(2) Adjusting Radial Clearance of Cylindrical Roller Bearings Without a GN Gauge (Calculation Method)

This section briefly explains how to measure radial clearance without using a GN gauge and how to calculate the spacer width L_a required to obtain the target mounted clearance value.

When not using a GN gauge, the outer ring needs to be measured before inserting it into the housing. Further, the amount of shrinkage of the outer ring raceway diameter due to fitting in the housing must be taken into account when determining the required dimension of the spacer for clearance adjustment.

$$L_a = L - K (\Delta r_m - \Delta r + \Delta r_e)$$

- ① Based upon measurement of the housing bore and the dimension of the bearing outer ring, calculate the amount of shrinkage of the outer ring raceway diameter owing to the fit of the outer ring with the housing, Δr_e . If the outer ring is mounted with positive clearance, there is no need for this calculation (in this case, $\Delta r_e = 0$).

$$\Delta r_e = (D_h - D) \times H$$

(if this value is positive, a value of $\Delta r_e = 0$ is adopted)

Table 1.1 Housing Wall Thickness and Shrinkage Factor H

| Housing wall thickness ratio $h_o (=D_o/D_h)$ | Shrinkage factor H |
|--|----------------------|
| 110% | 0.32 |
| 120% | 0.47 |
| 130% | 0.56 |
| 140% | 0.61 |
| 150% | 0.65 |
| 160% | 0.68 |
| 170% | 0.70 |
| 180% | 0.71 |

- ② Place the outer ring over the rollers. Apply a dial gauge to the outer diameter of the outer ring. Then lightly tighten the shaft locknut.
- ③ Moving the outer ring up and down by hand, measure the free radial play Δr_m with the dial gauge.
Body temperature may increase the temperature of the outer ring, resulting in an erroneous measurement. Therefore we recommend you wear gloves and finish the measurement quickly.

Fig 1.13 Explanation of Variables

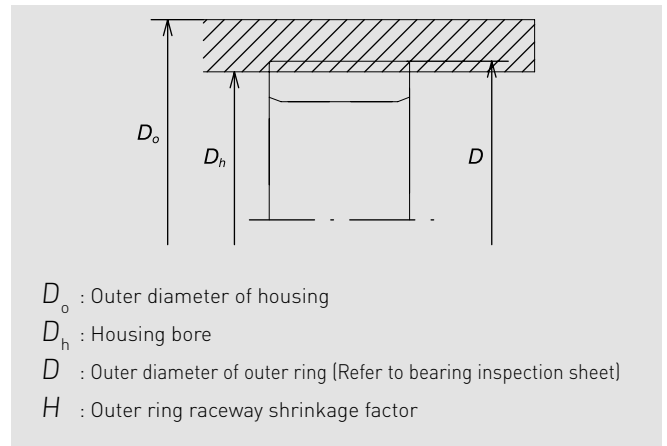
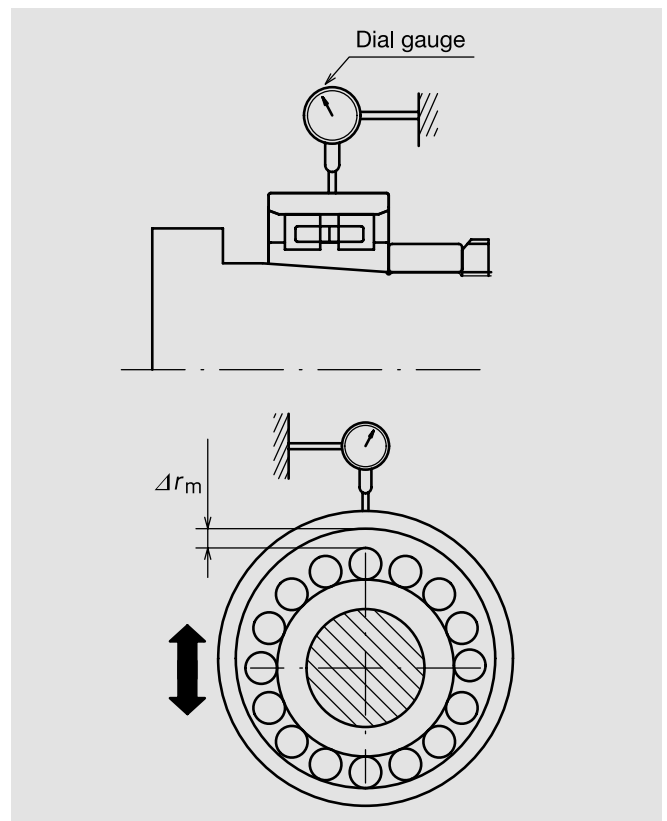


Fig 1.14 Measuring the Free Radial Play of the Outer Ring



④ Repeat ② and ③ until $\Delta r_m = 5\mu\text{m}$

Note: We adopted $5\mu\text{m}$ as a guideline value because if Δr_m is too large the deformation of the outer ring due to the measuring force may result in an incorrect measurement. Smaller values than $5\mu\text{m}$ are acceptable, for example if the target radial clearance Δr is negative. However, it should be considered that the radial clearance will be further reduced due to shrinkage of the outer ring by Δr_e as determined in ①, so the shaft locknut should not be tightened excessively.

⑤ Measure the distance between the inner ring end face and the shaft shoulder L as described on page 251, step 3.

⑥ Using the following equations, determine the inner ring expansion Δr_i required to achieve the target radial clearance Δr as well as the necessary distance ΔL_i that the inner ring needs to be pushed to achieve expansion Δr_i .

$$\Delta r_i = \Delta r_m + \Delta r_e - \Delta r$$

$$\Delta L_i = K \Delta r_i$$

Table 1.2 Hollow Shaft Ratio k_0 and Coefficient K

| Hollow shaft ratio k_0 (=do/d) | Coefficient K | Hollow shaft ratio k_0 (=do/d) | Coefficient K |
|----------------------------------|-----------------|----------------------------------|-----------------|
| 0% | 14.1 | 50% | 15.2 |
| 10% | 14.1 | 60% | 16.0 |
| 20% | 14.2 | 70% | 17.4 |
| 30% | 14.4 | 80% | 20.2 |
| 40% | 14.7 | | |

⑦ Calculate the required length L_a for the clearance adjustment spacer according to the results obtained in ⑥ and ⑦:

$$L_a = L - \Delta L_i$$

[Example calculation]

Setting radial clearance after mounting to $\Delta r = -0.002\text{ mm}$ for NN3020MBKR:

$$h_0 = D_o/D = 225/150 = 150\% \Rightarrow H = 0.65$$

Shrinkage of outer ring raceway diameter due to fitting

Amount of inner ring expansion necessary to achieve target clearance value

$$k_0 = d_o/d = 50/100 = 50\% \Rightarrow K = 15.2$$

Distance that the inner ring needs to be pushed up the tapered shaft

Width of clearance adjustment spacer

Fig 1.15 Deformation of the Outer Ring Due to Measuring Force

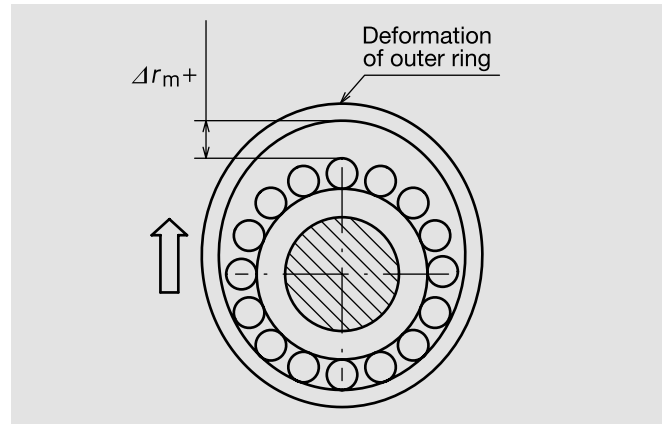
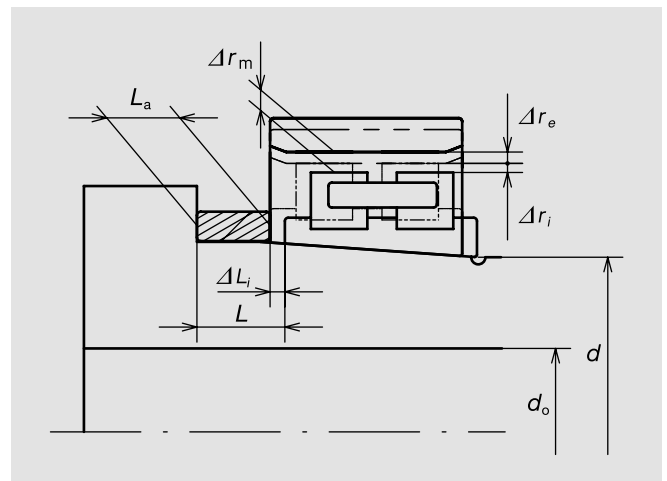


Fig 1.16 Explanation of Variables



Values used in the calculation example (mm)

| | |
|--------------|---------|
| Δr | -0.002 |
| Δr_m | 0.005 |
| D_o | 225 |
| D | 149.998 |
| Dh | 149.993 |
| d | 100 |
| d_o | 50 |
| L | 20.55 |

$$\Delta r_e = (149.993 - 149.998) \times 0.65 = -0.003\text{ mm}$$

$$\Delta r_i = 0.005 - 0.003 - (-0.002) = 0.004\text{ mm}$$

$$\Delta L_i = 15.2 \times 0.004 = 0.061\text{ mm}$$

$$L_a = 20.55 - 0.061 = 20.489\text{ mm}$$

1. Mounting

2.2 Securing the Outer Ring

A retaining cover held by bolts is generally used to secure the bearing outer ring axially. If a bolt is tightened excessively or a combination of bolts is tightened unevenly, the bearing outer ring may become deformed. Therefore the dimensions of the surrounding parts should be checked and the clearance between retaining cover and housing controlled prior to mounting the bearings into the housing.

Measure the bearing width as well as the width of the housing section where the bearing seats are and the amount the retaining cover projects (stick-out); if necessary, machine the retaining cover to adjust the clearance between the retaining cover and housing (Fig. 1.17). In the case of a DB arrangement, we recommend to adjust the clearance between the retaining cover and housing end face at this point to about 0.01 to 0.05 mm according to the bearing size as listed in Table 1.5 on page 263 before the bolts are completely tightened.

Figures 1.18 through 1.20 show examples of deformation of the outer ring raceway caused by securing the outer ring.

Fig. 1.18: Clearance between retaining cover and housing and outer ring raceway deformation of a small bearing

Fig. 1.19: Example of deformation of the outer ring of an angular contact ball bearing as a result of tightening force of the retaining cover

Fig. 1.20: Deformation of the outer ring of a double-row cylindrical roller bearing as a result of tightening force of the retaining cover

Fig. 1.17 Adjusting the Retaining Cover

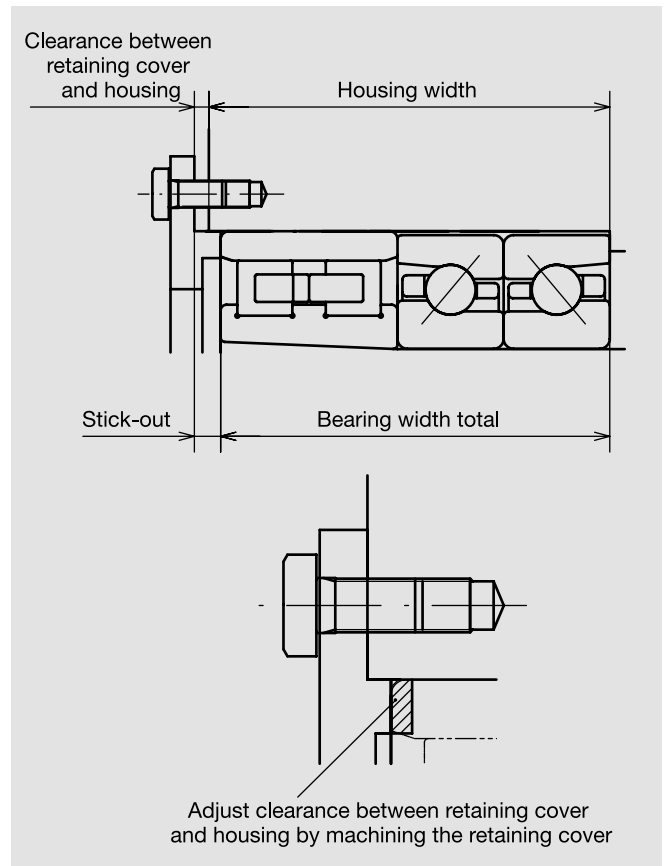


Fig. 1.18 Example of Outer Ring Deformation Due to Clearance Between Retaining Cover and Housing

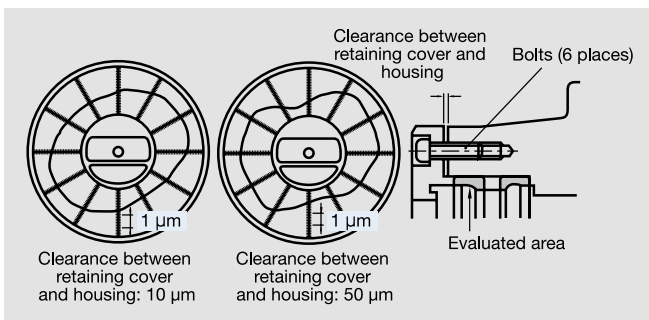


Fig. 1.19 Example of Outer Ring Deformation Caused by Tightening of Retaining Cover

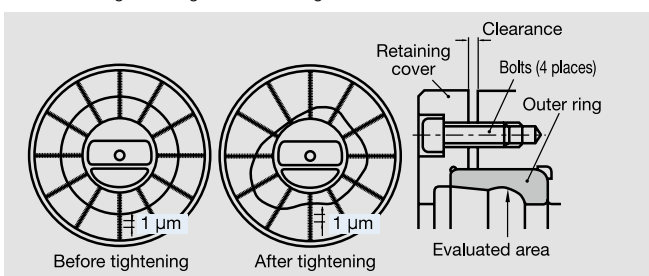
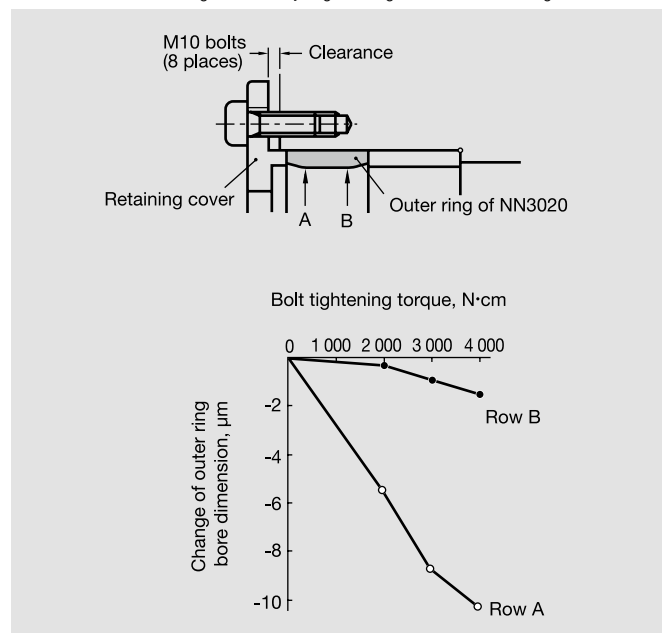


Fig. 1.20 Example of Outer Ring Deformation of a Double-Row Cylindrical Roller Bearing Caused by Tightening Force of Retaining Cover

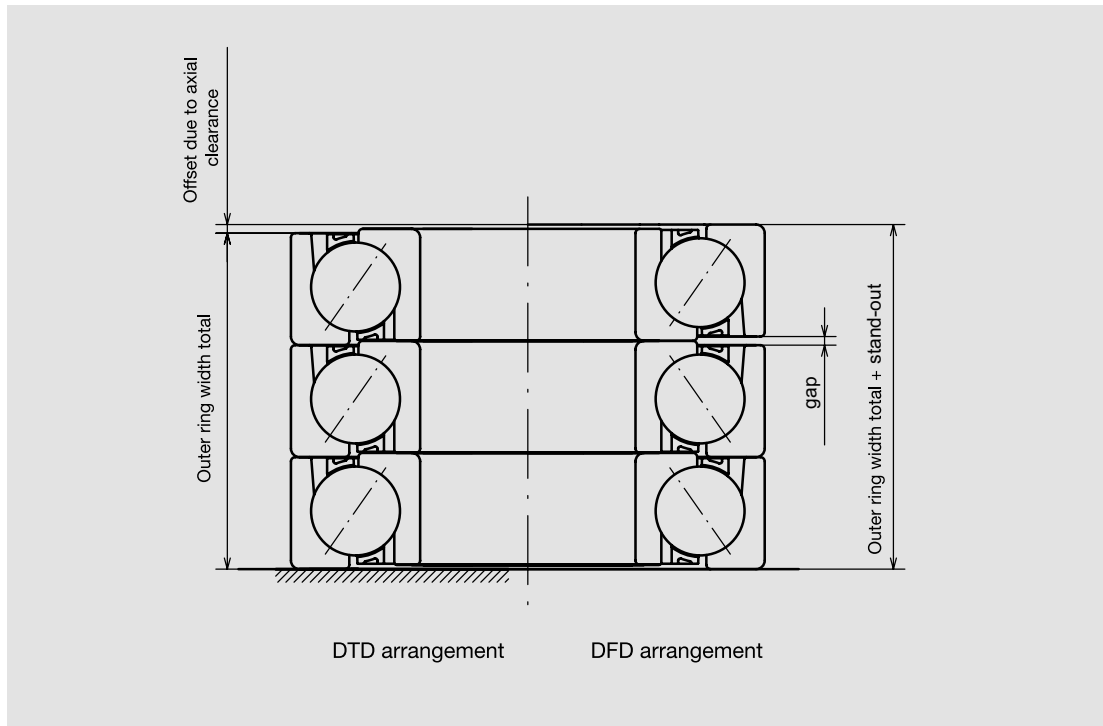


Note concerning the adjustment of clearance between the retaining cover and housing in DF arrangements

When using bearings in DF arrangement (including DFD, DFF, DFT arrangements etc.), there is a stand-out of on the outer rings before the outer rings are secured. Therefore, the outer ring width total cannot simply be measured as such. Some methods of working out the exact outer ring width total are:

- ① Measure the outer ring width of each bearing individually.
- ② Rearrange bearings so that there is no axial clearance: e.g. DT, DTT etc.
- ③ Measure the outer ring width of your bearing arrangement, then correct for the amount of ring stand-out.

Fig. 1.21 Influence of Arrangement Type on Measurement of Outer Ring Width Total



Note for method ①: When using universal combination bearings the outer ring width of each bearing is printed on the bearing inspection sheet, so there is no need for you to measure again.

Note for method ②: After rearranging the bearings for measurement, take care when mounting not to mistake the order and direction of bearings.

Note for method ③: In the case of matched bearings, stand-out (f, b) is stated on the bearing inspection sheet, so you only need to subtract this value after you have measured the outer ring width of your arrangement.

1. Mounting

3.1 Packing grease

Procedure for packing grease after cleaning bearings

After selecting a grease suited to the operating conditions, it needs to be properly packed into the bearing. Packing bearings incorrectly or with too much grease may result in a much longer running-in period or cause unusual temperature rise leading to seizure. Following proper procedures for packing grease and using the correct amount of grease require careful attention. Recommended procedures are as follows:

1. Pre-Inspection

Check to ensure there is no foreign matter in the bearing interior. Bearings for high-speed spindles should be cleaned and degreased before packing with grease. For other applications, it is advisable to remove the anti-corrosion agent adhering to interior surfaces of the bearings to prevent grease outflow.

2. Grease dispensers

Use a grease dispenser, such as a plastic syringe for precision grease dispensing. If possible, use a dispenser that comes with a gauge for packing accurate amounts of grease. Alternatively, measure the weight of the bearing before and after packing.

3. Amount of grease

Recommended amounts of grease for super precision bearings:

Angular contact ball bearings for high-speed spindles: 15-30% of internal space

Cylindrical roller bearings for high-speed spindles: 10-15% of internal space

Increasing the amount of grease extends grease life. However, more time will be required for running-in and the bearing will exhibit higher temperature rise. The advantages and disadvantages need to be considered and the grease amount chosen to suit operating conditions.

For small bearings up to 30 mm bore diameter, setting the grease amount to 15% of internal space results in a very small total amount of grease. In such cases, we suggest 20% for increased reliability.

Recommended grease quantities for each bearing type are listed in Table 1.3.

- Packing method for ball bearings

- (1) Pack grease evenly between the balls. If a ring guided cage is used, apply a light coating of grease on the guided surface of the cage.
- (2) Rotate the bearing by hand to spread the grease evenly. In doing so, take care not to expose angular contact ball bearings to reverse thrust loads.

- Packing method for cylindrical roller bearings

- (1) Coat about 80% of the grease amount evenly on the rolling surfaces of the rollers. Avoid putting too much grease on the cage bore. Grease on the cage bore is difficult to disperse during the running-in period, which can result in a rapid rise in temperature or a long running-in period.
- (2) Spread the grease applied to the rolling surfaces thinly to the roller end faces, roller cage contact points and along the face edges of each cage pocket.
- (3) Using the remaining 20% of grease, apply a thin film of grease to the raceway surface of the mounted outer ring (to the raceway surface of the inner ring for NNU type bearings).

Fig. 1.22 Grease Packed Angular Contact Ball Bearing



Fig. 1.23 Grease Packed Cylindrical Roller Bearing



Table 1.3 Recommended Grease Quantities for High-Speed Spindle Bearings

Unit: cc/bearing

| Bore number | Nominal bearing bore dia. (mm) | Angular contact ball bearings: 15% of internal space | | | | | | Cylindrical roller bearings: 10% of internal space | | | |
|-------------|--------------------------------|--|-----------|-----------|----------------------------------|------------------|------------------|--|-------------|-------------|------------|
| | | BNR19 BER19 79 Series | 70 Series | 72 Series | BNR10 BER10 BAR10 BTR10 | TAC29F TAC29D | TAC20F TAC20D | NN49 Series NNU49 series | NN39 Series | NN30 Series | N10 Series |
| 5 | 5 | - | - | 0.03 | - | - | - | - | - | - | - |
| 6 | 6 | - | 0.04 | 0.07 | - | - | - | - | - | - | - |
| 7 | 7 | - | 0.07 | - | - | - | - | - | - | - | - |
| 8 | 8 | - | 0.1 | 0.1 | - | - | - | - | - | - | - |
| 00 | 10 | 0.06 | 0.13 | 0.16 | - | - | - | - | - | - | - |
| 01 | 12 | 0.06 | 0.14 | 0.23 | - | - | - | - | - | - | - |
| 02 | 15 | 0.11 | 0.18 | 0.29 | - | - | - | - | - | - | - |
| 03 | 17 | 0.13 | 0.24 | 0.41 | - | - | - | - | - | - | - |
| 04 | 20 | 0.23 | 0.44 | 0.68 | - | - | - | - | - | - | - |
| 05 | 25 | 0.27 | 0.52 | 0.85 | - | - | - | - | - | 0.4 | - |
| 06 | 30 | 0.31 | 0.69 | 1.2 | 0.58 | - | - | - | - | 0.6 | 0.4 |
| 07 | 35 | 0.48 | 0.98 | 1.7 | 0.78 | - | - | - | - | 0.8 | 0.6 |
| 08 | 40 | 0.75 | 1.2 | 2.1 | 0.92 | - | - | - | - | 1 | 0.7 |
| 09 | 45 | 0.83 | 1.5 | 2.6 | 1.2 | - | - | - | - | 1.3 | 1 |
| 10 | 50 | 0.91 | 1.6 | 3 | 1.2 | - | <u>1.7</u> | - | - | 1.4 | 1.1 |
| 11 | 55 | 1.1 | 2.4 | 3.9 | 1.7 | - | <u>2.4</u> | - | - | 2 | 1.5 |
| 12 | 60 | 1.2 | 2.6 | 4.8 | 1.8 | - | <u>2.5</u> | - | - | 2.1 | 1.6 |
| 13 | 65 | 1.3 | 2.6 | 5.7 | 1.9 | - | <u>2.7</u> | - | - | 2.2 | 1.6 |
| 14 | 70 | 2.1 | 3.6 | 6.5 | 2.8 | - | <u>3.9</u> | - | - | 3.2 | 2.4 |
| 15 | 75 | 2.3 | 3.6 | 7 | 2.9 | - | <u>4.2</u> | - | - | 3.5 | 2.5 |
| 16 | 80 | 2.4 | 5.1 | 8.7 | 3.8 | - | <u>5.3</u> | - | - | 4.7 | 3.5 |
| 17 | 85 | 3.5 | 5.3 | 11 | 4 | - | <u>5.5</u> | - | - | 4.9 | 3.7 |
| 18 | 90 | 3.6 | 6.6 | 13 | 5.5 | - | <u>7.6</u> | - | - | 6.5 | 4.5 |
| 19 | 95 | 3.6 | 6.8 | 16 | 5.7 | - | <u>8</u> | - | - | 6.6 | 4.7 |
| 20 | 100 | 4.9 | 7.2 | 19 | 6.1 | <u>5.3</u> | <u>8.3</u> | 5.4 | 4.5 | 6.8 | 4.9 |
| 21 | 105 | 5.1 | 9 | 23 | 7.6 | - | <u>10</u> | 5.6 | 4.6 | 9.3 | 5.9 |
| 22 | 110 | 5.2 | 12 | 27 | 9.1 | <u>5.7</u> | <u>12</u> | 5.7 | 4.8 | 11 | 7.5 |
| 24 | 120 | 7.9 | 12 | 31 | 9.8 | <u>7.6</u> | <u>13</u> | 8.4 | 6.5 | 13 | 8.1 |
| 26 | 130 | 9 | 18 | 34 | 15 | <u>9.5</u> | <u>19</u> | 11 | 8.5 | 18 | 12 |
| 28 | 140 | 9.9 | 20 | 42 | 17 | - | 44 | 12 | 9.3 | 20 | 13 |
| 30 | 150 | 14 | 25 | 53 | 22 | 33 | 55 | 24 | 14 | 23 | 16 |
| 32 | 160 | 16 | 34 | 61 | 26 | 36 | 67 | 20 | 15 | 29 | 21 |
| 34 | 170 | 14 | 42 | 80 | 33 | 39 | 84 | 21 | 15 | 38 | 38 |
| 36 | 180 | 22 | 51 | 82 | 46 | 54 | 116 | 28 | 23 | 51 | 36 |
| 38 | 190 | 27 | 47 | 86 | 50 | 51 | 127 | 30 | 24 | 54 | 37 |
| 40 | 200 | 39 | 76 | 105 | 61 | 80 | 156 | 44 | 35 | 69 | 47 |
| 44 | 220 | 42 | 89 | 157 | 71 | 83 | 198 | 37 | 37 | 94 | 64 |
| 48 | 240 | 41 | 102 | 180 | 76 | 96 | 214 | 52 | 40 | 99 | 68 |
| 52 | 260 | 77 | 157 | 283 | 111 | 158 | 299 | 88 | 70 | 140 | 101 |
| 56 | 280 | 80 | 153 | 324 | - | 169 | - | 95 | 75 | 157 | 107 |

- To convert to weight value, multiply the value listed above by 0.93 (density 0.93g/cc) for the greases listed on Page 221.
- Please refer to page 148 for the recommended grease quantities for angular contact thrust ball bearings for ball screw support.
- For bore diameters larger than 280mm, please contact NSK.

1. Mounting

3.2 Mounting of Bearings with Cylindrical Bores

(1) Press Fit

Press fits tend to be used for smaller bearings. A mounting tool is placed on the inner ring as shown in Fig. 1.24 and the bearing is slowly pressed on the shaft with a press until the side of the inner ring rests against the shoulder of the shaft. When press mounting the inner ring, the mounting tool must never be placed on the outer ring, as it would cause dents or other damage to the raceway surfaces.

Before mounting, lightly oiling the mating parts is recommended for smooth insertion. Never use a hammer when mounting super precision bearings.

In the case of separable bearings, such as cylindrical roller bearings and tapered roller bearings, the inner and outer rings can be mounted onto the shaft and into the housing as separate units. When assembling the two units, take extra care to align the inner and outer rings correctly. Careless or forced assembly may cause scratches on the rolling contact surfaces.

(2) Shrink Fit

Press fitting large bearings or press fitting bearings with high interference requires a great deal of force. Therefore, a shrink fit is widely used. The inner rings of the bearings are heated to expand them before mounting. This method prevents excessive force from being imposed on the bearings and enables mounting them in a short time.

The temperature required for shrink fitting depends on the bearing size and the selected interference. To aid you in selecting the right temperature, Fig. 1.25 shows the expansion of the inner ring for various temperature differences and bearing sizes.

The following precautions need to be taken when shrink fitting:

1. Do not heat bearings to more than 120 °C.
2. Heat the bearings to a temperature 20 to 30 °C higher than the lowest temperature required for mounting without interference since the inner ring will cool a little during mounting.
3. After mounting, the bearings will shrink in the axial direction as well as the radial direction while cooling. Therefore, after confirming that the bearing has sufficiently cooled down, it is advisable to press by applying the mounting tool again or by further tightening the locknut, to eliminate any clearance between the bearing and shoulder (Fig 1.26).

Fig 1.24 Press Fitting the Inner Ring

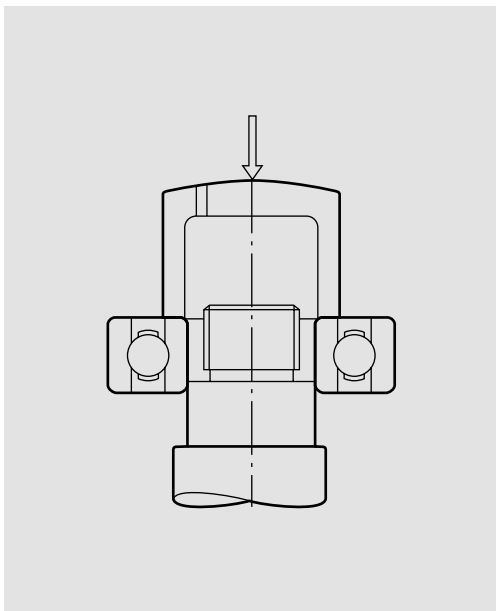
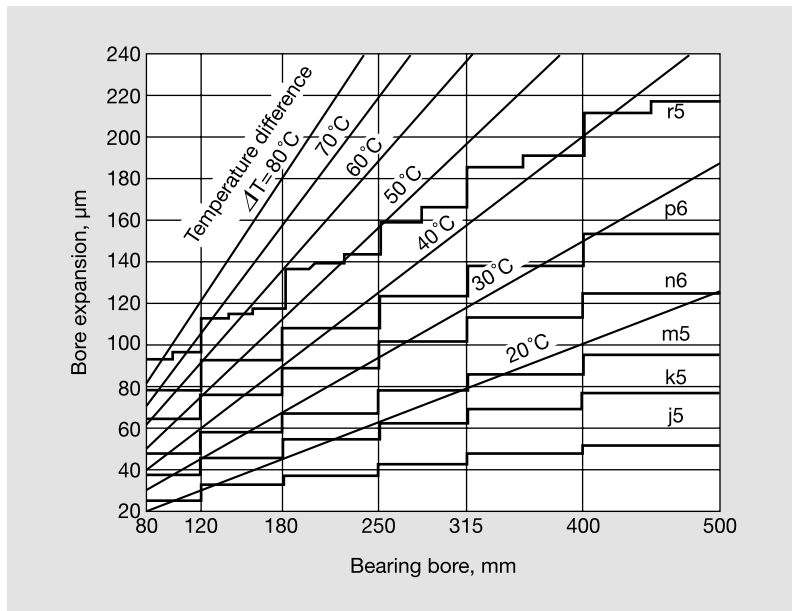


Fig 1.25 Temperature and Thermal Expansion of Inner Ring



Using NSK Bearing Heaters makes the shrink fit process more efficient. For more information, refer to Pages 184-185

Fig 1.26 Additional Pressing

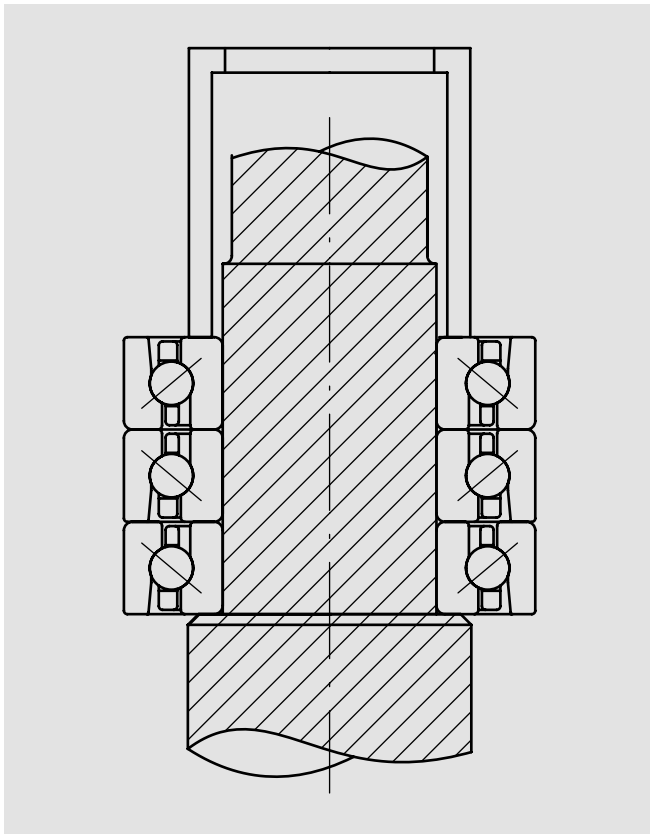
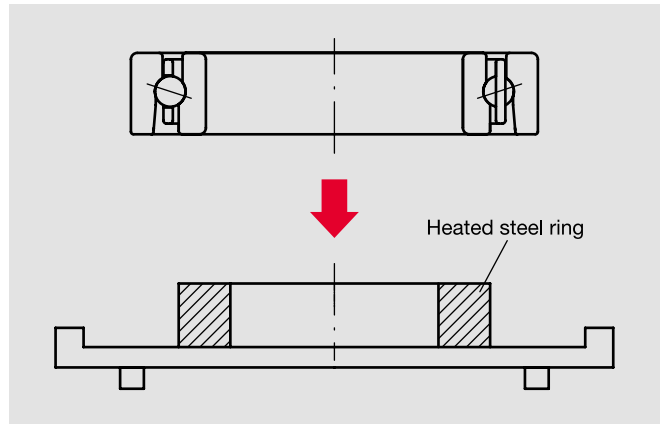


Fig 1.27 Heating the Inner Ring by means of a Hot Plate



1. Mounting

3.3 Securing the Bearing

(1) Securing the inner ring

The inner ring is usually secured onto the shaft by tightening the locknut on the threaded shaft, which explains why perpendicularity of the threads and the end face of the locknut are very important. Even if accuracy as a single component is good, a gap between the shaft and locknut can result in a slightly tilted locknut, causing shaft misalignment, which in turn results in misalignment of the bearing. Therefore, adjustments are necessary to ensure constant running accuracy. It is important that the locknut is completely tightened so as to eliminate any risk of it becoming loose.

Tightening torque information for shaft locknuts is shown in Table 1.5.

To reduce the risk of unbalance due to locknut misalignment and clearance between the shaft thread and locknut thread, stepped sleeves are widely used to achieve an interference fit between the shaft and the sleeve bore. However, compared to a locknut a stepped sleeve is more likely to become loose after continuous operation, so it must be checked periodically.

When a wide spacer is used between combined bearings with position preload, and the tightening torque of the locknut is excessive, the inner ring spacer may become deformed and alter the preload increased to a level higher than expected. It is necessary to consider this deformation when determining the preload.

Bearings for machine tool spindles

Refer to Table 1.5 for recommended tightening force values.

Please note that when shaft interference increases, insertion pressure increases. Add an allowance to the insertion pressure value to obtain the tightening force.

Extra caution is required for high-speed operation, in particular.

Angular contact thrust ball bearings for ball screw support

Recommended locknut tightening force values for face-to-face combination (DF, DFD, DFT, etc.) are listed in Table 1.5.

For back-to-back combination (DB, DBD, DBT etc.), we recommend adding preload to the tightening force value from Table 1.5 to obtain the recommended locknut tightening force. However, compare the value thus obtained to the insertion pressure. If the insertion pressure value is higher, use the insertion pressure value and add an allowance to obtain the locknut tightening force.

(2) Securing the outer ring

Adjust the clearance between the retaining cover and housing as shown in Table 1.5, then tighten the bolts. Take care when tightening the bolts since uneven tightening forces will increase out-of-roundness of the outer ring.

Reference tightening torque values for each bolt size are listed in Table 1.4.

Table 1.4 Bolt Tightening Torque for Securing the Outer Ring

| Nominal thread dimension | Tightening torque N·m |
|--------------------------|--------------------------|
| M3×0.5 | 1.7 |
| M4×0.7 | 3.9 |
| M5×0.8 | 7.9 |
| M6×1 | 13.5 |
| M8×1.25 | 32.8 |
| M10×1.5 | 65.0 |
| M12×1.75 | 114 |
| M14×2 | 180 |
| M16×2 | 281 |
| M18×2.5 | 387 |
| M20×2.5 | 549 |
| M22×2.5 | 747 |
| M24×3 | 949 |

Note: Tightening torque is affected by various conditions such as material and surface conditions. Therefore, the values in this table are reference values only.

Table 1.5 Shaft Locknut Tightening Force and Clearance Between Retaining Cover and Housing

| Nominal bearing bore (mm) | Locknut tightening force (N) | Locknut tightening torque, reference (N·m) | Clearance between retaining cover and housing (mm) |
|---------------------------|------------------------------|--|--|
| 6 | 1 500 | 2 | 0.01~0.03 |
| 8 | 1 500 | 2 | 0.01~0.03 |
| 10 | 1 500 | 3 | 0.01~0.03 |
| 12 | 3 000 | 7 | 0.01~0.03 |
| 15 | 3 000 | 8 | 0.01~0.03 |
| 17 | 3 000 | 9 | 0.01~0.03 |
| 20 | 4 900 | 17 | 0.01~0.03 |
| 25 | 4 900 | 21 | 0.01~0.03 |
| 30 | 4 900 | 25 | 0.01~0.03 |
| 35 | 9 800 | 57 | 0.01~0.03 |
| 40 | 9 800 | 64 | 0.01~0.03 |
| 45 | 9 800 | 72 | 0.01~0.03 |
| 50 | 9 800 | 80 | 0.01~0.03 |
| 55 | 14 700 | 132 | 0.01~0.03 |
| 60 | 14 700 | 142 | 0.01~0.03 |
| 65 | 14 700 | 153 | 0.01~0.03 |
| 70 | 14 700 | 166 | 0.01~0.03 |
| 75 | 14 700 | 176 | 0.01~0.03 |
| 80 | 19 600 | 251 | 0.01~0.03 |
| 85 | 19 600 | 267 | 0.01~0.03 |
| 90 | 19 600 | 281 | 0.01~0.03 |
| 95 | 19 600 | 296 | 0.01~0.03 |
| 100 | 19 600 | 311 | 0.01~0.03 |
| 105 | 19 600 | 327 | 0.01~0.03 |
| 110 | 19 600 | 343 | 0.01~0.03 |
| 120 | 19 600 | 371 | 0.01~0.03 |
| 130 | 19 600 | 403 | 0.01~0.03 |
| 140 | 29 400 | 649 | 0.03~0.05 |
| 150 | 29 400 | 695 | 0.03~0.05 |
| 160 | 29 400 | 745 | 0.03~0.05 |
| 170 | 29 400 | 796 | 0.03~0.05 |
| 180 | 29 400 | 841 | 0.03~0.05 |
| 190 | 29 400 | 886 | 0.03~0.05 |
| 200 | 29 400 | 932 | 0.03~0.05 |
| 220 | 39 200 | - | 0.03~0.05 |
| 240 | 39 200 | - | 0.03~0.05 |
| 260 | 39 200 | - | 0.03~0.05 |
| 280 | 39 200 | - | 0.03~0.05 |
| 300 | 39 200 | - | 0.03~0.05 |

Note: For bearing bores larger than 300 mm, please contact NSK.

- Conversion equation of locknut tightening torque

$$T = 0.5F \{ d_p \cdot \tan(p^* + \beta) + d_w \cdot \mu_w \} \cdot 10^{-3} \quad [\text{N} \cdot \text{m}]$$

The locknut tightening torque values in the table have been calculated using a friction coefficient of 0.15.

T : Locknut tightening torque [N·m]

F : Locknut tightening force [N]

d_p : Effective diameter of locknut [mm]

p^* : Friction angle of locknut surface

$$p^* = \tan^{-1} \mu_s$$

μ_s : Friction coefficient of locknut surface

d_w : Frictional torque equivalent diameter at locknut seating surface [mm]

μ_w : Friction coefficient of locknut seating surface

β : Lead angle of nut

$$\beta = \tan^{-1} (\text{pitch} / (3.142 d_p))$$

- Equation of press-fit force (insertion pressure)

$$K = \mu \cdot p_m \cdot \pi \cdot d \cdot B \quad [\text{N}]$$

$$P_m = \frac{E}{2} \frac{\Delta d}{d} \frac{(1 - k^2)(1 - k_0^2)}{1 - k^2 k_0^2}$$

μ : Friction coefficient at fitting surface [=0.12]

p_m : Surface pressure [MPa]

d : Shaft diameter [mm]

B : Bearing width [mm]

Δd : Effective interference [mm]

E : Young's modulus of steel [MPa]

k : Wall thickness ratio of inner ring ($k = d/D_i$)

D_i : Raceway diameter of inner ring [mm]

k_0 : Wall thickness ratio of hollow shaft ($k_0 = d_0/d$)

d_0 : Bore diameter of hollow shaft [mm]

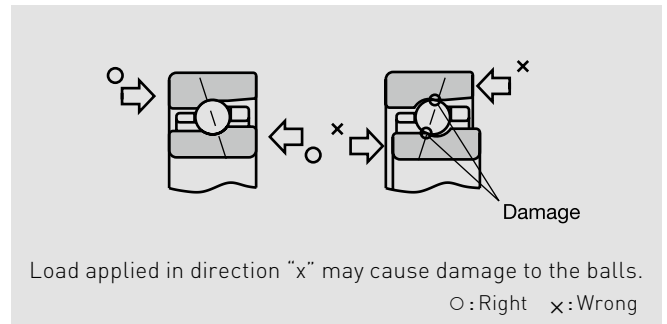
1. Mounting

3.4 Precautions for Mounting Angular Contact Ball Bearings

Due to design restrictions, an angular contact ball bearing can sustain loads in only one direction. Therefore, when mounting angular contact ball bearings onto the shaft or into the housing, it is important not to apply any load in the wrong direction.

Pay special attention to the mounting order of combined bearings, as it is different for back-to-back and face-to-face arrangements.

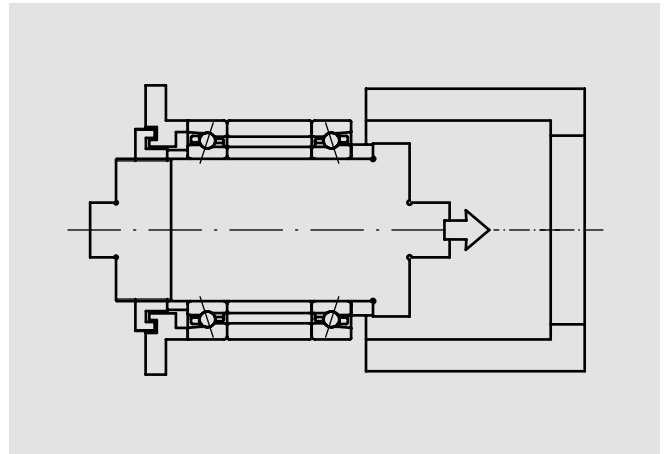
Fig 1.28 Direction of Load for Angular Contact Ball Bearings



Back-to-back arrangement:

- ① Press bearings onto shaft.
- ② Tighten shaft locknut for preloading.
- ③ Insert shaft with bearings into the housing and attach the retaining cover.

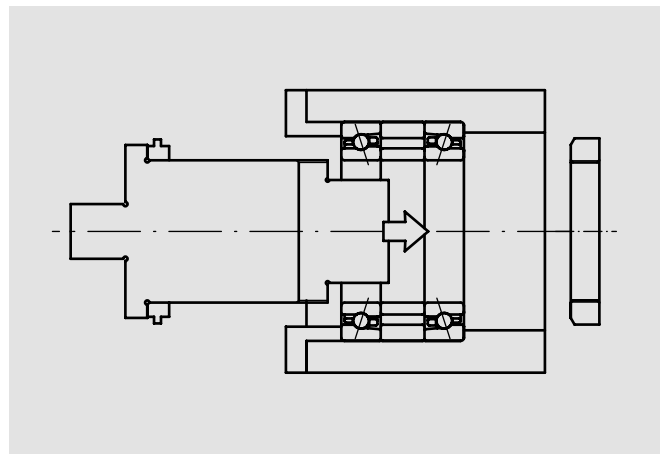
Fig 1.29 Mounting of Back-to-back Arrangement



Face-to-face arrangement:

- ① Insert bearings into housing.
- ② Secure the retaining cover for preloading.
- ③ Insert shaft into the inner rings and tighten the shaft locknut.

Fig 1.30 Mounting of Face-to-face Arrangement



Reverse the order of each step for dismounting.

4. Inspection after Mounting

4.1 Runout Accuracy

Spindle accuracy requires accurate components as well as an accurate assembly process. For example, misalignment of the locknut can cause the shaft and bearing to bend when tightened, as depicted in Fig. 1.31.

- 1: Assembled bearing outer ring face runout with raceway for angular contact ball bearings:
Adjust to 0.002 mm or less by lightly tapping on the outer ring end face.
- 2: Shaft locknut misalignment:
Adjust shaft nut misalignment to 0.005 mm or less (Fig. 1.31)
- 3: Shaft runout:
0.005 mm or less
- 4: Concentricity of rear side housing:
0.015 mm or less

The values given above are provided as an example. Define target accuracy values based on spindle size and application. If the target accuracy values cannot be met, disassemble and check the accuracy of the components again.

Fig 1.31 Adjusting Misaligned Shaft Locknut

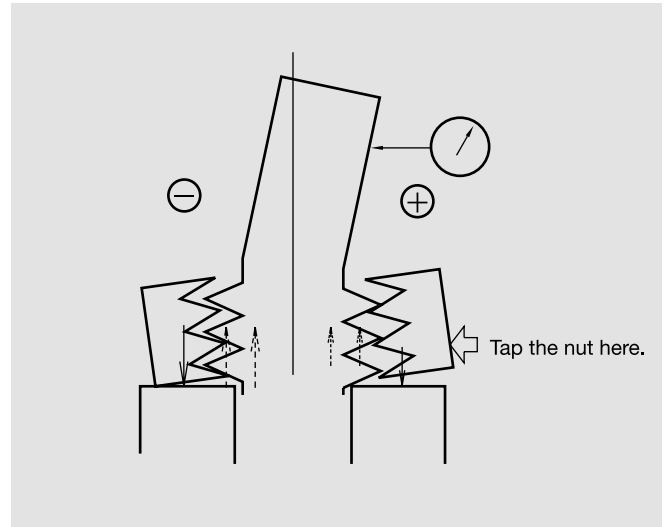
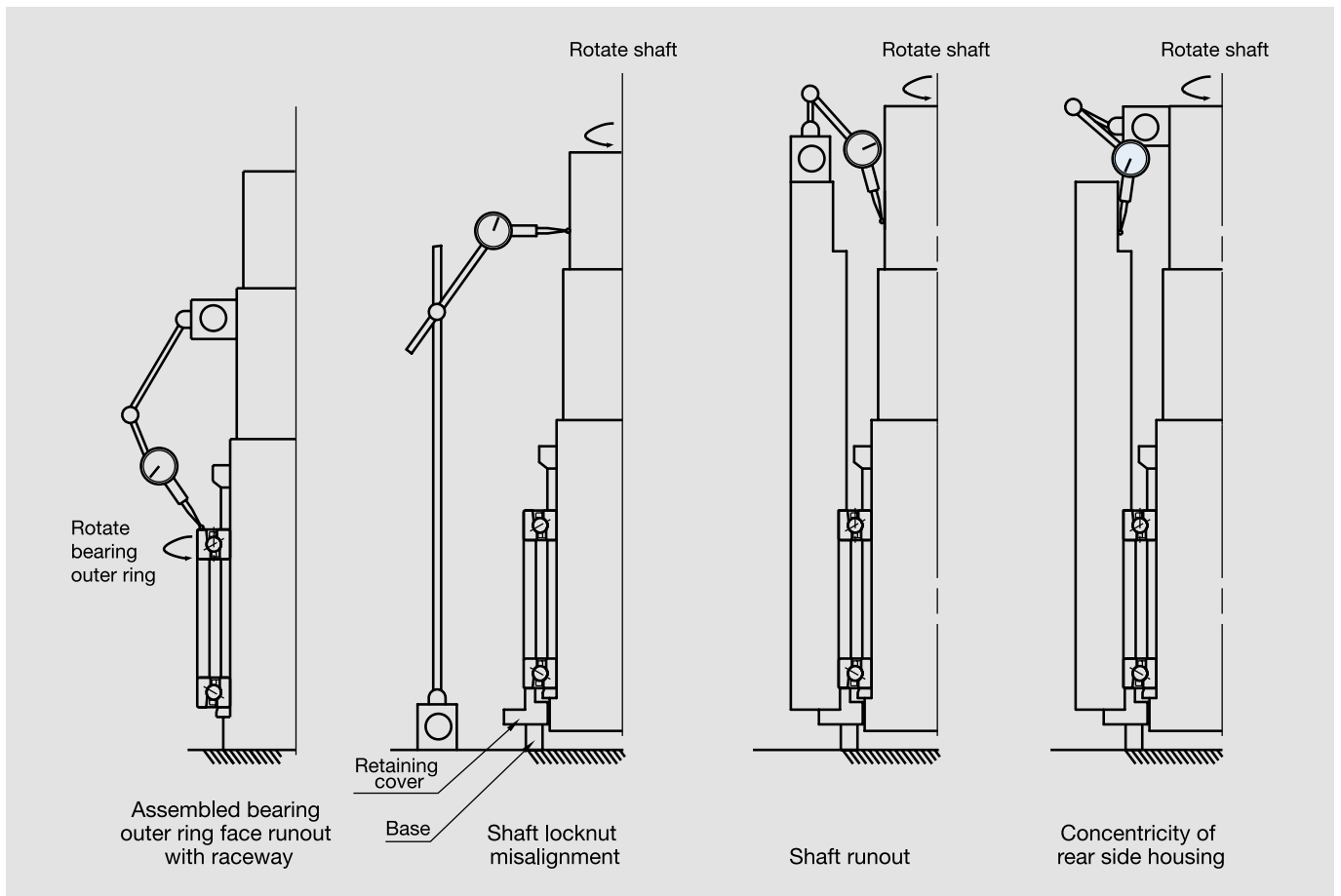


Fig 1.32 Measuring Spindle Runout



1. Mounting

4.2 Control of Preload after Mounting of Bearings

Setting a higher preload will increase the rigidity of the bearing, but heat generation will also increase. In extreme cases it may cause seizure. Therefore, it is necessary to set the optimum preload carefully in accordance with the operating conditions and to control mounted preload. Methods for measuring preload are detailed below.

For cylindrical roller bearings, we recommend you use a GN gauge to control mounted radial preload (please refer to Page 252).

Measuring preload

There are three methods for checking the preload of bearings after they have been mounted onto a spindle: the starting torque method, the force deflection method (thrust static rigidity method), and the natural frequency method. The features of each method are summarized in Table 1.6.

For tapered roller bearings starting torque method is suitable because as shown in page 216 the axial rigidity of tapered roller bearings is not sensitive for preload amount.

Table 1.6 Methods of Measuring Mounted Preload

| | Starting torque method | Force deflection method | Natural frequency method |
|---------------|--|--|--|
| Advantages | Suitable for heavy preload Measurement error is small if starting torque is high | Suitable for light preload | High measuring accuracy Excellent repeatability |
| Disadvantages | Not suitable for light preload Variation of measurement is large if starting torque is small | Not suitable for heavy preload May require large loading device Measurement may be affected by deformation of related parts | Easily influenced by measuring jig structure and spindle orientation |

(1) Starting torque method

Measure the initial tangential force required to start the spindle from standstill using a push-pull gauge (Fig. 1.33). The product of the initial tangential force F and the shaft radius at the point of measurement ($d/2$) yields the starting torque T .

$$T = F \cdot d/2$$

Obtain the level of preload from the relationship between preload and starting torque (Fig. 1.34).

With the starting torque method, measurement is simple. However, measurement accuracy varies depending on the level of starting torque. As the starting torque is low in most high-speed machine tool spindles, the measurement error is higher.

If oil film formation in the rolling contact areas is unstable during measurement, stick-slip may occur: this is the phenomenon that rotation initially does not start even though tangential force is applied, then rotation suddenly starts as the tangential force is increased gradually. In this case, the measured force tends to be higher than the actual force. Therefore, take a sufficient number of measurements and exclude any such exaggerated measurements.

Fig. 1.33 Starting Torque Method

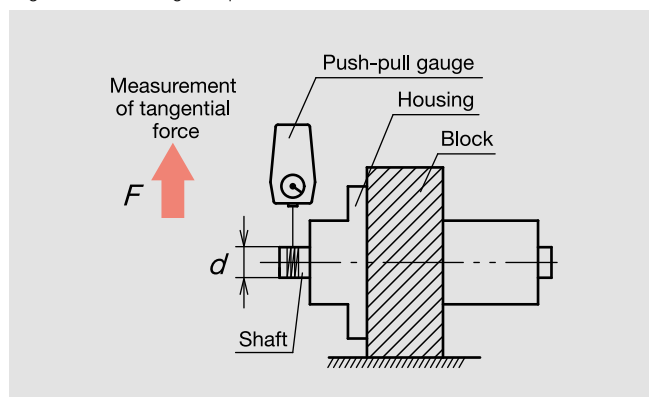
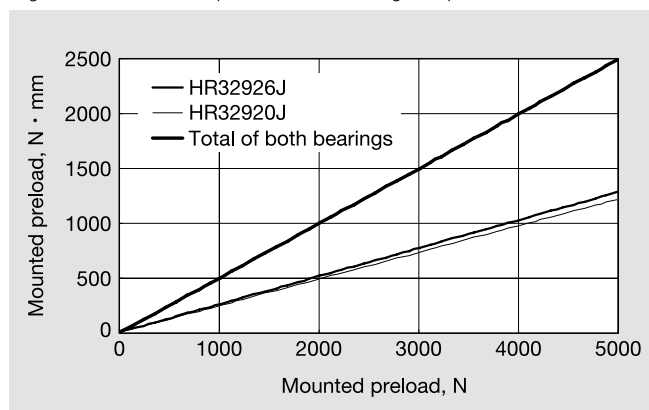


Fig. 1.34 Relationship between Starting Torque and Preload



(2) Force deflection method

Apply a thrust load to the shaft and measure its axial displacement (Fig. 1.35). The preload is obtained by the relationship between axial displacement and preload (Fig. 1.36).

This method is suitable for ball bearings since they exhibit a large change in rigidity in response to a change in preload. It is useful for spindles with moderate axial rigidity as force deflection can easily be measured. By contrast, when measuring spindles with high axial rigidity, it may be necessary to use special hydraulic equipment to apply a large enough axial load. For example, if the axial rigidity is 200 N/μm, an axial load of 2000 N will be required to deflect the spindle by 10μm.

If excessive load is applied, elastic deformation can occur in both the bearing internals and associated machine parts; in this case, the measured value tends to be lower than the actual preload.

(3) Natural frequency method

Vibrate the shaft in the axial direction and measure its resonance frequency (Fig. 1.37).

This method is the most sensitive and repeatable method when measuring angular contact ball bearings. However, the measurement results can be affected by the measuring jig structure. In other word, when the fixing condition of spindle, spindle orientation, or both were changed, the measuring result will be affected. This means that when user adopt this natural frequency method it is desirable to do other checking method in parallel, and decide the target value at its initial production.

Measurement of resonance frequency (F_z) of shaft in axial direction



Axial spring constant (K_a) of bearing

$$K_a = m \left(\frac{\pi \cdot F_z}{500} \right)^2$$



Mounted preload

K_a : Axial spring constant of bearing (N/μm)
 F_z : Resonance frequency (Hz)
 m : Mass of rotating body

Fig. 1.35 Force Deflection Method

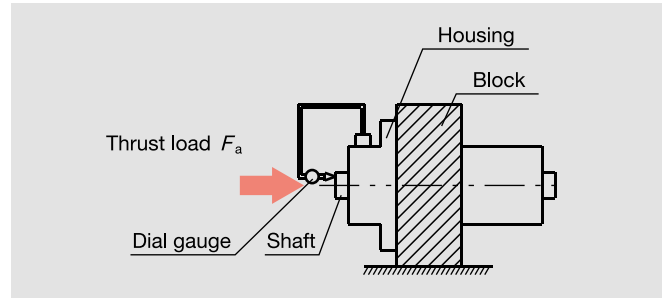


Fig. 1.36 Relationship between Axial Displacement and Preload

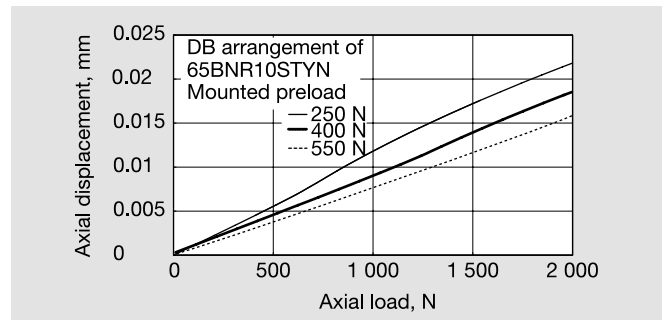


Fig. 1.37 Natural Frequency Method

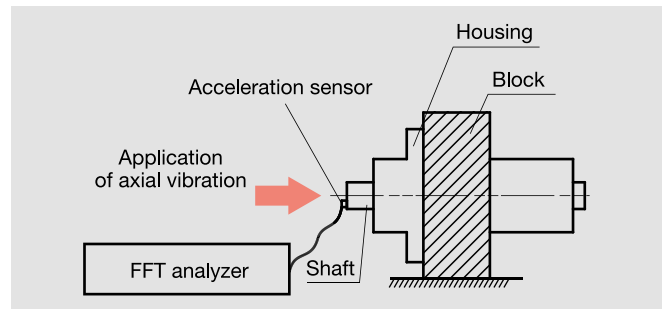
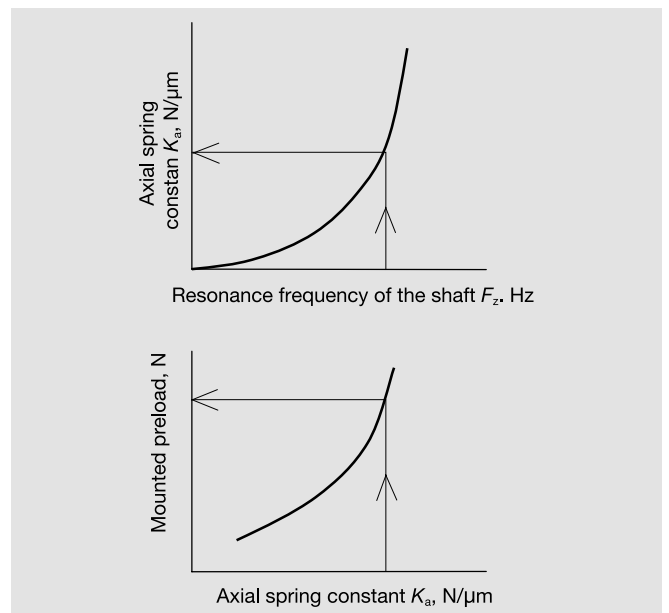


Fig. 1.38 Relationship between Resonance Frequency of Shaft and Axial Spring Constant of Bearing



2. Operational Inspection

Preparing for Operation

After spindle assembly has been completed, connect the spindle to the power source.

- Connection with motor

When using V-belt drives, adjust parallelism and misalignment of the spindle pulley and the motor pulley.

Coupling drives need to be well-balanced and checked for offset and misalignment.

Fig. 2.1 V-belt Drive

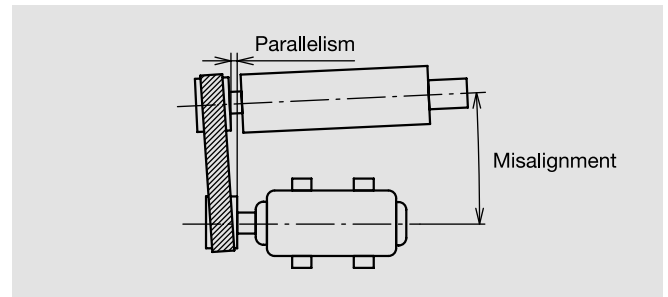
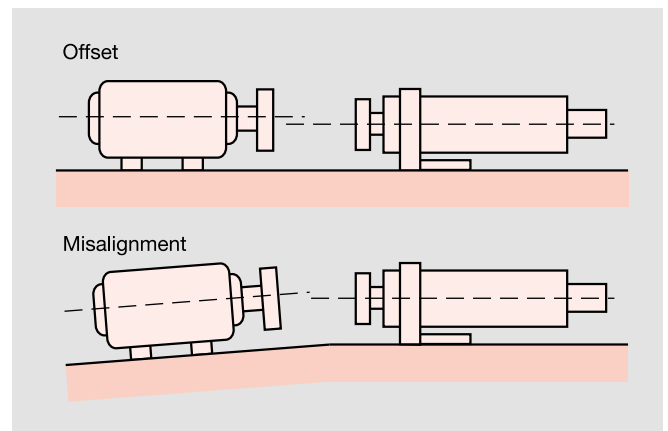


Fig. 2.2 Coupling Drive



- Balance

Any unbalance in rotating components will cause an eccentric load during rotation due to the centrifugal force. This results in vibrations, decreased machining accuracy and decreased service life of the bearings [Fig 2.3].

Recommended balance quality grades for different types of rotors are listed in ISO 1940/1. Table 2.1 and Fig 2.4 show an excerpt of this standard. Use specialized equipment when measuring ϵ (permissible residual specific unbalance) as you apply the values in Table 2.1.

Fig. 2.3 Bearing Load due to Unbalance

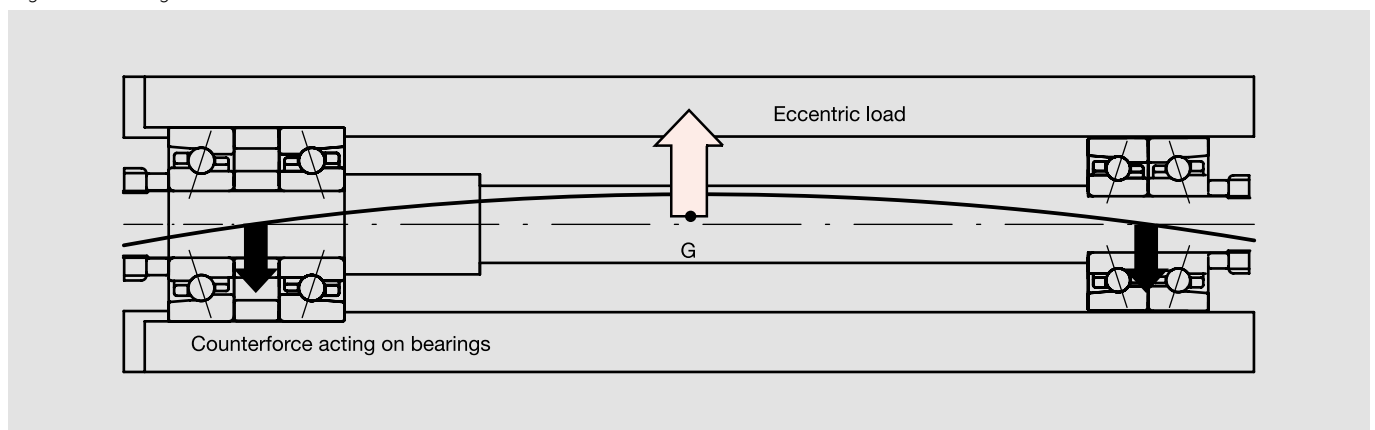
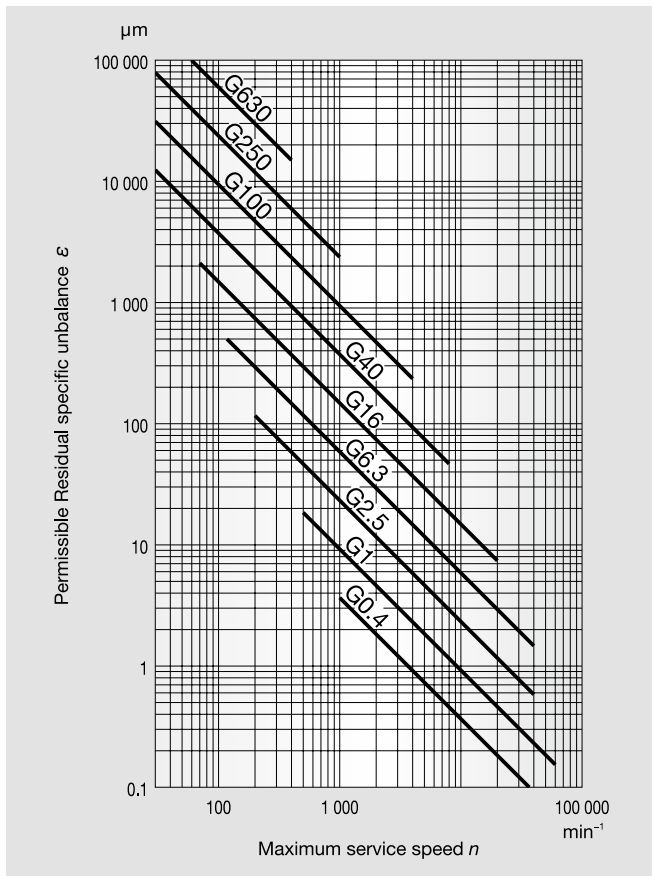


Table 2.1 Balance Quality Grades and Examples of Rotor Types

| Balance Quality Grade | Rotor Type Example |
|-----------------------|---|
| G0.4 | Precision grinder |
| G1.0 | Grinding machine spindles, Small motors with special requirements |
| G2.5 | Machine tool spindles, Medium and large motors with special requirements |
| G6.3 | Components of machine tools and general machinery |

Fig. 2.4 Permissible Residual Specific Unbalance Based on Balance Quality Grade G



Operational Inspection

After mounting has been completed, conduct a test run to determine if the bearing has been mounted correctly. Small equipment may be manually operated to assure that they rotate smoothly. Items to be checked include sticking due to contamination, surface damage or dents; uneven torque caused by improper mounting or an improperly machined mounting surface; excessive torque caused by an

inadequate clearance, mounting errors or seal friction. If there are no abnormalities, a running-in can be started.

As large equipment is impossible to turn by hand, start up without load and switch power off again immediately to allow the spindle to coast. Check for vibration, noise and abnormalities in the contact of the rotating components.

Start running-in slowly without load, then gradually increase the speed until the maximum speed is reached (page 270-271). During the test run, check for abnormal noise, excessive rise of bearing temperature, leakage or discoloration of lubricants, etc. If any abnormality is found, stop the test run immediately and inspect the machinery. If necessary, dismount the bearings for examination.

Although the temperature of the outside surface of the housing can generally help determine bearing temperature, it is better to directly measure the temperature of the outer ring using oil holes for access.

Bearing temperature should rise gradually to a steady level within one or two hours after starting operation. If problems arise in a bearing, or if an error was made in mounting, bearing temperature may increase rapidly and become abnormally high. Possible causes of such an abnormal temperature include an excessive amount of lubricant, insufficient bearing clearance, incorrect mounting, or excessive friction of the seals. In high-speed operations, an incorrect selection of bearing type or lubricating method may also cause an abnormal temperature rise.

Bearing noise can be checked with a sound detector or other instruments. Abnormal conditions are indicated by a loud metallic sound or other irregular noise. Possible causes include incorrect lubrication, insufficient accuracy of the shaft and housing, damaged bearings or ingress of contamination into the bearing.

Possible causes and countermeasures for irregularities are listed on page 277.

3. Running-in Procedures

Running-in

If operating speed is suddenly increased after the bearings are mounted, bearings may be damaged due to insufficient lubrication, or the lubricant may deteriorate.

Proper running-in with gradual increases of operating speed is indispensable, especially for grease lubricated bearings where grease must be allowed to spread evenly. Running-in should be conducted at room temperature (15°C to 25°C) while monitoring bearing temperature.

Maximum operating temperature of the bearing should be targeted at about 60°C (50 °C at the spindle housing exterior). Do not to exceed additional 5°C. If temperature increases beyond this limit, temporarily stop the running-in process or decelerate to lower the temperature.

Some spindle assemblies incorporate both cylindrical roller bearings and angular contact ball bearings. Since cylindrical roller bearings tend to require more time than ball bearings for temperature to level off, the timing of the speed increases must be set to correspond with the cylindrical roller bearings.

Note

Spindle assemblies operating under oil mist and oil-air lubrication are at risk of a sudden temperature rise at initial operation or after the spindle assembly has not been operated for a long time. Excess oil that has collected in the oil lines of the lubrication system may suddenly flood the bearing interior, causing a temperature spike. Running-in for bearings with these lubricating systems requires much less time than for grease-based systems, and is highly recommended.

(1) Continuous running-in method

Continuous running-in works by gradually increasing the operating speed from the low speed zone. Divide the

maximum operating speed evenly into a number of stages and increase speed in increments:

1. Begin at a reasonably low operating speed.
2. Monitor temperature rise.
3. When temperature has stabilized, increase speed to the next target speed.
4. Continue repeating steps 2 and 3 until the maximum operating speed is reached.

Maximum operating speed is commonly divided into ten stages to determine the target speed for each stage. Allow between 30 min. and two hours for the temperature to stabilize before you increase speed to the next stage. Fig. 3.2 shows patterns of temperature development that help you decide whether speed may be increased or not.

Determine the target speeds that are optimally suited for your application while monitoring the actual temperature on your spindle.

Although somewhat time consuming, this procedure helps machine operators to detect potential spindle defects, thus avoiding costly damage to the bearings.

Fig. 3.1 Bearing Temperature Change during Continuous Running-in

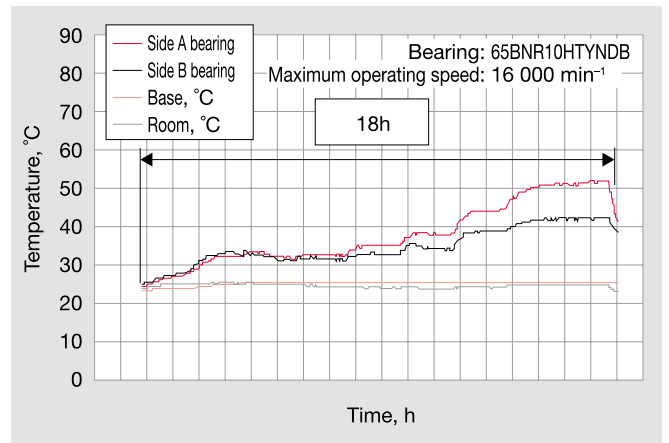
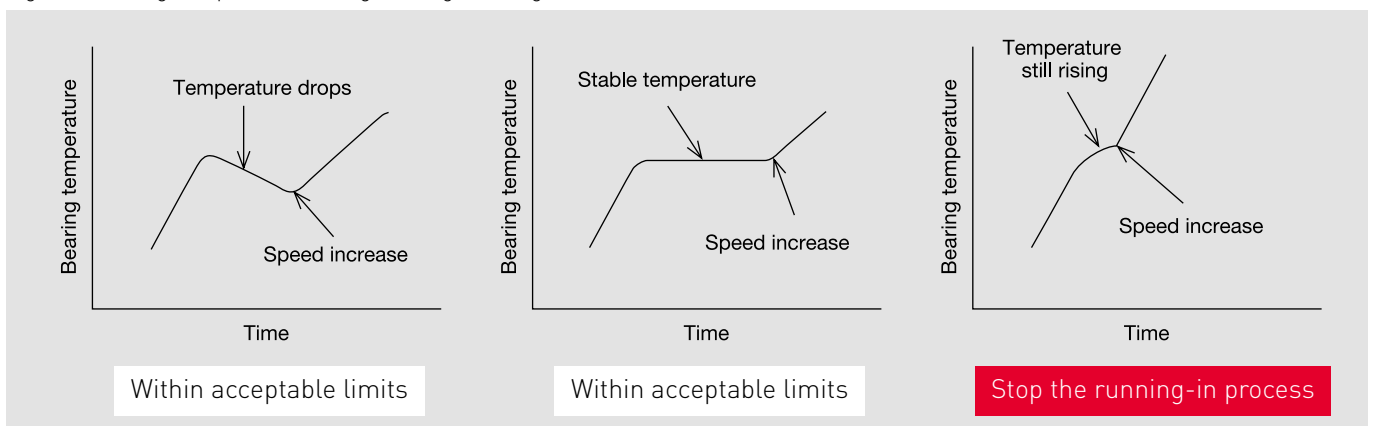


Fig. 3.2 Bearing Temperature Change during Running-in



Increase operating speed when temperature rise characteristics are within limits.

(2) Intermittent running-in method

At first, run the spindle continuously at about 500 min⁻¹ (100 min⁻¹ for larger machines) for 15 minutes to allow the grease to settle. Take the maximum operating speed and divide it into eight to ten stages to determine the maximum target speed for each stage.

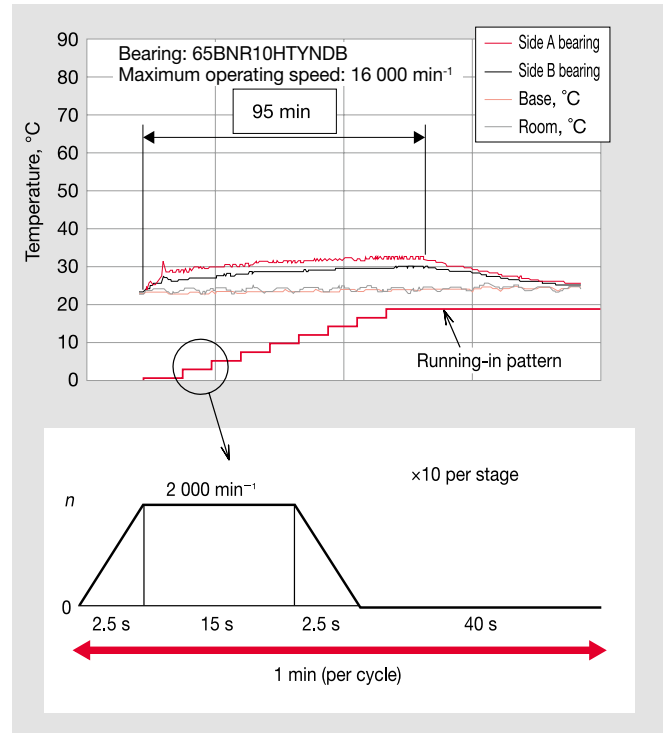
1. Each stage is divided into 10 cycles that are approximately one minute long.
2. During each cycle, rapidly accelerate the spindle to the target speed for the current stage, then decelerate back to zero, and then rest for a period of 40 seconds.
3. Repeat this cycle about 10 times.
4. Continue moving up through the stages, following the above procedures, until you reach the maximum operating speed.

The temperature data shown in Fig 3.3 were gained during intermittent running-in with a maximum operating speed of 16 000 min⁻¹, 8 speed stages and 10 cycles per stage. After the maximum operating speed is reached, we recommend continuously running the spindle at that speed for about 1 hour.

Speed increase causes a sudden supply of grease to the bearing’s interior resulting in a sharp temperature rise. During intermittent running-in, the spindle is stopped to allow the temperature to stabilize. This saves time compared to the continuous running-in method.

The number of target speed stages and the number of cycles to be performed in each speed stage vary according to spindle design and arrangement. Please determine appropriate values on the actual machine.

Fig. 3.3 Cycle Structure and Bearing Temperature Change during Intermittent Running-in

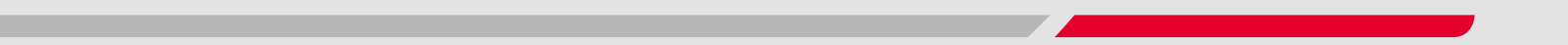


Bearing Failure Diagnosis

Bearing Failure Diagnosis

1. Bearing Failure and Countermeasures 274-279
2. Diagnosis with Sound and Vibration 280-281

Part 7



1. Bearing Failure and Countermeasures

Maintenance, Inspection and Corrective Measures

Proper maintenance and inspection help to maintain the original performance of a bearing for as long as possible, avoid bearing problems, increase reliability and productivity, and keep operating costs low. We suggest periodic maintenance with specified procedures that should include the supervision of operating conditions, replenishment or replacement of lubricants, and the inspection of parts.

Items that should regularly be checked during operation include bearing noise, vibration, temperature, and lubrication. If any irregularity is found during operation, the cause should be determined and the proper corrective action taken after referring to Table 1.2 on page 277. If necessary, bearings should be dismantled and examined in detail.

Bearing Failure and Countermeasures

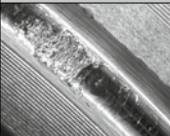





In general, if rolling bearings are used correctly they will continue to perform to their predicted fatigue life.

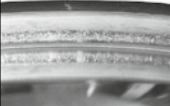



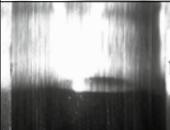
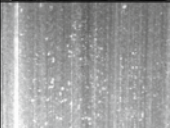





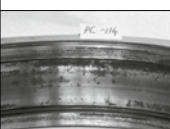
However, bearings often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting, handling or lubrication, ingress of contamination, or abnormal heat generation.

Possible causes of rib scoring in roller bearings, as one example, include the use of improper lubricant, a faulty lubrication system, ingress of contamination, bearing mounting errors, excessive shaft deflection, or any combination of these.

Therefore, it is difficult to determine the real cause of some premature failures by looking only at the bearing itself. If all the conditions at the time of failure and prior to failure are known, including the application, operating conditions, and the detail of spindle structure around bearings then by studying the bearing damage and its probable causes the risk of similar future failures can be reduced. The most frequent types of bearing failure, along with probable causes and countermeasures, are listed in Table 1.1.

Table 1.1 Causes and Measures for Bearing Failures

| Type of Failure | Symptoms | Photo | Probable Causes | Countermeasures |
|-----------------|--|---|---|---|
| Flaking | Flaking on one side of the raceway of radial bearing. |  | <ul style="list-style-type: none"> Abnormal axial load (sliding failure of free-side bearing). | <ul style="list-style-type: none"> Select a larger loose amount on housing to allow axial expansion of the shaft. |
| | Flaking pattern inclined relative to the raceway in radial ball bearings Flaking near the edge of the raceway and rolling surface in roller bearings. |  | <ul style="list-style-type: none"> Improper mounting, bending of shaft Inadequate centering Inadequate tolerances for shaft and housing. | <ul style="list-style-type: none"> Use care in mounting and centering Select a bearing with a larger clearance Correct the perpendicularity of shaft and housing shoulder. |
| | Flaking of raceway with same spacing as rolling element. |  | <ul style="list-style-type: none"> Large shock load during mounting Rusting while bearing is out of operation for prolonged period Damage to cylindrical roller bearings during mounting | <ul style="list-style-type: none"> Use care in mounting Apply a rust preventative when machine operation is suspended for a long time. |
| | Premature flaking of raceway and rolling element. |  | <ul style="list-style-type: none"> Insufficient clearance Excessive load Improper lubrication, rust, etc. | <ul style="list-style-type: none"> Select proper fit, bearing clearance, and lubricant. |
| | Premature flaking of combined bearings. |  | <ul style="list-style-type: none"> Excessive preload. | <ul style="list-style-type: none"> Adjust the preload. |
| Scoring | Scoring or smearing between raceway and rolling surface. |  | <ul style="list-style-type: none"> Inadequate initial lubrication Excessively hard grease High acceleration when starting operation. | <ul style="list-style-type: none"> Use a softer grease Avoid rapid acceleration. |

| Type of Failure | Symptoms | Photo | Probable Causes | Countermeasures |
|--------------------|--|---|--|---|
| Scoring | Scoring or smearing between the end face of the rollers and guide rib. |  | <ul style="list-style-type: none"> • Inadequate lubrication • Incorrect mounting • Large axial load. | <ul style="list-style-type: none"> • Select proper lubricant • Modify the mounting. |
| Cracks | Crack in outer or inner ring. |  | <ul style="list-style-type: none"> • Excessive shock load • Excessive interference in fitting • Poor shaft cylindricity • Large fillet radius • Development of thermal cracks • Increased flaking. | <ul style="list-style-type: none"> • Examine load conditions • Modify the fit of bearing and sleeve • Improve accuracy in machining shaft • Correct fillet radius (the fillet radius must be smaller than the bearing chamfer). |
| | Crack in rolling element or broken rib. |  | <ul style="list-style-type: none"> • Increased flaking • Shock applied to rib during mounting • Dropped during handling. | <ul style="list-style-type: none"> • Use care in mounting and handling a bearing. |
| | Fracture of cage. |  | <ul style="list-style-type: none"> • Abnormal loading on cage due to incorrect mounting. • Improper lubrication | <ul style="list-style-type: none"> • Correct mounting • Examine the lubrication method and lubricant. |
| Indentations | Indentations on raceway with the same spacing as rolling element (Brinelling). |  | <ul style="list-style-type: none"> • Shock load during mounting • Excessive load while stationary | <ul style="list-style-type: none"> • Use care in handling the bearing. |
| | Indentations on raceway and rolling elements. |  | <ul style="list-style-type: none"> • Ingress of contamination such as metallic particles or grit. | <ul style="list-style-type: none"> • Clean the housing • Improve the seals and use clean lubricant. |
| Abnormal wear | False brinelling (phenomenon similar to brinelling). |  | <ul style="list-style-type: none"> • Vibration of a stationary bearing during such times as transport • Oscillating motion with small amplitude. | <ul style="list-style-type: none"> • Secure the shaft and housing during transport • Select a suitable lubricant • Reduce vibration by applying preload. |
| | Fretting, localized wear with reddish-brown wear dust at fitting surface. |  | <ul style="list-style-type: none"> • Sliding wear at a minute gap in the fitting surface. | <ul style="list-style-type: none"> • Increase interference • Apply oil. |
| | Wearing on raceway, rolling surfaces, rib and cage. |  | <ul style="list-style-type: none"> • Ingress of contamination • Incorrect lubrication and rust. | <ul style="list-style-type: none"> • Improve sealing capabilities • Clean the housing • Use a clean lubricant. |
| | Creep, scoring wear at fitting surface. |  | <ul style="list-style-type: none"> • Insufficient interference • Insufficiently secured sleeve. | <ul style="list-style-type: none"> • Modify fit • Tighten the sleeve properly. |
| Seizure | Wear of raceway, rolling elements, rib and cage. Discoloration and melting of rib surface. |  | <ul style="list-style-type: none"> • Insufficient clearance • Incorrect lubrication • Improper mounting. | <ul style="list-style-type: none"> • Examine fit and internal clearance of bearings • Supply an adequate amount of suitable lubricant • Examine the mounting method and quality of related parts. |
| Corrosion and Rust | Corrosion and rust at bearing interior or fitting surface. |  | <ul style="list-style-type: none"> • Condensation due to humidity, fretting, • Entry of corrosive substances (especially varnish solvents etc.) | <ul style="list-style-type: none"> • Store carefully when in a moist or hot climate • Take rust prevention measures for periods of non-running • Select suitable varnish and grease. |

● Please contact NSK when bearings show this kind of symptoms.

1. Bearing Failure and Countermeasures

Running Paths and Applied Loads

As the bearing rotates, the raceways of the inner ring and outer ring make contact with the rolling elements. This results in a wear path on both the rolling elements and raceways. Running paths are a source of information about the load conditions and should be carefully studied when the bearing is dismantled.

If the running paths are clearly defined, it is possible to detect whether the bearing was subjected to radial loads, axial loads or moment loads, or whether there was an excessive unevenness in housing rigidity. Running paths may point you to major mounting errors, unexpected loads or other causes of bearing damage.

Fig. 1.1 shows the running paths generated in deep groove ball bearings under various load conditions. Pattern (a) is the most common running trace generated when the inner

ring rotates under a radial load only. Patterns (e) through (h) indicate adverse conditions which usually lead to shortened service life.

Similarly, Fig 1.2 shows running paths for cylindrical roller bearings. The outer ring paths of pattern (i) indicate properly applied radial load with inner ring rotation. Running paths (j) exhibit a color shade across the width and diagonal boundaries where the load sets in. This indicates misalignment of inner and outer rings relative to each other, or shaft bending. Patterns (k) and (l) show outer ring running paths of double-row cylindrical roller bearings with inner ring rotation. While pattern (k) exhibits radial loads applied evenly to both rows, pattern (l) indicates a mismatch of bearing taper and shaft taper angle that results in an uneven preloads between the two rows.

Fig. 1.1 Typical Running Paths of Deep Groove Ball Bearings

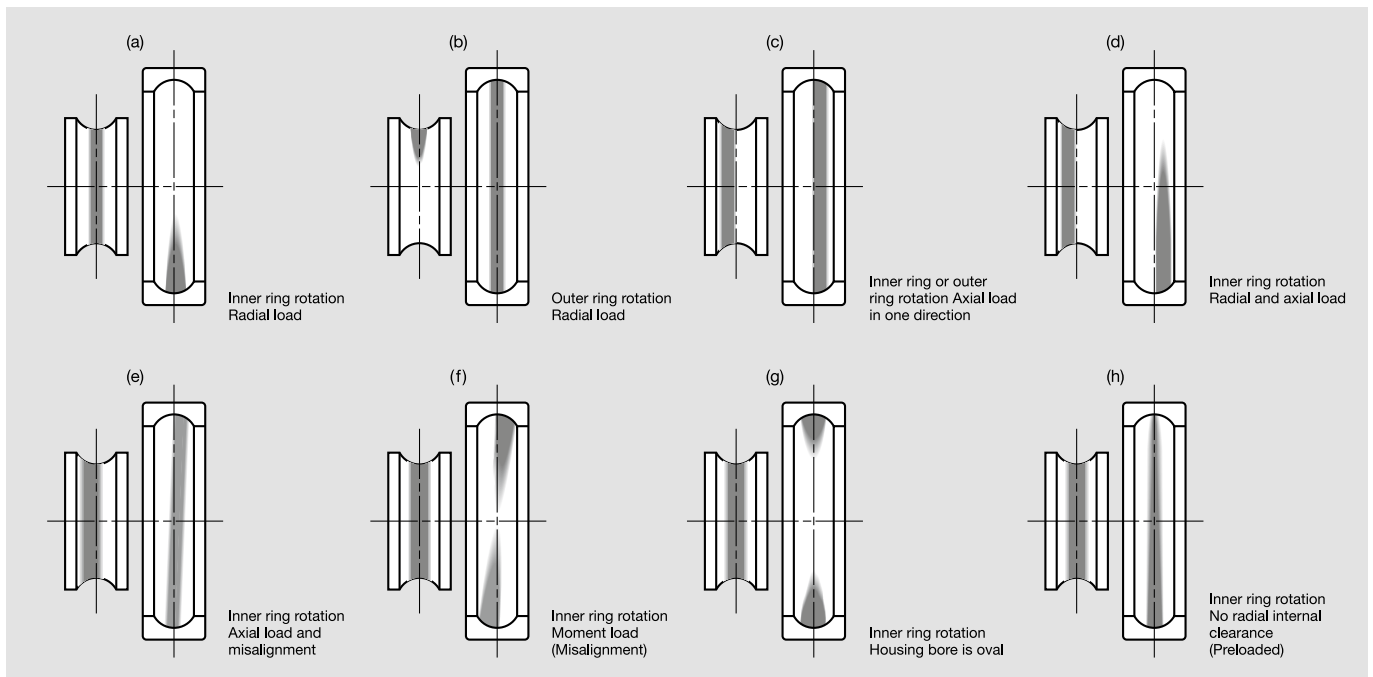


Fig. 1.2 Typical Running Paths of Roller Bearings

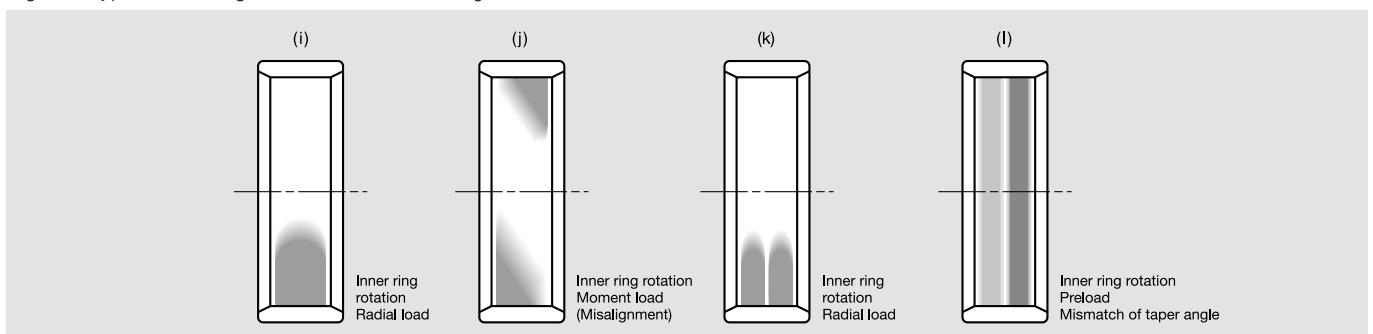


Table 1.2 Causes and Countermeasures for Operating Irregularities

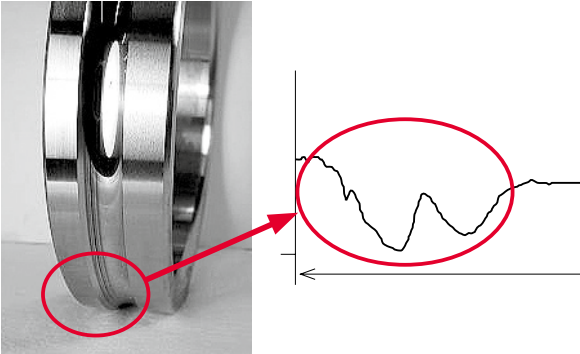
| Irregularities | | Possible causes | Countermeasures |
|---------------------------------------|---|--|---|
| Noise | High-pitched metallic sound ⁽¹⁾ | Abnormal load | Improve fit, examine internal clearance, adjust preload, correct position of housing shoulder, etc. |
| | | Incorrect mounting | Improve machining accuracy of shaft and housing, mounting accuracy and mounting method |
| | | Insufficient or improper lubricant | Replenish lubricant, use suitable lubricant |
| | | Contact of rotating parts | Modify the contact area of labyrinth seal etc. |
| | Regular sound | Dents, corrosion or scratches on raceways due to contamination | Replace bearing, clean related parts, improve seals, use clean lubricant |
| | | Brinelling | Replace bearing, handle bearings with care |
| | | Flaking on raceway | Replace bearing |
| | Irregular sound | Excessive clearance | Examine fit and clearance, correct preload |
| | | Ingress of contamination | Consider bearing replacement, clean related parts, improve seals, use clean lubricant |
| | | Scratches or flaking on balls | Replace bearing |
| Abnormal temperature rise | Excessive amount of lubricant | Reduce amount of lubricant | |
| | Insufficient or improper lubricant | Replenish lubricant, use suitable lubricant | |
| | Abnormal load | Improve fit, examine clearance, adjust preload, correct position of housing shoulder, etc. | |
| | Incorrect mounting | Improve machining accuracy of shaft and housing, mounting accuracy and mounting method | |
| | Creep on fitted surface, excessive seal friction | Replace bearing, examine fit, correct shaft and housing, change seal type | |
| Vibration (Whirling of shaft) | Brinelling | Replace bearing, handle bearings with care | |
| | Flaking | Replace bearing | |
| | Incorrect mounting | Correct perpendicularity of shaft shoulder, housing shoulder and spacer end faces | |
| | Ingress of contamination | Replace bearing, clean related parts, improve seals, etc. | |
| Leakage or discoloration of lubricant | Excessive amount of lubricant, ingress of contamination, abrasion with ingress of abrasion dust | Optimize the amount of lubricant, consider replacement or selection of a different lubricant, consider bearing replacement, clean housing etc. | |

⁽¹⁾ Squeal noise may occur when using medium- to large-sized cylindrical roller bearings and ball bearings with grease lubrication during the winter or in cold environments. Generally, such noise is not accompanied by temperature rise and has no adverse effect on rolling fatigue life or grease life. The bearings are fully functional and can continue to be used. If you are concerned that squeal noise may become a problem, feel free to contact NSK.

1. Bearing Failure and Countermeasures

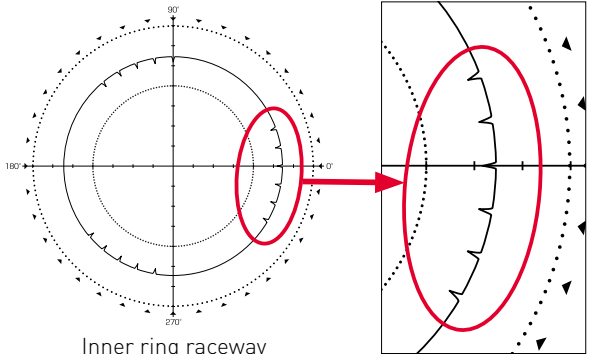
Some examples of bearing damage are shown in detail below.

Example 1



Type : Angular contact ball bearing
 Application : Machining center spindle
 Lubrication : Grease
 Symptom : Unusual noise
 Probable cause : Abnormal wear due to excessive preload
 Countermeasure : Adjust preload

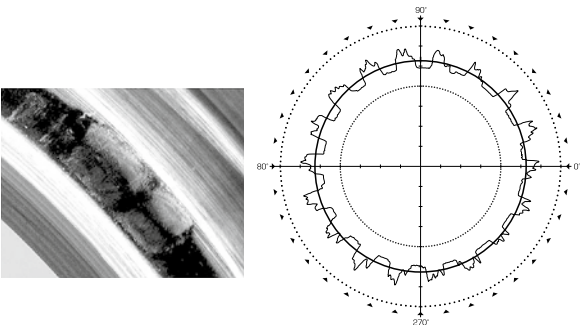
Example 2



Inner ring raceway out-of-roundness

Type : Angular contact ball bearing
 Application : Machining center spindle
 Lubrication : Grease
 Symptom : Unusual noise
 Probable cause : Brinell indentations caused by a shock load
 Countermeasure : Review operating conditions

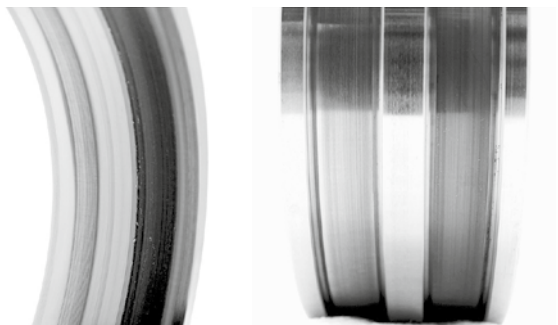
Example 3



Outer ring raceway out-of-roundness

Type : Angular contact ball bearing for ball screw support
 Application : Machine tool feed shaft
 Lubrication : Grease
 Symptom : Unusual noise
 Probable cause : Fretting caused by minute vibration
 Countermeasures : Change to ceramic ball bearing
 Review stroke length
 Add a re-organization stroke for grease and balls (dummy-stroke)

Example 4



Outer ring raceway Inner ring raceway

Type : Double-row cylindrical roller bearing
 Application : Lathe spindle
 Lubrication : Grease
 Symptom : Seizure
 Probable cause : Mismatch of shaft taper angle resulting in excessive load on one row and subsequent interruption of oil film
 Countermeasure : Adjust shaft taper angle

● Please contact NSK when bearings show this kind of symptoms.

Table 1.3 Bearing Diagnostic Chart

| Type of damage | Location (Phenomenon) | Cause | | | | | | | | | | | | Remarks | |
|----------------------------|---|-------------------|----------|---------------------|-------------------------------|-------------|-------------|--------------------|----------------------------|-------------|------------------|-------------------------------|------------------------------------|---------|--|
| | | Handling | | Bearing surrounding | | | Lubrication | | Load | | | Speed | | | Bearing selection |
| | | Storage, Shipping | Mounting | Shaft, Housing | Sealing device, Water, Debris | Temperature | Lubricant | Lubrication method | Excessive load, Shock Load | Moment load | Ultra small load | High speed, high acceleration | Oscillation, Vibration, Stationary | | |
| 01. Flaking | Raceway, Rolling surface | | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | | | | ○ | |
| 02. Peeling | Raceway, Rolling surface Bearing outside surfaces | | | | ○ | | ○ | ○ | | | ○ | ○ | | | |
| | (Rolling contact) | | | ○* | ○ | | ○ | ○ | | | | | | | *Mating rolling part |
| 03. Scoring | Roller end face, Rib surface | | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | | ○ | | | |
| | Cage guide surface, Pocket surface | | ○ | | ○ | | ○ | ○ | | | | | | | |
| 04. Smearing | Raceway, Rolling surface | | | | ○ | | ○ | ○ | | | ○ | ○ | | | |
| 05. Fracture | Ribs, Rollers | ○ | ○ | ○ | | | | | ○ | ○ | | | | | |
| 06. Cracks | Raceway rings, Rolling elements | | ○ | ○ | | ○ | | | ○ | ○ | | | | | |
| | Rib surface, Roller end face, Cage guide surface (Thermal crack) | | | ○ | | | | ○ | ○ | ○ | | | | | |
| 07. Cage damage | (Deformation), (Fracture) | | ○ | ○ | | | | | ○ | ○ | | | | | |
| | (Wear) | | ○ | | ○ | | ○ | ○ | ○ | ○ | | ○ | | | |
| 08. Denting | Raceway, Rolling surface (Indentation at rolling element pitch) | | | | ○ | | | ○ | | | | | | | |
| | Raceway (Dents on the rolling element pitch) | ○ | ○ | | | | | | ○ | | | | ○ | | |
| 09. Pitting | Raceway, Rolling surface | | | | ○ | | ○ | ○ | | | | | | | |
| 10. Wear | Raceway, Rolling surface, Rib surface, Roller end face | | ○ | | ○ | | ○ | ○ | | | | | | | |
| 11. Fretting | Raceway, Rolling surface | ○ | ○ | ○ | | | ○ | ○ | ○ | | | ○ | ○ | | |
| | Bearing outside and bore, side surface (Contact with housing and shaft) | | ○ | ○ | | | | | ○ | | | | | | |
| 12. False brinelling | Raceway, Rolling surface | ○ | | | | | ○ | ○ | | | | | ○ | | |
| 13. Creep | Fitting surface | | ○ | ○ | | ○ | ○* | ○* | ○ | | | ○ | | | *Loose fit |
| 14. Seizure | Rings, Rolling elements, Cage | | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | | ○ | | ○ | |
| 15. Electrical corrosion | Raceway, Rolling surface | | ○* | ○* | | | | | | | | | | | *Electricity passing through the rolling element |
| 16. Rust and corrosion | Rings, Rolling elements, Cage | ○ | ○ | | ○ | ○ | ○ | ○ | | | | | | | |
| 17. Damage due to mounting | Raceway, Rolling surface | | ○ | ○ | | | | | | | | | | | |
| 18. Discoloration | Raceway ring, Rolling element, Cage | | | | | ○ | ○ | ○ | | | | | | | |

Remark: This chart is not comprehensive. It lists only the more common causes for damages.

2. Diagnosis with Sound and Vibration

Classification of Sounds and Vibrations

Sound and vibration accompany the rotation of rolling bearings. The tone and amplitude of such sound and vibration vary depending on the type of bearing, mounting conditions, operating conditions, etc. The sound and vibration of a rolling bearing can be classified under the following four chief categories and each category can be further classified into several sub-categories, as described in Table 2.1 below. However, the distinctions between the categories are not absolute. Even if some types of sound or vibration are inherent in the bearings, the volume might be

related to the manufacturing process, while some types of sound or vibration, even if they are due to manufacturing, cannot be eliminated even in normal conditions.

By recording the sounds and vibrations of a rotating machine and analyzing them, it is possible to determine the likely cause. As can be seen from the figures on the next page, a mechanically normal bearing shows a stable waveform. However, a bearing with a scratch, for example, shows a waveform with wide swings indicating large-amplitude sounds at regular intervals.

Table 2.1 Classification of sounds and vibrations in rolling bearings

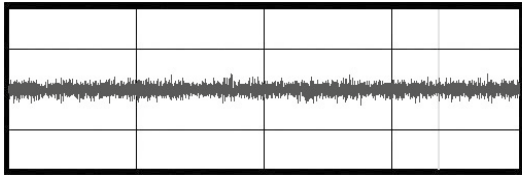
| | Type of sound | Vibration | | Features | |
|---------------|--|--|------------------------|--|--|
| Structural | Race noise | Free vibration of raceway ring | | Continuous noise, basic unavoidable noise which all bearings generate | |
| | Click noise | Free vibration of raceway ring, free vibration of cage | | Regular noise at a certain interval, large bearings and horizontal shaft, radial load and low rpm | |
| | Squeal noise | Free vibration of raceway ring | | Intermittent or continuous, mostly large cylindrical roller bearings, radial load, grease lubrication, at particular speed | |
| | Cage noise | "CK" noise (Kacha-kacha) | Free vibration of cage | | Regular noise at a certain interval, all bearing types generate it |
| | | "CG" noise (Gaga-gaga) | Vibration of cage | | Intermittent or continuous, lubrication with particular grease |
| | | Tapping noise | Free vibration of cage | | Certain interval, but a little irregular, under radial load and during initial stage |
| | — | Rolling element passage vibration | | Continuous noise, may pause occasionally (ball bearings) | |
| Manufacturing | Waviness noise | Vibration due to waviness | Inner ring | Continuous noise | |
| | | | Outer ring | | |
| | | | Rolling element | Continuous noise, may pause occasionally (ball bearings) | |
| Handling | Noise caused by scratches and other damage | Vibration due to flaw | Inner ring | Regular noise at a certain interval | |
| | | | Outer ring | | |
| | | | Rolling element | Regular noise, may pause occasionally (ball bearings) | |
| | Contamination noise | Vibration due to contamination | | Irregular | |
| Others | Seal noise | Free vibration of a seal | | Contact seal | |
| | Lubricant noise | — | | Irregular | |
| | — | Runout | f_r | Continuous | |
| | | | f_c | Continuous | |
| $f_r - 2f_c$ | | | Continuous | | |

n : Positive integer (1, 2, 3...)

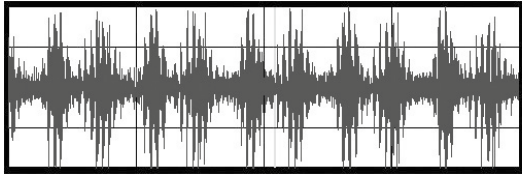
Z : Number of rolling elements

f_{RIN}^* : Ring natural frequency in radial bending mode, Hz

f_{MI}^* : Natural frequency in the mode of angular vibration in inertia of outer ring-spring system,



Sound waveform of a normal bearing



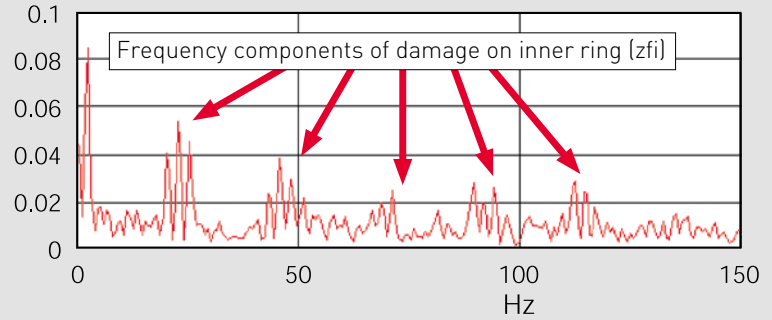
Sound waveform of a scratched bearing

Frequency analysis of bearing with damage on inner ring raceway

Bore diameter: 100 mm Method of recording and analysis:

Envelope analysis of the sounds of a test machine recorded by microphone.

Speed: 50 min⁻¹



| Generated frequency (frequency analysis) | | | Source | Countermeasures |
|--|----------------------------|--------------------------------|---|---|
| FFT of original wave | | FFT after envelope (basic No.) | | |
| Radial (angular) direction | Axial direction | | | |
| f_{RIN}, f_{MI} | f_{AIN}, f_{AM} | — | Selective resonance of waviness (rolling friction) | Improve rigidity around the bearings, appropriate radial clearance, high-viscosity lubricant, high-quality bearings |
| f_{RIN}, f_{MI} | f_{AIN}, f_{AM} | Zf_c | Collision of rolling elements with inner ring or cage | Reduce radial clearance, apply preload, high-viscosity lubricant |
| $(\approx f_{R2N}, f_{R3N})$ | — | ? | Self-induced vibration caused by sliding friction at rolling surface | Reduce radial clearance, apply preload, change grease, replace with suitable bearings |
| Natural frequency of cage | | f_c | Collision of cage with rolling elements or rings | Apply preload, high-viscosity lubricant, reduce mounting error |
| Natural frequency of cage | | ? | Self-induced vibration caused by friction at cage guide surface | Change grease, replace with suitable cage |
| Natural frequency of cage | | Zf_c | Collision of cage and rolling element caused by grease resistance | Reduce radial clearance, apply preload, low-viscosity lubricant |
| Zf_c | — | — | Displacement of inner ring due to rolling element passage | Reduce radial clearance, apply preload |
| $nZf_i \pm f_r (nZ \pm 1 \text{ peaks})$ | $nZf_i (nZ \text{ peaks})$ | — | Inner ring raceway waviness, irregularity of shaft exterior | High-quality bearings, improve shaft accuracy |
| $nZf_c (nZ \pm 1 \text{ peaks})$ | $nZf_c (nZ \text{ peaks})$ | — | Outer ring raceway waviness, irregular bore of housing | High-quality bearings, improve housing bore accuracy |
| $2nf_b \pm f_c (2n \text{ peaks})$ | $2nf_b (2n \text{ peaks})$ | — | Rolling element waviness | High-quality bearings |
| f_{RIN}, f_{MI} | f_{AIN}, f_{AM} | Zf_i | Nicks, dents, rust, flaking on inner ring raceway | Replace bearings and handle them carefully |
| | | Zf_c | Nicks, dents, rust, flaking on outer ring raceway | Replace bearings and handle them carefully |
| | | $2f_b$ | Nicks, dents, rust, flaking on rolling elements | Replace bearings and handle them carefully |
| f_{RIN}, f_{MI} | f_{AIN}, f_{AM} | Irregular | Entry of dirt and debris | Clean, improve sealing |
| Natural frequency of seal | | $\{f_r\}$ | Self-induced vibration due to friction at seal contact area | Change the seal, change the grease |
| ? | ? | Irregular | Lubricant or lubricant bubbles crushed between rolling elements and raceways | Change the grease |
| f_r | — | — | Irregular inner ring cross-section | High-quality bearings |
| f_c | — | — | Inner ring deflection due to vibration in or unequal spacing of balls | High-quality bearings |
| $f_r - 2f_c$ | — | — | Non-linear vibration caused by anisotropic rigidity due to vibration in balls | High-quality bearings |

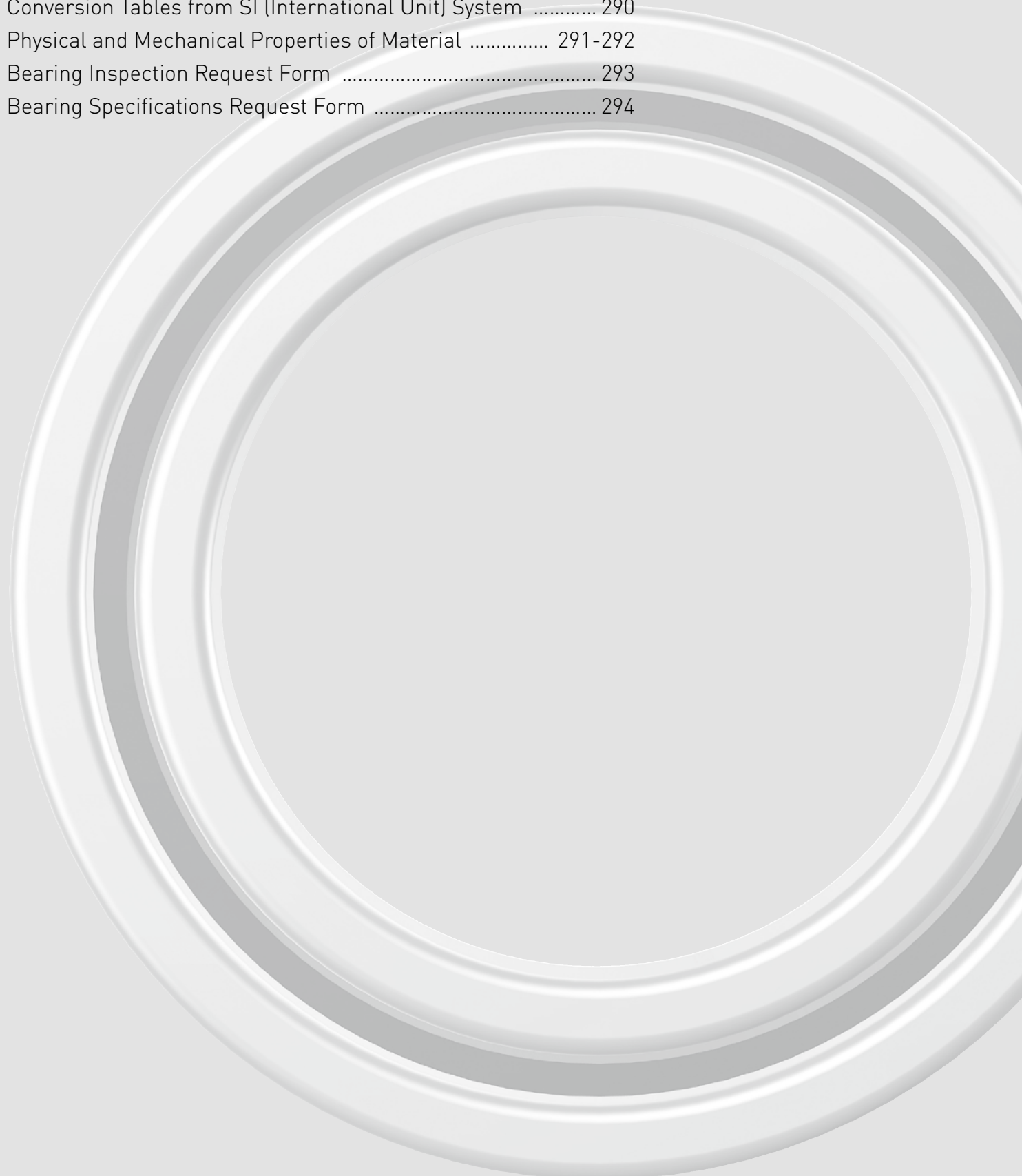
Hz
 f_i : Rotation frequency of inner ring, Hz
 f_c : Orbital revolution frequency of rolling elements, Hz

f_{AIN} : Ring natural frequency in axial bending mode, Hz
 f_{AM} : Natural frequency in the mode of axial vibration in mass of outer ring-spring system, Hz
 f_i : $f_i = f_c - f_c$, Hz
 f_b : Rotation frequency of rolling element around its center, Hz

Appendices

Appendices

| | |
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| Tolerances for Shaft Diameters | 284-285 |
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| Values of Standard Tolerances for IT Grades | 288-289 |
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| Bearing Specifications Request Form | 294 |



Appendices

Tolerances for Shaft Diameters

| Diameter classification (mm) | | d6 | e6 | f6 | g5 | g6 | h5 | h6 | h7 | h8 | h9 | h10 | js5 | js6 |
|------------------------------|--------------|--------------|--------------|--------------|------------|-------------|----------|----------|-----------|-----------|-----------|-----------|--------|--------|
| Over | Incl. | | | | | | | | | | | | | |
| 3 | 6 | -30 -38 | -20 -28 | -10 -18 | -4 -9 | -4 -12 | 0 -5 | 0 -8 | 0 -12 | 0 -18 | 0 -30 | 0 -48 | ± 2.5 | ± 4 |
| 6 | 10 | -40 -49 | -25 -34 | -13 -22 | -5 -11 | -5 -14 | 0 -6 | 0 -9 | 0 -15 | 0 -22 | 0 -36 | 0 -58 | ± 3 | ± 4.5 |
| 10 | 18 | -50 -61 | -32 -43 | -16 -27 | -6 -14 | -6 -17 | 0 -8 | 0 -11 | 0 -18 | 0 -27 | 0 -43 | 0 -70 | ± 4 | ± 5.5 |
| 18 | 30 | -65 -78 | -40 -53 | -20 -33 | -7 -16 | -7 -20 | 0 -9 | 0 -13 | 0 -21 | 0 -33 | 0 -52 | 0 -84 | ± 4.5 | ± 6.5 |
| 30 | 50 | -80 -96 | -50 -66 | -25 -41 | -9 -20 | -9 -25 | 0 -11 | 0 -16 | 0 -25 | 0 -39 | 0 -62 | 0 -100 | ± 5.5 | ± 8 |
| 50 | 80 | -100 -119 | -60 -79 | -30 -49 | -10 -23 | -10 -29 | 0 -13 | 0 -19 | 0 -30 | 0 -46 | 0 -74 | 0 -120 | ± 6.5 | ± 9.5 |
| 80 | 120 | -120 -142 | -72 -94 | -36 -58 | -12 -27 | -12 -34 | 0 -15 | 0 -22 | 0 -35 | 0 -54 | 0 -87 | 0 -140 | ± 7.5 | ± 11 |
| 120 | 180 | -145 -170 | -85 -110 | -43 -68 | -14 -32 | -14 -39 | 0 -18 | 0 -25 | 0 -40 | 0 -63 | 0 -100 | 0 -160 | ± 9 | ± 12.5 |
| 180 | 250 | -170 -199 | -100 -129 | -50 -79 | -15 -35 | -15 -44 | 0 -20 | 0 -29 | 0 -46 | 0 -72 | 0 -115 | 0 -185 | ± 10 | ± 14.5 |
| 250 | 315 | -190 -222 | -110 -142 | -56 -88 | -17 -40 | -17 -49 | 0 -23 | 0 -32 | 0 -52 | 0 -81 | 0 -130 | 0 -210 | ± 11.5 | ± 16 |
| 315 | 400 | -210 -246 | -125 -161 | -62 -98 | -18 -43 | -18 -54 | 0 -25 | 0 -36 | 0 -57 | 0 -89 | 0 -140 | 0 -230 | ± 12.5 | ± 18 |
| 400 | 500 | -230 -270 | -135 -175 | -68 -108 | -20 -47 | -20 -60 | 0 -27 | 0 -40 | 0 -63 | 0 -97 | 0 -155 | 0 -250 | ± 13.5 | ± 20 |
| 500 | 630 | -260 -304 | -145 -189 | -76 -120 | — | -22 -66 | — | 0 -44 | 0 -70 | 0 -110 | 0 -175 | 0 -280 | — | ± 22 |
| 630 | 800 | -290 -340 | -160 -210 | -80 -130 | — | -24 -74 | — | 0 -50 | 0 -80 | 0 -125 | 0 -200 | 0 -320 | — | ± 25 |
| 800 | 1 000 | -320 -376 | -170 -226 | -86 -142 | — | -26 -82 | — | 0 -56 | 0 -90 | 0 -140 | 0 -230 | 0 -360 | — | ± 28 |
| 1 000 | 1 250 | -350 -416 | -195 -261 | -98 -164 | — | -28 -94 | — | 0 -66 | 0 -105 | 0 -165 | 0 -260 | 0 -420 | — | ± 33 |
| 1 250 | 1 600 | -390 -468 | -220 -298 | -110 -188 | — | -30 -108 | — | 0 -78 | 0 -125 | 0 -195 | 0 -310 | 0 -500 | — | ± 39 |
| 1 600 | 2 000 | -430 -522 | -240 -332 | -120 -212 | — | -32 -124 | — | 0 -92 | 0 -150 | 0 -230 | 0 -370 | 0 -600 | — | ± 46 |

Unit: µm

| j5 | j6 | j7 | k5 | k6 | k7 | m5 | m6 | n6 | p6 | r6 | r7 | Diameter classification (mm) | |
|-----|-----|-----|-----|-----|------|-----|------|------|------|------|------|------------------------------|--------------|
| | | | | | | | | | | | | Over | Incl. |
| - 3 | - 6 | - 8 | + 6 | + 9 | + 13 | + 9 | + 12 | + 16 | + 20 | + 23 | + 27 | 3 | 6 |
| - 2 | - 2 | - 4 | + 1 | + 1 | + 1 | + 4 | + 4 | + 8 | + 12 | + 15 | + 15 | | |
| + 4 | + 7 | +10 | + 7 | +10 | + 16 | +12 | + 15 | + 19 | + 24 | + 28 | + 34 | 6 | 10 |
| - 2 | - 2 | - 5 | + 1 | + 1 | + 1 | + 6 | + 6 | + 10 | + 15 | + 19 | + 19 | | |
| + 5 | + 8 | +12 | + 9 | +12 | + 19 | +15 | + 18 | + 23 | + 29 | + 34 | + 41 | 10 | 18 |
| - 3 | - 3 | - 6 | + 1 | + 1 | + 1 | + 7 | + 7 | + 12 | + 18 | + 23 | + 23 | | |
| + 5 | + 9 | +13 | +11 | +15 | + 23 | +17 | + 21 | + 28 | + 35 | + 41 | + 49 | 18 | 30 |
| - 4 | - 4 | - 8 | + 2 | + 2 | + 2 | + 8 | + 8 | + 15 | + 22 | + 28 | + 28 | | |
| + 6 | +11 | +15 | +13 | +18 | + 27 | +20 | + 25 | + 33 | + 42 | + 50 | + 59 | 30 | 50 |
| - 5 | - 5 | -10 | + 2 | + 2 | + 2 | + 9 | + 9 | + 17 | + 26 | + 34 | + 34 | | |
| + 6 | +12 | +18 | +15 | +21 | + 32 | +24 | + 30 | + 39 | + 51 | + 60 | + 71 | 50 | 65 |
| | | | | | | | | | | - 7 | - 7 | | |
| + 6 | +13 | +20 | +18 | +25 | + 38 | +28 | + 35 | + 45 | + 59 | + 62 | + 73 | 80 | 100 |
| | | | | | | | | | | - 9 | - 9 | | |
| + 7 | +14 | +22 | +21 | +28 | + 43 | +33 | + 40 | + 52 | + 68 | + 73 | + 86 | 100 | 120 |
| | | | | | | | | | | -11 | -11 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | + 76 | + 89 | 120 | 140 |
| | | | | | | | | | | -13 | -13 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | + 88 | +103 | 160 | 180 |
| | | | | | | | | | | -13 | -13 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | + 90 | +105 | 180 | 200 |
| | | | | | | | | | | -13 | -13 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | + 93 | +108 | 200 | 225 |
| | | | | | | | | | | -13 | -13 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +106 | +123 | 225 | 250 |
| | | | | | | | | | | -13 | -13 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +109 | +126 | 250 | 280 |
| | | | | | | | | | | -16 | ±16 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +126 | +146 | 280 | 315 |
| | | | | | | | | | | -16 | ±16 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +130 | +150 | 315 | 355 |
| | | | | | | | | | | -18 | ±18 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +144 | +165 | 355 | 400 |
| | | | | | | | | | | -18 | ±18 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +150 | +171 | 400 | 450 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +166 | +189 | 450 | 500 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +172 | +195 | 500 | 560 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +194 | +220 | 560 | 630 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +199 | +225 | 630 | 710 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +225 | +255 | 710 | 800 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +235 | +265 | 800 | 900 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +266 | +300 | 900 | 1 000 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +276 | +310 | 1 000 | 1 120 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +316 | +355 | 1 120 | 1 250 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +326 | +365 | 1 250 | 1 400 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +378 | +425 | 1 400 | 1 600 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +408 | +455 | 1 600 | 1 800 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +462 | +520 | 1 800 | 2 000 |
| | | | | | | | | | | -20 | ±20 | | |
| + 7 | +16 | +25 | +24 | +33 | + 50 | +37 | + 46 | + 60 | + 79 | +492 | +550 | 2 000 | 2 000 |
| | | | | | | | | | | -20 | ±20 | | |

Appendices

Tolerances for Housing Bore Diameters

| Diameter classification (mm) | | E6 | F6 | F7 | G6 | G7 | H6 | H7 | H8 | J6 | J7 | JS6 | JS7 |
|------------------------------|--------------------------|--------------|--------------|--------------|--------------|--------------|-----------|-----------|-----------|------------|------------|-------|-------|
| Over | Incl. | | | | | | | | | | | | |
| 10 | 18 | + 43 + 32 | + 27 + 16 | + 34 + 16 | + 17 + 6 | + 24 + 6 | + 11 0 | + 18 0 | + 27 0 | + 6 - 5 | +10 - 8 | ± 5.5 | ± 9 |
| 18 | 30 | + 53 + 40 | + 33 + 20 | + 41 + 20 | + 20 + 7 | + 28 + 7 | + 13 0 | + 21 0 | + 33 0 | + 8 - 5 | +12 - 9 | ± 6.5 | ±10.5 |
| 30 | 50 | + 66 + 50 | + 41 + 25 | + 50 + 25 | + 25 + 9 | + 34 + 9 | + 16 0 | + 25 0 | + 39 0 | +10 - 6 | +14 -11 | ± 8 | ±12.5 |
| 50 | 80 | + 79 + 60 | + 49 + 30 | + 60 + 30 | + 29 + 10 | + 40 + 10 | + 19 0 | + 30 0 | + 46 0 | +13 - 6 | +18 -12 | ± 9.5 | ±15 |
| 80 | 120 | + 94 + 72 | + 58 + 36 | + 71 + 36 | + 34 + 12 | + 47 + 12 | + 22 0 | + 35 0 | + 54 0 | +16 - 6 | +22 -13 | ±11 | ±17.5 |
| 120 150 | 150 180 | +110 + 85 | + 68 + 43 | + 83 + 43 | + 39 + 14 | + 54 + 14 | + 25 0 | + 40 0 | + 63 0 | +18 - 7 | +26 -14 | ±12.5 | ±20 |
| 180 | 250 | +129 +100 | + 79 + 50 | + 96 + 50 | + 44 + 15 | + 61 + 15 | + 29 0 | + 46 0 | + 72 0 | +22 - 7 | +30 -16 | ±14.5 | ±23 |
| 250 | 315 | +142 +110 | + 88 + 56 | +108 + 56 | + 49 + 17 | + 69 + 17 | + 32 0 | + 52 0 | + 81 0 | +25 - 7 | +36 -16 | ±16 | ±26 |
| 315 | 400 | +161 +125 | + 98 + 62 | +119 + 62 | + 54 + 18 | + 75 + 18 | + 36 0 | + 57 0 | + 89 0 | +29 - 7 | +39 -18 | ±18 | ±28.5 |
| 400 | 500 | +175 +135 | +108 + 68 | +131 + 68 | + 60 + 20 | + 83 + 20 | + 40 0 | + 63 0 | + 97 0 | +33 - 7 | +43 -20 | ±20 | ±31.5 |
| 500 | 630 | +189 +145 | +120 + 76 | +146 + 76 | + 66 + 22 | + 92 + 22 | + 44 0 | + 70 0 | +110 0 | — | — | ±22 | ±35 |
| 630 | 800 | +210 +160 | +130 + 80 | +160 + 80 | + 74 + 24 | +104 + 24 | + 50 0 | + 80 0 | +125 0 | — | — | ±25 | ±40 |
| 800 | 1 000 | +226 +170 | +142 + 86 | +176 + 86 | + 82 + 26 | +116 + 26 | + 56 0 | + 90 0 | +140 0 | — | — | ±28 | ±45 |
| 1 000 | 1 250 | +261 +195 | +164 + 98 | +203 + 98 | + 94 + 28 | +133 + 28 | + 66 0 | +105 0 | +165 0 | — | — | ±33 | ±52.5 |
| 1 250 | 1 600 | +298 +220 | +188 +110 | +235 +110 | +108 + 30 | +155 + 30 | + 78 0 | +125 0 | +195 0 | — | — | ±39 | ±62.5 |
| 1 600 | 2 000 | +332 +240 | +212 +120 | +270 +120 | +124 + 32 | +182 + 32 | + 92 0 | +150 0 | +230 0 | — | — | ±46 | ±75 |
| 2 000 | 2 500 | +370 +260 | +240 +130 | +305 +130 | +144 + 34 | +209 + 34 | +110 0 | +175 0 | +280 0 | — | — | ±55 | ±87.5 |

Unit: μm

| K5 | K6 | K7 | M5 | M6 | M7 | N5 | N6 | N7 | P6 | P7 | Diameter classification (mm) | |
|------------|-------------|--------------|------------|--------------|--------------|------------|--------------|--------------|--------------|--------------|------------------------------|--------------|
| | | | | | | | | | | | Over | Incl. |
| + 2 - 6 | + 2 - 9 | + 6 - 12 | - 4 -12 | - 4 - 15 | 0 - 18 | - 9 -17 | - 9 - 20 | - 5 - 23 | - 15 - 26 | - 11 - 29 | 10 | 18 |
| + 1 - 8 | + 2 - 11 | + 6 - 15 | - 5 -14 | - 4 - 17 | 0 - 21 | -12 -21 | - 11 - 24 | - 7 - 28 | - 18 - 31 | - 14 - 35 | 18 | 30 |
| + 2 - 9 | + 3 - 13 | + 7 - 18 | - 5 -16 | - 4 - 20 | 0 - 25 | -13 -24 | - 12 - 28 | - 8 - 33 | - 21 - 37 | - 17 - 42 | 30 | 50 |
| + 3 -10 | + 4 - 15 | + 9 - 21 | - 6 -19 | - 5 - 24 | 0 - 30 | -15 -28 | - 14 - 33 | - 9 - 39 | - 26 - 45 | - 21 - 51 | 50 | 80 |
| + 2 -13 | + 4 - 18 | + 10 - 25 | - 8 -23 | - 6 - 28 | 0 - 35 | -18 -33 | - 16 - 38 | - 10 - 45 | - 30 - 52 | - 24 - 59 | 80 | 120 |
| + 3 -15 | + 4 - 21 | + 12 - 28 | - 9 -27 | - 8 - 33 | 0 - 40 | -21 -39 | - 20 - 45 | - 12 - 52 | - 36 - 61 | - 28 - 68 | 120 | 180 |
| + 2 -18 | + 5 - 24 | + 13 - 33 | -11 -31 | - 8 - 37 | 0 - 46 | -25 -45 | - 22 - 51 | - 14 - 60 | - 41 - 70 | - 33 - 79 | 180 | 250 |
| + 3 -20 | + 5 - 27 | + 16 - 36 | -13 -36 | - 9 - 41 | 0 - 52 | -27 -50 | - 25 - 57 | - 14 - 66 | - 47 - 79 | - 36 - 88 | 250 | 315 |
| + 3 -22 | + 7 - 29 | + 17 - 40 | -14 -39 | - 10 - 46 | 0 - 57 | -30 -55 | - 26 - 62 | - 16 - 73 | - 51 - 87 | - 41 - 98 | 315 | 400 |
| + 2 -25 | + 8 - 32 | + 18 - 45 | -16 -43 | - 10 - 50 | 0 - 63 | -33 -60 | - 27 - 67 | - 17 - 80 | - 55 - 95 | - 45 -108 | 400 | 500 |
| — | 0 - 44 | 0 - 70 | — | - 26 - 70 | - 26 - 96 | — | - 44 - 88 | - 44 -114 | - 78 -122 | - 78 -148 | 500 | 630 |
| — | 0 - 50 | 0 - 80 | — | - 30 - 80 | - 30 -110 | — | - 50 -100 | - 50 -130 | - 88 -138 | - 88 -168 | 630 | 800 |
| — | 0 - 56 | 0 - 90 | — | - 34 - 90 | - 34 -124 | — | - 56 -112 | - 56 -146 | -100 -156 | -100 -190 | 800 | 1 000 |
| — | 0 - 66 | 0 -105 | — | - 40 -106 | - 40 -145 | — | - 66 -132 | - 66 -171 | -120 -186 | -120 -225 | 1 000 | 1 250 |
| — | 0 - 78 | 0 -125 | — | - 48 -126 | - 48 -173 | — | - 78 -156 | - 78 -203 | -140 -218 | -140 -265 | 1 250 | 1 600 |
| — | 0 - 92 | 0 -150 | — | - 58 -150 | - 58 -208 | — | - 92 -184 | - 92 -242 | -170 -262 | -170 -320 | 1 600 | 2 000 |
| — | 0 -110 | 0 -175 | — | - 68 -178 | - 68 -243 | — | -110 -220 | -110 -285 | -195 -305 | -195 -370 | 2 000 | 2 500 |

Appendices

Values of Standard Tolerances for IT Grades

| Basic size (mm) | | Standard grade | | | | | | | | |
|--------------------|--------------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|
| | | IT1 | IT2 | IT3 | IT4 | IT5 | IT6 | IT7 | IT8 | IT9 |
| Over | Incl. | Tolerances (µm) | | | | | | | | |
| – | 3 | 0.8 | 1.2 | 2 | 3 | 4 | 6 | 10 | 14 | 25 |
| 3 | 6 | 1 | 1.5 | 2.5 | 4 | 5 | 8 | 12 | 18 | 30 |
| 6 | 10 | 1 | 1.5 | 2.5 | 4 | 6 | 9 | 15 | 22 | 36 |
| 10 | 18 | 1.2 | 2 | 3 | 5 | 8 | 11 | 18 | 27 | 43 |
| 18 | 30 | 1.5 | 2.5 | 4 | 6 | 9 | 13 | 21 | 33 | 52 |
| 30 | 50 | 1.5 | 2.5 | 4 | 7 | 11 | 16 | 25 | 39 | 62 |
| 50 | 80 | 2 | 3 | 5 | 8 | 13 | 19 | 30 | 46 | 74 |
| 80 | 120 | 2.5 | 4 | 6 | 10 | 15 | 22 | 35 | 54 | 87 |
| 120 | 180 | 3.5 | 5 | 8 | 12 | 18 | 25 | 40 | 63 | 100 |
| 180 | 250 | 4.5 | 7 | 10 | 14 | 20 | 29 | 46 | 72 | 115 |
| 250 | 315 | 6 | 8 | 12 | 16 | 23 | 32 | 52 | 81 | 130 |
| 315 | 400 | 7 | 9 | 13 | 18 | 25 | 36 | 57 | 89 | 140 |
| 400 | 500 | 8 | 10 | 15 | 20 | 27 | 40 | 63 | 97 | 155 |
| 500 | 630 | 9 | 11 | 16 | 22 | 32 | 44 | 70 | 110 | 175 |
| 630 | 800 | 10 | 13 | 18 | 25 | 36 | 50 | 80 | 125 | 200 |
| 800 | 1 000 | 11 | 15 | 21 | 28 | 40 | 56 | 90 | 140 | 230 |
| 1 000 | 1 250 | 13 | 18 | 24 | 33 | 47 | 66 | 105 | 165 | 260 |
| 1 250 | 1 600 | 15 | 21 | 29 | 39 | 55 | 78 | 125 | 195 | 310 |
| 1 600 | 2 000 | 18 | 25 | 35 | 46 | 65 | 92 | 150 | 230 | 370 |
| 2 000 | 2 500 | 22 | 30 | 41 | 55 | 78 | 110 | 175 | 280 | 440 |
| 2 500 | 3 150 | 26 | 36 | 50 | 68 | 96 | 135 | 210 | 330 | 540 |

Remarks 1. Standard tolerance grades IT14 to IT18 shall not be used for basic sizes less than or equal to 1 mm.

2. Values for standard tolerance grades IT1 to IT5 for basic size over 500 mm are included for experimental use.

| Standard grade | | | | | | | | | Basic size (mm) | |
|-----------------|-------|------|------|------|------|-------|-------|-------|--------------------|--------------|
| IT10 | IT11 | IT12 | IT13 | IT14 | IT15 | IT16 | IT17 | IT18 | | |
| Tolerances (mm) | | | | | | | | | Over | Incl. |
| 40 | 60 | 0.10 | 0.14 | 0.25 | 0.40 | 0.60 | 1.00 | 1.40 | - | 3 |
| 48 | 75 | 0.12 | 0.18 | 0.30 | 0.48 | 0.75 | 1.20 | 1.80 | 3 | 6 |
| 58 | 90 | 0.15 | 0.22 | 0.36 | 0.58 | 0.90 | 1.50 | 2.20 | 6 | 10 |
| 70 | 110 | 0.18 | 0.27 | 0.43 | 0.70 | 1.10 | 1.80 | 2.70 | 10 | 18 |
| 84 | 130 | 0.21 | 0.33 | 0.52 | 0.84 | 1.30 | 2.10 | 3.30 | 18 | 30 |
| 100 | 160 | 0.25 | 0.39 | 0.62 | 1.00 | 1.60 | 2.50 | 3.90 | 30 | 50 |
| 120 | 190 | 0.30 | 0.46 | 0.74 | 1.20 | 1.90 | 3.00 | 4.60 | 50 | 80 |
| 140 | 220 | 0.35 | 0.54 | 0.87 | 1.40 | 2.20 | 3.50 | 5.40 | 80 | 120 |
| 160 | 250 | 0.40 | 0.63 | 1.00 | 1.60 | 2.50 | 4.00 | 6.30 | 120 | 180 |
| 185 | 290 | 0.46 | 0.72 | 1.15 | 1.85 | 2.90 | 4.60 | 7.20 | 180 | 250 |
| 210 | 320 | 0.52 | 0.81 | 1.30 | 2.10 | 3.20 | 5.20 | 8.10 | 250 | 315 |
| 230 | 360 | 0.57 | 0.89 | 1.40 | 2.30 | 3.60 | 5.70 | 8.90 | 315 | 400 |
| 250 | 400 | 0.63 | 0.97 | 1.55 | 2.50 | 4.00 | 6.30 | 9.70 | 400 | 500 |
| 280 | 440 | 0.70 | 1.10 | 1.75 | 2.80 | 4.40 | 7.00 | 11.00 | 500 | 630 |
| 320 | 500 | 0.80 | 1.25 | 2.00 | 3.20 | 5.00 | 8.00 | 12.50 | 630 | 800 |
| 360 | 560 | 0.90 | 1.40 | 2.30 | 3.60 | 5.60 | 9.00 | 14.00 | 800 | 1 000 |
| 420 | 660 | 1.05 | 1.65 | 2.60 | 4.20 | 6.60 | 10.50 | 16.50 | 1 000 | 1 250 |
| 500 | 780 | 1.25 | 1.95 | 3.10 | 5.00 | 7.80 | 12.50 | 19.50 | 1 250 | 1 600 |
| 600 | 920 | 1.50 | 2.30 | 3.70 | 6.00 | 9.20 | 15.00 | 23.00 | 1 600 | 2 000 |
| 700 | 1 100 | 1.75 | 2.80 | 4.40 | 7.00 | 11.00 | 17.50 | 28.00 | 2 000 | 2 500 |
| 860 | 1 350 | 2.10 | 3.30 | 5.40 | 8.60 | 13.50 | 21.00 | 33.00 | 2 500 | 3 150 |

Appendices

Conversion Tables from SI (International Unit) System

The values accompanied by (*) in the marked boxes denote SI units.

Comparison of SI, CGS and Engineering Units (Gravitational Metric System)

| Units Unit System | Length | Mass | Time | Temperature | Acceleration | Force | Stress | Pressure | Energy | Power |
|----------------------|--------|---------|------|-------------|------------------|-------|---------------------|---------------------|--------|---------|
| SI | m | kg | s | K, °C | m/s ² | N | Pa | Pa | J | W |
| CGS System | cm | g | s | °C | Gal | dyn | dyn/cm ² | dyn/cm ² | erg | erg/s |
| Engineering Units | m | kgf·s/m | s | °C | m/s ² | kgf | kgf/m ² | kgf/m ² | kgf·m | kgf·m/s |

Prefixes Used in SI System

| Multiples | Prefix | Symbol | Multiples | Prefix | Symbol |
|------------------|--------|--------|-------------------|--------|--------|
| 10 ¹⁸ | Exa | E | 10 ⁻¹ | Deci | d |
| 10 ¹⁵ | Peta | P | 10 ⁻² | Centi | c |
| 10 ¹² | Tera | T | 10 ⁻³ | Milli | m |
| 10 ⁹ | Giga | G | 10 ⁻⁶ | Micro | μ |
| 10 ⁶ | Mega | M | 10 ⁻⁹ | Nano | n |
| 10 ³ | Kilo | k | 10 ⁻¹² | Pico | p |
| 10 ² | Hecto | h | 10 ⁻¹⁵ | Femto | f |
| 10 | Deca | da | 10 ⁻¹⁸ | Ato | a |

| | | | |
|-------|--------------------|-------------------------|--------------------------|
| Force | *N | dyn | kgf |
| | 1 | 1×10 ⁵ | 1.01972×10 ⁻¹ |
| | 1×10 ⁻⁵ | 1 | 1.01972×10 ⁻⁶ |
| | 9.80665 | 9.80665×10 ⁵ | 1 |

| | | | | |
|--------|-------------------------|---------------------------|--------------------------|--------------------------|
| Stress | *Pa | *MPa or N/mm ² | kgf/mm ² | kgf/cm ² |
| | 1 | 1×10 ⁻⁶ | 1.01972×10 ⁻⁷ | 1.01972×10 ⁻⁵ |
| | 1×10 ⁶ | 1 | 1.01972×10 ⁻¹ | 1.01972×10 |
| | 9.80665×10 ⁶ | 9.80665 | 1 | 1×10 ² |
| | 9.80665×10 ⁴ | 9.80665×10 ⁻² | 1×10 ⁻² | 1 |

| | | | | | | |
|----------|-------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Pressure | *Pa | bar | kgf/cm ² | atm | mmH ₂ O | mmHg or Torr |
| | 1 | 1×10 ⁻⁵ | 1.01972×10 ⁻⁵ | 9.86923×10 ⁻⁶ | 1.01972×10 ⁻¹ | 7.50062×10 ⁻³ |
| | 1×10 ⁵ | 1 | 1.01972 | 9.86923×10 ⁻¹ | 1.01972×10 ⁴ | 7.50062×10 ² |
| | 9.80665×10 ⁴ | 9.80665×10 ⁻¹ | 1 | 9.67841×10 ⁻¹ | 1×10 ⁴ | 7.35559×10 ² |
| | 1.01325×10 ⁵ | 1.01325 | 1.03323 | 1 | 1.03323×10 ⁴ | 7.60000×10 ² |
| | 9.80665 | 9.80665×10 ⁻⁵ | 1×10 ⁻⁴ | 9.67841×10 ⁻⁵ | 1 | 7.35559×10 ⁻² |
| | 1.33322×10 ² | 1.33322×10 ⁻³ | 1.35951×10 ⁻³ | 1.31579×10 ⁻³ | 1.35951×10 | 1 |

Note: 1Pa=1N/m²

| | | | |
|-----------|--------------------|-------------------|--------------------|
| Viscosity | *Pa·s | cP | P |
| | 1 | 1×10 ³ | 1×10 |
| | 1×10 ⁻³ | 1 | 1×10 ⁻² |
| | 1×10 ⁻¹ | 1×10 ² | 1 |

Note: 1Pa=1dyn·s/cm²=1g/cm·s, 1Pa·s=1N·s/m², 1cP=1mPa·s

| | | |
|----------------------|----------|------------------------------|
| Thermal Conductivity | *W/(m·K) | kcal _{IT} /(h·m·°C) |
| | 1 | 8.59845×10 ⁻¹ |
| | 1.16300 | 1 |

| | | | |
|---------------------|--------------------|-------------------|--------------------|
| Kinematic Viscosity | *m ² /s | cSt | St |
| | 1 | 1×10 ⁶ | 1×10 ⁴ |
| | 1×10 ⁻⁶ | 1 | 1×10 ⁻² |
| | 1×10 ⁻⁴ | 1×10 ² | 1 |

Note: 1St=1cm²/s, 1cSt=1mm²/s,

| | | |
|---------------------------|------------------------|--|
| Heat Transfer Coefficient | *W/(m ² ·K) | kcal _{IT} /(h·m ² ·°C) |
| | 1 | 8.59845×10 ⁻¹ |
| | 1.16300 | 1 |

| | | | | |
|------------------------------|-------------------------|---------------------------|--------------------------|--------------------------|
| Energy, Work, Amount of Heat | *J | kW·h | kgf·m | kcal _{IT} |
| | 1 | 2.77778×10 ⁻⁷ | 1.01972×10 ⁻¹ | 2.38846×10 ⁻⁴ |
| | 3.600×10 ⁶ | 1 | 3.67098×10 ⁵ | 8.5985×10 ² |
| | 9.80665 | 2.272407×10 ⁻⁶ | 1 | 2.34228×10 ⁻³ |
| | 4.18680×10 ³ | 1.16300×10 ⁻³ | 4.26935×10 ² | 1 |

Note: 1J=1W·s, 1W·h=3600W·s 1cal_{IT}=4.186 8J

| | | | | |
|---------------------|-----------------------|--------------------------|--------------------------|--------------------------|
| Power, Thermal Flow | *W | kgf·m/s | PS | kcal _{IT} /h |
| | 1 | 1.01972×10 ⁻¹ | 1.35962×10 ⁻³ | 8.59845×10 ⁻¹ |
| | 9.80665 | 1 | 1.33333×10 ⁻² | 8.43220 |
| | 7.355×10 ² | 7.5×10 | 1 | 6.32415×10 ² |
| | 1.16300 | 1.18593×10 ⁻¹ | 1.58124×10 ⁻³ | 1 |

Note: 1W=1J/s, PS : Metric horsepower

Physical and Mechanical Properties of Material

| Application | Material | Heat treatment | Density g/cm ³ | Specific heat KJ/ (kg K) | Thermal conductivity W/(m K) | Electric resistance μΩ•cm | Coefficient of linear expansion (0°-100°C) ×10 ⁻⁶ /°C | Young's modulus MPa | Yield point MPa | Tensile strength MPa | Elong- ation % | Hard- ness HB | | |
|-------------|--|--------------------------------------|------------------------------|-----------------------------------|------------------------------------|---------------------------------|--|---------------------------|-----------------------|----------------------------|----------------------|---------------------|-------------|-------|
| Bearing | High-carbon chrome bearing steel No.2 SUJ2 | Quenching, tempering | 7.83 | 0.47 | 46 | 22 | 12.5 | 208 000 | 1 370 | 1 570 -1 960 | Max. 0.5 | 650 -740 | | |
| | | Spheroidizing annealing | 7.86 | | | | 11.9 | | 420 | 647 | 27 | 180 | | |
| | Chrome steel SCr420 | Quenching, Low temp. tempering | 7.83 | | 48 | 21 | 12.8 | | 882 | 1 225 | 15 | 370 | | |
| | Nickel-chromium-molybdenum steel SAE4320 (SNCM420) | Quenching, Low temp. tempering | | | 44 | 20 | 11.7 | | 902 | 1 009 | 16 | **293 -375 | | |
| | Nickel-chromium-molybdenum steel SNCM815 | Quenching, Low temp. tempering | 7.89 | | 40 | 35 | - | | - | Min. *1 080 | Min. *12 | *311 -375 | | |
| | Martensitic stainless steel SUS440C | Quenching, Low temp. tempering | 7.68 | | 0.46 | 24 | 60 | | 10.1 | 200 000 | 1 860 | 1 960 | - | **580 |
| | Cold rolled steel plate SPCC | Annealing | 7.86 | | 0.47 | 59 | 15 | | 11.6 | 206 000 | - | Min. *275 | Min. *32 | - |
| | Carbon steel for machine structure S25C | Annealing | | | 0.48 | 50 | 17 | | 11.8 | | 323 | 431 | 33 | 120 |
| | High-tension brass CAC301 (HB ₅ C1) | | 8.5 | | 0.38 | 123 | 6.2 | | 19.1 | 103 000 | - | Min. *431 | Min. *20 | - |

Notes *Standard value of JIS or reference value.

**The hardness is usually expressed using the Rockwell C scale, but for comparison, it is converted into Brinell hardness.

Reference Proportional limits of SUJ2 and SCr420 are 833 MPa (85kgf/mm²) and 440 MPa (45kgf/mm²) respectively.

Appendices

Physical and Mechanical Properties of Material

| Application | Material | Heat treatment (°C) | Density g/cm ³ | Specific heat KJ/(kg K) | Thermal conductivity W/(m K) | Electric resistance μΩ•cm | Coefficient of linear expansion (0°-100°C) ×10 ⁻⁶ /°C | Young's modulus MPa | Yield point MPa | Tensile strength MPa | Elongation % | Hardness HB |
|-----------------------------------|--|--|---------------------------|-------------------------|------------------------------|---------------------------|--|---------------------|-----------------|----------------------|--------------|-------------|
| Shaft | Carbon steel for machine structure S45C | Quenching, 650 °C tempering | 7.83 | 0.48 | 47 | 18 | 12.8 | 207 000 | 440 | 735 | 25 | 217 |
| | Chrome steel SCR430 | Quenching, 520 to 620 °C fast cooling | | | | 22 | 12.5 | 208 000 | Min. *637 | Min. *784 | Min. *18 | *229 -293 |
| | Chrome steel SCR440 | Quenching, 520 to 620 °C fast cooling | | | | 23 | | | Min. *784 | Min. *930 | Min. *13 | *269 -331 |
| | Chrome Molybdenum steel SCM420 | Quenching, 150 to 200 °C air cooling | | | 48 | 21 | 12.8 | | - | Min. *930 | Min. *14 | *262 -352 |
| | Nickel-chromium-molybdenum steel SNCM439 | Quenching, 650 °C tempering | | | 38 | 30 | 11.3 | 207 000 | 920 | 1 030 | 18 | 320 |
| | Low carbon cast steel SC46 | Normalizing | | | - | - | - | - | - | 206 000 | 294 | 520 |
| Housing | Martensitic stainless steel SUS420J2 | 1038 °C oil cooling, 400 °C air cooling. | 7.75 | 0.46 | 22 | 55 | 10.4 | 200 000 | 1 440 | 1 650 | 10 | 400 |
| | Gray cast iron FC200 | Casting | 7.3 | 0.50 | 43 | - | | 98 000 | - | Min. *200 | - | Max. *217 |
| | Spheroidal graphite cast iron FCD400 | Casting | 7.0 | 0.48 | 20 | - | 11.7 | Min. *250 | Min. *400 | Min. *12 | Max. *201 | |
| | Pure aluminum A1100 | Annealing | 2.69 | 0.90 | 222 | 3.0 | 23.7 | 70 600 | 34 | 78 | 35 | - |
| | Aluminum alloy for sand casting AC4C | Casting | 2.68 | 0.88 | 151 | 4.2 | 21.5 | 72 000 | 88 | 167 | 7 | - |
| | Aluminum alloy for die casting ADC10 | Casting | 2.74 | 0.96 | 96 | 7.5 | 22.0 | 71 000 | 167 | 323 | 4 | - |
| Austenitic stainless steel SUS304 | Annealing | 8.03 | 0.50 | 15 | 72 | 15.7-16.8 | 193 000 | 245 | 588 | 60 | 150 | |

Notes *Standard value of JIS or reference value.

Bearing Investigation Request Form

Please complete the form below and send to your nearest NSK sales office if you wish to have a bearing investigated.

Investigation Request for Super Precision Bearings

Company name: _____ Reference No. of previous NSK reports: _____

Attachments: Structural drawing attached: Yes No Other attachments: Yes No

● Symptoms Observed symptoms: Abnormal noise Seizure Lockup Excessive temperature rise Vibration
 Crack on machined surface Poor accuracy Entry of coolant Others

Bearing condition: Seized Sticks when turned by hand Adhesion of foreign matter Discolored grease

Abnormal noise: Synchronous with rotation Not synchronous with rotation Continuous Not continuous In low speed operation

Failure occurred during: Routine operation In-house test Running-in Development evaluation Other ()

Time bearing was in service: _____ months, _____ hours Actual operating time: _____ months (_____ years _____ days)
 Full time operation Operation in _____ shift(s) per day

Further details of operating conditions: _____

● Conditions of use: Machine type: Machining center Lathe Grinder Others () Production machine Test Machine

Bearing position: Spindle Ball screw support Automatic Tool Changer Motor Other ()

Model No.: _____

Spindle position: Vertical Horizontal Swiveling

Drive type: Built-in motor spindle Belt drive Direct drive Gear drive Other ()

Maximum speed: _____ min⁻¹ Speed during operation: _____ min⁻¹ Regular speed: _____ min⁻¹

Lubrication: Grease Oil-air Oil mist Circulating lubrication Other ()
 MTE MTS NBU 15 NBU 8 EP Alvania S2 Viscosity (_____ cSt)

Coolant: Yes Brand name: _____ No Set temperature of cooling oil: _____ °C Synchronized with room temperature: + _____ °C
 Temperature control: Oil cooling unit (OCU) Control at OCU outlet Control at OCU inlet

Bearing arrangement: (example: Angular contact ball bearing Cylindrical roller bearing , With Spacers With Spring)

| | |
|--|--------------|
| Spindle front (tool/chuck) - for vertical spindles, please indicate top and bottom | Spindle rear |
| <small>(Please enter bearing serial No. and indicate the mounting position as well as the direction of the bearing, e.g. whether row A faces the chuck or the rear side, etc.)</small> | |

| | |
|---|--|
| ● Bearing: Front-side (fixed side) bearing Serial No.: _____ Bearing number: _____ Mounted clearance/preload, amount of adjustment by spacers: _____ Jacket cooling: <input type="checkbox"/> Yes <input type="checkbox"/> No Sleeve: <input type="checkbox"/> Yes <input type="checkbox"/> No Spacer Width: 1 st Spacer _____ mm, 2 nd Spacer _____ mm, 3 rd Spacer _____ mm Shaft bore: _____ mm Housing outer diameter: _____ mm Inner ring temp.: _____ °C Outer ring temp.: _____ °C Shaft fit: _____ Housing fit: _____ | Rear-side (free side) bearing Serial No.: _____ Bearing number: _____ Mounted clearance/preload, amount of adjustment by spacers: _____ Jacket cooling: <input type="checkbox"/> Yes <input type="checkbox"/> No Sleeve: <input type="checkbox"/> Yes <input type="checkbox"/> No Spacer Width: 1 st Spacer _____ mm, 2 nd Spacer _____ mm, 3 rd Spacer _____ mm Shaft bore: _____ mm Housing outer diameter: _____ mm Inner ring temp.: _____ °C Outer ring temp.: _____ °C Shaft fit: _____ Housing fit: _____ |
|---|--|

● Comments, suspected causes, further observations:

Appendices

Bearing Specification Request Form

To request bearing specification, please complete the form below and send to your nearest NSK sales office.

Specification Request for Super Precision Bearings

Company name: _____

Your reason for requesting specification:

(Example: to increase spindle rigidity, to avoid previous bearing damage, etc.)

Attachments: Yes No

● Specification: Machine type: Machining center Lathe Grinder Other (_____)

Model No.: _____

Orientation: Vertical Horizontal Swiveling

Drive type: Built-in motor spindle Belt drive Direct drive Gear drive

Maximum speed: _____ min^{-1} Unclamping force: _____ N

Lubrication: Grease Oil-air Oil mist Circulating lubrication
 Other (_____)

Bearing arrangement: (example: Angular contact ball bearing \oslash Cylindrical roller bearing $\square\square$, \square Spacers $\oslash=\oslash$ Spring WWW \oslash)

(If currently using bearings, please provide the bearing numbers)

Front side bearings

Rear side bearings

Shaft material: _____ Housing material: _____

Front-side (fixed side) bearing

Bearing number: _____

Bore diameter: _____ mm Outer diameter: _____ mm

Combined width: _____ mm Accuracy class: _____

Clearance/Preload: _____ (e.g. EL, 800N, CC9)

Jacket cooling: Yes No Sleeve: Yes No

Spacer Width: 1st Spacer _____ mm, 2nd Spacer _____ mm,
 3rd Spacer _____ mm

Shaft bore: _____ mm Housing outer diameter: _____ mm

Inner ring temp.: _____ °C Outer ring temp.: _____ °C

Shaft fit: _____

Housing fit: _____

Rear-side (free side) bearing

Bearing number: _____

Bore diameter: _____ mm Outer diameter: _____ mm

Combined width: _____ mm Accuracy class: _____

Clearance/Preload: _____ (e.g. EL, 800N, CC9)

Jacket cooling: Yes No Sleeve: Yes No

Spacer Width: 1st Spacer _____ mm, 2nd Spacer _____ mm,
 3rd Spacer _____ mm

Shaft bore: _____ mm Housing outer diameter: _____ mm

Inner ring temp.: _____ °C Outer ring temp.: _____ °C

Shaft fit: _____

Housing fit: _____

● Room to write down your priorities, comments, etc.

Detail your requests in order of importance. Example: 1. Rolling fatigue life 20 000 hours or more, 2. Mounted axial rigidity 100N/μm, etc.
 - Please understand it may not always be possible to meet all of the requested criteria.

※Note: If you wish to request calculation of service life under external load, please provide additional information on the load conditions (Load point, amount and direction of load, rotational speed, duty cycle in %) and the spindle structure (spindle dimensions, distance between bearings).



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