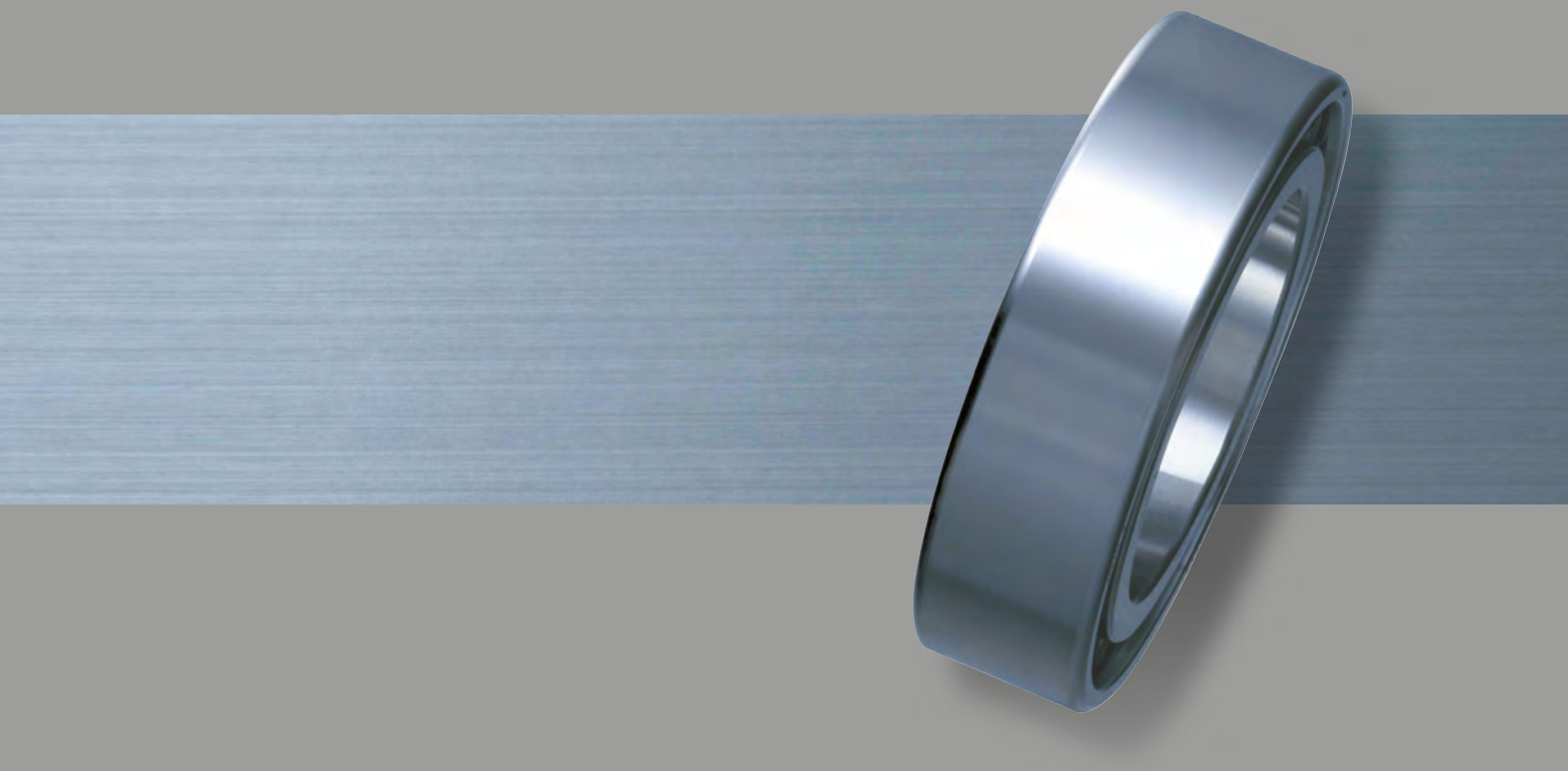
MOTION & CONTROL™

NSK

SUPER PRECISION BEARINGS



INTRODUCTION

As technologies evolve, all manufacturers share a global responsibility to respect and protect the environment. NSK Motion and Control products reflect our corporate commitment to environmental responsibility. While our products improve the performance of machines in a variety of industries, they also save energy and conserve resources because of our superior precision machining technologies.

To meet the needs of the highly specialized machine tool industry, we have enhanced each and every aspect of our R&D capabilities at our Technology Centers. Therefore, NSK's precision bearings are used in a wide variety of industries, such as semiconductor production and industrial robots, and have earned a reputation for excellent performance. Today, NSK manufactures highly accurate, reliable precision bearings in Japan and Europe and supplies them all over the world.

This catalog explains technical materials including our latest research and experimental data, various applications, the types of precision bearings available, and the proper utilization of each specific type of NSK's precision bearing.

MOTION & CONTROL™
NSK

Table of Contents

Part1. NSK Super Precision Bearings

Global Support Capabilities P6
Development Capabilities P8
Quality Control and Production Capabilities P10

Part2. Features of Precision Bearings

Metallurgical Technology to Extend Bearing Life P14
Ceramic Balls P16
Cages P18
Product Range P20
Performance of Each Bearing Type P22

Part3. Guidelines for Bearing Selection

Selection Flow P36
Typical High-Speed Spindle Structures P38
Other Spindle Structures P40
Features of Angular Contact Ball Bearings P44
Features of Cylindrical Roller Bearings P46

Part4. Bearing Types

1. Angular Contact Ball Bearings

Angular Contact Ball Bearings P50-107
Numbering System
Bearing Tables
- High Accuracy Angular Contact Ball Bearings (Standard Series)
- Ultra High Speed Angular Contact Ball Bearings (NSKROBUST Series)

2. Cylindrical Roller Bearings

Cylindrical Roller Bearings P110-127
Features
Numbering 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 (Low Heat Generation Series)
- Double Row Cylindrical Roller Bearings (High Rigidity Series)
- Double Row Cylindrical Roller Bearings (Low Heat Generation Series)

3. Angular Contact Thrust Ball Bearings

Angular Contact Thrust Ball Bearings P130-141
Features
Numbering System
Bearing Tables
- 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)

4. Ball Screw Support Bearings

NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support P144-153
Features
Numbering System
Bearing Tables
- For High Rigidity Applications (NSKTAC C Series)
- For High-Load Drive Applications (NSKTAC03 Series)
- BSBD Series

Units for Ball Screw Support P154-155
Features
Numbering System
Support Unit Tables

5. Tapered Roller Bearings

Tapered Roller Bearings P158-161
Features
Numbering System
Bearing Tables

6. Thrust Bearings

Thrust Bearings P164-173
Features
Numbering System
Bearing Tables
- Single Direction Thrust Ball Bearings
- Thrust Cylindrical Roller Bearings
- Thrust Cylindrical Roller Bearings for Vertical Lathe Table

ROBUSTSLIM P174-175
Features
Numbering System
Bearing Tables
- High Accuracy Low Profile Angular Contact Ball Bearings (ROBUSTSLIM Series)

7. Peripheral Equipment

Gauges P178-181
GR Gauges
- Features
- Gauge Dimensions

GN Gauges
- Features
- Gauge Dimensions

NSK Bearing Induction Heater P182-183
Grease Replenishing System FINE-LUB II P184-185
High Speed Built-in Motor Spindle P186-187

Part5. Technical Guide

1. Life P190-197
· Rolling Fatigue Life and Dynamic Load Rating
· New Life Theory
2. Basic Static Load Ratings and Static Equivalent Loads P198-199
3. Angular Contact Ball Bearing Combinations P200-205
· Features of Each Combination
· Precautions for Handling of Bearing Sets
· Universal Arrangement
4. Preload and Rigidity P206-215
5. Limiting Speeds P216-217
6. Lubrication P218-221
7. Bearing Tolerances P222-231
· Tolerances for Radial Bearings
· Tolerances for Tapered Bores
· Tolerances for Angular Contact Thrust Ball Bearings
· Tolerances for Tapered Roller Bearings
· Tolerances for Thrust Ball Bearings
8. Designing of Shafts and Housings P232-236
· Fitting of Shafts and Housings
· Shafts and Housing Tolerance
· Chamfer Dimensions
9. Spacers P237-241
· Spacer Dimensions
· Nozzle Position

Part6. Bearing Handling

1. Mounting P244-265
1. Cleaning the Bearings and Related Parts
2. Checking Dimensions of Related Parts
3. Mounting Procedures
4. Inspection after Mounting
2. Operational Inspection P266-267
3. Running-in Method P268-269

Part7. Bearing Failure Diagnosis

1. Examples of Bearing Failures and Countermeasures P272-277
2. Diagnosis with Sound and Vibration P278-279

Part8. Appendices

1. Tolerances for Shaft Diameters P282-283
2. Tolerances for Housing Bore Diameters P284-285
3. Values of Standard Tolerance Grades IT P286-287
4. Conversion Table for SI Units P288
5. Physical and Mechanical Properties of Material P289-290
6. Bearing Inspection Request Form P291
7. Bearing Specifications Request Form P292



SUPER PRECISION



BEARINGS

Part 1

Contents

Part1. NSK Super Precision Bearings

Global Support Capabilities ——— P6

Development Capabilities ——— P8

Quality Control and Production Capabilities ——— P10



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 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.



01 Global network management provides optimal, high-quality products

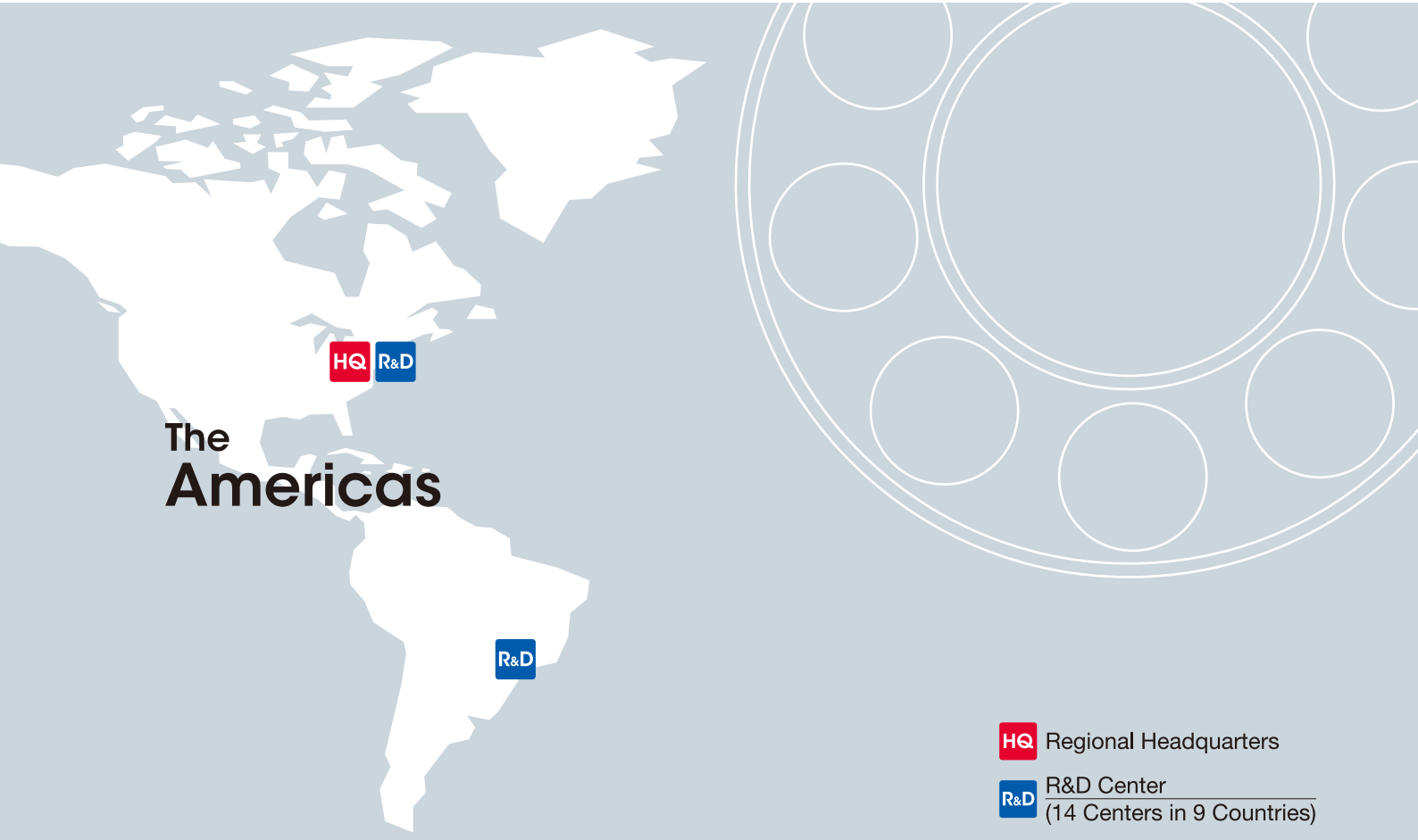
NSK has established a highly developed information network centered on Technology Centers located in the four major markets of the world – Europe, the United States, Asia and Japan. With this network, we are able to gather information, in real time, related to the changes and trends in any market in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


Information system directly linked to customers

02 Technology Center customer support

Our 14 Technology Centers are located in 9 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.





(as of March 31st, 2022)

03 Custom products for unique customer applications

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.

04 Our global support network is available wherever our customers are located

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.



http://www.nsk.com

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. Thus NSK has been contributing to the evolution of industry, to making peoples' lives safer and easier, and to the conservation of global environment.
NSK started overseas activities in the early 1960s and today encompasses a network of production plants, sales offices and Technology Centers across 31 countries; this enables us to respond quickly to customer requests and regional requirements anywhere in the world with specially designed and regionally manufactured products.
NSK is working to further advance its Four Core Technologies in the service of customers and society, to forge ahead with the development of environmentally friendly products based on these technologies.

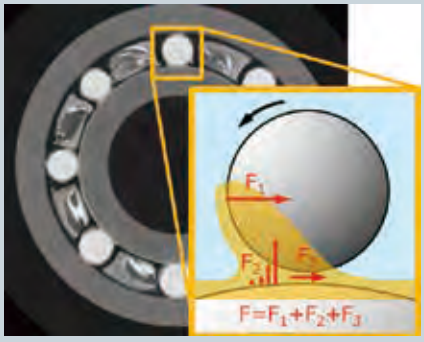
NSK's technological foundation

Four Core Technologies plus One

Tribology

Tribology is the study of friction and wear of contact surfaces in relative motion, such as rotating parts that endure enormous forces with a thin oil film. Severe operating conditions are mitigated through lubrication and surface treatments developed by NSK, resulting in superior performance for applications requiring low friction, high-speed rotation, quiet operation, or enhanced durability.

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



Friction on the bearing's ball surface

Numerical Simulation

In the past, accuracy and reliability in product development were achieved with experience-based design and longer testing periods. NSK's simulation technology allows virtual validation to accelerate design and production. Extreme conditions or innovative designs that defy previous expectations can also be evaluated and analyzed.

Areas Motion/Friction Analysis, Analysis of Macro-Scale and Nano-Scale Lubrication, Simulation


Simulated example of an automotive component

Materials

Materials research and development affects nearly every aspect of product performance. Through careful selection of material composition, heat treatment, and ceramic materials, NSK enables optimization of application performance. This may result from improvements in function, endurance, or reliability, or through advancements in cost-effectiveness or production efficiency.

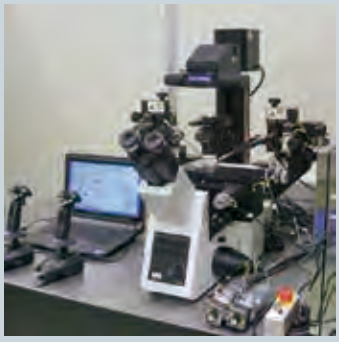
Areas Sliding Materials (brass, resin, ceramic materials), Heat Treatment, Material Fatigue


Durability testing machines

Mechatronics

Mechatronics integrates machine elements technology with control technology. By combining bearings, ball screws and linear guides, together with motors, sensors and computers, greater mechanical functionality is elicited with computer control. This technology applies new functions and performance to a range of industrial machinery, such as for automobiles and bio-medicine. It also contributes to greater reliability, as well as to convenience and safety in daily life.

Areas Motors / Circuits / Control Technology, Sensors, Technology for Biomedical Micro electro mechanical Systems (Bio-MEMS)



Manipulation system for bio-medicine

plus One Manufacturing Engineering

Contributing to the environment and heightening safety and security through our Four Core Technologies requires something to breathe life into these technologies. In addition, it is essential to consistently produce with high quality. NSK tackles these issues by applying AI to its equipment, utilizing IoT, and optimizing its overall production framework while it works to realize the creation of smart factories that economize on space, save on energy, and reduce manpower requirements.



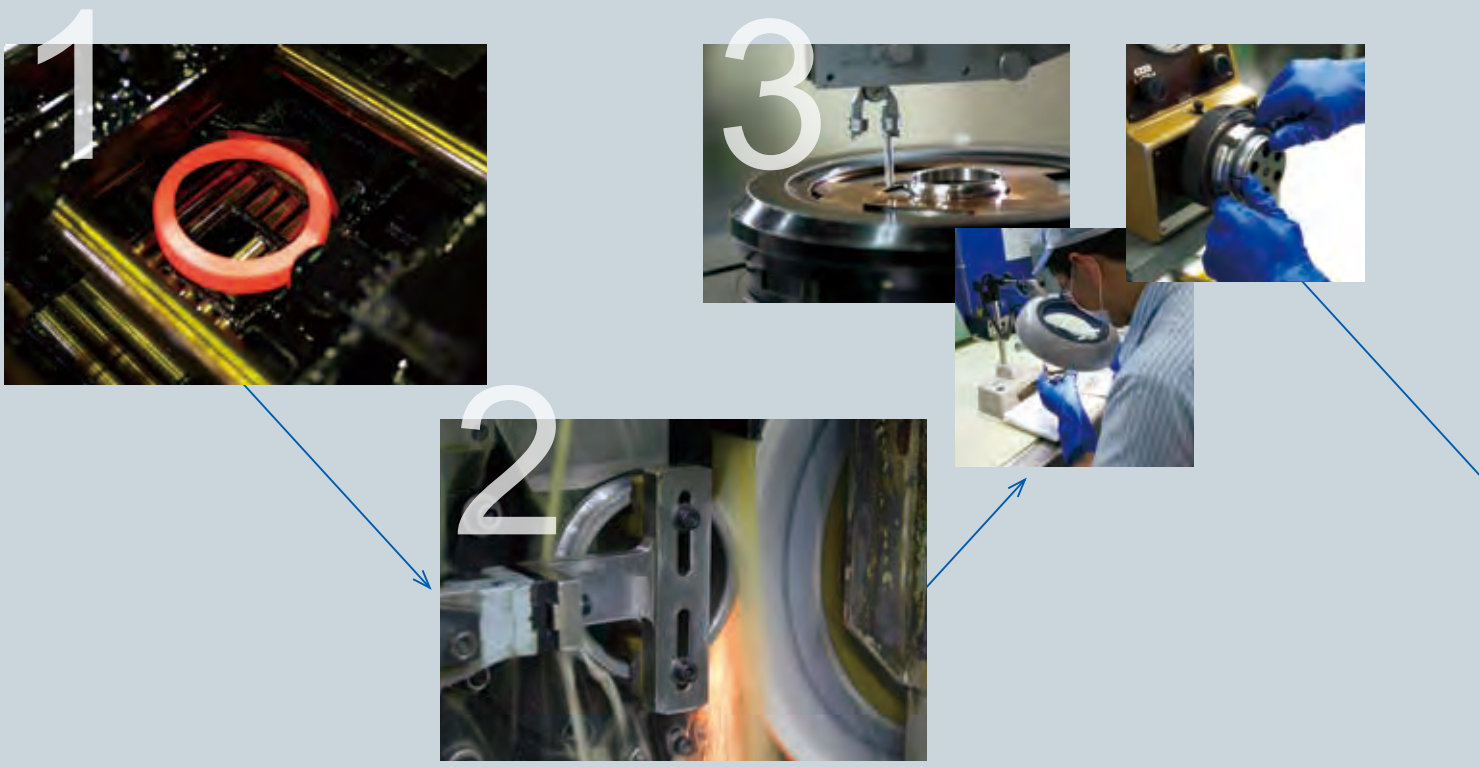
Cheonan Plant in South Korea

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.



1 Heat treatment 2 Grinding 3 Component Inspection

01 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.

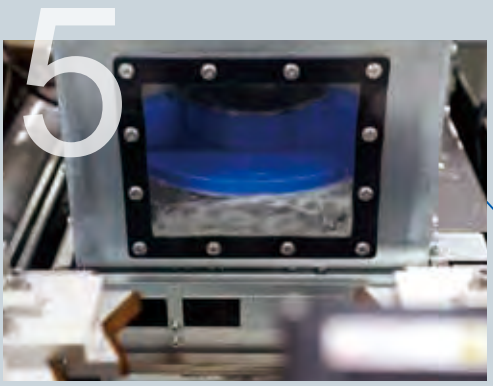


02 Global production sites in England and Japan

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.


NSK Newark Plant


NSK Fujisawa Plant







4 Assembly

5 Cleaning

6 Packaging

03 Complete 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.



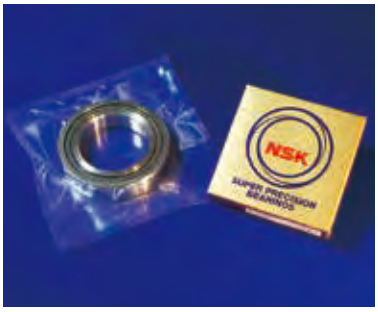
ISO 9001 Certification



ISO 14001 Certification

04 NSK symbol

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.



Part 2

Contents

Part2. **Features of Super Precision Bearings**

Metallurgical Technologies to Extend Bearing Life — P14

Ceramic Balls — P16

Cages — P18

Product Range — P20

Performance of Each Bearing Type — P22



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

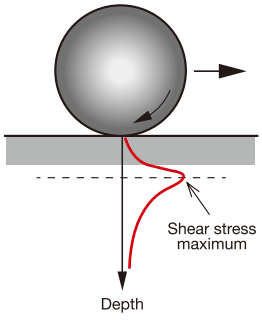
Z Steel — **Standard Long Life Material**
Long Life Steel with Minimized Oxide Non-metallic Inclusion

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.

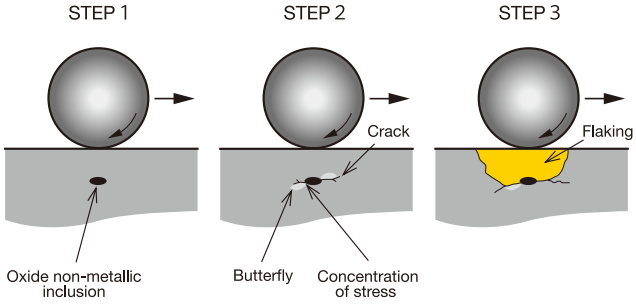
· Features of Z Steel

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.

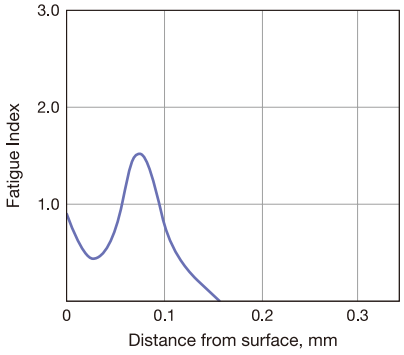
Stress Distribution



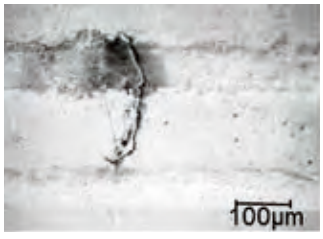
Mechanism of Subsurface Originated Flaking



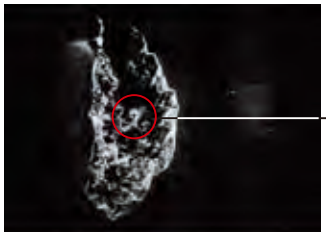
Analysis Results for Fatigue Distribution in Subsurface Originated Flaking



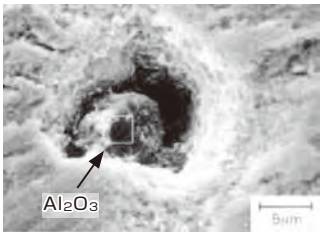
Identification of Flaking Origin



Life testing is stopped just before flaking occurs



The crack is removed



The inclusion at the origin of damage is analysed

· 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

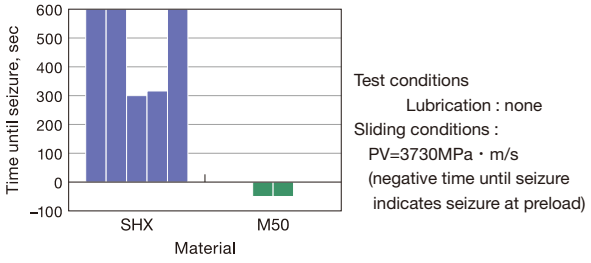
SHX is a heat resistant steel created from NSK's special heat treatment technology.

· 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

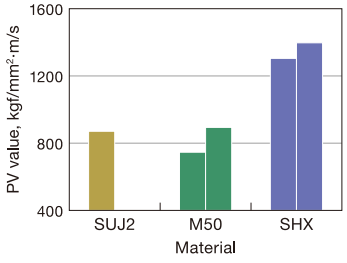
· Seizure Resistance

Dry Seizure Limit Test (4 Balls Test)



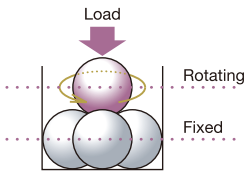
Test conditions
Lubrication : none
Sliding conditions :
PV=3730MPa・m/s
(negative time until seizure indicates seizure at preload)

Oil Bath Seizure Limit Test (4 Balls Test)



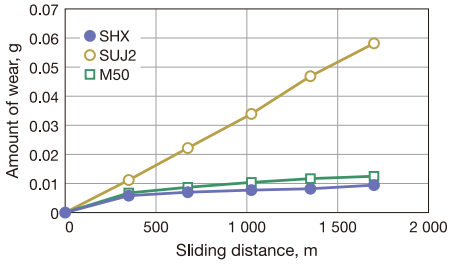
Test conditions
Lubrication : oil bath
Speed : 6000 min⁻¹ constant

4 Balls Test

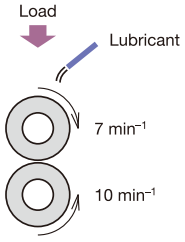


· Wear Resistance

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



2 Cylindrical Rollers Wear Test

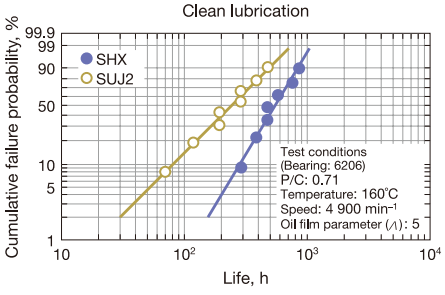


Test conditions
Surface pressure : 880 MPa
Sliding ratio : 30%
Lubrication : Spindle oil (2 cc/min)
Temperature : Room temperature

· Fatigue Life

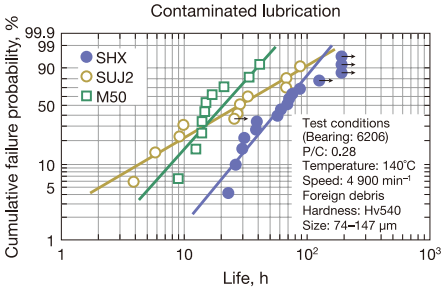
Subsurface Originated Flaking Test

Clean lubrication



Surface Originated Flaking Test

Contaminated lubrication



· 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 ball bearings have many excellent performance characteristics such as heat resistance, durability, light weight, lower thermal expansion, electrically non-conductive 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.



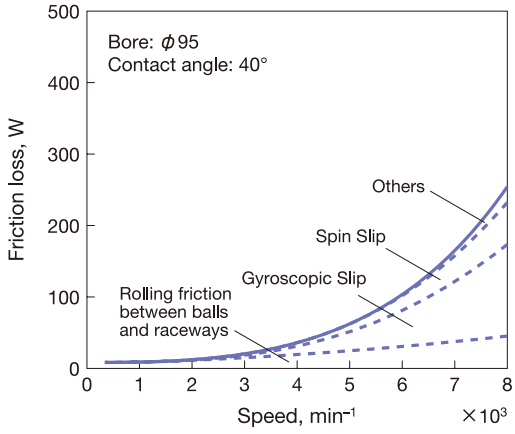
Low Heat Generation

- **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.

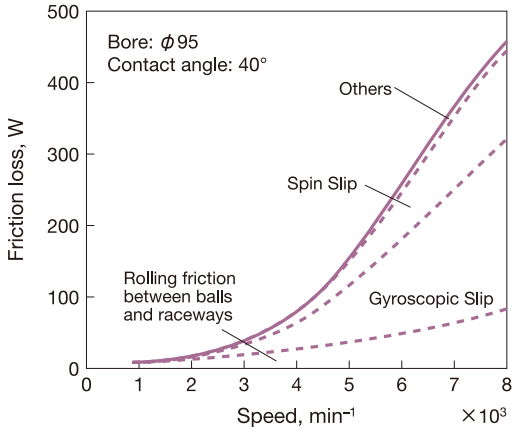
→ Less heat is generated, making ultra high-speed operation possible

Calculated Results of Friction Loss

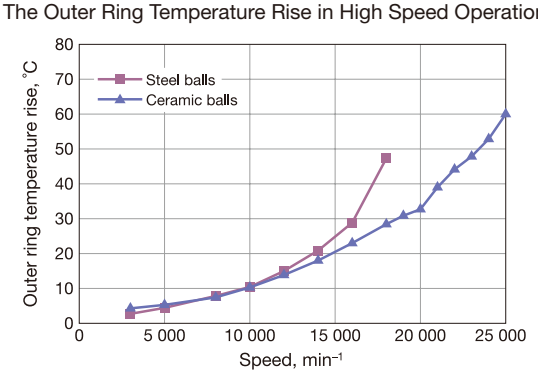
Ceramic Ball Bearings



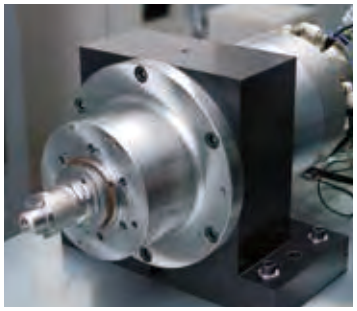
Steel Ball Bearings



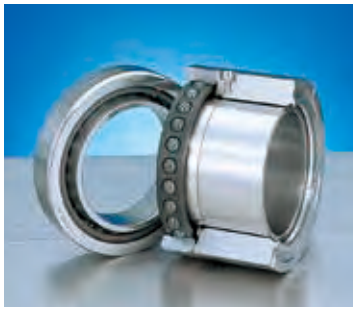
The Outer Ring Temperature Rise in High Speed Operation



NSK Spindle that achieved 4 million $d_m n$ using ceramic ball bearings

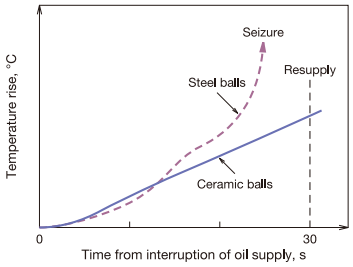


Ceramic Ball Bearing



Seizure Resistance

Ceramic balls exhibit a higher seizure resistance than steel balls



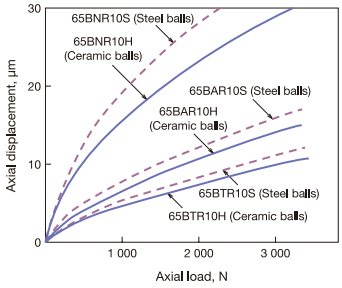
Cutting with NSK spindle using ceramic ball bearing



End Mill: ϕ16
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.



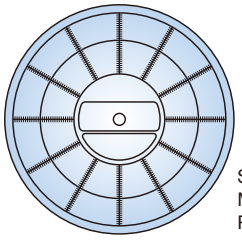
Cutting with NSK spindle using ceramic ball bearing



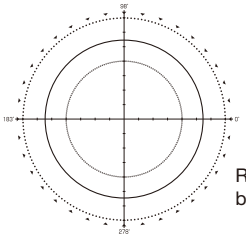
Face Mill: ϕ80
Work Material: C50
Speed: 1 200 min^{-1}
504 cc/min

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



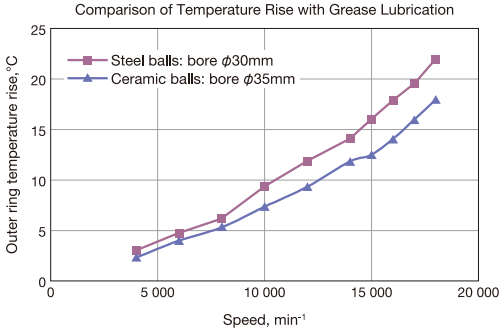
Roundness of material being ground 0.14 µm
1 µm/div

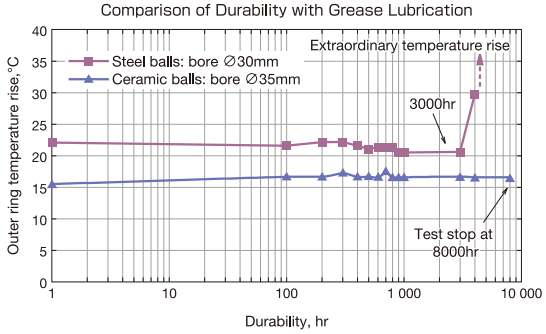


High magnification (200 000 times) Sphericity measuring equipment

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}

Engineered polymer cages offer higher speed capability and less wear

Engineered polymer cages are lighter (1/6 the weight of cages made of brass), self-lubricating and have a low friction coefficient. Bearings fitted with such cages generate less heat under 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.

Cages for Angular Contact Ball Bearings

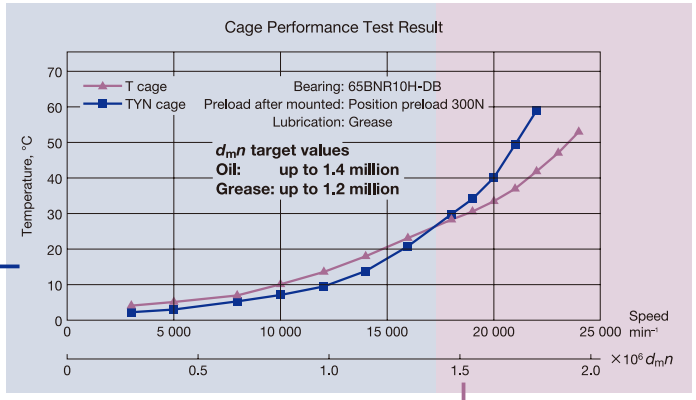
Ball Guided Polyamide Cage — (TYN) Engineered Polymer

Low Noise

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







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 SURSAVE™ Cage — (TSR) Super Engineering Plastic

Ultra High-Speed



- A high-performance cage that minimizes non-repeatable runout (NRRO) and offers low torque to realize low temperature rise
- Maintains grease lubrication in both sealed and open bearings
- Supports high speeds up to a d_mn value of 3 000 000 under oil-air lubrication



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

Cages for Cylindrical Roller Bearings

Cages for Single Row Cylindrical Roller Bearings

Outer Ring Guided PEEK Cage — (TP) Super Engineering Plastic

Ultra High-Speed

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



Products:
Ultra High Speed Single Row Cylindrical Roller Bearings
NSKROBUST 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

Cages for Double Row Cylindrical Roller Bearings

Roller Guided PPS Cage — (TB) Super Engineering Plastic

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 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 NSKROBUST™ series high performance bearings, special series of bearings for unique and specialized applications, and 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: ϕ 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

NSKROBUST Series is the high performance series of NSK Super Precision Bearings



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 arrangement: 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 arrangement: 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

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



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



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



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 Outer Ring Guided PPS SURSAVE™ Cage

· **Low Vibration and Low Torque**
A high-performance cage that minimizes non-repeatable runout (NRRO) and offers low torque to realize low temperature rise.

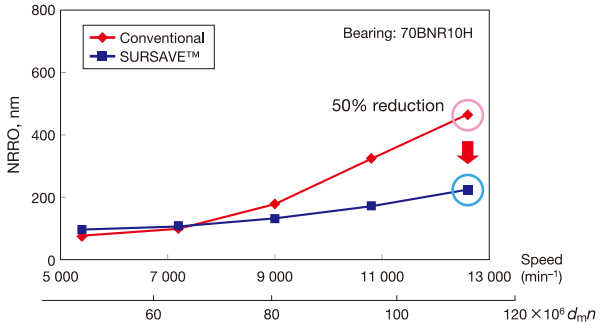
· **High-Speed Performance**
Maintains grease lubrication in both sealed and open bearings.

· **Durability**
Supports high speeds up to a $d_m n$ value of 3 000 000 under oil-air lubrication.

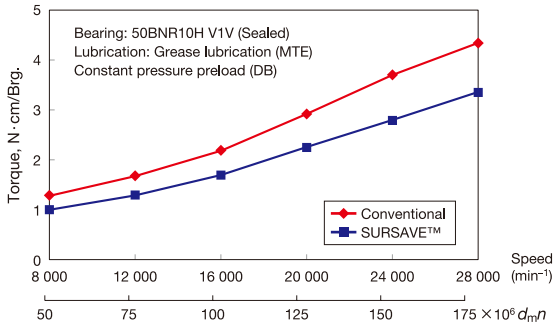
Appearance of SURSAVE Cage



Comparison of Non-Repeatable RunOut (NRRO)



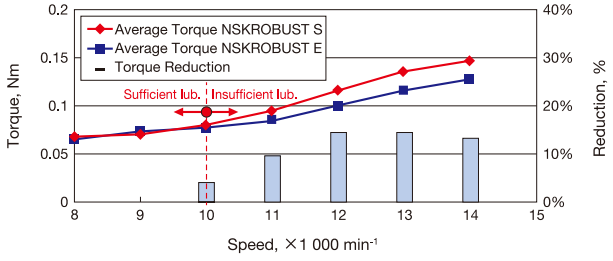
Comparison of Running Torque



Features of NSKROBUST Series E Type

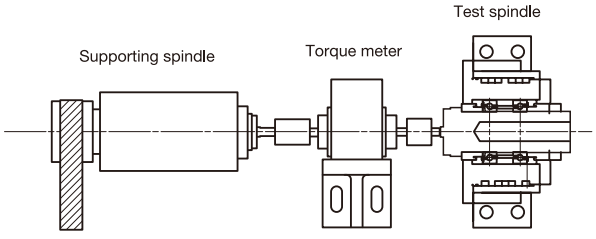
Higher seizure resistance and extended life due to strengthened material.

Bearing Torque in Seizure Resistance Test Result



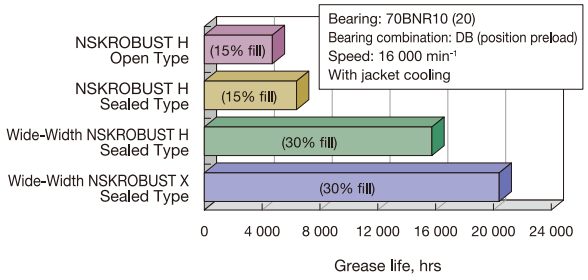
Torque reduction under harsh lubrication conditions.

Test Bench Structure

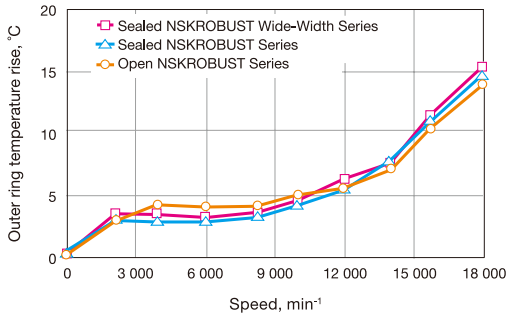


Features of Sealed Angular Contact Ball Bearings

Comparison of Grease Life in Various Types of Bearings



Comparison of Temperature Rise in Open vs. Sealed Bearings



High Performance Cylindrical Roller Bearings

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 outside 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 outside diameter of up to 360mm.

Features of Double Row Cylindrical Roller Bearings High Rigidity Series

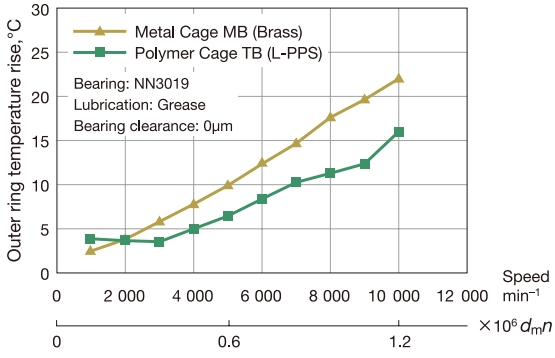
· **Extended Life**

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.

Temperature Rise with Grease Lubrication





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.

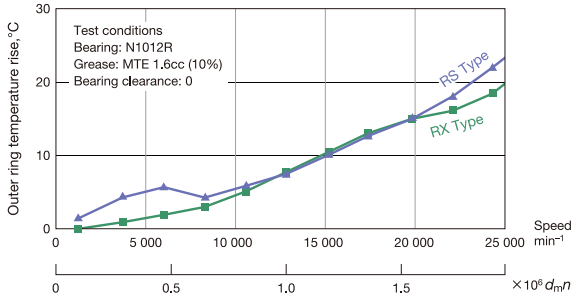
· **Seizure Resistance**

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

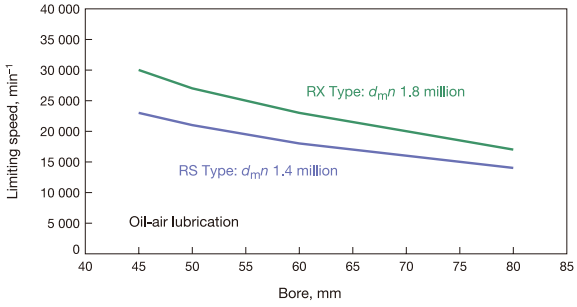
· **High-Speed Capability**

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

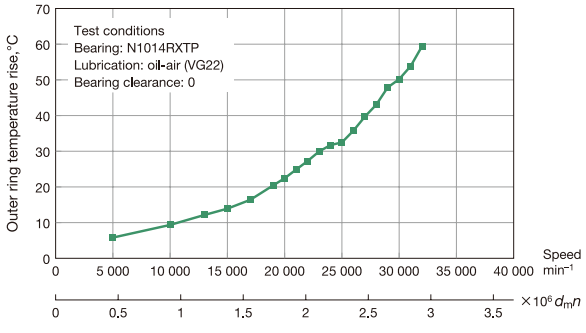
Temperature Rise with Grease Lubrication



Limiting Speed



Temperature Rise with Oil-Air Lubrication



High Speed Angular Contact Thrust Ball Bearings

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.

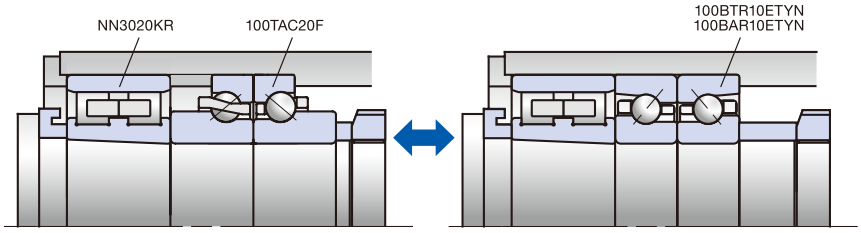


Double Row Angular Contact Thrust Ball Bearings
NSKTAC D Series
60° contact angle with the highest axial rigidity. Separable type.

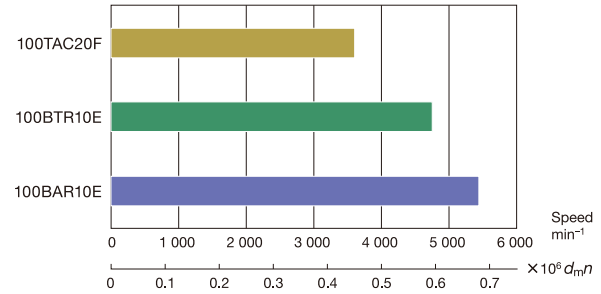
Features of Angular Contact Thrust Ball Bearings for Lathe Spindles

· Interchangeability between NSKTAC ⇔ BAR, BTR

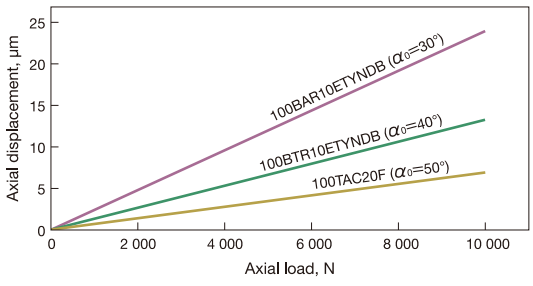
BAR and BTR have special width dimensions. By replacing NSKTAC with BAR or BTR, it is possible to achieve lower heat generation and higher speeds. Correspondingly, replacing BAR or BTR with NSKTAC will provide higher rigidity. (see figure on the right).



Limiting Speeds with Grease Lubrication (when lightly preloaded)



Axial Load and Axial Displacement



Ultra High Speed Small-size Angular Contact Ball Bearings

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

Benefits

1 Optimal for Constant Pressure Preload

2 Easy Handling Due to Non Separable Structure

3 Available as Sealed Bearing



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

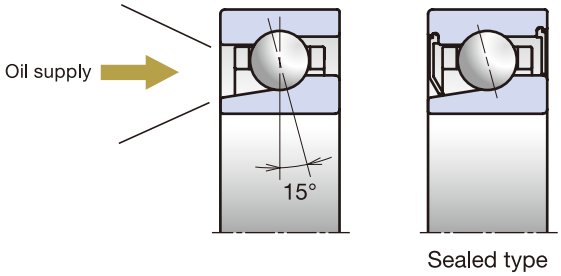
· Optimal Design
Rigidity remains high even during high-speed operation with constant pressure preload, minimizing the need for reduction of maximum spindle speeds. A counter bore in the inner ring enlarges the opening for oil-air or oil mist to enter into the bearing, thus ensuring a stable oil supply.

· 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)

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

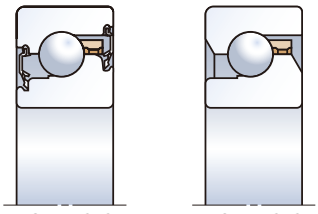
Applications: ball screw support in machine tool feed drives, transport ball screws etc.



· 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 arrangement 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)

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

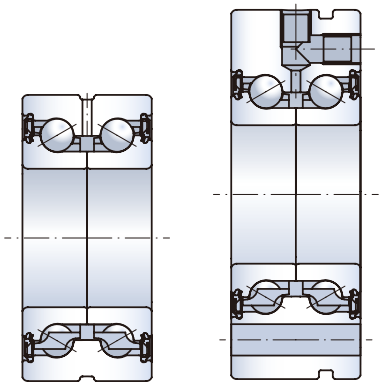
Double row angular contact thrust ball bearings in back-to-back arrangement(DB) with a single outer ring. The bearings from this series are contact sealed and pre-greased for easy handling.

· 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 onto the housing. The outer ring is equipped with an extraction groove for easier removal from the housing.



BSN Type BSF Type

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

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



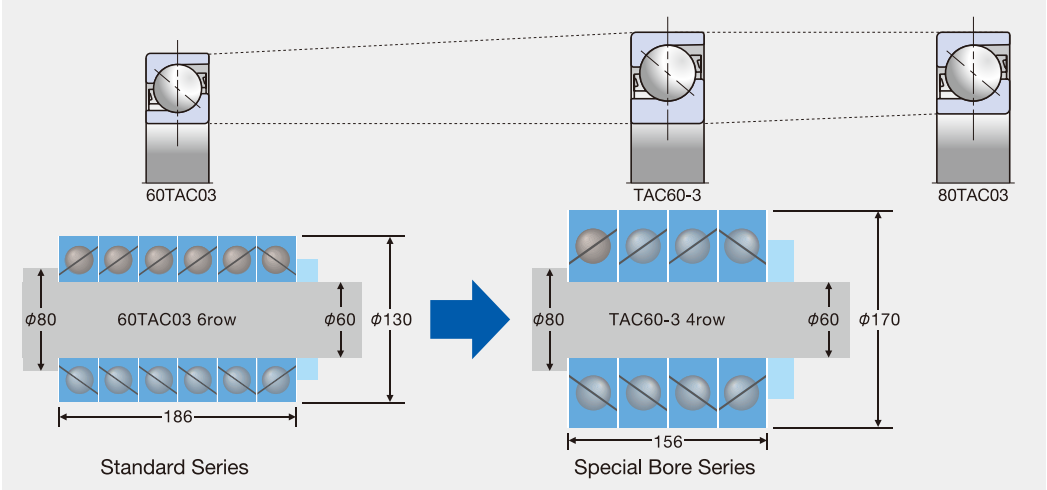
Features of NSKHPS NSKTAC 03 Series

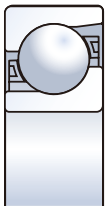
· **Longer Bearing Life**
Larger size balls and a 55° contact angle for extended bearing life.

· **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.







NSKTAC 03 Series

High Accuracy Low Profile Angular Contact Ball Bearings ROBUSTSLIM

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

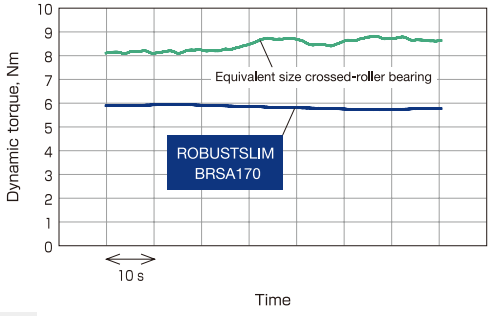
· **Low Torque**
Lower torque is achieved with ball bearings

· **High Accuracy**
NRRO (Non-Repeatable Runout) less than 0.5 μm was archived with BRSA130.

· **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

Comparison of Dynamic Torque (Speed: 100 min-1)



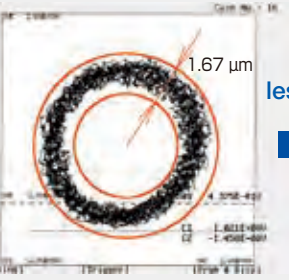
■ Rotational Runout Measurement



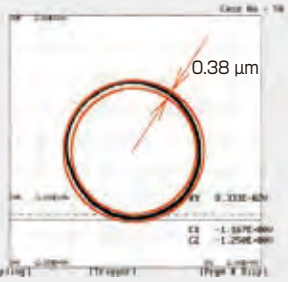
Conventional crossed-roller bearing

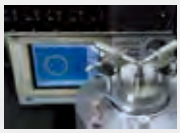


ROBUSTSLIM Series



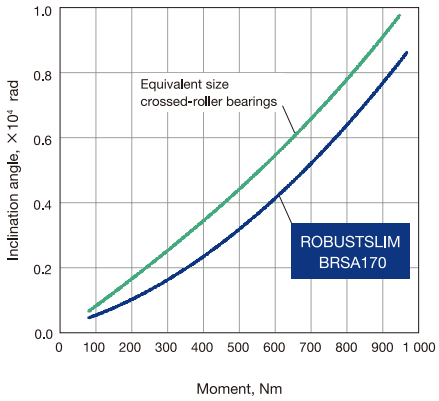
NRRO
less than 1/3





NRRO
measuring
equipment

Comparison of Moment Stiffness



High Performance Greases for Machine Tool Spindles

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.



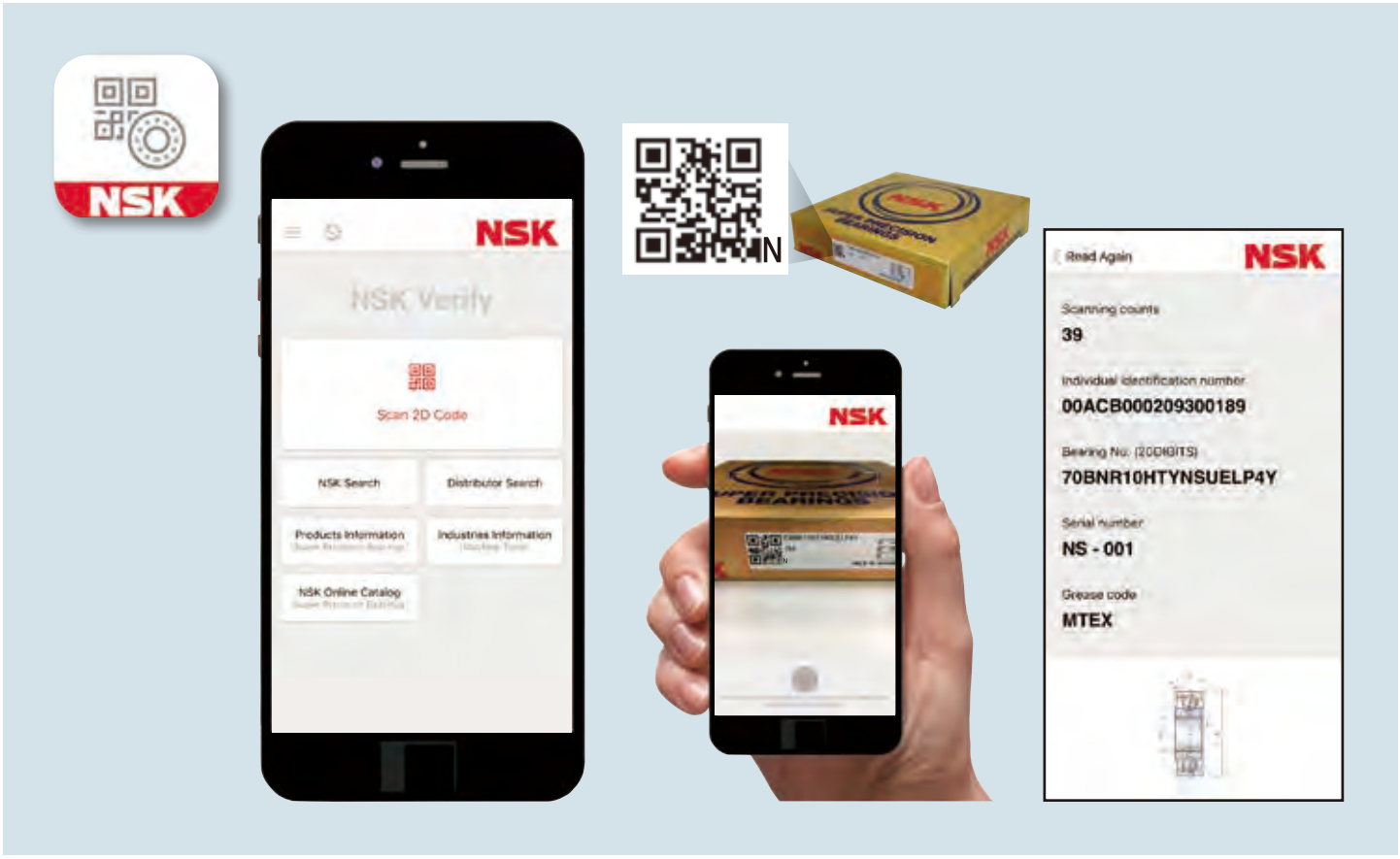
Characteristics of each grease

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℃	22	23	JIS K2283
Worked Penetration	25℃, 60 W	2-3	2	JIS K2220 (Clause7)
Dropping Point (℃)	—	> 220	>260	JIS K2220 (Clause8)
Evaporation (mass%)	99℃ × 22 H	0.3	0.2	JIS K2220 (Clause10)
Oil Separation (mass%)	100℃ × 24 H	0.4	1.0	JIS K2220 (Clause11)
Package Sizes (Mass)	—	100g tube 1kg can	100g tube 1kg can	—

2D Barcode Service NSK Verify

NSK is pleased to launch the new mobile application primarily for machine tool precision bearings to support efficient operation and IT-based plant management. Customers are now able to scan the unique 2D barcode printed on each NSK bearing box after downloading this free NSK App.

※ This service is only applicable for items with “N” at the bottom right corner of the 2D code.



Features

1. Access bearing inspection certification electronically

Users can now access to inspection certification contents for each individual bearing at their fingertips. The data can be exported into CSV and PDF formats, enabling plant to use data to improve product traceability and for more automated, IT-based management.

2. Support assessing product authenticity

The NSK app will read the information on the 2D barcode, check it against the NSK database, and inform users if their product is genuine or possibly counterfeit.

3. NSK sales office locator

For quicker product inquiries and order process, customers can scan the 2D barcode to receive an individual product ID and use it when contacting NSK sales offices to order products promptly.

4. Other services

The NSK app allows users to access useful tools from the NSK website conveniently.

NSK website

App for iOS

App for android

Our Support for Your Bearing Selection

NSK supports customers to select the right bearings to meet their needs and ensure their 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 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.nsk.com





Part 3

Contents

Part3. Guidelines for Bearing Selection

Selection Flow — P36

Typical High-Speed Spindle Structures — P38

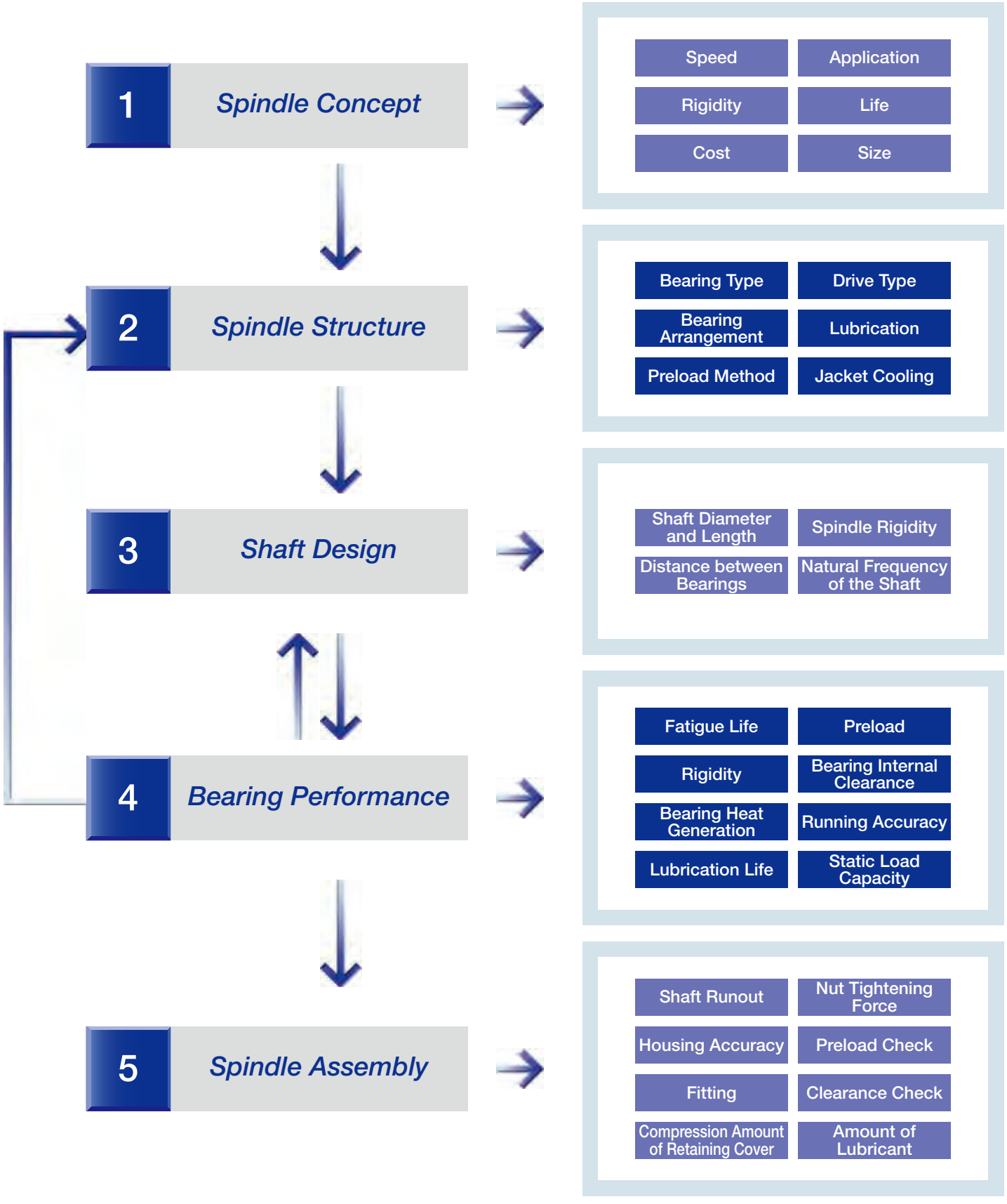
Other Spindle Structures — P40

Features of Angular Contact Ball Bearings — P44

Features of Cylindrical Roller Bearings — P46

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 38-39 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.

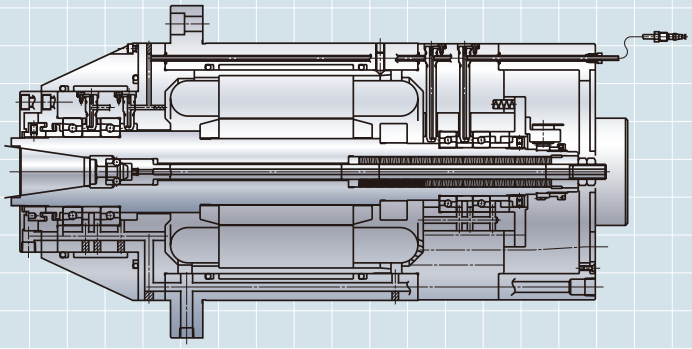
Part 4
Part 5

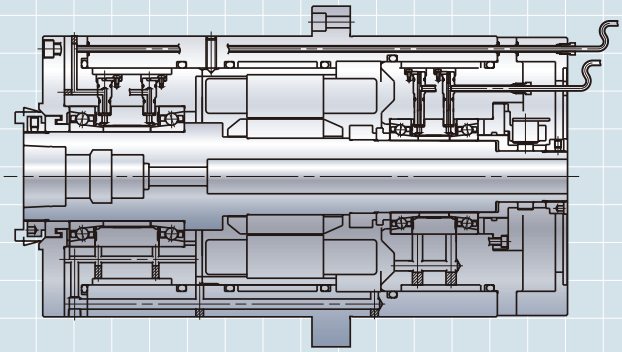
After the specification of the main shaft is complete, the final stage is the specification of the assembly method. Accuracy of the shaft and housing at the bearing seats is important. Specify the fit and clearance of the bearings to the shaft and housing. Use the correct nut tightening force to fix 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 (Speeds higher than

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 $d_m n$ 2.5M
Grease lubrication $d_m n$ 1.5M

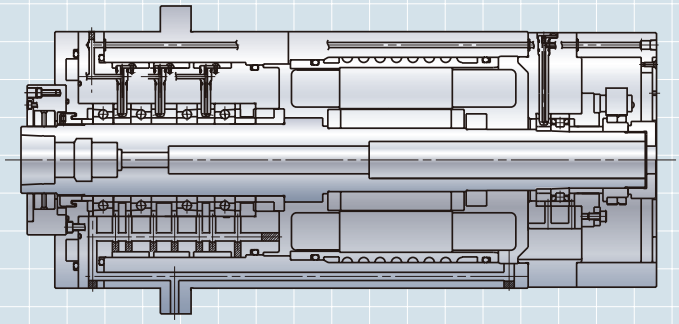
Bearing Arrangement Ⅳ

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 $d_m n$ 2.2M
Grease lubrication $d_m n$ 1.3M



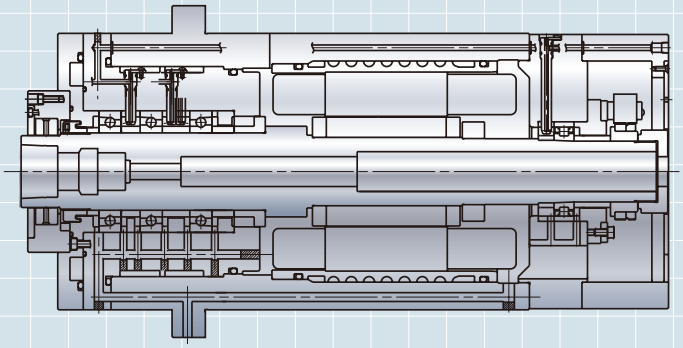
Bearing Arrangement Ⅵ

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 $d_m n$ 1.8M
Grease lubrication $d_m n$ 1.2M



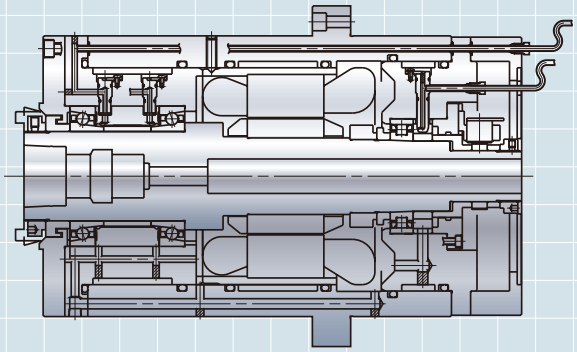
Bearing Arrangement Ⅰ

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 $d_m n$ ↗3.5M | Grease lubrication $d_m n$ ↗2.0M



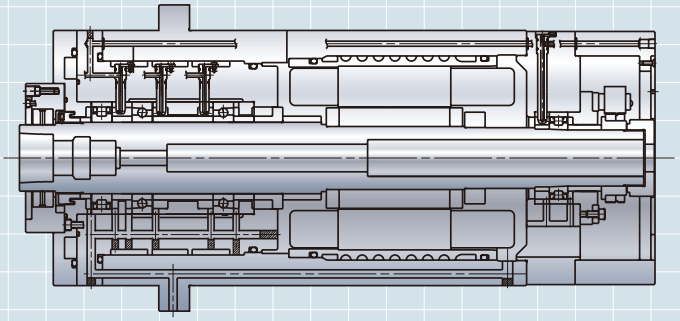
Bearing Arrangement Ⅲ

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 $d_m n$ ↗2.5M | Grease lubrication $d_m n$ ↗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 $d_m n$ ↗2.2M | Grease lubrication $d_m n$ ↗1.3M

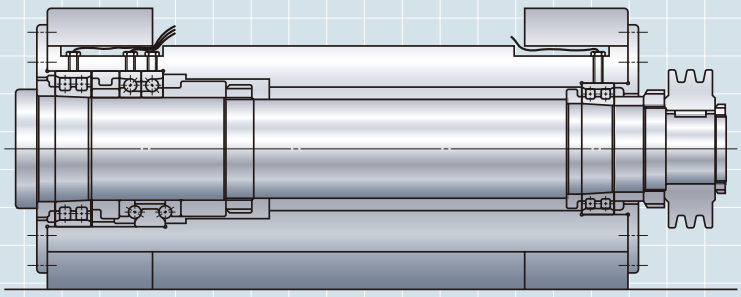
Bearing Arrangement Ⅶ

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.

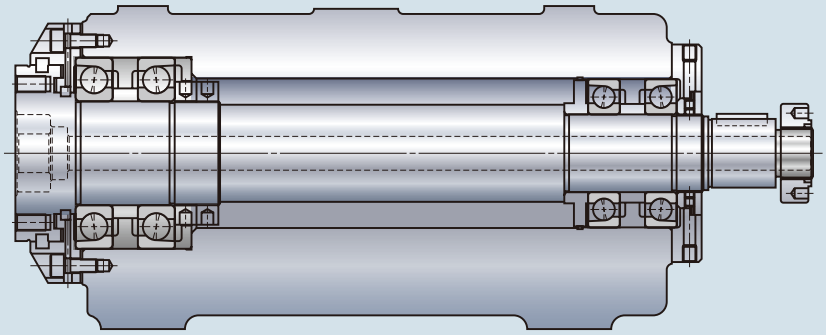
Applications: NC Lathes, NC Milling Machines, Boring Machines, Machining Centers, etc.

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

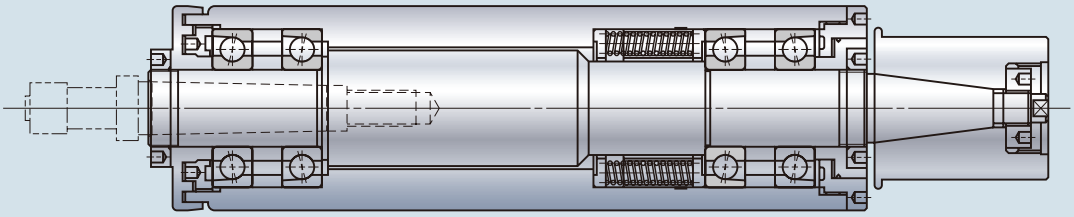


OTHER SPINDLE STRUCTURES

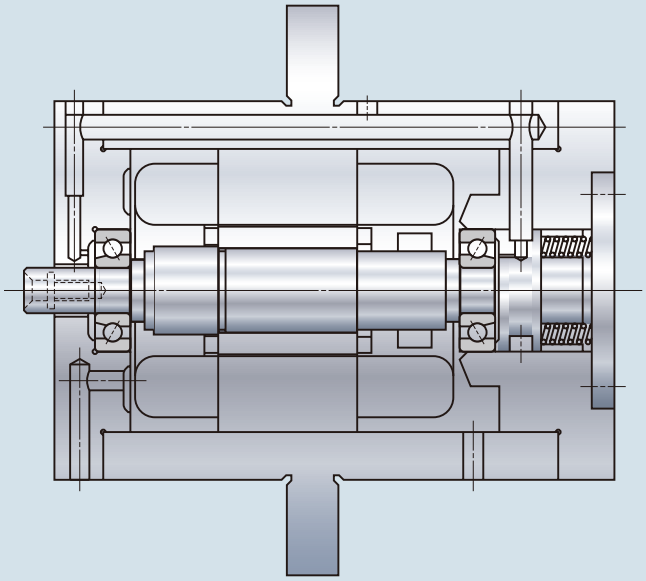
Boring Head



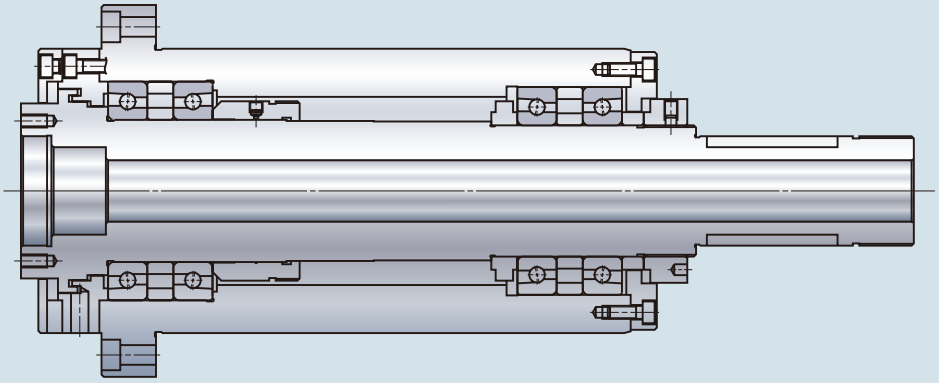
Grinding Spindle



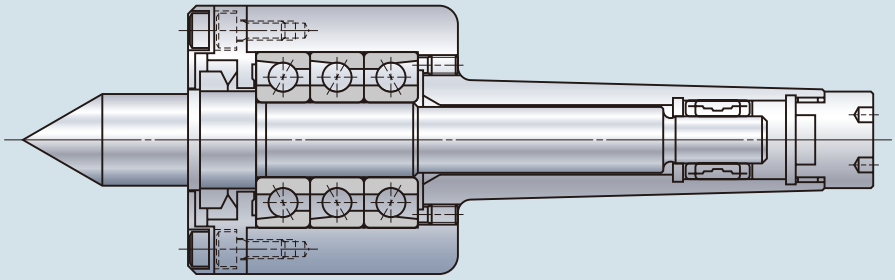
High Frequency Spindle



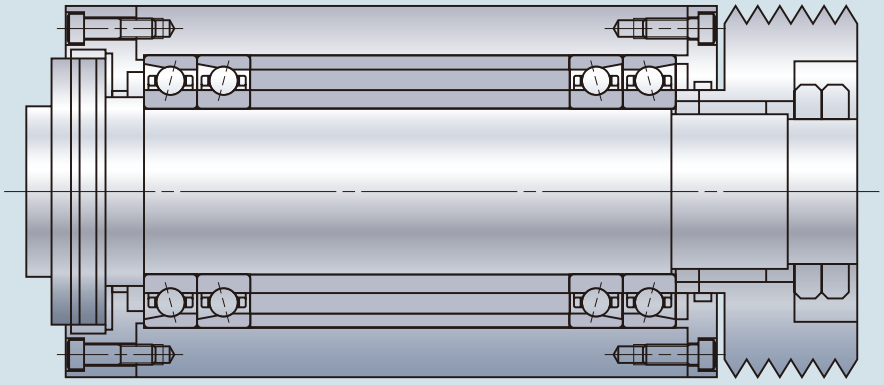
High Precision Spindle for Lathe



Live Center

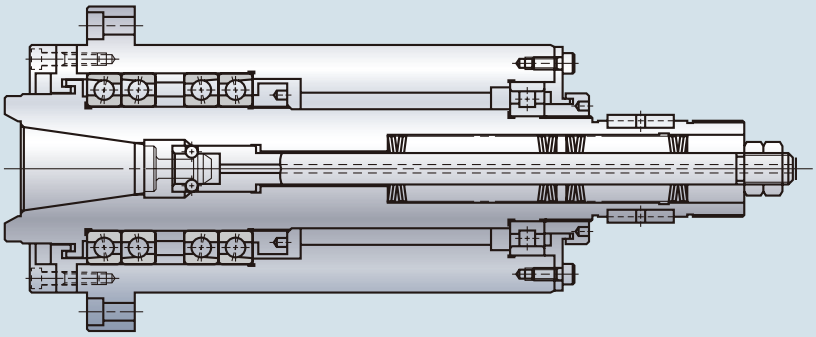


Work Head Spindle

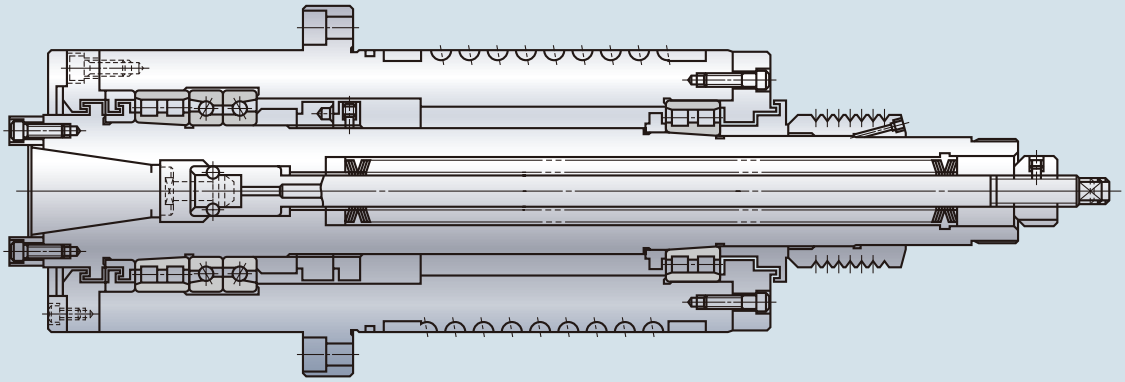


OTHER SPINDLE STRUCTURES

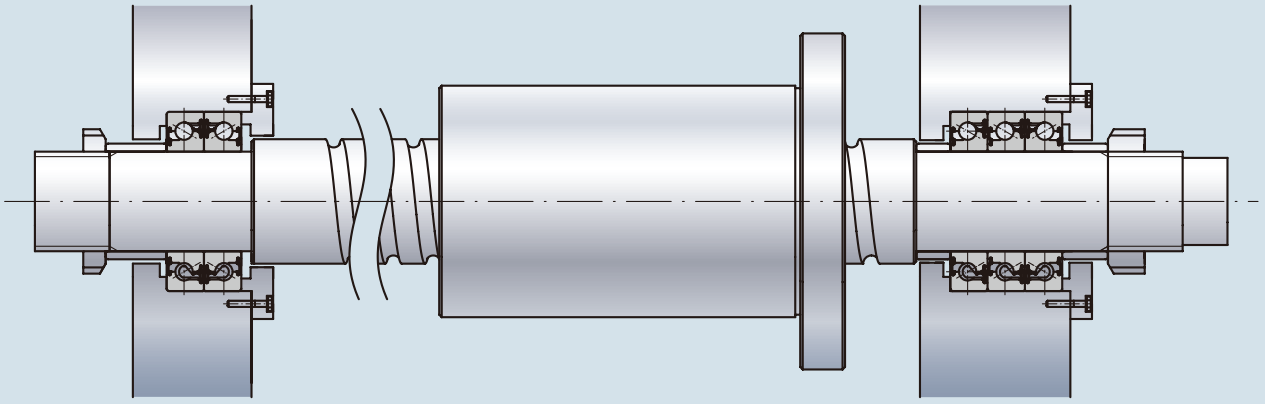
Cutting Spindle



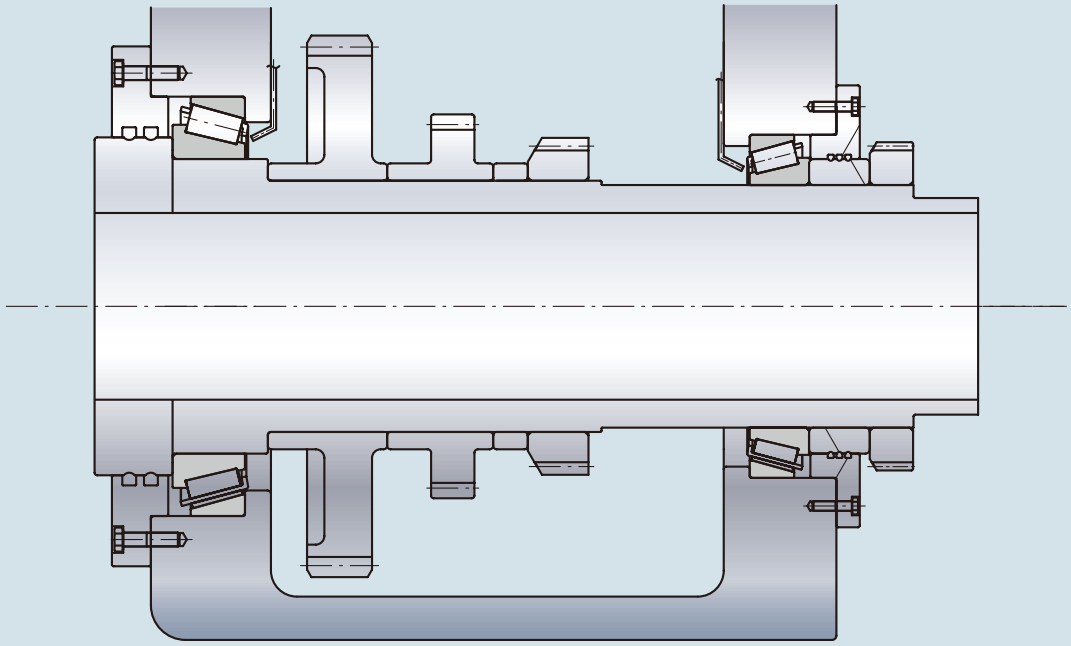
High Rigidity Spindle



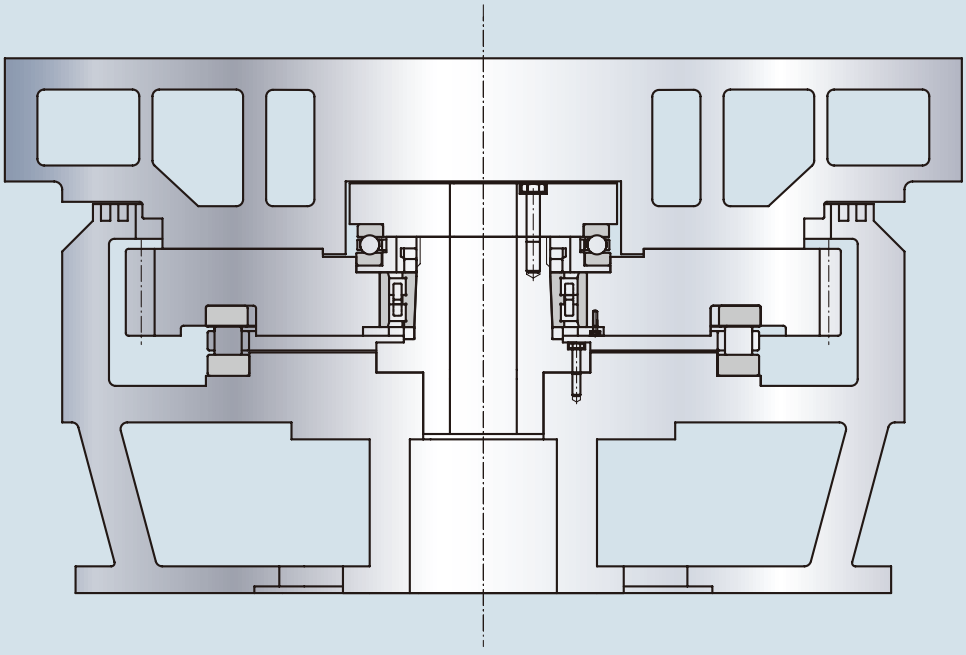
Ball Screw Support



Large Lathe



Rotary Table for Vertical Lathe



Features of Angular Contact Ball Bearings

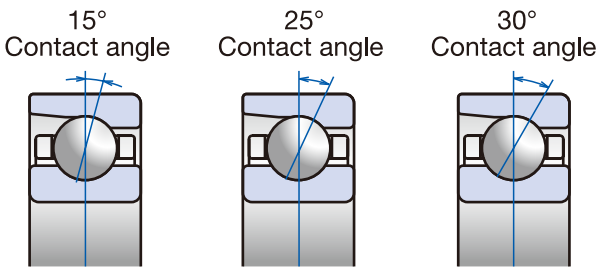
The main features of the Angular Contact Ball Bearing (ACBB)

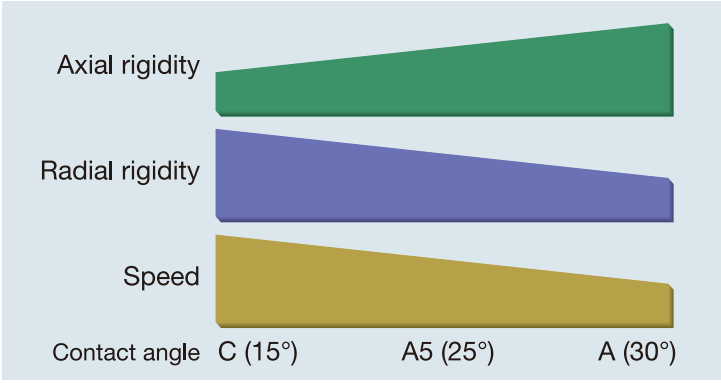
- Predefined contact angle
- Choice of preload level
- Several combinations of bearings in rows are possible

· 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.

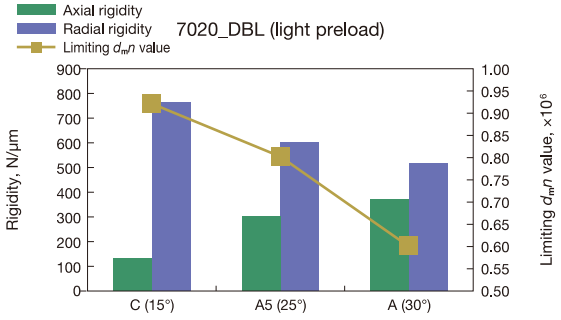
The Effect of Contact Angle

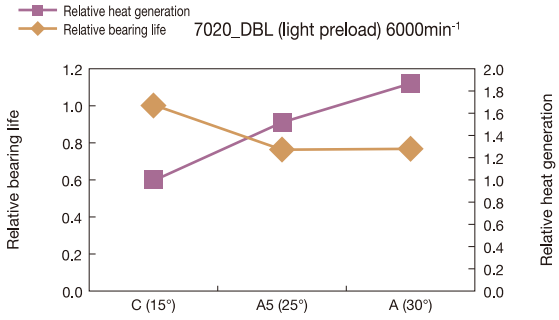
· A larger contact angle means that the bearing can support higher axial loads. Smaller contact angles, while supporting less axial load, are better suited for high speed and high radial load applications.





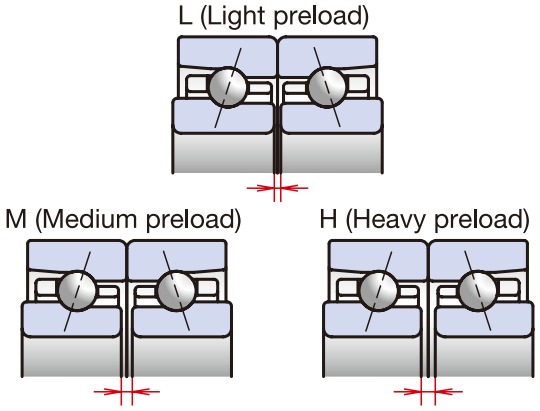
· The graphs below show rigidity, limiting speed and heat generation of a 7020 angular contact ball bearing with different contact angles: C (15°), A5 (25°) and A (30°). Under the same light preload level (L), the bearing with A angle delivers the highest axial rigidity, roughly three times the axial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

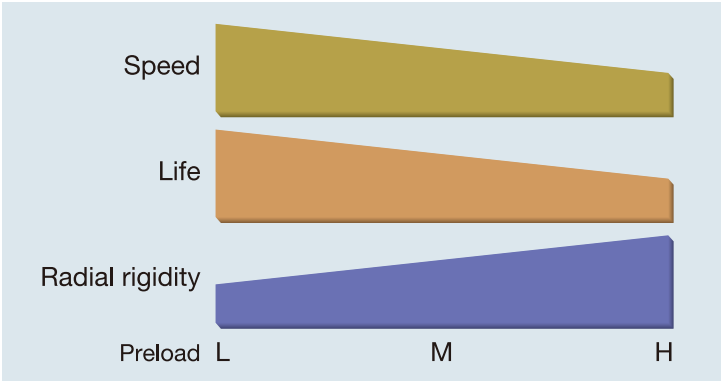


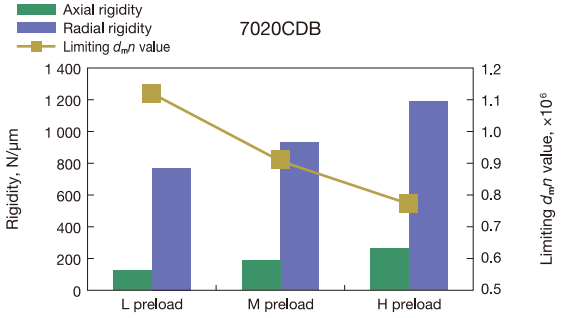


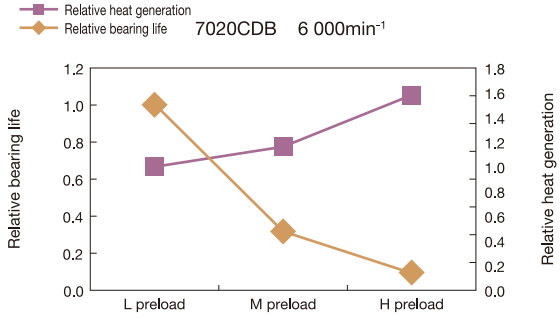
The Effect of Preload

· 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.





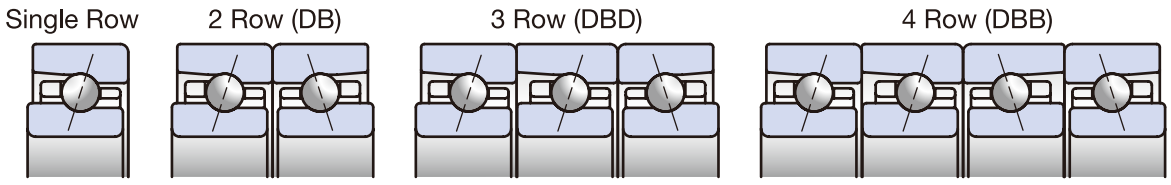


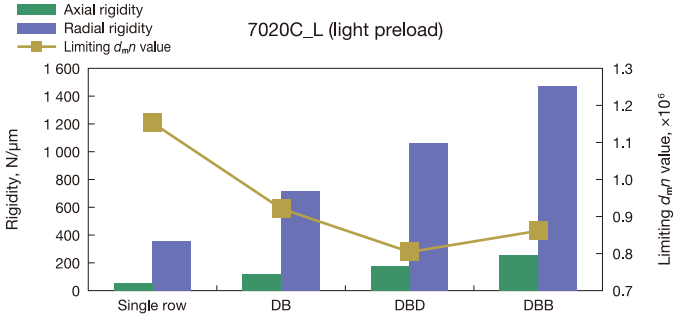


The Effect of Combination

· 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.

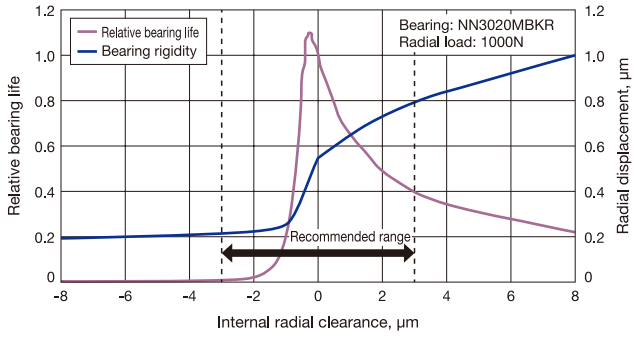
· In general, double row cylindrical roller bearings are used for high rigidity applications such as lathes, while single row cylindrical roller bearings are used in high-speed applications such as machining centers. The following graphs display the effect of internal radial clearance on the performance 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 0μm 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 -3μm will practically not increase rigidity at all, while bearing life will fall sharply. Positive clearance of about +3μm 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

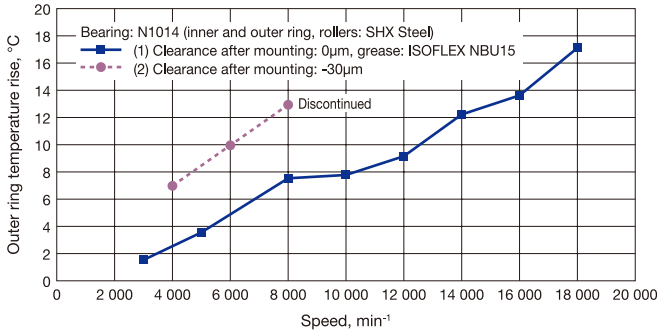
The figure on the right shows test results of the temperature rise in cylindrical roller bearings.

Internal radial clearance after mounting:

Bearing (1): 0μm

Bearing (2) -30μm

The bearing (2) with -30μm 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 outside diameter of the bearing, to achieve the target radial clearance.

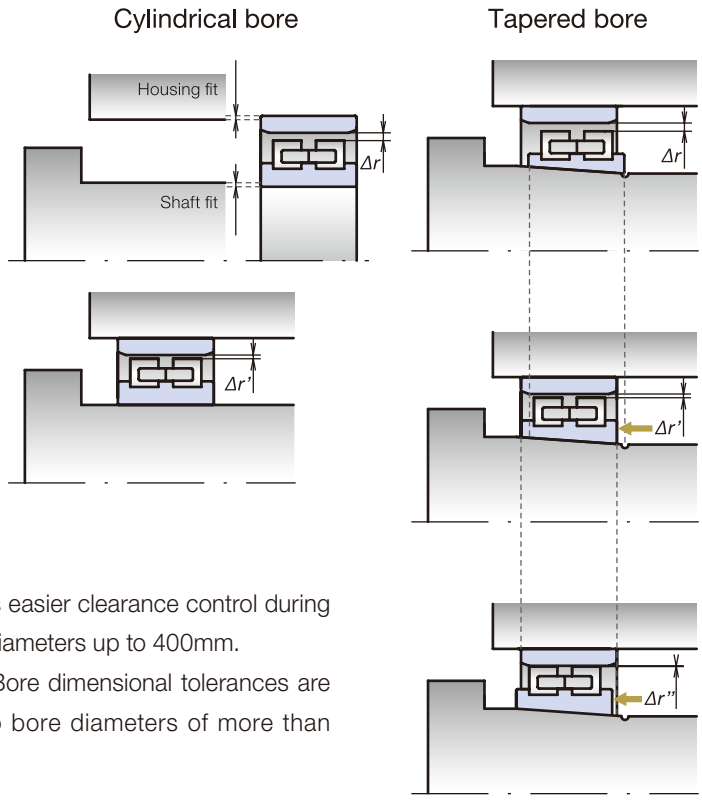
With tapered bore bearings, how far the bearing is driven onto the shaft determines the amount of inner ring expansion. That way internal radial clearance after mounting is easily adjusted.

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.

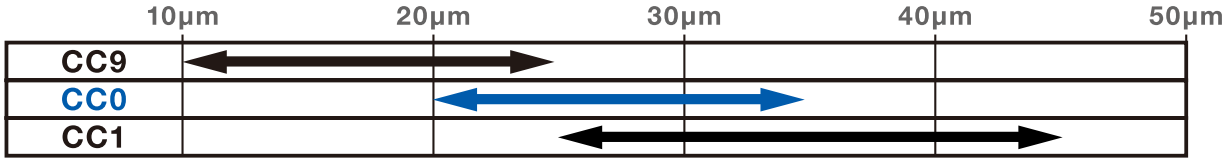


- The ISO standards for 1:12 tapered bores have a rather wide tolerance range for the taper angle. Therefore, for precision cylindrical roller bearings, NSK has established its own narrower tolerances:
  1) KR tolerance has a very narrow range that is positioned towards the lower limit of the standard 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 226 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

Part 4

Angular Contact Ball Bearings

Angular Contact Ball Bearings ····· 50-107
Numbering 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

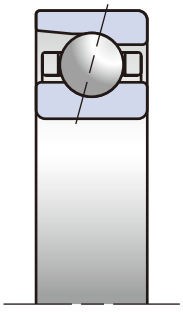
Numbering System

Angular Contact Ball Bearings (Standard Series)

(Designation example)	7	0	10	C	SN24	TR	V1V	DU	EL	P4	MTE	X
	① Bearing type											
		② Dimension series										
			③ Bore number									
				④ Contact angle								

Angular Contact Ball Bearings (NSKROBUST Series)

(Designation example)	50	BNR	10	H	TSR	E34	V1V	DU	EL	P3W	+Y3	MTE	X
	⑤ Nominal bore diameter												⑰ Grease quantity
		⑥ Bearing type										⑯ Grease brand	
			⑦ Dimension series								⑮ Accessories		
				⑧ Material						⑭ Accuracy			
					⑨ Cage				⑬ Preload				
						⑩ Lubrication holes			⑫ Arrangement				
								⑪ Seal					



①⑥ Bearing Type

Page 20, 22-23

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

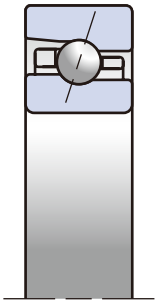
The high performance standard NSKHPS Series features a high basic dynamic load rating and is suitable for low to medium speed operation and high-load applications. NSK's original material evaluation technology ensures only high purity materials are used in their manufacture, which has the most influence 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)

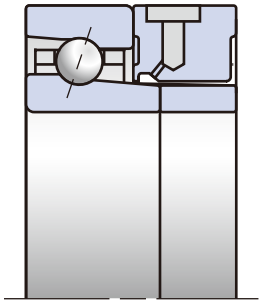
High performance ACBBs with high rigidity and low heat generation. The results of temperature rise simulations undertaken to evaluate rolling element slip were used to optimize the design of this series.

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.

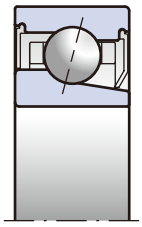
Sealed bearings are available mainly up to 120mm bore diameter. Optimization of the space between seal and cage and minimization of the seal labyrinth prevent grease leakage. The wide-width series (29, 20 series) has been designed to allow more grease to be held inside the bearing. This helps keep temperature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



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

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

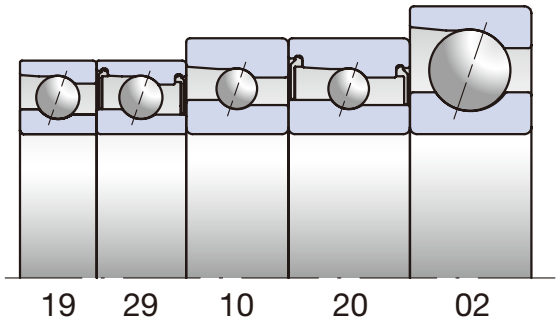
②⑦ Dimension series

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

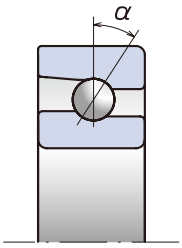
Up to 3: Bore diameter 00: 10mm, 01: 12mm, 02: 15mm, 03: 17mm

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 44-45



④ Standard Series

C: 15° A5: 25° A: 30°

⑥ NSKROBUST Series

BNR: 18° BER: 25° BSR: 15°

⑧ Material Page 14-17, 22

Standard Series

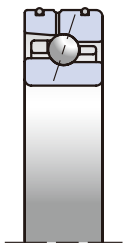
No code: steel ball SN24: ceramic ball

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_3N_4)
X	Heat resistant steel for high-speed operation (SHX)	Ceramic (Si_3N_4)
XE (Spinshot™ Ⅱ)	Heat resistant steel for high-speed operation (SHX)	Ceramic (Si_3N_4)

⑩ Lubrication holes Page 22

No code: No lubrication holes E34: Direct lubricating bearing



⑩ NSKROBUST Series

E34: 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 18

	Code	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

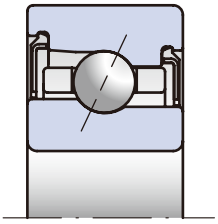
Numbering System

Angular Contact Ball Bearings (Standard Series)

(Designation example)	7	0	10	C	SN24	TR		V1V	DU	EL	P4	MTE	X
① Bearing type													
② Dimension series													
③ Bore number													
④ Contact angle													

Angular Contact Ball Bearings (NSKROBUST Series)

(Designation example)	50	BNR	10	H	TSR	E34	V1V	DU	EL	P3W	+Y3	MTE	X
⑤ Nominal bore diameter													
⑥ Bearing type													
⑦ Dimension series													
⑧ Material													
⑨ Cage													
⑩ Lubrication holes													
⑰ Grease quantity													
⑯ Grease brand													
⑮ Accessories													
⑭ Accuracy													
⑬ Preload													
⑫ Arrangement													
⑪ Seal													



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

Page 23

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 205

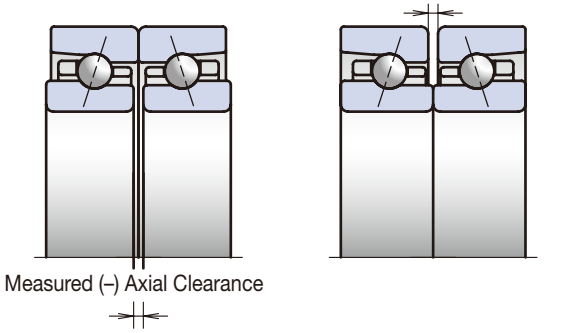
Universal arrangement		Arrangement example
SU	Single row	
DU	2 row	DB, DF, DT
DUD	3 row	DBD, DFD, DTD
QU	4 row	DBB, DFF, DTT, DBT, DFT

Universal arrangement 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 designation indicates two or more rows (DU, DUD and QU), tolerances for the bore and outside diameter are controlled for the set of bearings.

⑬ Preload

Page 206-212

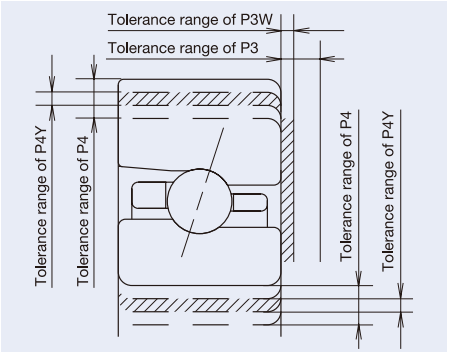


EL: Extra Light Preload L: Light Preload
M: Medium Preload H: Heavy Preload

CP: Special Measured (–) Axial Clearance
CA: Special Measured (+) Axial Clearance

⑭ Accuracy

Page 222-225



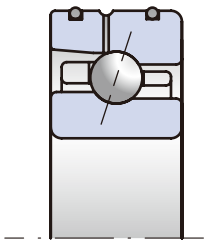
P2: ISO Class 2 P4: ISO Class 4 P5: ISO Class 5

P3W: Special class (Special tolerances for deviation of inner/outer ring width, others are P3)

P3: Special class (ISO Class 4 dimensional tolerances and ISO Class 2 running accuracy)

P4Y: Special class (Special bore and outside diameter tolerances, others are ISO Class 4. See figure on left.)

⑮ Accessories



+Y3: O-ring on bearing outside surface

Available for NSKROBUST direct lubricating bearings (E34) only.

⑯ Grease brand

Page 219

Grease typically used in machine tool spindles:

MTE: MTE grease MTS: MTS grease

⑰ Grease quantity

Page 256

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

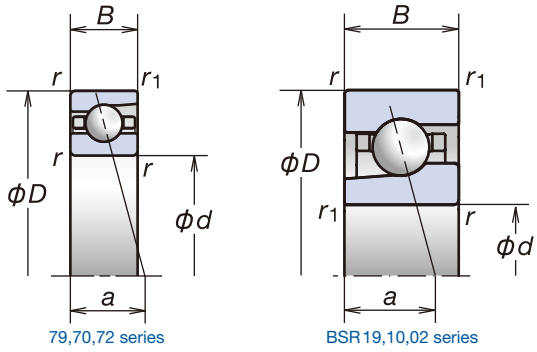
Which specification is available for which bearing?

19 Series 10 Series 02 Series

| Standard Series | Bore diameter | | |

1. Angular Contact Ball Bearings

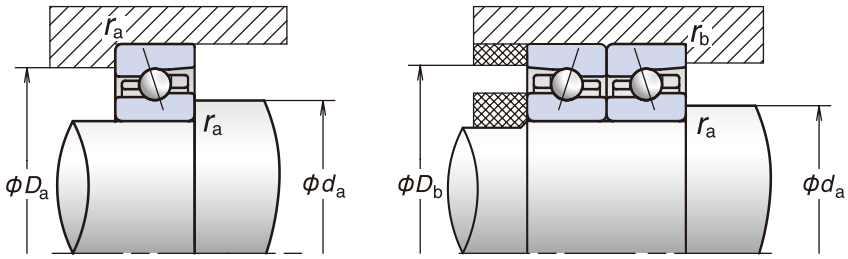
Bore Diameter 5 - 10 mm



79,70,72 series BSR 19,10,02 series

Designation (1)	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (2) (kN)	Contact Angle (°)	Factor f_o	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
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	0.425	0.345	15	6.6	4.5	166 000	244 000
*6BSR10X	6	17	6	0.3	0.15	1.35	0.425	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	0.545	0.440	15	7.1	4.7	147 000	216 000
*7BSR10X	7	19	6	0.3	0.15	1.57	0.545	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	0.800	0.660	15	7.0	5.5	127 000	187 000
*8BSR10X	8	22	7	0.3	0.15	2.31	0.800	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	3.05	1.46	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	2.90	1.40	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	0.685	0.560	15	7.4	5.1	119 000	175 000
*10BSR19X	10	22	6	0.3	0.15	1.78	0.685	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	5.25	2.33	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	5.05	2.25	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	1.13	0.94	15	7.1	6.4	106 000	156 000
*10BSR10X	10	26	8	0.3	0.15	3.00	1.13	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	5.30	2.44	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	5.10	2.35	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	1.41	1.18	15	6.7	7.2	95 000	140 000
*10BSR02X	10	30	9	0.6	0.3	3.85	1.41	1.18	15	6.7	7.2	110 000	150 000

(1) Bearings denoted by an asterisk (*) are available with seals. Some series are comprised exclusively of sealed bearings.
(2) For details on permissible axial load, refer to Page 199.
(3) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor 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

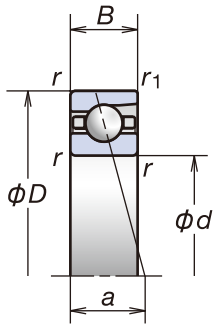
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

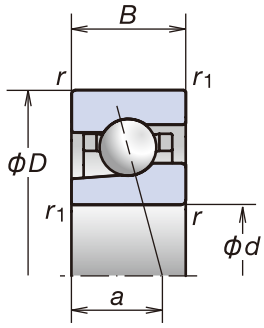
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter 12, 15mm



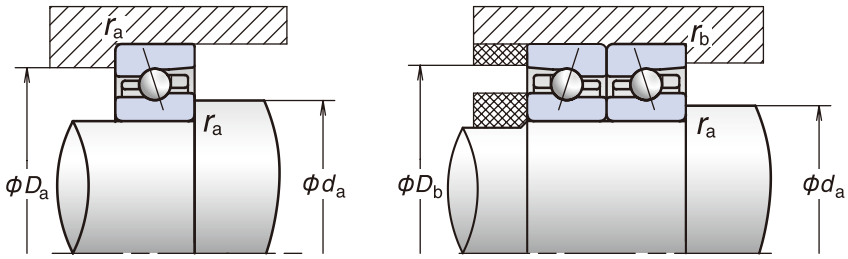
79,70,72 series



BSR 19,10,02 series

Designation (1)	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (2) (kN)	Contact Angle (°)	Factor f_o	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
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	3.40	1.79	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	3.20	1.71	2.04	25	—	7.2	72 200	108 000
*12BSR19S	12	24	6	0.3	0.15	1.95	0.850	1.02	15	7.7	5.4	88 900	123 000
*12BSR19H	12	24	6	0.3	0.15	1.95	0.815	0.665	15	7.7	5.4	106 000	156 000
*12BSR19X	12	24	6	0.3	0.15	1.95	0.815	0.665	15	7.7	5.4	123 000	167 000
7001C	12	28	8	0.3	0.15	6.10	2.90	2.40	15	13.2	6.7	57 500	87 500
7001CSN24	12	28	8	0.3	0.15	5.70	2.71	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	5.50	2.61	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	1.27	1.06	15	7.4	6.7	95 000	140 000
*12BSR10X	12	28	8	0.3	0.15	3.25	1.27	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	7.80	3.60	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	7.55	3.50	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	1.89	1.59	15	6.6	7.9	86 400	128 000
*12BSR02X	12	32	10	0.6	0.3	5.05	1.89	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	4.85	2.61	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	4.65	2.49	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	1.26	1.04	15	7.7	6.4	88 400	131 000
*15BSR19X	15	28	7	0.3	0.15	2.96	1.26	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	6.15	3.15	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	5.90	3.05	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	1.65	1.38	15	7.2	7.6	80 900	120 000
*15BSR10X	15	32	9	0.3	0.15	4.20	1.65	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	8.55	4.25	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	8.25	4.10	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	2.24	1.89	15	6.8	8.8	76 000	112 000
*15BSR02X	15	35	11	0.6	0.3	5.80	2.24	1.89	15	6.8	8.8	88 000	120 000

(1) Bearings denoted by an asterisk (*) are available with seals. Some series are comprised exclusively of sealed bearings.
(2) For details on permissible axial load, refer to Page 199.
(3) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor 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

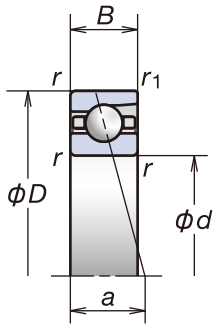
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

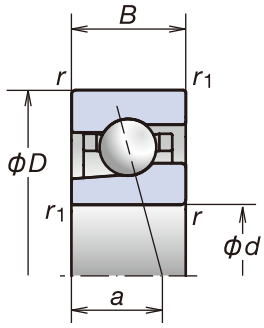
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter 17, 20 mm



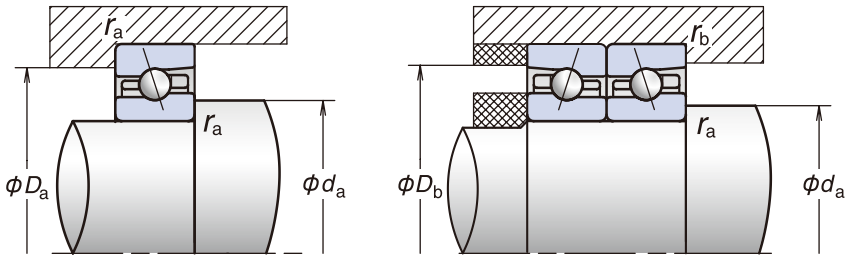
79,70,72 series



BSR19,10,02 series

Designation (1)	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (2) (kN)	Contact Angle (°)	Factor f_o	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
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	5.10	2.90	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	4.85	2.76	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	1.47	1.22	15	7.8	6.6	80 900	120 000
*17BSR19X	17	30	7	0.3	0.15	3.25	1.47	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	6.50	3.55	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	6.20	3.40	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	1.85	1.56	15	7.4	8.5	73 100	108 000
*17BSR10X	17	35	10	0.3	0.15	4.45	1.85	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	10.8	5.55	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	10.4	5.35	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	2.86	2.39	15	6.8	9.8	66 700	98 300
*17BSR02X	17	40	12	0.6	0.3	7.25	2.86	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	6.85	6.85	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	6.50	3.80	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	2.05	1.73	15	7.7	8.3	66 700	98 300
*20BSR19X	20	37	9	0.3	0.15	4.70	2.05	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	11.2	6.30	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	10.7	6.05	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	3.20	2.67	15	7.2	10.1	61 300	90 400
*20BSR10X	20	42	12	0.6	0.3	7.45	3.20	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	14.5	7.65	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	13.9	7.35	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	3.95	3.30	15	6.8	11.5	56 800	83 600
*20BSR02X	20	47	14	1	0.6	9.70	3.95	3.30	15	6.8	11.5	65 700	89 600

(1) Bearings denoted by an asterisk (*) are available with seals. Some series are comprised exclusively of sealed bearings.
(2) For details on permissible axial load, refer to Page 199.
(3) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor 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

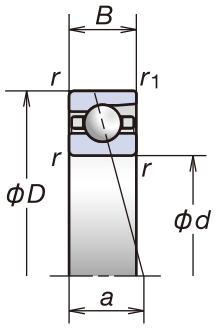
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

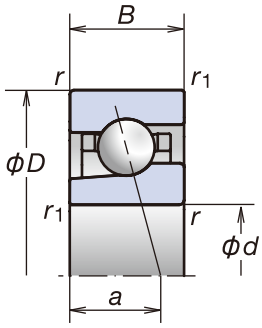
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

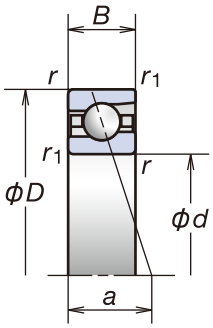
Bore Diameter 25 mm



79,70,72 series



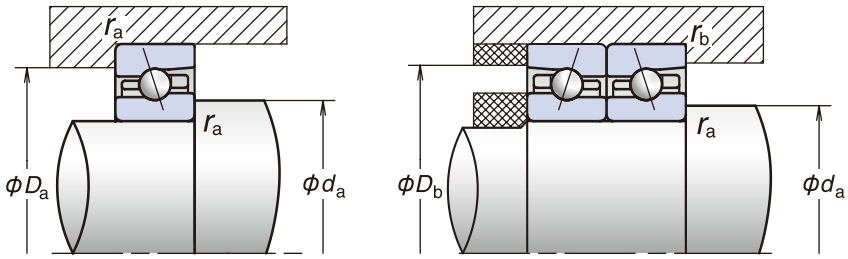
BSR19,10,02 series



BNR19 series
BER19 series

Designation (1)	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (2) (kN)	Contact Angle (°)	Factor f_o	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
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	7.70	5.05	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	7.30	4.80	5.20	25	—	12.3	38 900	58 300
***25BSR19S**	**25**	**42**	**9**	0.3	0.15	5.40	2.74	3.40	15	7.8	9.0	47 800	65 700
***25BSR19H**	**25**	**42**	**9**	0.3	0.15	5.35	2.62	2.22	15	7.8	9.0	56 800	83 600
***25BSR19X**	**25**	**42**	**9**	0.3	0.15	5.35	2.62	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	11.8	7.15	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	11.2	6.85	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	3.60	3.05	15	7.6	10.8	52 800	77 800
***25BSR10X**	**25**	**47**	**12**	0.6	0.3	7.90	3.60	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	16.5	9.70	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	15.8	9.25	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	11.1	5.20	6.45	15	7.1	12.7	41 600	57 200
***25BSR02H**	**25**	**52**	**15**	1	0.6	11.1	4.95	4.20	15	7.1	12.7	49 400	72 800
***25BSR02X**	**25**	**52**	**15**	1	0.6	11.1	4.95	4.20	15	7.1	12.7	57 200	78 000

(1) Bearings denoted by an asterisk (*) are available with seals. Some series are comprised exclusively of sealed bearings.
(2) For details on permissible axial load, refer to Page 199.
(3) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

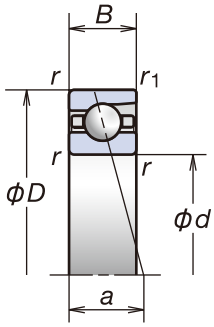
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

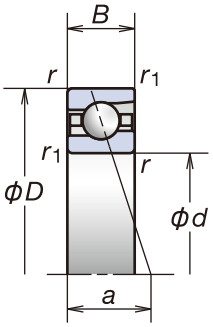
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

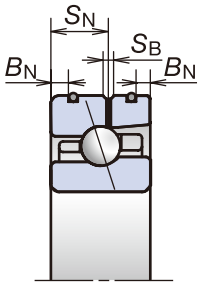
Bore Diameter 30 mm



79,70,72 series
BNR10,20 series
BER10,20 series



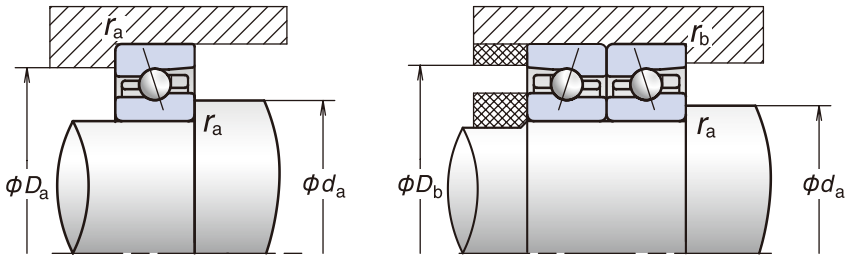
BNR19 series
BER19 series



ROBUSTSHOT

Designation (1)	Boundary Dimensions (2) (mm)								Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (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	8.20	5.85	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	7.75	5.55	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	3.45	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	3.30	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	3.90	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	3.90	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	3.75	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	3.75	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	15.4	10.0	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	14.6	9.55	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	5.50	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	5.50	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	5.30	6.50	25	—	16.3	37 700	58 900
*30BER10X	30	55	13	2.8	7.5	1.4	1	0.6	8.30	5.30	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	5.50	5.35	18	10.3	14.8	42 400	—
*30BNR20XV1V	30	55	16	—	—	—	1	0.6	8.65	5.50	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	5.30	6.50	25	—	17.8	37 700	—
*30BER20XV1V	30	55	16	—	—	—	1	0.6	8.30	5.30	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	23.2	14.2	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	22.2	13.6	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 is comprised exclusively of sealed bearings.
(2) ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

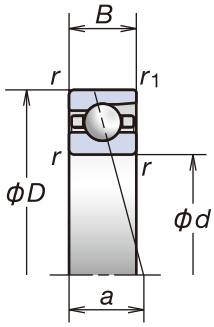
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

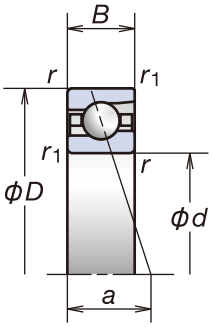
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

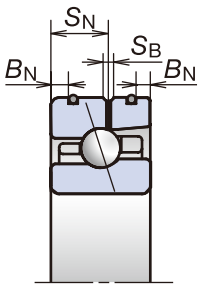
Bore Diameter 35 mm



79,70,72 series
BNR10,20 series
BER10,20 series



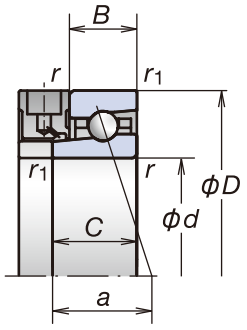
BNR19 series
BER19 series



ROBUSTSHOT

Designation (1)	Boundary Dimensions (2) (mm)								Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (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	11.9	8.55	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	11.3	8.15	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	4.90	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	4.70	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	5.70	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	5.70	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	5.50	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	5.50	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	19.0	13.0	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	18.1	12.4	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	6.80	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	6.80	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	6.55	8.10	25	–	18.2	33 000	51 600
*35BER10X	35	62	14	2.8	8.3	1.4	1	0.6	9.70	6.55	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	6.80	6.70	18	10.6	16.3	37 200	–
*35BNR20XV1V	35	62	17	–	–	–	1	0.6	10.1	6.80	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	6.55	8.10	25	–	19.7	33 000	–
*35BER20XV1V	35	62	17	–	–	–	1	0.6	9.70	6.55	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	30.5	19.0	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	29.0	18.2	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 is comprised exclusively of sealed bearings.
(2) ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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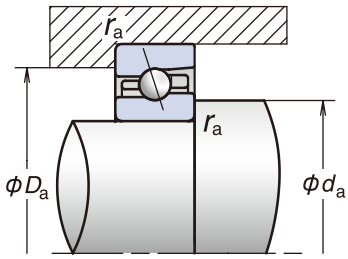
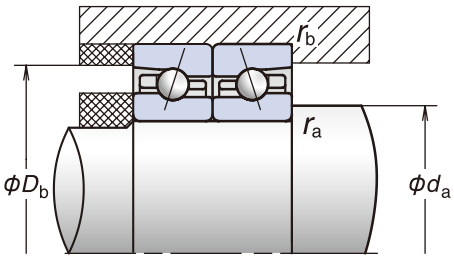




Abutment and Fillet Dimensions (mm)					Preload (DB and DF Arrangement) (N)				Axial Rigidity (DB and DF Arrangement) (N/μm)				Measured Axial Clearance (μm)				Mass (kg) (approx.)
d_a (min.)	D_a (max.)	D_b (max.)	r_a (max.)	r_b (max.)	EL	L	M	H	EL	L	M	H	EL	L	M	H	
40	50	52.5	0.6	0.3	33	67	149	297	29	39	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

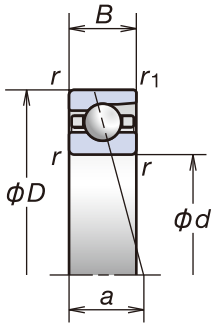
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

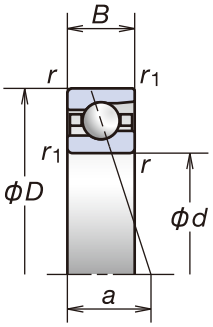
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

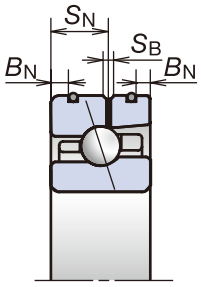
Bore Diameter 40 mm



79,70,72 series
BNR10,20 series
BER10,20 series



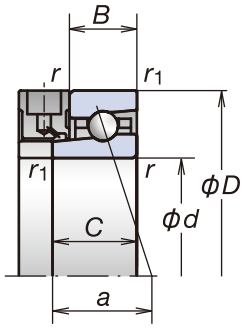
BNR19,29 series
BER19,29 series



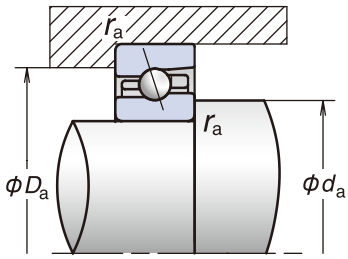
ROBUSTSHOT

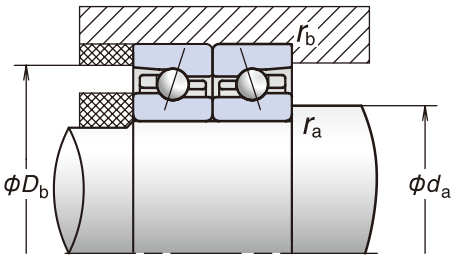
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7908C	40	62	12	—	—	—	—	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	15.1	11.2	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	14.3	10.6	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	7.30	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	7.30	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	7.05	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	7.05	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	7.30	7.10	18	10.4	15.3	35 300	—
*40BNR29XV1V	40	62	14	—	—	—	—	0.6	0.3	11.5	7.30	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	7.05	8.65	25	—	18.9	31 400	—
*40BER29XV1V	40	62	14	—	—	—	—	0.6	0.3	11.0	7.05	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	20.5	15.1	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	19.4	14.3	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	7.60	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	7.60	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	7.30	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	7.30	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	7.60	7.50	18	10.7	17.7	33 400	—
*40BNR20XV1V	40	68	18	—	—	—	—	1	0.6	10.6	7.60	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	7.30	9.10	25	—	21.4	29 700	—
*40BER20XV1V	40	68	18	—	—	—	—	1	0.6	10.1	7.30	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	36.5	24.2	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	35.0	23.1	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

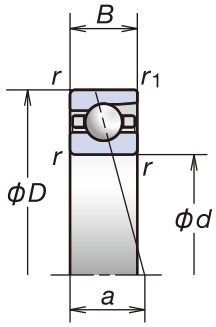
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

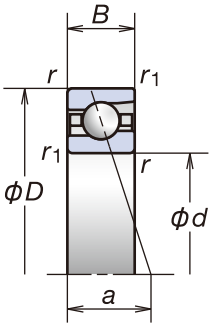
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

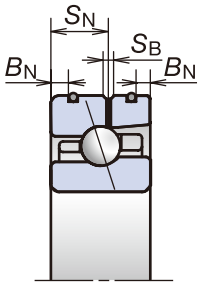
Bore Diameter 45 mm



79,70,72 series
BNR10,20 series
BER10,20 series



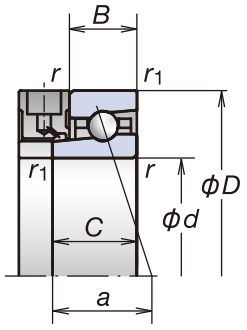
BNR19,29 series
BER19,29 series



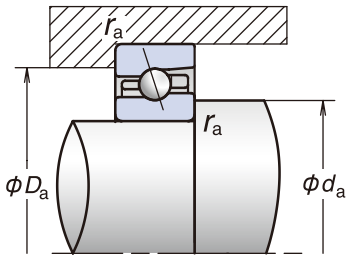
ROBUSTSHOT

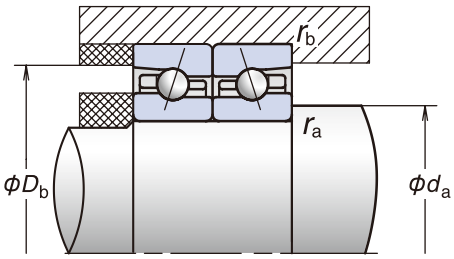
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7909C	45	68	12	—	—	—	—	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	16.0	12.7	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	15.1	12.1	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	8.30	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	8.30	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	8.00	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	8.00	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	8.30	8.10	18	10.6	16.2	31 900	—
*45BNR29XV1V	45	68	14	—	—	—	—	0.6	0.3	12.1	8.30	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	8.00	9.85	25	—	20.2	28 400	—
*45BER29XV1V	45	68	14	—	—	—	—	0.6	0.3	11.6	8.00	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	24.4	18.4	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	23.1	17.5	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
*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	8.60	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	8.60	8.35	18	10.6	17.6	35 000	55 000
*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	8.25	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	8.25	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	8.60	8.35	18	10.6	19.1	30 000	—
*45BNR20XV1V	45	75	19	—	—	—	—	1	0.6	11.7	8.60	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	8.25	10.1	25	—	23.3	26 700	—
*45BER20XV1V	45	75	19	—	—	—	—	1	0.6	11.2	8.25	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	41.0	27.8	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	39.0	26.6	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

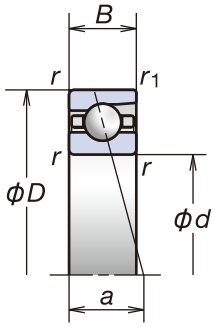
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

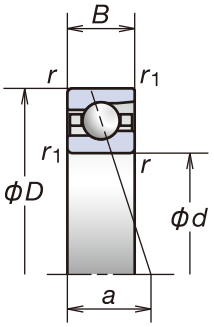
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

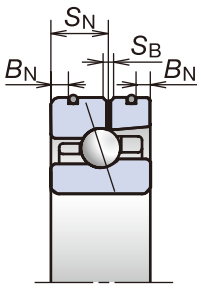
Bore Diameter 50 mm



79,70,72 series
BNR10,20 series
BER10,20 series



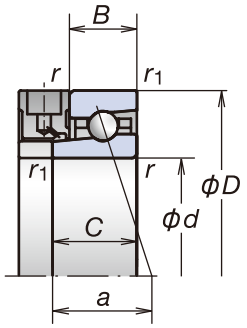
BNR19,29 series
BER19,29 series



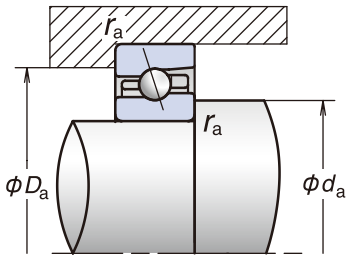
ROBUSTSHOT

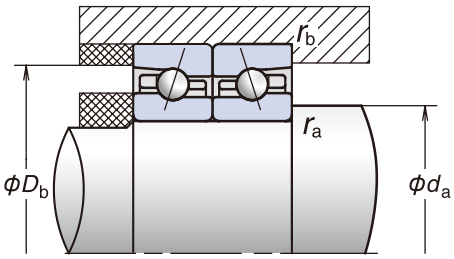
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7910C	50	72	12	—	—	—	—	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	16.8	14.3	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	15.9	13.5	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	9.30	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	9.30	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	8.95	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	8.95	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	9.30	9.10	18	10.7	16.9	29 600	—
*50BNR29XV1V	50	72	14	—	—	—	—	0.6	0.3	12.8	9.30	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	8.95	11.0	25	—	21.2	26 300	—
*50BER29XV1V	50	72	14	—	—	—	—	0.6	0.3	12.2	8.95	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	26.0	21.0	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	24.6	19.9	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
*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	9.50	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	9.50	9.20	18	10.8	18.4	32 400	50 800
*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	9.10	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	9.10	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	9.50	9.20	18	10.8	19.9	27 700	—
*50BNR20XV1V	50	80	19	—	—	—	—	1	0.6	12.2	9.50	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	9.10	11.1	25	—	24.5	24 700	—
*50BER20XV1V	50	80	19	—	—	—	—	1	0.6	11.6	9.10	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	43.0	30.5	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	41.0	29.3	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

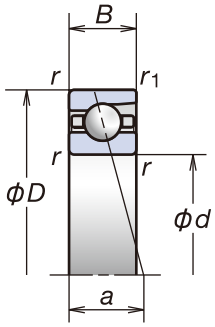
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

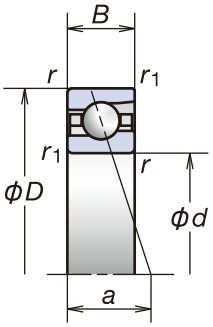
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

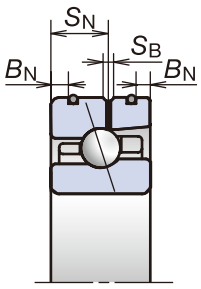
Bore Diameter 55 mm



79,70,72 series
BNR10,20 series
BER10,20 series



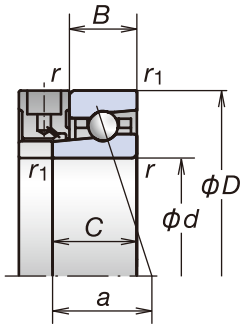
BNR19,29 series
BER19,29 series



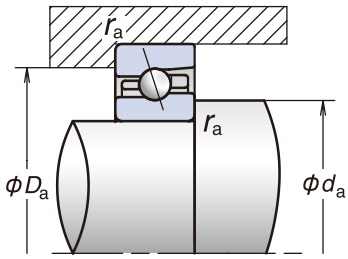
ROBUSTSHOT

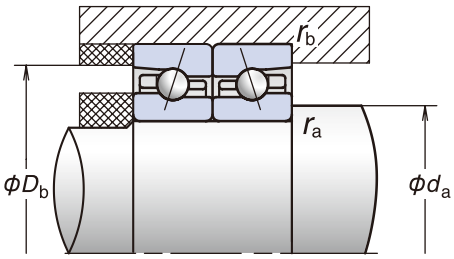
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7911C	55	80	13	—	—	—	—	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	19.4	17.3	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	18.3	16.4	14.8	25	—	22.2	19 300	28 900
*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	10.9	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	10.9	10.6	18	10.7	17.5	31 200	48 900
*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	10.4	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	10.4	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	10.9	10.6	18	10.7	19.0	26 700	—
*55BNR29XV1V	55	80	16	—	—	—	—	1	0.6	14.4	10.9	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	10.4	12.9	25	—	23.7	23 800	—
*55BER29XV1V	55	80	16	—	—	—	—	1	0.6	13.8	10.4	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	34.0	27.1	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	32.0	25.7	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
*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	12.0	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	12.0	11.7	18	10.8	20.6	29 000	45 600
*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	11.5	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	11.5	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	12.0	11.7	18	10.8	22.6	24 900	—
*55BNR20XV1V	55	90	22	—	—	—	—	1.1	0.6	15.1	12.0	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	11.5	14.1	25	—	27.7	22 100	—
*55BER20XV1V	55	90	22	—	—	—	—	1.1	0.6	14.4	11.5	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	53.0	38.0	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	50.5	36.5	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	1 059	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	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	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	1 118	58	80	119	169	− 4	− 11	− 24	− 40	0.332
62	83	85	1	0.6	157	345	804	1 552	129	171	236	307	− 4	− 9	− 18	− 29	0.383
62	83	85	1	0.6	172	391	928	1 807	148	199	277	362	− 4	− 9	− 18	− 29	0.335
62	83	85	1	0.6	49	246	887	1 307	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	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	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	1 554	56	74	116	163	− 8	− 17	− 38	− 60	0.601
64	91	94	1.5	0.8	155	323	906	1 802	64	86	136	191	− 8	− 17	− 38	− 60	0.502
64	91	94	1.5	0.8	248	491	1 206	2 397	142	182	256	338	− 7	− 13	− 26	− 42	0.596
64	91	94	1.5	0.8	277	562	1 401	2 804	165	213	301	399	− 7	− 13	− 26	− 42	0.497
64	91	94	1.5	0.8	49	494	1 722	2 635	108	236	372	438	0	− 10	− 26	− 35	0.609

Calculation of radial rigidity
Multiply axial rigidity by the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

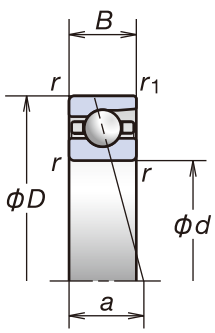
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

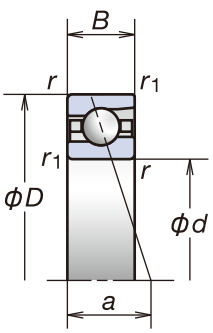
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

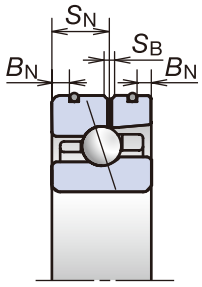
Bore Diameter 60 mm



79,70,72 series
BNR10,20 series
BER10,20 series



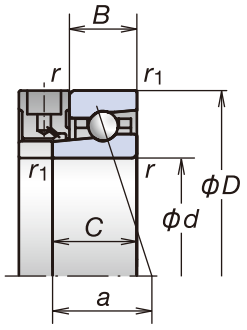
BNR19,29 series
BER19,29 series



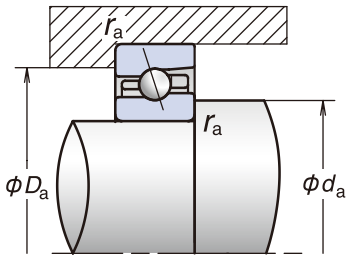
ROBUSTSHOT

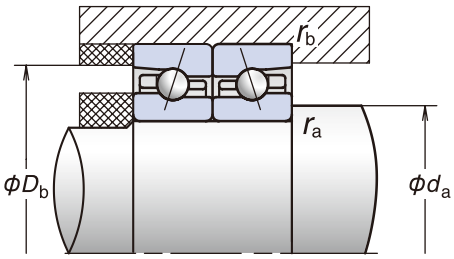
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7912C	60	85	13	—	—	—	—	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	19.7	18.3	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	18.6	17.3	15.5	25	—	23.4	18 000	26 900
*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	11.5	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	11.5	11.2	18	10.7	18.3	29 000	45 600
*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	11.0	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	11.0	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	11.5	11.2	18	10.7	19.8	24 900	—
*60BNR29XV1V	60	85	16	—	—	—	—	1	0.6	14.6	11.5	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	11.0	13.6	25	—	24.9	22 100	—
*60BER29XV1V	60	85	16	—	—	—	—	1	0.6	14.0	11.0	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	35.0	29.0	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	33.0	27.5	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
*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	1.4	1.1	0.6	15.6	13.1	12.8	18	10.8	21.5	23 300	36 200
*60BNR10X	60	95	18	23	4.3	10	1.4	1.1	0.6	15.6	13.1	12.8	18	10.8	21.5	27 100	42 600
*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	1.4	1.1	0.6	15.0	12.5	15.5	25	—	26.9	20 700	32 300
*60BER10X	60	95	18	23	4.3	10	1.4	1.1	0.6	15.0	12.5	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	13.1	12.8	18	10.8	23.5	23 300	—
*60BNR20XV1V	60	95	22	—	—	—	—	1.1	0.6	15.6	13.1	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	12.5	15.5	25	—	28.9	20 700	—
*60BER20XV1V	60	95	22	—	—	—	—	1.1	0.6	15.0	12.5	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	63.5	46.5	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	61.0	44.5	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

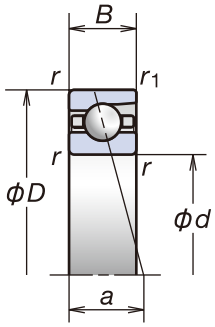
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

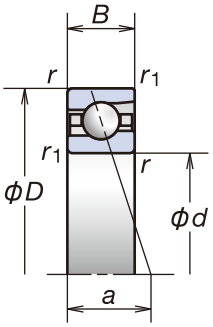
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

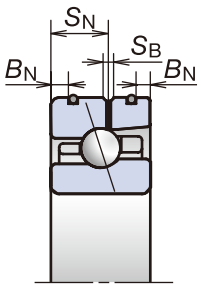
Bore Diameter 65 mm



79,70,72 series
BNR10,20 series
BER10,20 series



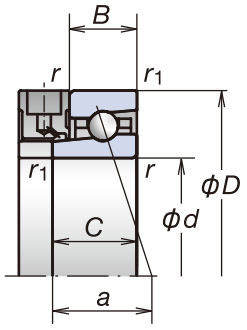
BNR19,29 series
BER19,29 series



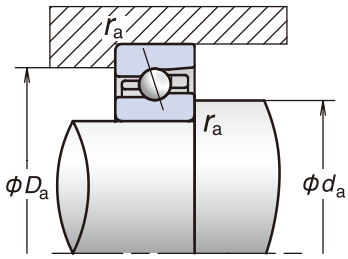
ROBUSTSHOT

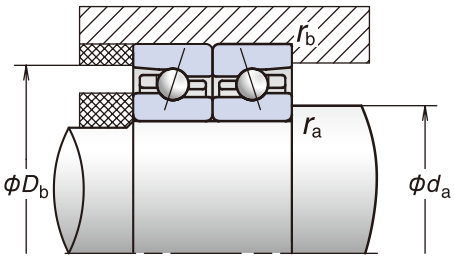
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min⁻¹)	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7913C	65	90	13	—	—	—	—	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	20.5	20.1	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	19.3	19.0	16.8	25	—	24.6	16 800	25 200
*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	12.6	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	12.6	12.3	18	10.8	19.1	27 100	42 600
*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	12.1	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	12.1	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	12.6	12.3	18	10.8	20.6	23 300	—
*65BNR29XV1V	65	90	16	—	—	—	—	1	0.6	15.2	12.6	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	12.1	14.9	25	—	26.1	20 700	—
*65BER29XV1V	65	90	16	—	—	—	—	1	0.6	14.5	12.1	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	37.0	32.5	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	35.0	31.0	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
*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	14.2	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	14.2	13.9	18	10.9	22.3	25 500	40 000
*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	13.6	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	13.6	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	14.2	13.9	18	10.9	24.3	21 900	—
*65BNR20XV1V	65	100	22	—	—	—	—	1.1	0.6	16.2	14.2	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	13.6	16.8	25	—	30.0	19 400	—
*65BER20XV1V	65	100	22	—	—	—	—	1.1	0.6	15.5	13.6	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	73.0	56.0	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	69.5	53.5	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

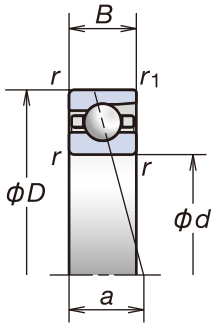
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

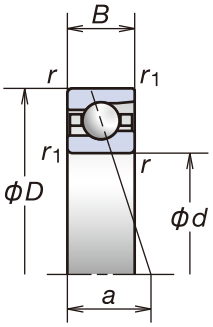
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

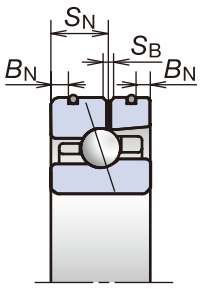
Bore Diameter 70 mm



79,70,72 series
BNR10,20 series
BER10,20 series



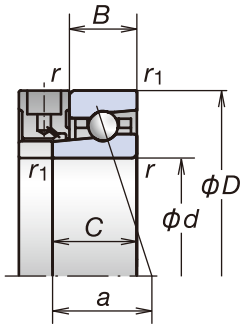
BNR19,29 series
BER19,29 series



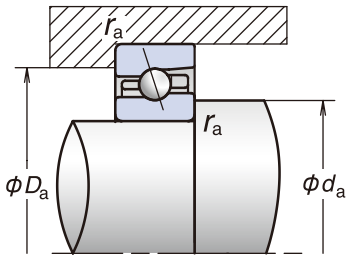
ROBUSTSHOT

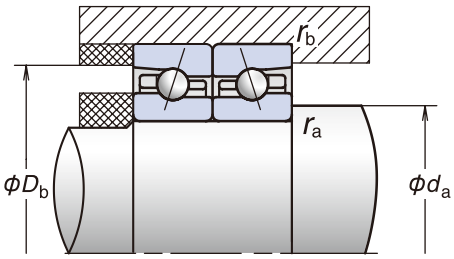
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7914C	70	100	16	—	—	—	—	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	28.1	26.6	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	26.5	25.2	24.1	25	—	27.8	15 300	23 000
*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	17.3	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	17.3	17.1	18	10.8	21.8	24 800	38 900
*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	16.6	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	16.6	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	17.3	17.1	18	10.8	23.3	21 200	—
*70BNR29XV1V	70	100	19	—	—	—	—	1	0.6	21.3	17.3	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	16.6	20.7	25	—	29.3	18 900	—
*70BER29XV1V	70	100	19	—	—	—	—	1	0.6	20.4	16.6	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	47.0	41.5	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	44.5	39.0	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
*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	18.9	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	18.9	18.8	18	10.9	24.5	23 400	36 700
*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	18.1	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	18.1	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	18.9	18.8	18	10.9	26.5	20 000	—
*70BNR20XV1V	70	110	24	—	—	—	—	1.1	0.6	22.3	18.9	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	18.1	22.6	25	—	32.8	17 800	—
*70BER20XV1V	70	110	24	—	—	—	—	1.1	0.6	21.3	18.1	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	79.5	61.5	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	76.0	59.0	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

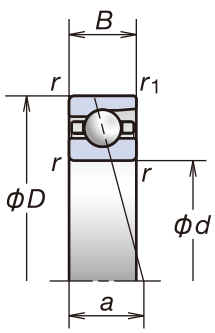
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

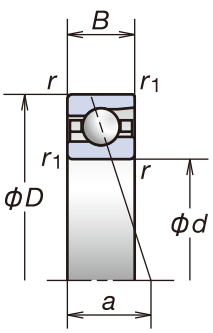
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

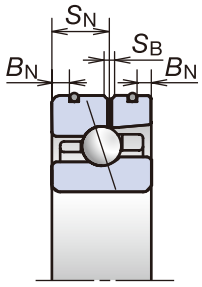
Bore Diameter 75 mm



79,70,72 series
BNR10,20 series
BER10,20 series



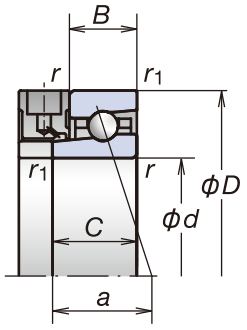
BNR19,29 series
BER19,29 series



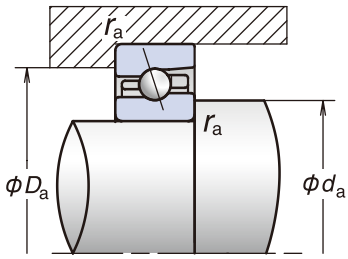
ROBUSTSHOT

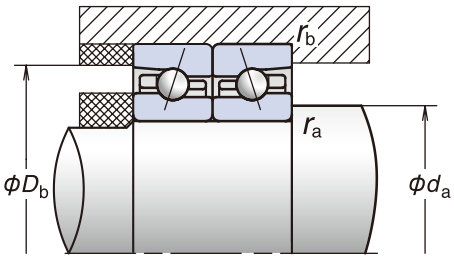
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7915C	75	105	16	—	—	—	—	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	28.6	28.0	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	26.9	26.5	25.1	25	—	29.0	14 500	21 700
*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	18.2	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	18.2	18.0	18	10.9	22.6	23 400	36 700
*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	17.4	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	17.4	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	18.2	18.0	18	10.9	24.1	20 000	—
*75BNR29XV1V	75	105	19	—	—	—	—	1	0.6	21.6	18.2	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	17.4	21.7	25	—	30.5	17 800	—
*75BER29XV1V	75	105	19	—	—	—	—	1	0.6	20.7	17.4	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	48.0	44.0	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	45.5	41.5	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
*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	19.8	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	19.8	19.7	18	11.0	25.3	22 200	34 800
*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	19.0	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	19.0	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	19.8	19.7	18	11.0	27.3	19 000	—
*75BNR20XV1V	75	115	24	—	—	—	—	1.1	0.6	22.6	19.8	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	19.0	23.7	25	—	33.9	16 900	—
*75BER20XV1V	75	115	24	—	—	—	—	1.1	0.6	21.6	19.0	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	83.0	67.0	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	79.0	63.5	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

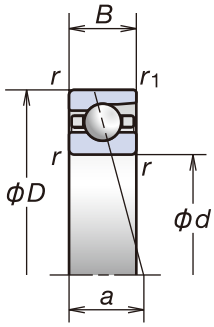
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

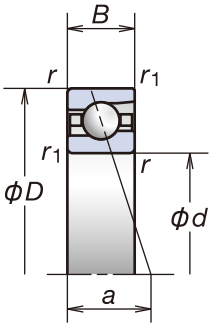
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

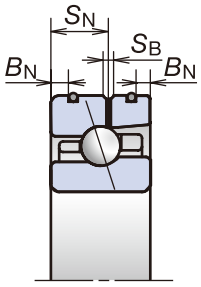
Bore Diameter 80 mm



79,70,72 series
BNR10,20 series
BER10,20 series



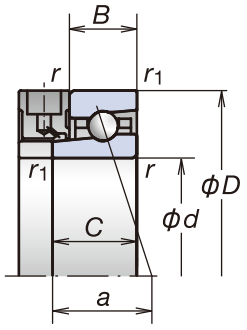
BNR19,29 series
BER19,29 series



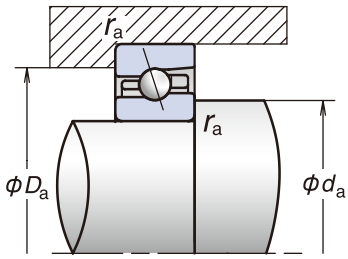
ROBUSTSHOT

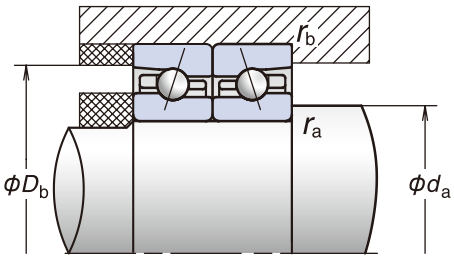
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7916C	80	110	16	—	—	—	—	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	29.0	29.4	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	27.3	27.8	26.2	25	—	30.2	13 700	20 600
*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	19.1	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	19.1	18.9	18	11.0	23.4	22 200	34 800
*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	18.3	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	18.3	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	19.1	18.9	18	11.0	24.9	19 000	—
*80BNR29XV1V	80	110	19	—	—	—	—	1	0.6	22.0	19.1	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	18.3	22.8	25	—	31.7	16 900	—
*80BER29XV1V	80	110	19	—	—	—	—	1	0.6	21.0	18.3	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	58.5	52.5	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	55.5	50.0	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
*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	23.5	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	23.5	23.4	18	10.9	27.5	20 500	32 200
*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	22.5	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	22.5	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	23.5	23.4	18	10.9	30.0	17 600	—
*80BNR20XV1V	80	125	27	—	—	—	—	1.1	0.6	26.5	23.5	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	22.5	28.2	25	—	37.1	15 700	—
*80BER20XV1V	80	125	27	—	—	—	—	1.1	0.6	25.3	22.5	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	92.5	73.5	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	88.0	70.5	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

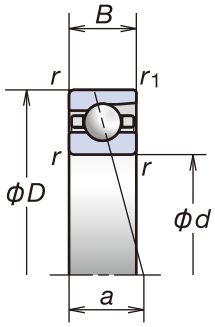
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

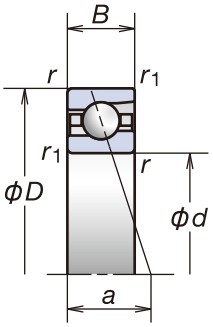
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

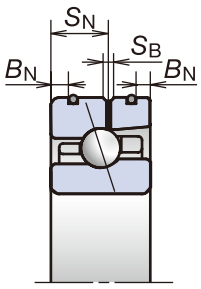
Bore Diameter 85 mm



79,70,72 series
BNR10,20 series
BER10,20 series



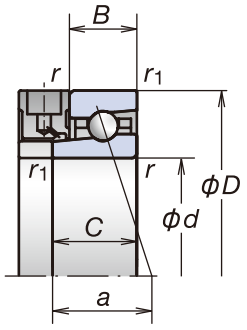
BNR19,29 series
BER19,29 series



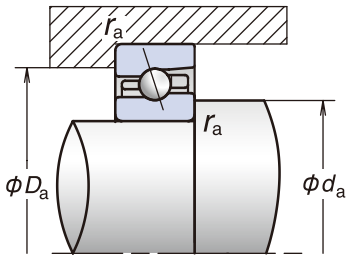
ROBUSTSHOT

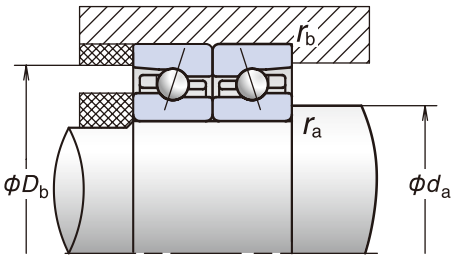
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7917C	85	120	18	—	—	—	—	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	38.5	38.5	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	36.5	36.5	35.6	25	—	32.9	12 700	19 100
*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	25.1	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	25.1	24.8	18	10.8	25.7	20 500	32 200
*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	24.1	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	24.1	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	25.1	24.8	18	10.8	27.7	17 600	—
*85BNR29XV1V	85	120	22	—	—	—	—	1.1	0.6	29.4	25.1	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	24.1	30.0	25	—	34.9	15 700	—
*85BER29XV1V	85	120	22	—	—	—	—	1.1	0.6	28.1	24.1	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	60.0	55.5	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	56.5	53.0	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
*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	24.6	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	24.6	24.5	18	11.0	28.5	19 600	30 700
*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	23.6	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	23.6	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	24.6	24.5	18	11.0	31.0	16 800	—
*85BNR20XV1V	85	130	27	—	—	—	—	1.1	0.6	26.8	24.6	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	23.6	29.5	25	—	38.6	14 900	—
*85BER20XV1V	85	130	27	—	—	—	—	1.1	0.6	25.6	23.6	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	108	87.0	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	102	83.0	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

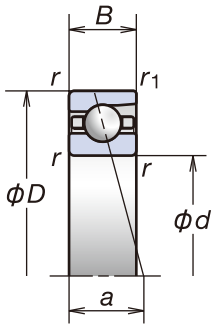
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

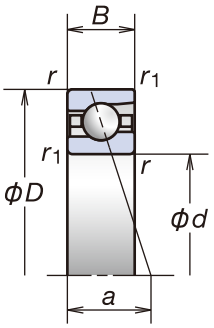
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

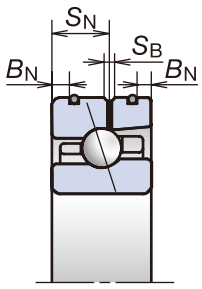
Bore Diameter 90 mm



79,70,72 series
BNR10,20 series
BER10,20 series



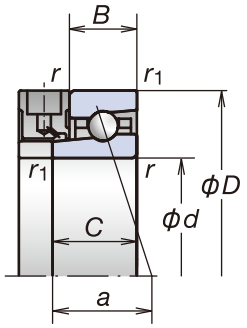
BNR19,29 series
BER19,29 series



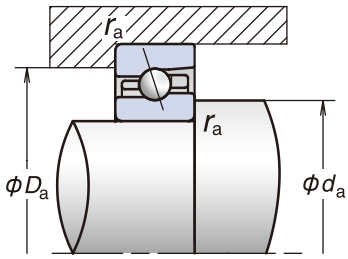
ROBUSTSHOT

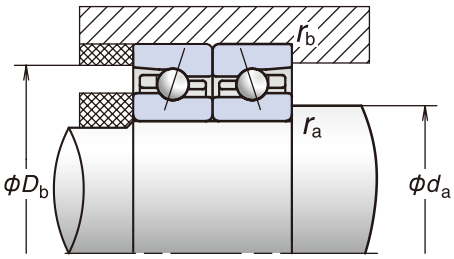
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7918C	90	125	18	—	—	—	—	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	41.5	43.5	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	39.0	41.0	40.0	25	—	34.1	12 100	18 200
*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	28.5	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	28.5	28.1	18	10.9	26.5	19 600	30 700
*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	27.3	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	27.3	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	28.5	28.1	18	10.9	28.5	16 800	—
*90BNR29XV1V	90	125	22	—	—	—	—	1.1	0.6	31.5	28.5	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	27.3	34.0	25	—	36.1	14 900	—
*90BER29XV1V	90	125	22	—	—	—	—	1.1	0.6	30.0	27.3	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	72.0	66.5	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	68.0	63.0	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
*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	31.5	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	31.5	31.5	18	10.9	30.7	18 300	28 700
*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	30.5	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	30.5	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	31.5	31.5	18	10.9	33.7	15 700	—
*90BNR20XV1V	90	140	30	—	—	—	—	1.5	1	35.0	31.5	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	30.5	38.0	25	—	41.8	14 000	—
*90BER20XV1V	90	140	30	—	—	—	—	1.5	1	33.5	30.5	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	122	100	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	117	95.5	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

(1) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

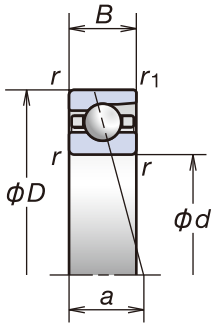
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

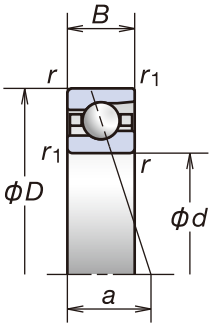
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

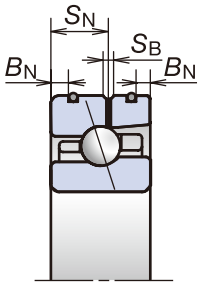
Bore Diameter 95 mm



79,70,72 series
BNR10,20 series
BER10,20 series



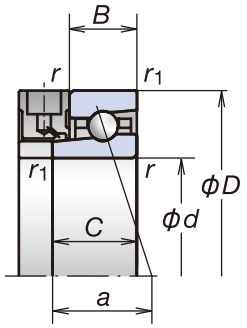
BNR19,29 series
BER19,29 series



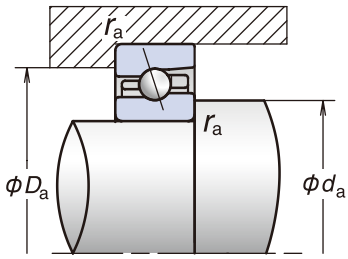
ROBUSTSHOT

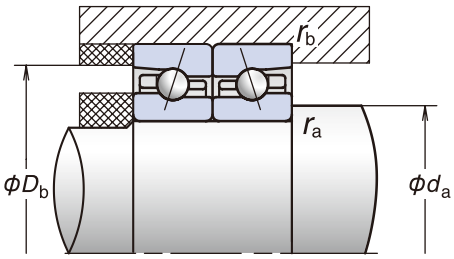
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min⁻¹)	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7919C	95	130	18	—	—	—	—	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	42.0	45.5	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	39.5	43.0	41.5	25	—	35.2	11 600	17 400
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	29.7	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	29.7	32.5	18	10.9	27.3	18 700	29 400
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	28.5	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	28.5	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	73.5	70.5	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	69.5	66.5	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
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	33.0	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	33.0	32.5	18	10.8	31.3	17 500	27 500
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	31.5	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	31.5	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	133	107	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	127	103	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

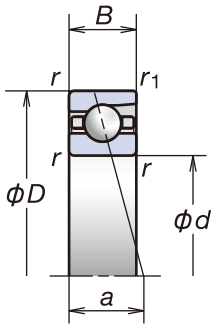
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

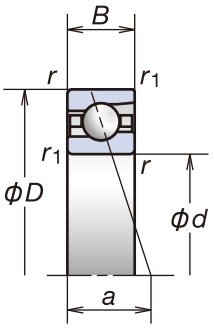
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

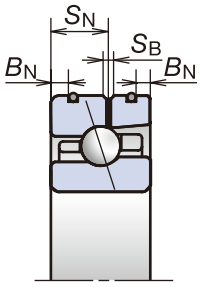
Bore Diameter 100 mm



79,70,72 series
BNR10,20 series
BER10,20 series



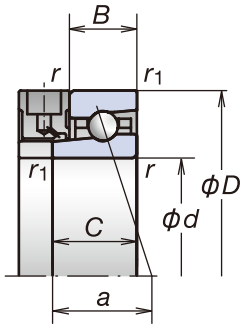
BNR19,29 series
BER19,29 series



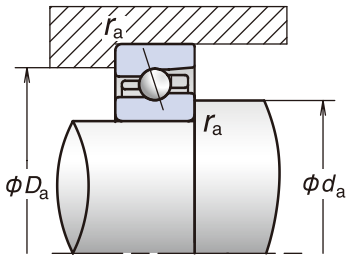
ROBUSTSHOT

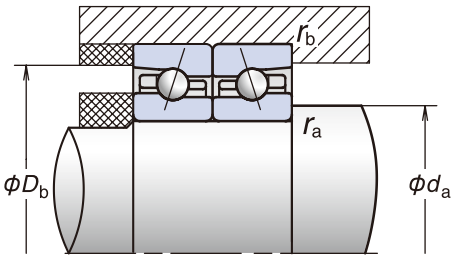
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min⁻¹)	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
*7920C	100	140	20	—	—	—	—	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	50.5	52.0	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	47.5	49.5	46.8	25	—	38.0	10 900	16 300
*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	33.5	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	33.5	33.0	18	10.8	29.5	17 500	27 500
*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	32.0	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	32.0	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	33.5	33.0	18	10.8	31.5	15 000	—
*100BNR29XV1V	100	140	24	—	—	—	—	1.1	0.6	38.0	33.5	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	32.0	40.0	25	—	40.0	13 400	—
*100BER29XV1V	100	140	24	—	—	—	—	1.1	0.6	36.0	32.0	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	75.5	74.0	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	71.5	70.5	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
*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	34.5	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	34.5	34.0	18	10.9	32.3	16 800	26 400
*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	33.0	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	33.0	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	34.5	34.0	18	10.9	35.3	14 400	—
*100BNR20XV1V	100	150	30	—	—	—	—	1.5	1	36.0	34.5	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	33.0	41.0	25	—	44.2	12 800	—
*100BER20XV1V	100	150	30	—	—	—	—	1.5	1	34.5	33.0	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

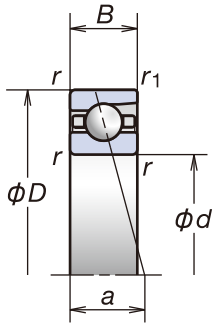
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

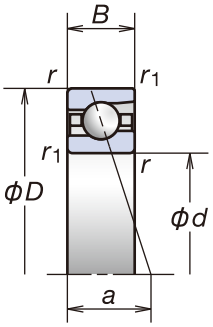
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

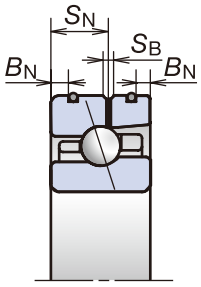
Bore Diameter 105 mm



79,70,72 series
BNR10 series
BER10 series



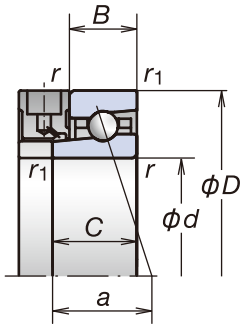
BNR19 series
BER19 series



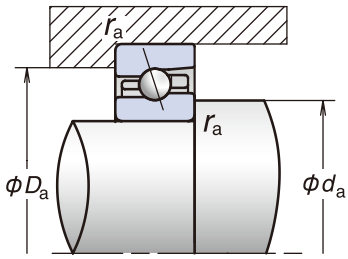
ROBUSTSHOT

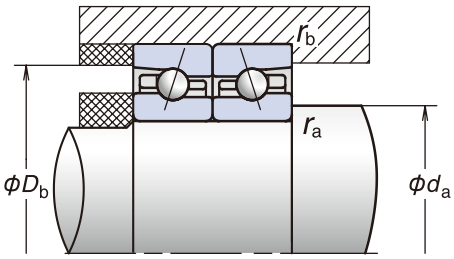
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
7921C	**105**	**145**	**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	51.0	54.5	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	48.5	51.5	48.7	25	—	39.2	10 400	15 600
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	35.0	39.0	18	10.8	30.3	14 400	22 400
105BNR19X	**105**	**145**	**20**	25	—	—	—	1.1	0.6	38.5	35.0	39.0	18	10.8	30.3	16 800	26 400
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	33.5	42.0	25	—	39.2	12 800	20 000
105BER19X	**105**	**145**	**20**	25	—	—	—	1.1	0.6	37.0	33.5	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	88.0	85.5	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	83.0	81.0	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
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	39.5	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	39.5	39.0	18	10.9	34.5	15 900	25 000
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	38.0	47.5	25	—	43.9	12 100	18 900
105BER10X	**105**	**160**	**26**	31	6.0	15.2	2.2	2	1	39.0	38.0	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

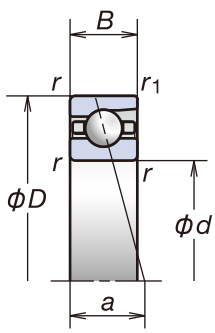
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

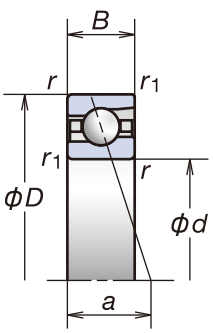
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

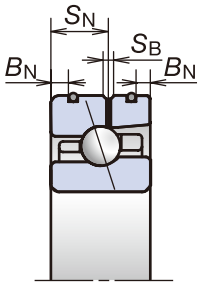
Bore Diameter 110 mm



79,70,72 series
BNR10 series
BER10 series



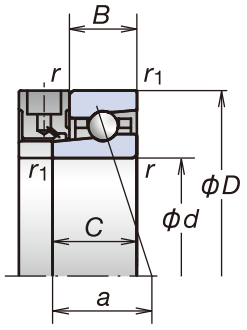
BNR19 series
BER19 series



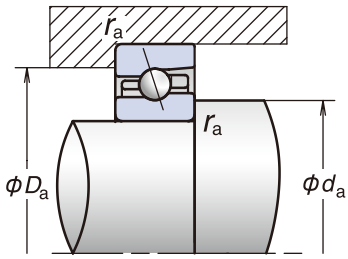
ROBUSTSHOT

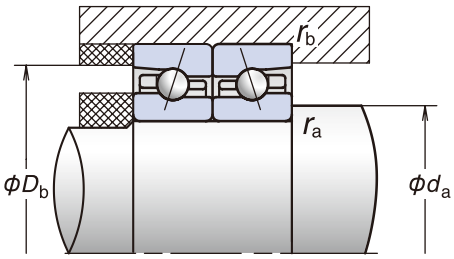
Designation (1)	Boundary Dimensions (2) (mm)									Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (min^{-1})	
	d	D	B	C	B_N	S_N	S_B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (Static)					Grease	Oil
7922C	**110**	**150**	**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	52.0	57.0	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	49.0	54.0	50.7	25	—	40.3	10 000	15 000
***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	36.5	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	36.5	36.5	18	10.9	31.1	16 200	25 400
***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	35.0	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	35.0	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	106	99.0	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	100	94.0	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
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	45.0	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	45.0	44.5	18	10.9	36.7	15 000	23 600
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	43.0	54.0	25	—	46.7	11 500	17 900
110BER10X	**110**	**170**	**28**	33	6.0	16.2	2.2	2	1	44.0	43.0	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) Bearings denoted by an asterisk (*) are available with seals. Series 20 and 29 are comprised exclusively of sealed bearings.
(2) Spinshot II bearings are available for designations with values in the C column, and ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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.)
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	
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	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	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	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	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

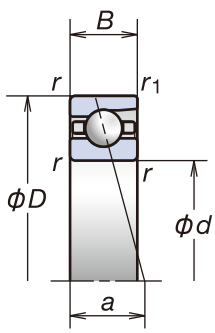
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

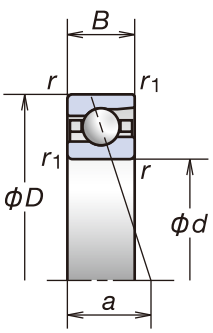
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

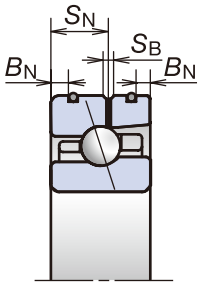
Bore Diameter 120 mm



79,70,72 series
BNR10 series
BER10 series



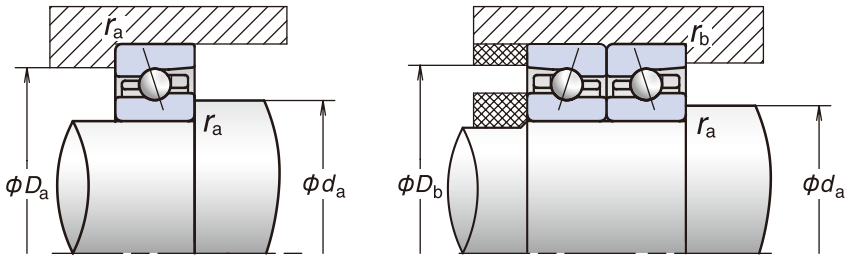
BNR19 series
BER19 series



ROBUSTSHOT

Designation (1)	Boundary Dimensions (2) (mm)								Basic Load Ratings (kN)		Permissible Axial Load (3) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (4) (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	72.0	77.5	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	67.5	73.5	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	50.0	49.0	18	10.8	34.2	12 700	19 700
120BNR19X	**120**	**165**	**22**	—	—	—	1.1	0.6	54.0	50.0	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	48.0	59.5	25	—	44.2	11 300	17 600
120BER19X	**120**	**165**	**22**	—	—	—	1.1	0.6	51.5	48.0	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	112	111	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	106	105	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	48.5	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	48.5	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	46.5	58.0	25	—	49.0	10 700	16 700
***120BER10X**	**120**	**180**	**28**	6.0	16.2	2.2	2	1	45.5	46.5	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) Bearings denoted by an asterisk (*) are available with seals.
(2) ROBUSTSHOT bearings are available for designations with values in the B_N, S_N, and S_B columns.
(3) For details on permissible axial load, refer to Page 199.
(4) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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	6371	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

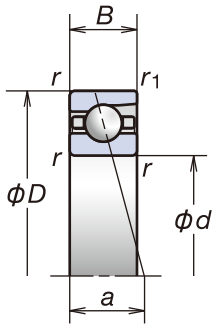
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

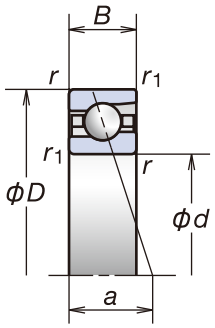
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter 130 mm



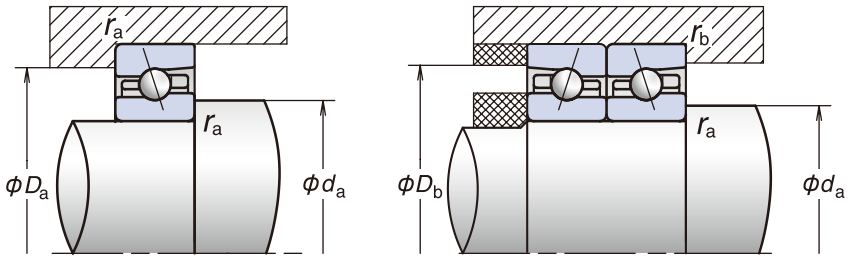
79,70,72 series
BNR10 series
BER10 series



BNR19 series
BER19 series

Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (2) (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	79.0	87.0	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	74.5	82.5	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	56.0	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	54.0	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	129	132	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	122	125	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	59.0	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	56.5	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) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

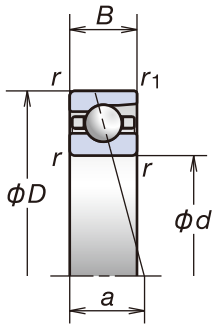
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

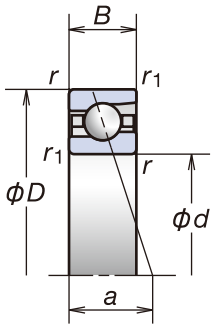
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter 140-150 mm



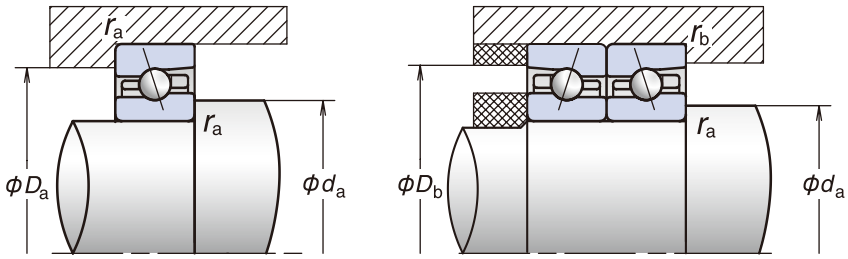
79,70,72 series
BNR10 series
BER10 series



BNR19 series
BER19 series

Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (2) (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	79.5	91.5	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	75.0	86.5	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	59.0	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	56.5	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	132	139	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	125	132	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	65.0	71.5	97.0	18	11.0	44.9	8 600	12 300
140BNR10H	**140**	**210**	**33**	2	1	65.0	68.5	63.5	18	11.0	44.9	10 300	16 000
140BER10E	**140**	**210**	**33**	2	1	62.5	68.5	113	25	—	57.3	7 400	10 400
140BER10H	**140**	**210**	**33**	2	1	62.5	65.5	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	102	117	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	96.5	110	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	75.0	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	72.0	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	151	161	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	142	152	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	77.0	84.0	114	18	11.0	48.0	7 500	10 700
150BNR10H	**150**	**225**	**35**	2.1	1.1	77.0	80.5	74.5	18	11.0	48.0	9 600	15 000
150BER10S	**150**	**225**	**35**	2.1	1.1	73.5	80.5	143	25	—	61.2	6 400	9 100
150BER10H	**150**	**225**	**35**	2.1	1.1	73.5	77.0	96.5	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) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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	1089	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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

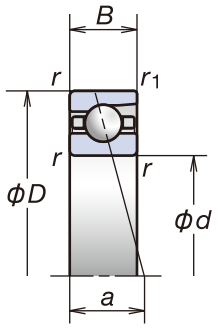
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

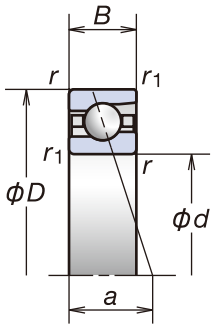
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter 160-180 mm



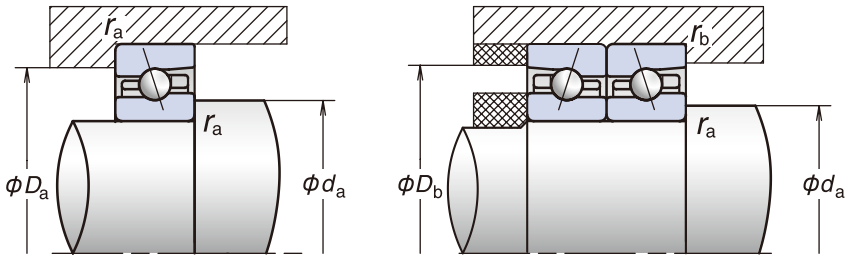
79,70,72 series
BNR10 series
BER10 series



BNR19 series
BER19 series

Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (2) (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	106	127	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	100	120	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	81.5	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	78.5	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	171	185	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	162	176	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	88.5	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	84.5	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	113	142	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	106	134	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	91.5	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	87.5	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	145	177	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	137	167	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	114	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	109	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) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

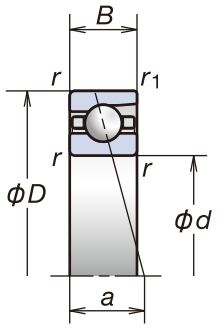
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

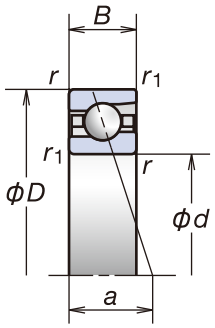
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

Bore Diameter **190-260** mm



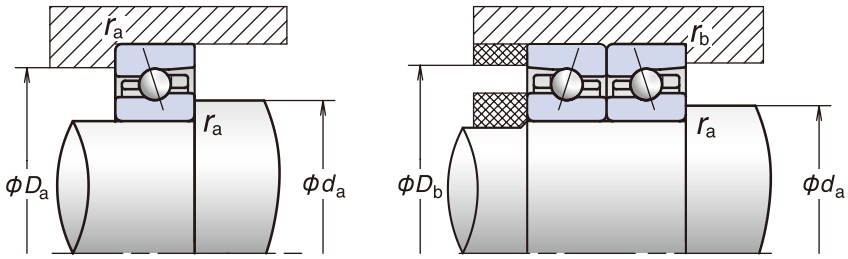
79,70,72 series



BNR19 series
BER19 series

Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (2) (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	147	184	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	139	174	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	119	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	114	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	189	234	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	179	222	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	150	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	144	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	191	246	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	180	232	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	201	274	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	189	259	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) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. See Page 51 for cage differences and their impact on $d_m n$ values.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor in Table B.

Table A

	EL	L	M	H
15°	6.5	6.0	5.0	4.5
18°	4.5			
25°	2.0			
30°	1.4			

Table B

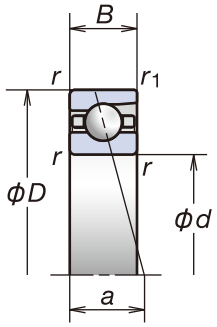
	DBD	DBB
Preload factor	1.36	2
Axial rigidity	1.48	2
Radial rigidity	1.54	2

For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

1. Angular Contact Ball Bearings

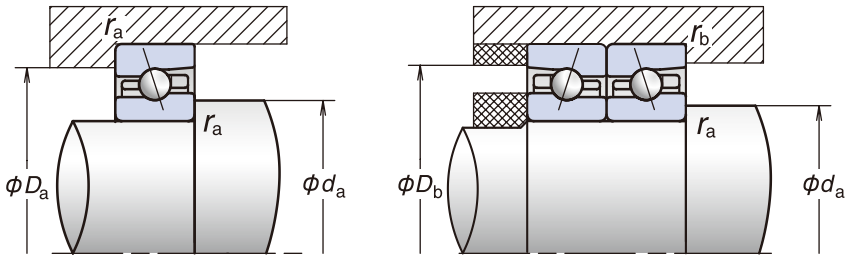
Bore Diameter 280-420 mm



79,70,72 series

Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Factor f_o	Effective Load Center (mm) a	Limiting Speeds (2) (min^{-1})	
	d	D	B	r (min.)	r_1 (min.)	C_r (Dynamic)	C_{or} (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 details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216.



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	
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 the appropriate factor in Table A.

Calculation of preload and axial rigidity for combined bearings
Multiply by the appropriate factor in Table B. For radial rigidity, multiply the value from Table A with the appropriate factor 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 ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

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

Cylindrical Roller Bearings ·····110-127
Features
Numbering 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

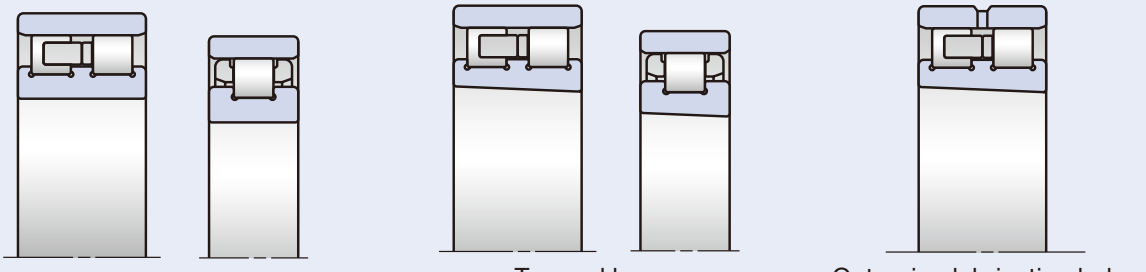
NN type cylindrical roller bearings are equipped with ribs on the inner ring, NNU type bearings with ribs on the outer ring. The NN type is widely used, as initial running-in with grease lubrication is short, and oil is prevented from accumulating inside the bearing with oil lubrication.

Bearing type	Cage	Specification	Available Sizes
NN	MB	Roller guided brass cage	NN3005-NN3048 (NN3008-NN3048)
			NN3920-NN3956 (NN3920-NN3952)
			NN4920-NN4952 (NN4920-NN4952)
	TB	Roller guided PPS cage	NN3006-NN3032 (NN3008-NN3032)
NNU	MB	Roller guided brass cage	NNU4920-NNU4952 (NNU4920-NNU4952)
N	MR	Roller guided brass cage	N1006-N1044 (N1007-N1044)
NSKROBUST Series	TP	Outer ring guided PEEK cage	N1009-N1017

The values in brackets indicate bearing sizes for which NSKHPS and APTSURF are available. For further information, please refer to page 25.

Bore Specifications and Lubrication Holes

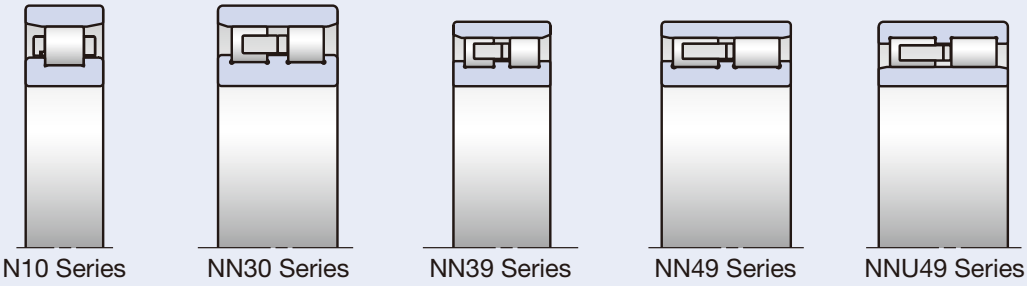
Fig. 2.1



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

Fig. 2.2



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

Designation example: **N 10 12 RX TP KR CC0 P4**

- Bearing type
- Dimension series
- Bore number
- Material
- Internal design
- Cage
- Tapered bore
- Radial clearance
- Accuracy

			Reference pages
N	Bearing type	N: Single-row CRB (inner ring rib type)	46-47, 110
10	Dimension series	10: 10 Series	46-47, 110
12	Bore number	Bearing bore = Bore number × 5 (mm)	112-115
RX	Material	No code: Standard CRB (material of inner and outer ring and rollers: SUJ2 bearing steel) RS, RX: Ultra high-speed single-row CRB (NSKROBUST Series)	14-15 24-25
Z	Internal design	No code: Standard type Z: Low heat generation type	112-115
TP	Cage	TP: Outer ring guided PEEK cage No code: Rib guided brass cage MR: Roller guided brass cage	19, 24-25
KR	Tapered bore	No code: Cylindrical bore KR (K): 1/12 Tapered bore	226-227
CC0	Radial clearance	CC1: Standard clearance for cylindrical bore (Non-interchangeable) CC0: Standard clearance for tapered bore (Non-interchangeable) CCG: Special radial clearance	46-47 112-115
P4	Accuracy	P2: ISO Class 2, P4: ISO Class 4, P5: ISO Class 5 P4Y: Special class (bore diameter and outside diameter are exclusive to NSK, all others are ISO Class 4)	222-225

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)

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

Designation example: **NN 30 17 TB KR E44 CC0 P4**

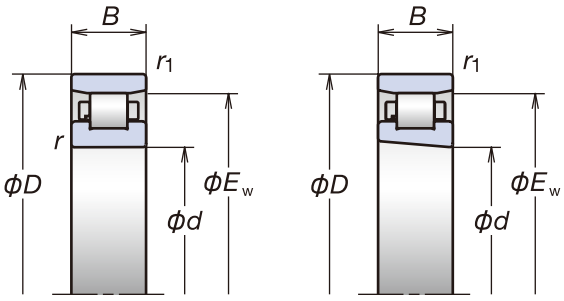
- Bearing type
- Dimension series
- Bore number
- Internal design
- Cage
- Tapered bore
- Lubrication holes
- Radial clearance
- Accuracy

			Reference pages
NN	Bearing type	NN: Double-row CRB (inner ring rib type) NNU: Double-row CRB (outer ring rib type)	46-47, 110
30	Dimension series	30: 30 Series 39: 39 Series 49: 49 Series	46-47, 110
17	Bore number	Bearing bore = Bore number × 5 (mm)	116-127
Z	Internal design	No code: Standard type Z: Low heat generation type	116-127
TB	Cage	TB: Roller guided PPS cage No code: Rib guided brass cage MB: Roller guided brass cage	19, 24-25
KR	Tapered bore	No code: Cylindrical bore KR (K): 1/12 Tapered bore	226-227
E44	Lubrication holes	No code: No lubrication holes E44: Outer ring with oil groove and lubrication holes	116-127
CC0	Radial clearance	CC1: Standard clearance for cylindrical bore (Non-interchangeable) CC0: Standard clearance for tapered bore (Non-interchangeable) CCG: Special radial clearance	46-47 116-127
P4	Accuracy	P2: ISO Class 2, P4: ISO Class 4, P5: ISO Class 5 P4Y: Special class (bore diameter and outside diameter are exclusive to NSK, all others are ISO Class 4)	222-225

2. Cylindrical Roller Bearings

Bore Diameter **30-70** mm

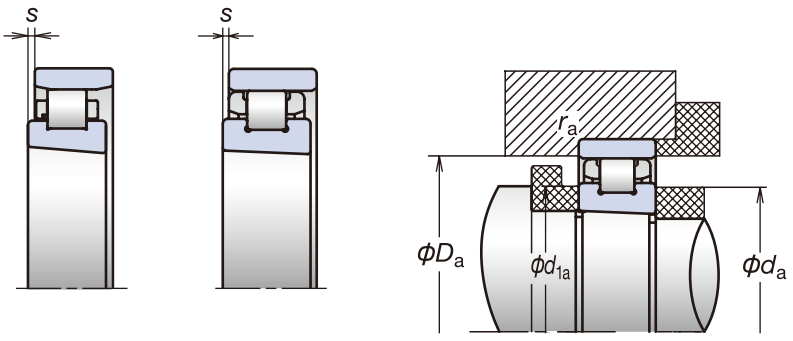
Single-Row Cylindrical Roller Bearings



Cylindrical Bore　　Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) GN gauges are available for bearing designations with asterisk (*). For details, refer to Page 180.
(3) For details on limiting speeds, refer to Page 216.
(4) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(5) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



TP Cage

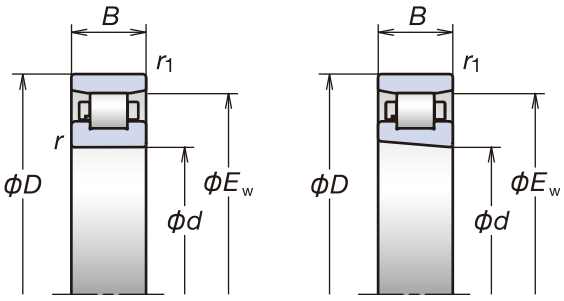
(4) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)	
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	CC9 (5) min.	CC9 (5) max.	CC0 min.	CC0 max.	CC1 min.	CC1 max.	CC1 min.	CC1 max.
1.1	35	36	51	49	0.5	5	10	8	15	10	25	5	15
1.5	40	41	58	56	0.5	5	12	8	15	12	25	5	15
1.7	45	46	64	62	0.6	5	12	8	15	12	25	5	15
2.0	50	51	71	68	0.6	5	15	10	20	15	30	5	18
1.1	50	51	71	68	0.6	5	15	10	20	15	30	5	18
1.1	50	51	71	68	0.6	5	15	10	20	15	30	5	18
1.1	50	51	71	68	0.6	5	15	10	20	15	30	5	18
1.1	50	51	71	68	0.6	5	15	10	20	15	30	5	18
2.0	55	56	76	73	0.6	5	15	10	20	15	30	5	18
1.1	55	56	76	73	0.6	5	15	10	20	15	30	5	18
1.1	55	56	76	73	0.6	5	15	10	20	15	30	5	18
1.1	55	56	76	73	0.6	5	15	10	20	15	30	5	18
1.1	55	56	76	73	0.6	5	15	10	20	15	30	5	18
2.7	61.5	63	85	82	1	5	15	10	20	15	35	5	20
1.1	61.5	63	85	82	1	5	15	10	20	15	35	5	20
1.1	61.5	63	85	82	1	5	15	10	20	15	35	5	20
1.1	61.5	63	85	82	1	5	15	10	20	15	35	5	20
1.1	61.5	63	85	82	1	5	15	10	20	15	35	5	20
2.7	66.5	68	90	87	1	5	15	10	20	15	35	5	20
1.1	66.5	68	90	87	1	5	15	10	20	15	35	5	20
1.1	66.5	68	90	87	1	5	15	10	20	15	35	5	20
1.1	66.5	68	90	87	1	5	15	10	20	15	35	5	20
1.1	66.5	68	90	87	1	5	15	10	20	15	35	5	20
2.7	71.5	73	95	92	1	5	15	10	20	15	35	5	20
1.1	71.5	73	95	92	1	5	15	10	20	15	35	5	20
1.1	71.5	73	95	92	1	5	15	10	20	15	35	5	20
1.1	71.5	73	95	92	1	5	15	10	20	15	35	5	20
1.1	71.5	73	95	92	1	5	15	10	20	15	35	5	20
3.2	76.5	78	105	101	1	10	20	15	30	20	40	10	25
1.3	76.5	78	105	101	1	10	20	15	30	20	40	10	25
1.3	76.5	78	105	101	1	10	20	15	30	20	40	10	25
1.3	76.5	78	105	101	1	10	20	15	30	20	40	10	25
1.3	76.5	78	105	101	1	10	20	15	30	20	40	10	25

For additional information:
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **75-400** mm

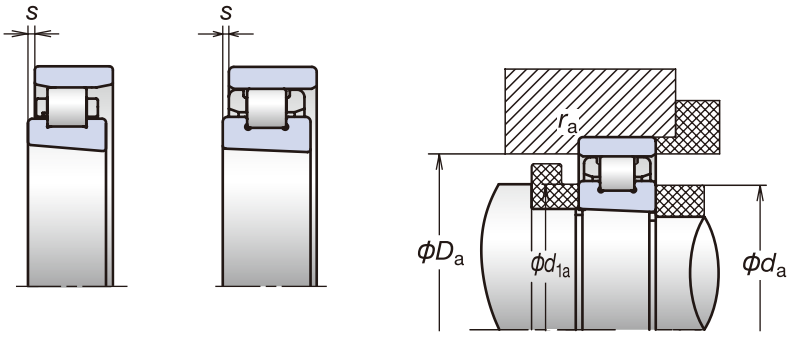
Single-Row Cylindrical Roller Bearings



Cylindrical Bore　　Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) GN gauges are available for bearing designations with asterisk (*). For details, refer to Page 180.
(3) For details on limiting speeds, refer to Page 216.
(4) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(5) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.



TP Cage

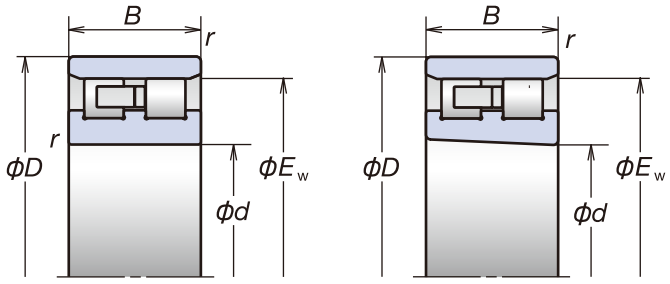
(a) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)	
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	CC9 (b) min.	CC9 (b) max.	CC0 min.	CC0 max.	CC1 min.	CC1 max.	CC1 min.	CC1 max.
2.7	81.5	83	110	106	1	10	20	15	30	20	40	10	25
1.3	81.5	83	110	106	1	10	20	15	30	20	40	10	25
1.3	81.5	83	110	106	1	10	20	15	30	20	40	10	25
1.3	81.5	83	110	106	1	10	20	15	30	20	40	10	25
1.3	81.5	83	110	106	1	10	20	15	30	20	40	10	25
2.2	86.5	88	120	115	1	10	20	15	30	20	40	10	25
1.8	86.5	88	120	115	1	10	20	15	30	20	40	10	25
1.8	86.5	88	120	115	1	10	20	15	30	20	40	10	25
1.8	86.5	88	120	115	1	10	20	15	30	20	40	10	25
1.8	86.5	88	120	115	1	10	20	15	30	20	40	10	25
3.7	91.5	93	125	120	1	10	25	20	35	25	45	10	30
1.8	91.5	93	125	120	1	10	25	20	35	25	45	10	30
1.8	91.5	93	125	120	1	10	25	20	35	25	45	10	30
1.8	91.5	93	125	120	1	10	25	20	35	25	45	10	30
1.8	91.5	93	125	120	1	10	25	20	35	25	45	10	30
1.1	98	100	133.5	129	1	10	25	20	35	25	45	10	30
1.6	103	105	138.5	134	1	10	25	20	35	25	45	10	30
1.1	108	110	143.5	139	1	10	25	20	35	25	45	10	30
1.6	114	116	153.5	148	1	10	25	20	35	25	50	10	30
2.1	119	121	163.5	157	1	10	25	20	35	25	50	10	30
1.8	129	131	173.5	167	1	10	25	20	35	25	50	10	30
3.3	139	142	193.5	184	1	15	30	25	40	30	60	10	35
3.8	149	152	203.5	194	1	15	30	25	40	30	60	10	35
3.8	161	164	217	208	1.5	15	35	30	50	35	65	10	35
1.9	171	174	232	221	1.5	15	35	30	50	35	65	10	35
2.9	181	185	249	239	2	15	35	30	50	35	75	10	40
1.5	191	195	269	258	2	15	35	30	50	35	75	10	40
1.5	201	205	279	268	2	20	40	30	50	40	80	15	45
3.0	211	215	299	284	2	20	40	30	50	40	80	15	45
3.5	233	238	327	313	2.5	20	45	35	60	45	90	15	50
3.5	253	258	347	333	2.5	25	50	40	65	50	100	15	50
3.8	276	281	384	367	3	25	55	40	70	55	110	20	55
5.3	316	322	444	424	3	30	60	45	75	60	120	20	60
5.3	336	342	464	444	3	30	65	45	80	65	135	20	65
4.3	360	367	500	479	4	30	65	45	80	65	135	20	65
4.3	380	387	520	499	4	35	75	50	90	75	150	25	75
5.8	420	428	580	554.5	4	35	75	50	90	75	150	25	75

For additional information:
- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **25-65** mm

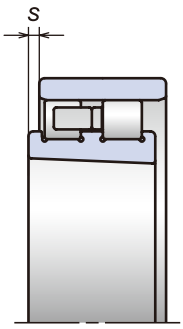
Double-Row Cylindrical Roller Bearings

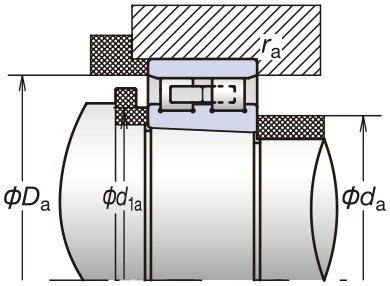


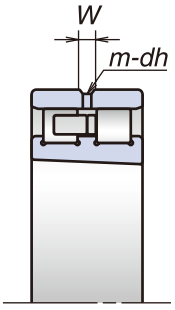
Cylindrical Bore　　Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) GN gauges are available for bearing designations with asterisk (*). For details, refer to Page 180.
(3) For details on limiting speeds, refer to Page 216.
(4) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(5) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

([4]) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	CC9 ([5]) min.	CC9 ([5]) max.	CC0 min.	CC0 max.	CC1 min.	CC1 max.	CC1 min.	CC1 max.	Hole Dia. dh	Oil Groove Width W	Number of Holes m
0.8	29	29	43	42	0.6	5	10	8	15	10	25	5	15	2	3.5	4
1.3	35	36	50	50	1	5	10	8	15	10	25	5	15	2	3.5	4
1.3	35	36	50	50	1	5	10	8	15	10	25	5	15	2	3.5	4
1.3	35	36	50	50	1	5	10	8	15	10	25	5	15	2	3.5	4
1.3	40	41	57	56	1	5	12	8	15	12	25	5	15	2	3.5	4
1.3	40	41	57	56	1	5	12	8	15	12	25	5	15	2	3.5	4
1.3	40	41	57	56	1	5	12	8	15	12	25	5	15	2	3.5	4
1.4	45	46	63	62	1	5	12	8	15	12	25	5	15	2	3.5	4
1.4	45	46	63	62	1	5	12	8	15	12	25	5	15	2	3.5	4
1.4	45	46	63	62	1	5	12	8	15	12	25	5	15	2	3.5	4
1.2	50	51	70	69	1	5	15	10	20	15	30	5	18	2	3.5	4
1.2	50	51	70	69	1	5	15	10	20	15	30	5	18	2	3.5	4
1.2	50	51	70	69	1	5	15	10	20	15	30	5	18	2	3.5	4
1.2	55	56	75	74	1	5	15	10	20	15	30	5	18	2	3.5	4
1.2	55	56	75	74	1	5	15	10	20	15	30	5	18	2	3.5	4
1.2	55	56	75	74	1	5	15	10	20	15	30	5	18	2	3.5	4
1.4	61.5	62	83.5	83	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	61.5	62	83.5	83	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	61.5	62	83.5	83	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	66.5	67	88.5	88	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	66.5	67	88.5	88	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	66.5	67	88.5	88	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	71.5	72	93.5	93	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	71.5	72	93.5	93	1	5	15	10	20	15	35	5	20	2	3.5	4
1.4	71.5	72	93.5	93	1	5	15	10	20	15	35	5	20	2	3.5	4

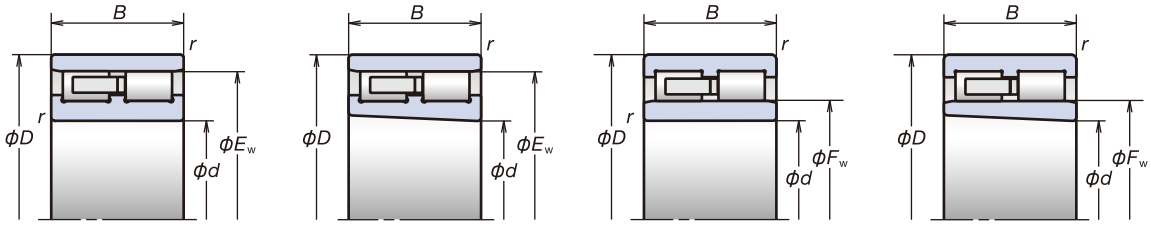
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **70-105** mm

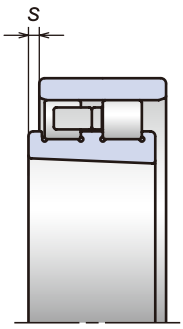
Double-Row Cylindrical Roller Bearings

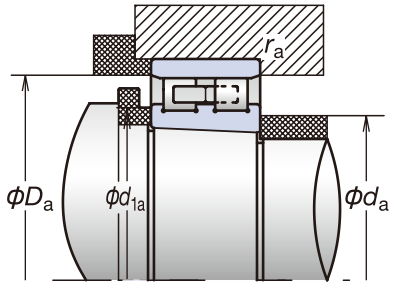


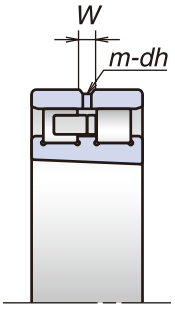
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

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
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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) GN gauges are available for bearing designations with asterisk (*). For details, refer to Page 180.
(3) For details on limiting speeds, refer to Page 216.
(4) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(5) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

(^{4}) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
						CC9 (^{5})		CC0		CC1		CC1		Hole Dia.	Oil Groove Width	Number of Holes
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	min.	max.	min.	max.	min.	max.	min.	max.	dh	W	m
1.2	76.5	77	103.5	102	1	10	20	15	30	20	40	10	25	2	3.5	4
1.2	76.5	77	103.5	102	1	10	20	15	30	20	40	10	25	2	3.5	4
1.2	76.5	77	103.5	102	1	10	20	15	30	20	40	10	25	2	3.5	4
1.2	81.5	82	108.5	107	1	10	20	15	30	20	40	10	25	2	3.5	4
1.2	81.5	82	108.5	107	1	10	20	15	30	20	40	10	25	2	3.5	4
1.2	81.5	82	108.5	107	1	10	20	15	30	20	40	10	25	2	3.5	4
1.7	86.5	87	118.5	115	1	10	20	15	30	20	40	10	25	2.5	5	4
1.7	86.5	87	118.5	115	1	10	20	15	30	20	40	10	25	2.5	5	4
1.7	86.5	87	118.5	115	1	10	20	15	30	20	40	10	25	2.5	5	4
2.2	91.5	92	123.5	120	1	10	25	20	35	25	45	10	30	2.5	5	4
2.2	91.5	92	123.5	120	1	10	25	20	35	25	45	10	30	2.5	5	4
2.2	91.5	92	123.5	120	1	10	25	20	35	25	45	10	30	2.5	5	4
1.4	98	99	132	129	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	98	99	132	129	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	98	99	132	129	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	103	104	137	134	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	103	104	137	134	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	103	104	137	134	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.2	106.5	108	133.5	132	1	10	25	20	35	25	45	10	30	2	3.5	4
1.2	106.5	108	133.5	132	1	10	25	20	35	25	45	10	30	2.5	5	4
1.2	106.5	108	133.5	—	1	10	25	20	35	25	45	10	30	2.5	5	4
1.4	108	109	142	139	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	108	109	142	139	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.4	108	109	142	139	1.5	10	25	20	35	25	45	10	30	2.5	5	4
1.2	111.5	113	138.5	137	1	10	25	20	35	25	50	10	30	2.5	5	4
1.2	111.5	113	138.5	—	1	10	25	20	35	25	50	10	30	2.5	5	4
2.7	114	115	151	148	2	10	25	20	35	25	50	10	30	3	6	4
2.7	114	115	151	148	2	10	25	20	35	25	50	10	30	3	6	4
2.7	114	115	151	148	2	10	25	20	35	25	50	10	30	3	6	4

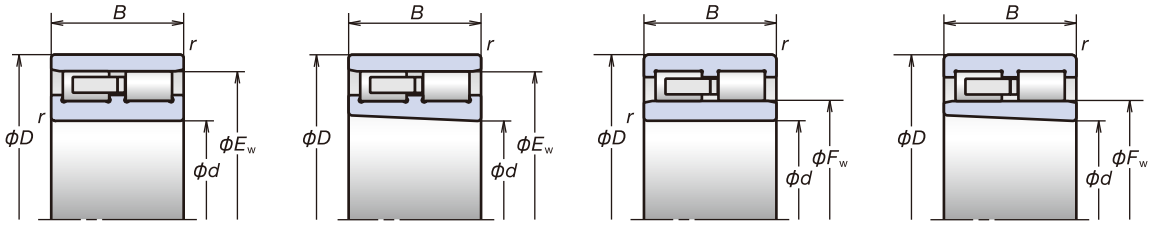
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **110-160** mm

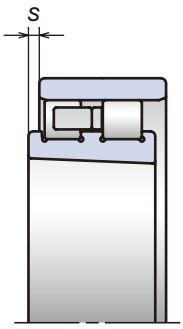
Double-Row Cylindrical Roller Bearings

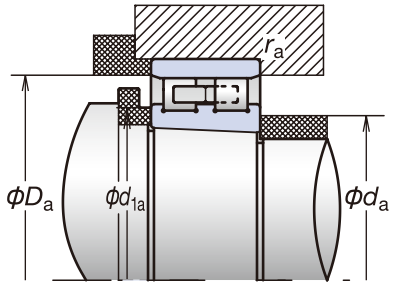


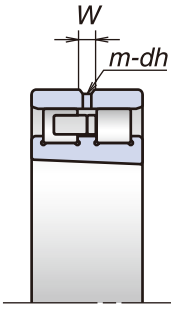
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) GN gauges are available for bearing designations with asterisk (*). For details, refer to Page 180.
(3) For details on limiting speeds, refer to Page 216.
(4) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(5) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

([4]) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
s	d_a	d_{1a}	D_a		r_a	CC9 ([5])		CC0		CC1		CC1		Hole Dia.	Oil Groove Width	Number of Holes
	(min.)	(min.)	(max.)	(min.)	(max.)	min.	max.	min.	max.	min.	max.	min.	max.	dh	W	m
1.2	116.5	118	143.5	142	1	10	25	20	35	25	50	10	30	2	3.5	4
1.2	116.5	118	143.5	142	1	10	25	20	35	25	50	10	30	2.5	5	4
1.2	116.5	118	143.5	—	1	10	25	20	35	25	50	10	30	2.5	5	4
1.4	119	121	161	157	2	10	25	20	35	25	50	10	30	3	6	4
1.4	119	121	161	157	2	10	25	20	35	25	50	10	30	3	6	4
1.4	119	121	161	157	2	10	25	20	35	25	50	10	30	3	6	4
1.7	126.5	128	158.5	156	1	10	25	20	35	25	50	10	30	2.5	5	4
2.7	126.5	128	158.5	156	1	10	25	20	35	25	50	10	30	3	6	4
2.1	126.5	128	158.5	—	1	10	25	20	35	25	50	10	30	3	6	4
1.4	129	131	171	167	2	10	25	20	35	25	50	10	30	3	6	4
1.4	129	131	171	167	2	10	25	20	35	25	50	10	30	3	6	4
1.4	129	131	171	167	2	10	25	20	35	25	50	10	30	3	6	4
1.4	138	140	172	169	1.5	15	30	25	40	30	60	10	35	2.5	5	4
1.2	138	140	172	170	1.5	15	30	25	40	30	60	10	35	3	6	4
1.2	138	140	172	—	1.5	15	30	25	40	30	60	10	35	3	6	4
2.4	139	141	191	185	2	15	30	25	40	30	60	10	35	4	8	4
2.4	139	141	191	185	2	15	30	25	40	30	60	10	35	4	8	4
2.4	139	141	191	185	2	15	30	25	40	30	60	10	35	4	8	4
1.2	148	150	182	180	1.5	15	30	25	40	30	60	10	35	2.5	5	4
1.7	148	150	182	180	1.5	15	30	25	40	30	60	10	35	3	6	4
1.7	148	150	182	—	1.5	15	30	25	40	30	60	10	35	3	6	4
1.3	149	151	201	195	2	15	30	25	40	30	60	10	35	4	8	4
1.3	149	151	201	195	2	15	30	25	40	30	60	10	35	4	8	4
1.3	149	151	201	195	2	15	30	25	40	30	60	10	35	4	8	4
1.4	159	162	201	197	2	15	35	30	50	35	65	10	35	3	6	4
1.3	159	162	201	197	2	15	35	30	50	35	65	10	35	4	8	4
1.3	159	162	201	—	2	15	35	30	50	35	65	10	35	4	8	4
2.4	161	162	214	209	2	15	35	30	50	35	65	10	35	4	8	4
2.4	161	162	214	209	2	15	35	30	50	35	65	10	35	4	8	4
2.4	161	162	214	209	2	15	35	30	50	35	65	10	35	4	8	4
1.4	169	172	211	207	2	15	35	30	50	35	65	10	35	3	6	4
1.3	169	172	211	207	2	15	35	30	50	35	65	10	35	4	8	4
1.3	169	172	211	—	2	15	35	30	50	35	65	10	35	4	8	4
2.3	171	172	229	222	2	15	35	30	50	35	65	10	35	4	8	4
2.3	171	172	229	222	2	15	35	30	50	35	65	10	35	4	8	4
2.3	171	172	229	222	2	15	35	30	50	35	65	10	35	4	8	4

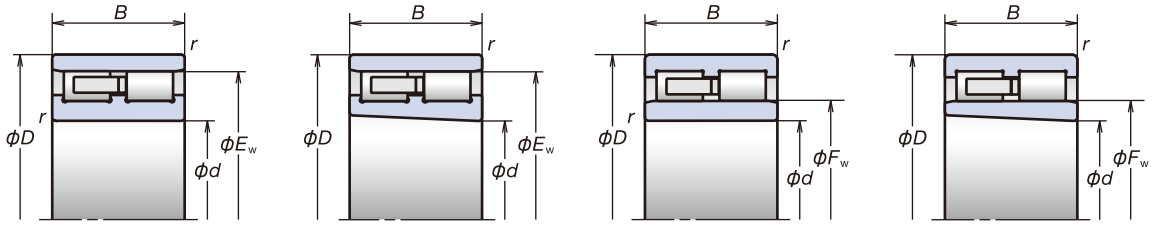
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **170-260** mm

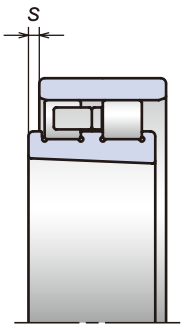
Double-Row Cylindrical Roller Bearings

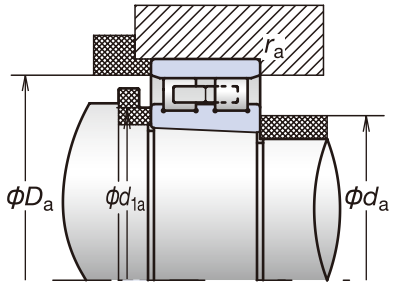


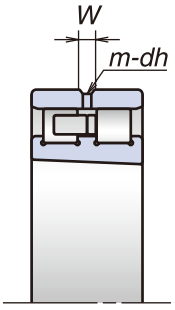
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

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
NNU4944MBKR	**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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) For details on limiting speeds, refer to Page 216.
(3) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(4) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

([3]) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	CC9 ([4]) min.	CC9 ([4]) max.	CC0 min.	CC0 max.	CC1 min.	CC1 max.	CC1 min.	CC1 max.	Hole Dia. dh	Oil Groove Width W	Number of Holes m
1.4	179	182	221	217	2	15	35	30	50	35	75	10	40	3	6	4
1.3	179	182	221	217	2	15	35	30	50	35	75	10	40	4	8	4
1.3	179	182	221	—	2	15	35	30	50	35	75	10	40	4	8	4
2.4	181	183	249	239	2	15	35	30	50	35	75	10	40	5	9	4
1.5	189	193	241	234	2	15	35	30	50	35	75	10	40	4	8	4
1.3	189	193	241	234	2	15	35	30	50	35	75	10	40	5	9	4
1.3	189	193	241	—	2	15	35	30	50	35	75	10	40	5	9	4
2.9	191	193	269	258	2	15	35	30	50	35	75	10	40	5	9	4
2.4	199	203	251	246	2	20	40	30	50	40	80	15	45	4	8	4
1.3	199	203	251	246	2	20	40	30	50	40	80	15	45	5	9	4
1.3	199	203	251	—	2	20	40	30	50	40	80	15	45	5	9	4
1.1	201	203	279	268	2	20	40	30	50	40	80	15	45	5	9	4
2.3	211	214	269	261	2	20	40	30	50	40	80	15	45	4	8	4
3.3	211	214	269	261	2	20	40	30	50	40	80	15	45	5	9	4
3.3	211	214	269	—	2	20	40	30	50	40	80	15	45	5	9	4
2.5	211	214	299	285	2	20	40	30	50	40	80	15	45	6	12	4
2.3	231	234	289	281	2	20	45	35	60	45	90	15	50	4	8	4
3.3	231	234	289	281	2	20	45	35	60	45	90	15	50	5	9	4
3.3	231	234	289	—	2	20	45	35	60	45	90	15	50	5	9	4
3.2	233	236	327	313	2.5	20	45	35	60	45	90	15	50	6	12	4
2.3	251	254	309	302	2	25	50	40	65	50	100	15	50	4	8	4
1.8	251	254	309	302	2	25	50	40	65	50	100	15	50	5	9	4
3.3	251	254	309	—	2	25	50	40	65	50	100	15	50	5	9	4
3.5	253	256	347	334	2.5	25	50	40	65	50	100	15	50	6	12	4
1.1	271	275	349	338	2	25	55	40	70	55	110	20	55	5	9	4
2.4	271	275	349	338	2	25	55	40	70	55	110	20	55	6	12	4
2.4	271	275	349	—	2	25	55	40	70	55	110	20	55	6	12	4
3.8	276	278	384	368	3	25	55	40	70	55	110	20	55	6	12	4

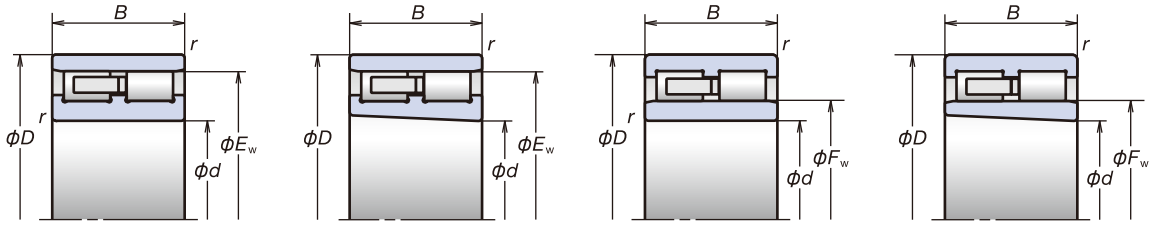
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **280-420** mm

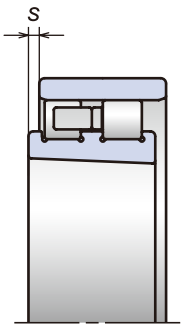
Double-Row Cylindrical Roller Bearings

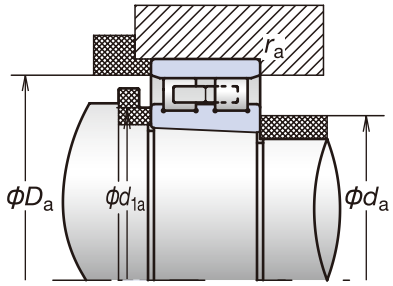


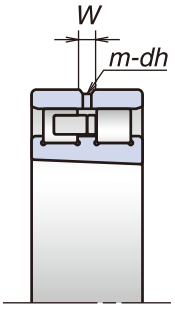
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) For details on limiting speeds, refer to Page 216.
(3) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(4) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

([3]) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	CC9 ([4]) min.	CC9 ([4]) max.	CC0 min.	CC0 max.	CC1 min.	CC1 max.	CC1 min.	CC1 max.	Hole Dia. dh	Oil Groove Width W	Number of Holes m
1.1	291	295	369	358	2	25	55	40	70	55	110	20	55	5	9	4
2.4	291	295	369	358	2	25	55	40	70	55	110	20	55	6	12	4
2.4	291	295	369	—	2	25	55	40	70	55	110	20	55	6	12	4
3.5	296	298	404	388	3	25	55	40	70	55	110	20	55	6	12	4
2.2	313	318	407	391	2.5	30	60	45	75	60	120	20	60	6	12	4
2.5	313	318	407	391	2.5	30	60	45	75	60	120	20	60	6	12	4
2.5	313	318	407	—	2.5	30	60	45	75	60	120	20	60	6	12	4
4.8	316	319	444	422	3	30	60	45	75	60	120	20	60	6	12	4
2.2	333	338	427	411	2.5	30	65	45	80	65	135	20	65	6	12	4
3.5	333	338	427	411	2.5	30	65	45	80	65	135	20	65	6	12	4
2.5	333	338	427	—	2.5	30	65	45	80	65	135	20	65	6	12	4
5.3	336	340	464	442	3	30	65	45	80	65	135	20	65	8	15	4
3.0	353	363	447	431	2.5	30	65	45	80	65	135	20	65	6	12	4
3.0	353	363	447	—	2.5	30	65	45	80	65	135	20	65	6	12	4
6.8	360	365	500	477	4	30	65	45	80	65	135	20	65	8	15	4
2.2	373	381	467	451	2.5	35	75	50	90	75	150	25	75	6	12	4
3.0	373	383	467	451	2.5	35	75	50	90	75	150	25	75	6	12	4
3.0	373	383	467	—	2.5	35	75	50	90	75	150	25	75	6	12	4
7.0	380	385	520	497	4	35	75	50	90	75	150	25	75	8	15	4
3.5	396	405	504	487	3	35	75	50	90	75	150	25	75	6	12	4
3.8	396	408	504	488	3	35	75	50	90	75	150	25	75	8	15	4
3.8	396	408	504	—	3	35	75	50	90	75	150	25	75	8	15	4
7.3	400	411	540	518	4	35	75	50	90	75	150	25	75	8	15	4
3.5	416	428	524	508	3	35	75	50	90	75	150	25	75	8	15	4
3.5	416	428	524	—	3	35	75	50	90	75	150	25	75	8	15	4
2.3	420	432	580	553	4	35	75	50	90	75	150	25	75	8	15	4
4.0	436	448	544	528	3	40	85	60	105	85	170	25	85	8	15	4
3.5	436	448	544	—	3	40	85	60	105	85	170	25	85	8	15	4
2.8	440	453	600	573	4	40	85	60	105	85	170	25	85	8	15	4

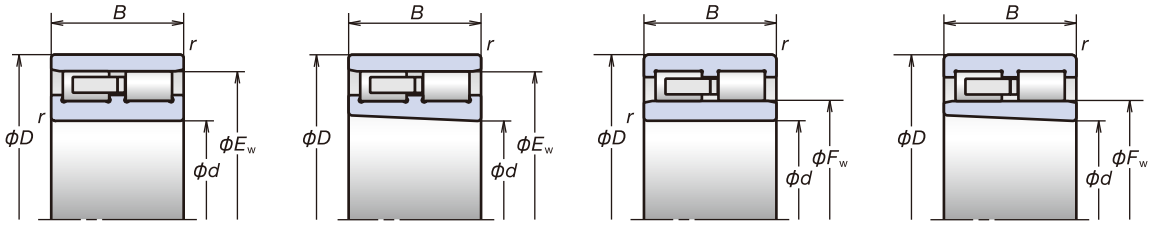
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

2. Cylindrical Roller Bearings

Bore Diameter **440-800** mm

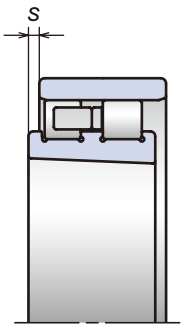
Double-Row Cylindrical Roller Bearings

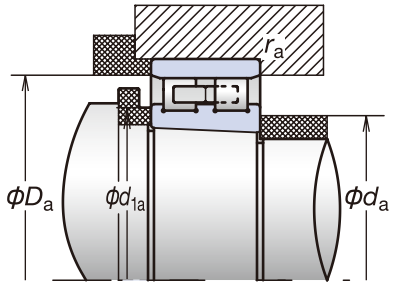


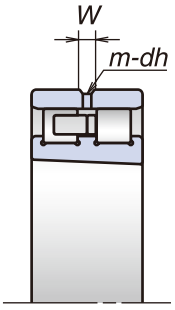
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

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) Designations listed here are suffixed with "K" or "KR" to indicate tapered bores (1:12). For cylindrical bores, omit this code.
(2) For details on limiting speeds, refer to Page 216.
(3) Axial displacement refers the allowable amount that the outer and inner rings may move from their normal positions in the axial direction.
(4) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.







E44 Specification

([3]) Axial Displacement (mm)	Abutment and Fillet Dimensions (mm)					Clearances in Bearings with Tapered Bores (μm)						Clearances in Bearings with Cylindrical Bores (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
						CC9 ([4])		CC0		CC1		CC1				
s	d_a (min.)	d_{1a} (min.)	D_a (max.)	D_a (min.)	r_a (max.)	min.	max.	min.	max.	min.	max.	min.	max.	Hole Dia. dh	Oil Groove Width W	Number of Holes m
3.3	456	469	584	562	3	40	85	60	105	85	170	25	85	8	15	4
3.3	456	469	584	—	3	40	85	60	105	85	170	25	85	8	15	4
3.0	466	479	624	601	5	40	85	60	105	85	170	25	85	8	15	4
3.8	476	486	604	581	3	45	95	70	120	95	190	25	95	6	12	4
3.3	476	489	604	582	3	45	95	70	120	95	190	25	95	8	15	4
3.3	476	489	604	—	3	45	95	70	120	95	190	25	95	8	15	4
3.5	486	500	654	628	5	45	95	70	120	95	190	25	95	10	18	4
2.0	500	514	630	610	4	45	95	70	120	95	190	25	95	10	18	4
2.0	500	514	630	—	4	45	95	70	120	95	190	25	95	10	18	4
4.3	506	520	674	648	5	45	95	70	120	95	190	25	95	10	18	4
3.8	520	534	650	630	4	45	95	70	120	95	190	25	95	10	18	4
3.8	520	534	650	—	4	45	95	70	120	95	190	25	95	10	18	4
5.5	526	540	694	668	5	45	95	70	120	95	190	25	95	10	18	4
4.0	550	561	690	668	4	50	105	80	135	105	210	30	105	8	15	4
3.0	550	565	690	667	4	50	105	80	135	105	210	30	105	10	18	4
3.0	550	565	690	—	4	50	105	80	135	105	210	30	105	10	18	4
4.2	556	571	754	720	5	50	105	80	135	105	210	30	105	10	18	4
2.3	580	596	730	704	4	50	105	80	135	105	210	30	105	10	18	4
2.2	580	596	730	—	4	50	105	80	135	105	210	30	105	10	18	4
3.3	620	637	780	752	4	55	115	85	145	115	230	30	115	10	18	4
3.3	620	637	780	—	4	55	115	85	145	115	230	30	115	10	18	4
2.8	656	674	824	796	5	55	115	85	145	115	230	30	115	12	20	4
2.7	656	674	824	—	5	55	115	85	145	115	230	30	115	12	20	4
6.3	696	715	874	841	5	60	130	90	160	130	260	30	130	12	20	4
6.2	696	715	874	—	5	60	130	90	160	130	260	30	130	12	20	4
11.4	736	756	924	—	5	60	130	90	160	130	260	30	130	12	20	4
7.1	776	797	974	—	5	70	150	110	190	145	290	35	145	12	20	4
8.9	826	848	1 034	—	5	70	150	110	190	145	290	35	145	12	20	4

For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Nozzle Position ····· P240
- Recommended Grease Quantities ·· P257

3. Angular Contact Thrust Ball Bearings



High-Speed Angular Contact Thrust Ball Bearings

NSKROBUST Series



Angular Contact Thrust Ball Bearings

NSKTAC F Series



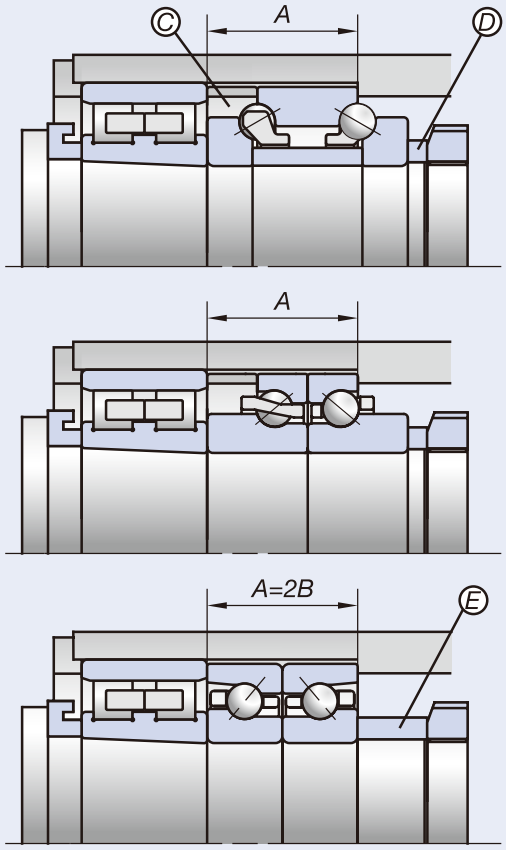
Double-Direction Angular Contact Thrust Ball Bearings

NSKTAC D Series

Angular Contact Thrust Ball Bearings

Angular Contact Thrust Ball Bearings ·····130-141
Features
Numbering System
Bearing Tables
High-Speed Angular Contact Thrust BallBearings (NSKROBUST Series)
BAR10 Series
BTR10 Series
Angular Contact Thrust BallBearings (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 outside diameter tolerances in order to provide clearance between the outside 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.

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

Designation example: **100 TAC 20F M E44 DB EL P4A**

- 100 — Nominal bore diameter
- TAC — Bearing type
- 20F — Dimension series
- M — Cage
- E44 — Lubrication holes
- DB — Arrangement
- EL — Preload
- P4A — Accuracy

			Reference pages
100	Nominal bore diameter	Bore diameter (mm) (50-130mm)	138-139
TAC	Bearing type	TAC: Angular contact thrust ball bearing	26
20F	Dimension series	20F: For combination with NN30 series 29F: For combination with NN39 and NN49 series	138-139
M	Cage	M: Machined brass cage	—
E44	Lubrication holes	No code: No lubrication holes E44: Lubrication groove and lubrication holes on outer ring	138-139
DB	Arrangement	DB: Back-to-back arrangement	200-205
EL	Preload	L: Light preload (standard for this series) EL: Extra light preload	210
P4A	Preload	P4A: Outside diameter tolerances are NSK-specific, all others are ISO Class 4 P5A: Outside diameter tolerances are NSK-specific, all others are ISO Class 5	228

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

Designation example: **100 BAR 10 S TYN DB L P4A**

- 100 — Nominal bore diameter
- BAR — Bearing type
- 10 — Dimension series
- S — Material
- TYN — Cage
- DB — Arrangement
- L — Preload
- P4A — Accuracy

			Reference pages
100	Nominal bore diameter	Bore diameter (mm)	132-137
BAR	Bearing type	BAR: 30° contact angle BTR: 40° contact angle	26, 44-45
10	Dimension series	10: 10 Series bore and outside diameter, special width	132-137
S	Material	See material table below	14-17, 26
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 code: Outer ring guided machined brass cage TYN cage is available up to 160mm bore diameter bearings	18
DB	Arrangement	DB: Back-to-back arrangement	200-205
L	Preload	L: Light preload (standard for this series) EL: Extra light preload	132-137, 210
P4A	Accuracy	P2A: Outside diameter tolerances are NSK-specific, all others are ISO Class 2 P4A: Outside diameter tolerances are NSK-specific, all others are ISO Class 4	228

Type	Material	
	Inner/Outer ring	Rolling elements
S	Bearing steel (SUJ2)	Bearing steel (SUJ2)
E	Bearing steel (SUJ2)	Ultra long life bearing rolling elements (EQTF)
H	Bearing steel (SUJ2)	Ceramics (Si_3N_4)

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

Designation example: **150 TAC 20D MY PN7 +L C6**

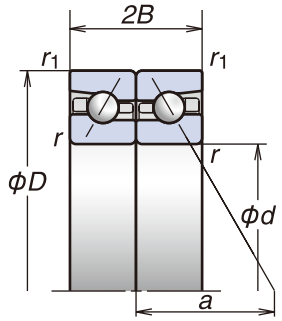
- 150 — Nominal bore diameter
- TAC — Bearing type
- 20D — Dimension series
- MY — Cage
- PN7 — Accuracy
- +L — Spacer
- C6 — Preload

			Reference pages
150	Nominal bore diameter	Bore diameter (mm) (140-320mm)	140-141
TAC	Bearing type	TAC: Angular contact thrust ball bearing	26
20D	Dimension series	20D, 20X: For combination with NN30 series 29D: For combination with NN39 and NN49 series	140-141
MY	Cage	MY: Machined brass cage	–
PN7	Accuracy	PN7: Special precision accuracy	228
+L	Spacer	Inner ring spacer	–
C6	Preload	C6: Extra light preload C7: Light preload (standard for this series) C8: Medium preload	140-141

3. Angular Contact Thrust Ball Bearings

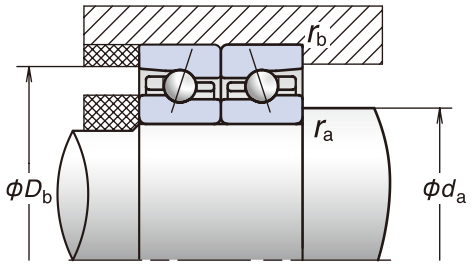
Bore Diameter **50-85** mm

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



Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Effective Load Center (mm) a	Mass (kg/row) (Reference)	Limiting Speeds (2) (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	26.5	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	30.0	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	33.5	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	38.0	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	36.5	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	41.5	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	39.5	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	45.0	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	53.0	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	60.0	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	55.5	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	63.0	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	65.5	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	74.5	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	68.5	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	78.0	41.0	40	55.2	0.926	7 000	8 900

(1) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. 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.



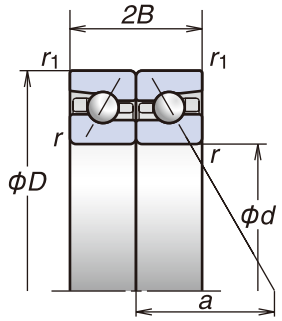
Abutment and Fillet Dimensions (mm)				Preload (DB and DF Arrangement) (N)		Axial Rigidity (DB and DF Arrangement) (N/μm)		Measured Axial Clearance (μm)	
d_a (min.)	D_b (max.)	r_a (max.)	r_b (max.)	EL	L	EL	L	EL	L
56	75	1	0.6	221	464	169	220	− 5	− 10
56	75	1	0.6	246	531	196	257	− 5	− 10
56	75	1	0.6	335	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 ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

3. Angular Contact Thrust Ball Bearings

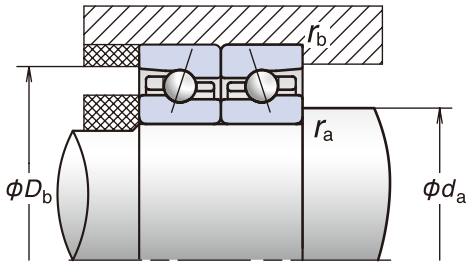
Bore Diameter **90-140** mm

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



Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Effective Load Center (mm)	Mass (kg/row) (Reference)	Limiting Speeds (2) (min^{-1})	
	d	*D*	*2B*	*r* (min.)	r_1 (min.)	C_a (Dynamic)	C_{oa} (Static)			*a*		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	88.5	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	101	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	92.0	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	105	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	96.0	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	109	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	110	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	125	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	125	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	142	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	135	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	153	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	164	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	187	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	191	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	217	100	40	89.2	3.30	4 300	5 500

(1) For details on permissible axial load, refer to Page 199.
(2) For details on limiting speeds, refer to Page 216. 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
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

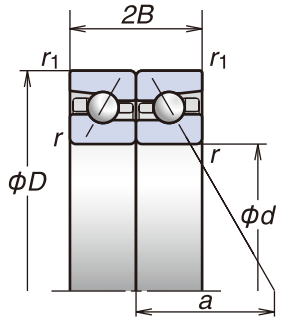
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

3. Angular Contact Thrust Ball Bearings

Bore Diameter **150-380** mm

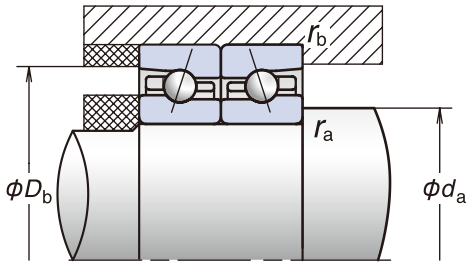
High-Speed Angular Contact Thrust Ball Bearings (NSKROBUST Series)



Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Effective Load Center (mm)	Mass (kg/row) (Reference)	Limiting Speeds (2) (min^{-1})	
	d	*D*	*2B*	*r* (min.)	r_1 (min.)	C_a (Dynamic)	C_{oa} (Static)			*a*		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	224	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	255	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	246	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	280	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) For details on permissible axial load, refer to Page 199.

(2) For details on limiting speeds, refer to Page 216. 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
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	—	—

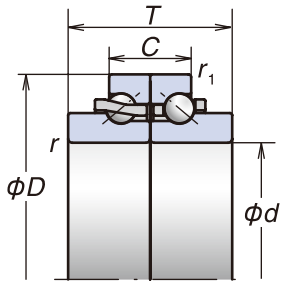
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Spacer Dimensions and Nozzle Position ·· P237
- Recommended Grease Quantities ·· P257

3. Angular Contact Thrust Ball Bearings

Bore Diameter **80-130** mm

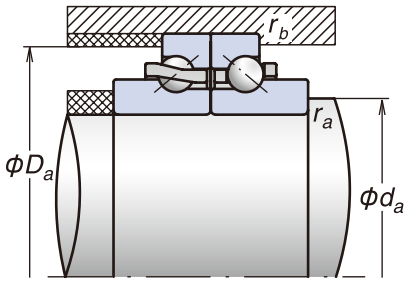
Angular Contact Thrust Ball Bearings (NSKTAC F Series)

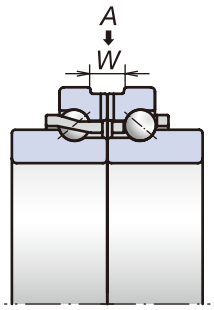


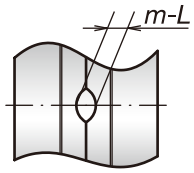
Designation	Boundary Dimensions (mm)						Basic Load Ratings (kN)		Permissible Axial Load (1) (kN)	Contact Angle (°)	Mass (kg/row) (Reference)	Limiting Speeds (2) (min^{-1})	
	d	*D*	*T*	*C*	*r* (min.)	r_1 (min.)	C_a (Dynamic)	C_{oa} (Static)				Grease	Oil
50TAC20F	**50**	**80**	**38**	19	1	0.6	25.3	64.0	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 details on permissible axial load, refer to Page 199.

(2) For details on limiting speeds, refer to Page 216. 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.







Notch Detail (Arrow View A)

E44 Specification

Abutment and Fillet Dimensions (mm)				Preload (N)		Axial rigidity (N/μm)		Measured Axial Clearance (μm)		E44 Specification Lubrication Holes Dimensions (mm)		
d_a	D_a	r_a (max.)	r_b (max.)	EL	L	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	− 5	− 15	8	3	4
69	84	1	0.6	580	2 485	565	934	− 5	− 15	8	3	4
74	89	1	0.6	619	2 677	609	1 010	− 5	− 15	8	3	4
79	94	1	0.6	658	2 868	652	1 086	− 5	− 15	8	3	4
87	104	1	0.6	648	2 814	641	1 062	− 5	− 15	10	4	4
92	109	1	0.6	670	2 920	665	1 104	− 5	− 15	10	4	4
99	117	1	0.6	806	3 236	733	1 181	− 5	− 15	12	5	4
104	122	1	0.6	829	3 348	758	1 225	− 5	− 15	12	5	4
110	131	1.5	1	847	3 428	778	1 254	− 5	− 15	12	5	4
115	136	1.5	1	872	3 548	805	1 301	− 5	− 15	12	5	4
117	134	1	0.6	931	3 839	871	1 418	− 5	− 15	10	4	4
120	141	1.5	1	897	3 667	833	1 348	− 5	− 15	12	5	4
127	150	2	1	925	3 802	864	1 400	− 5	− 15	12	6	4
127	144	1	0.6	996	4 157	944	1 543	− 5	− 15	10	4	4
134	158	2	1	952	3 933	894	1 451	− 5	− 15	14	6	4
139	157	2	1	1 036	4 351	989	1 619	− 5	− 15	10	5	4
144	168	2	1	1 005	4 189	954	1 551	− 5	− 15	14	6	4
150	170	1.5	1	1 102	4 666	1 062	1 741	− 5	− 15	10	5	4
160	187	2	1	956	3 946	898	1 453	− 5	− 15	14	6	4

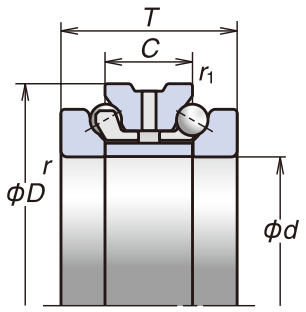
For additional information:

- Dynamic Equivalent Load ····· P191
- Static Equivalent Load ····· P198
- Recommended Grease Quantities ·· P257

3. Angular Contact Thrust Ball Bearings

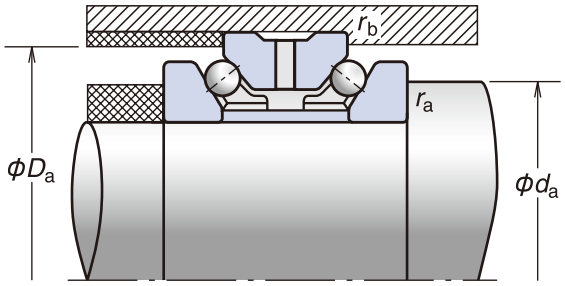
Bore Diameter **140-320** mm

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



Designation	Boundary Dimensions (mm)						Basic Load Ratings (kN)		Permissible Axial Load (2) (kN)	Contact Angle (°)	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) Outside diameter tolerance is f6.
(2) For details on permissible axial load, refer to Page 199.
(3) For details on limiting speeds, refer to Page 216. 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 and 70% when a medium preload (C8) has been selected.



Abutment and Fillet Dimensions (mm)				Preload (N)			Axial rigidity (N/μm)			Measured Axial Clearance (μm)		
d_a	D_a	r_a (max.)	r_b (max.)	C6	C7	C8	C6	C7	C8	C6	C7	C8
167	198	2	1	925	3 675	9 343	1 194	1 898	2 603	− 3	− 10	− 20
172	200	2	1	196	4 116	7 085	775	2 152	2 587	0	− 10	− 15
178	213	2	1	934	4 725	9 467	1 210	2 086	2 639	− 3	− 12	− 20
182	210	2	1	196	4 309	7 432	803	2 263	2 722	0	− 10	− 15
191	228	2	1	1 277	4 837	11 088	1 368	2 140	2 833	− 4	− 12	− 22
192	219	2	1	196	4 502	7 780	830	2 374	2 857	0	− 10	− 15
206	245	2	1	2 078	6 745	13 736	1 650	2 451	3 119	− 6	− 15	− 25
207	238	2	1	1 063	4 409	9 795	1 439	2 319	3 038	− 3	− 10	− 18
220	264	2	1	2 982	6 811	15 473	1 876	2 476	3 268	− 8	− 15	− 27
217	247	2	1	1 102	4 617	10 284	1 508	2 439	3 198	− 3	− 10	− 18
230	274	2	1	3 074	7 039	18 620	1 941	2 565	3 564	− 8	− 15	− 30
230	267	2	1	1 098	4 597	11 866	1 502	2 427	3 344	− 3	− 10	− 20
245	291	2	1	3 083	7 714	18 677	1 947	2 650	3 575	− 8	− 16	− 30
250	287	2	1	1 160	4 933	12 790	1 613	2 621	3 616	− 3	− 10	− 20
272	320	2	1	3 247	4 331	19 791	2 063	2 273	3 794	− 8	− 10	− 30
270	307	2	1	1 202	5 156	13 405	1 688	2 750	3 798	− 3	− 10	− 20
290	341	2.5	1	3 345	9 161	20 465	2 133	2 993	3 927	− 8	− 17	− 30
300	344	2	1	1 193	8 859	13 254	1 671	3 274	3 750	− 3	− 15	− 20
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	− 3	− 15	− 20
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	46 89	—	—	—

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

Part 4

Ball Screw Support Bearings

NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support ···144-153

- Features
- Numbering 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 ·····154-155

- Features
- Numbering 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 feeding mechanisms, 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 feeding mechanisms.

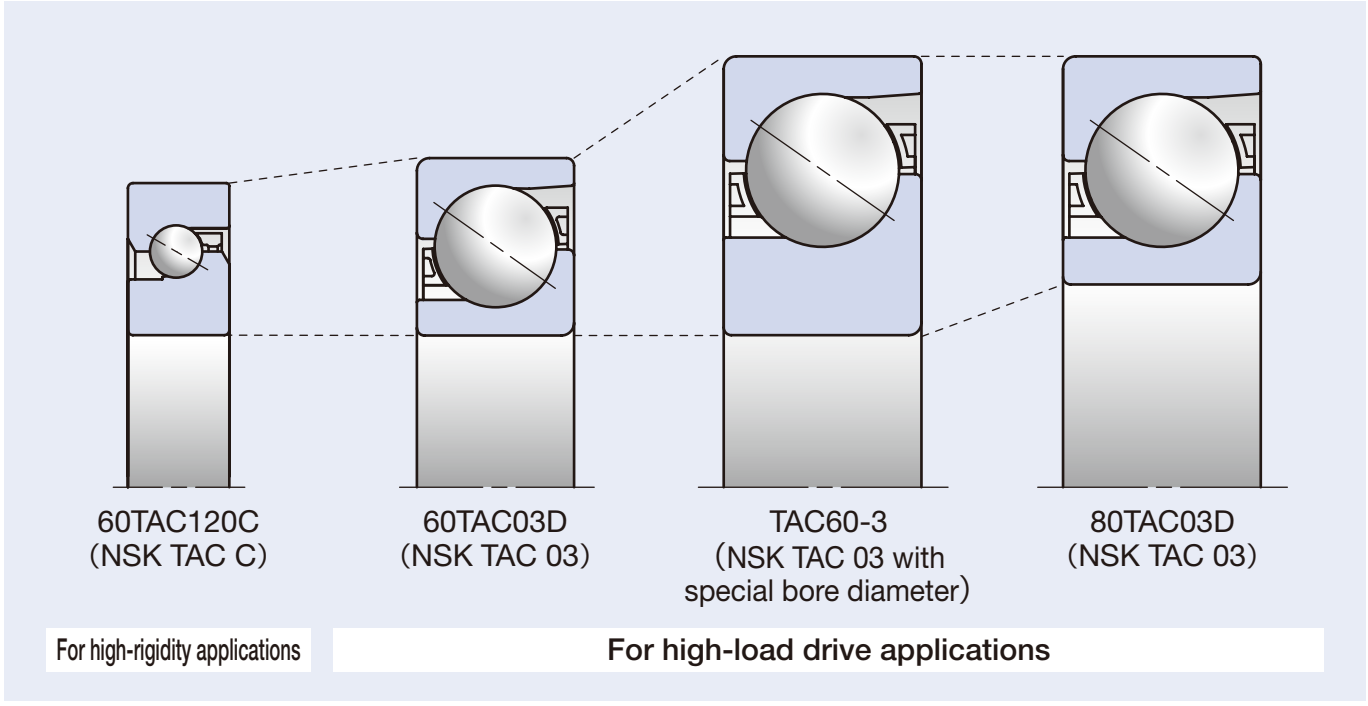
The "DDG" seals used for the sealed bearings of this series are light-contact seals for high-speed capability; a strong sealing effect is achieved by a labyrinth between the seal lip and the seal groove of the inner ring. This ensures that no foreign particles can get into the bearing and no grease can 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 come prepacked with "WPH" grease that resists high temperatures and is less likely to soften and leak.

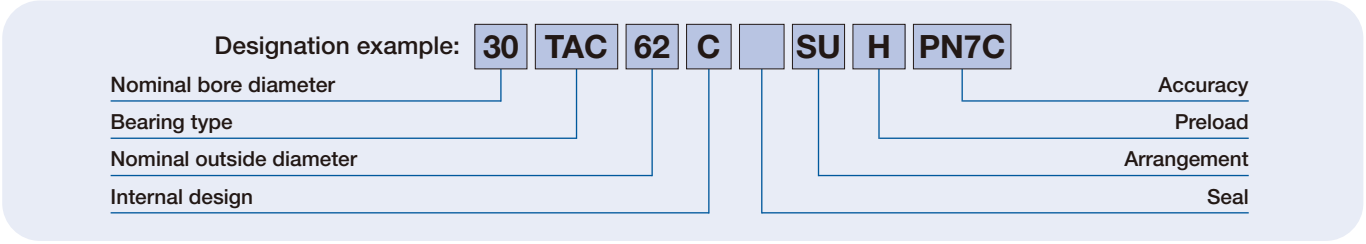
NSKTAC 03 Angular Contact Thrust Ball Bearings for Ball Screw Support in High-Load Drive Applications

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.

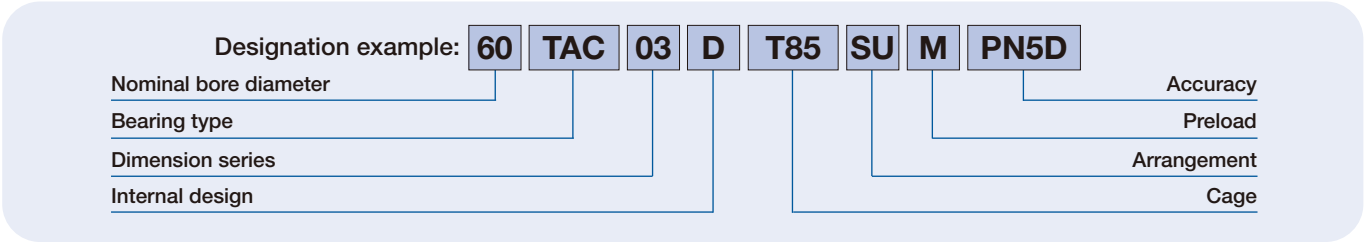


Numbering System of NSKHPS Angular Contact Thrust Ball Bearings for Ball Screw Support (for High-Rigidity Applications)



			Reference pages
30	Nominal bore diameter	Bore diameter (mm)	146-147
TAC	Bearing type	Angular contact thrust ball bearing	28, 144
62	Nominal outside diameter	Outside diameter (mm)	146-147
C	Internal design	Contact angle 60°	—
	Seal	No code: Open type DDG: Contact rubber seal V1V: Non-contact rubber seal	144
SU	Arrangement	SU: Universal arrangement (single-row)	200-205
H	Preload	H: Heavy preload (standard in the HPS Series)	146-147
PN7C	Accuracy	PN7C: NES Class 7C (axial runout equivalent to P2)	229

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



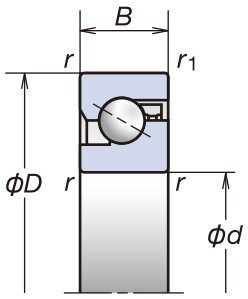
			Reference pages
60	Nominal bore diameter	Bore diameter (mm)	148-149
TAC	Bearing type	Angular contact thrust ball bearing	30, 144
03	Dimension series	02: 02 Series 03: 03 Series	144
D	Internal design	Contact angle 55°	—
T85	Cage	T85: Polyamide cage M:Brass Cage	—
SU	Arrangement	SU: Universal arrangement (single-row)	200-205
M	Preload	M: Medium preload EL: Extra light preload	148-149
PN5D	Accuracy	PN5D: Standard accuracy (equivalent to ISO Class 5)	229

NSKHPS is not applicable for TAC100-3～180TAC03DM.

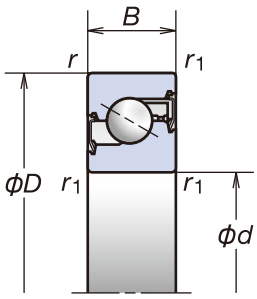
4. Ball Screw Support Bearings

Bore Diameter **15-60** mm

for High-Rigidity



Open type



Sealed type DDG

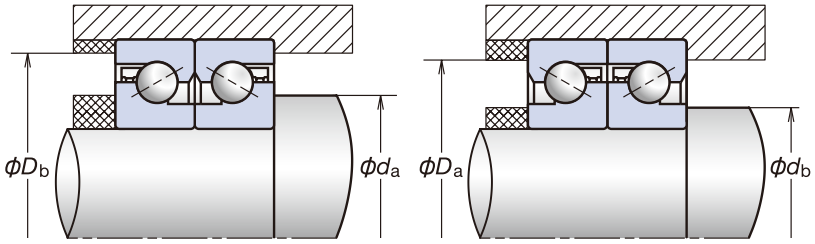
(Open type)

Designation	Boundary Dimensions (mm)					Abutment and Fillet Dimensions (mm)				Recommended Grease Quantities (cc)	Contact Angle (°)	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)

Designation (1)	Boundary Dimensions (mm)					Abutment and Fillet Dimensions (mm)				Contact Angle (°)	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	
***15TAC47CDDG**	**15**	**47**	**15**	1	0.6	42	19.5	41	19.5	60	6 900	0.146
***17TAC47CDDG**	**17**	**47**	**15**	1	0.6	42	22	41	22	60	6 900	0.140
***20TAC47CDDG**	**20**	**47**	**15**	1	0.6	42	25	41	25	60	6 900	0.135
***25TAC62CDDG**	**25**	**62**	**15**	1	0.6	57	30	56	30	60	5 200	0.252
30TAC62CDDG	**30**	**62**	**15**	1	0.6	57	36	56	36	60	4 900	0.224
35TAC72CDDG	**35**	**72**	**15**	1	0.6	67	41	66	41	60	4 100	0.310
40TAC72CDDG	**40**	**72**	**15**	1	0.6	67	46	66	46	60	4 100	0.275
40TAC90CDDG	**40**	**90**	**20**	1	0.6	85	47	84	47	60	3 500	0.674
45TAC100CDDG	**45**	**100**	**20**	1	0.6	93	54	92	54	60	3 000	0.842
50TAC100CDDG	**50**	**100**	**20**	1	0.6	92	59	91	59	60	3 000	0.778
55TAC100CDDG	**55**	**100**	**20**	1	0.6	92	63	91	63	60	3 000	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.

Table B

	DFD ⊘⊘⊘ DBD ⊘⊘⊘	DFF ⊘⊘⊘⊘ DBB ⊘⊘⊘⊘	DFT ⊘⊘⊘⊘ DBT ⊘⊘⊘⊘
Preload factor	1.36	2.00	1.57
Axial rigidity	1.49	2.00	1.89
Starting torque	1.35	2.00	1.55

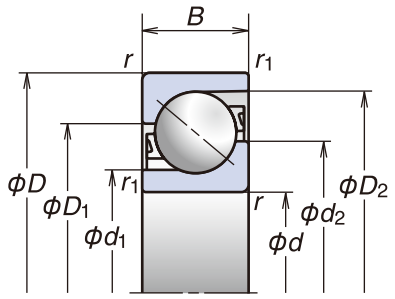
DB/DF Arrangement H preload				Basic dynamic load rating Ca by number of rows sustaining Fa			Limiting static axial load by number of rows sustaining Fa (3)		
Preload (N)	Axial Rigidity (N/μm)	Starting Torque (4) (N·m)	Measured Axial Clearance (μm)	1 row (kN)	2 rows (kN)	3 rows (kN)	1row (kN)	2 rows (kN)	3 rows (kN)
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
2 280	850	0.15	− 15	29.9	48.5	64.5	40.5	81.5	122
2 400	890	0.16	− 15	30.5	50.0	66.0	43.0	86.0	129
2 750	1 030	0.18	− 15	32.5	53.0	70.5	50.0	100	150
2 750	1 030	0.18	− 15	32.5	53.0	70.5	50.0	100	150
2 860	1 080	0.19	− 15	33.5	54.0	72.0	52.0	104	157
3 450	1 150	0.29	− 17	62.0	101	134	89.5	179	269
3 100	1 170	0.20	− 15	34.5	56.0	74.5	57.0	114	170
4 440	1 340	0.40	− 19	64.5	105	140	99.0	198	298
4 650	1 410	0.42	− 19	66.0	107	142	104	208	310
4 650	1 410	0.42	− 19	66.0	107	142	104	208	310
5 450	1 660	0.49	− 19	70.5	115	153	123	246	370
5 450	1 660	0.49	− 19	70.5	115	153	123	246	370

DB and DF Arrangement H preload				Basic dynamic load rating Ca by number of rows sustaining Fa			Limiting static axial load by number of rows sustaining Fa (3)		
Preload (N)	Axial Rigidity (N/μm)	Starting Torque (4) (N·m)	Measured Axial Clearance (μm)	1 row (kN)	2 rows (kN)	3 rows (kN)	1 row (kN)	2 rows (kN)	3 rows (kN)
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
1 450	630	0.09	− 13	23.0	37.5	49.5	26.6	53.0	79.5
2 280	850	0.15	− 15	29.9	48.5	64.5	40.5	81.5	122
2 400	890	0.16	− 15	30.5	50.0	66.0	43.0	86.0	129
2 750	1 030	0.18	− 15	32.5	53.0	70.5	50.0	100	150
2 860	1 080	0.19	− 15	33.5	54.0	72.0	52.0	104	157
3 450	1 150	0.29	− 17	62.0	101	134	89.5	179	269
4 440	1 340	0.40	− 19	64.5	105	140	99.0	198	298
4 650	1 410	0.42	− 19	66.0	107	142	104	208	310
4 650	1 410	0.42	− 19	66.0	107	142	104	208	310

4. Ball Screw Support Bearings

Bore Diameter **15-180** mm

for High-Load Drive Applications



Designation (1)	Boundary Dimensions (mm)					Reference Dimensions (mm)				Recommended Grease Quantities (cc/row)	Contact Angle (°)	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	216.4	223.6	268.3	336	55	1 300	1 700	24.4
***140TAC03DM**	**140**	**300**	**62**	4	1.5	174.3	216.4	223.6	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	227.0	275.6	284.9	338.8	624	55	1 000	1 400	47.0
***180TAC03DM**	**180**	**380**	**75**	4	1.5	227.0	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	DFF	DFT	DFFD	DFFF	DFTD	DFFT	DFTT
	DBD	DBB	DBT	DBBD	DBBB	DBTD	DBBT	DBTT
Preload factor	1.36	2.00	1.57	2.42	3.00	1.72	2.72	1.83
Axial rigidity	1.49	2.00	1.89	2.51	3.00	2.24	2.97	2.57
Starting torque	1.35	2.00	1.55	2.41	3.00	1.68	2.71	1.77

DB and DF Arrangement				Basic dynamic load rating Ca by number of rows sustaining Fa					Limiting static axial load by number of rows sustaining Fa [5]				
Preload [3] (N)	Axial Rigidity [3] (N/μm)	Starting Torque [4] (N·m)	Measured Axial Clearance (μm)	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	− 7	21.0	34.0	45.0	55.5	64.5	18.6	37.5	56.0	74.5	93.0
830	430	0.026	− 10	42.5	69.5	92.0	113	132	38.5	77.0	116	154	193
690	430	0.036	− 8	37.0	60.0	79.5	97.5	114	36.0	72.5	109	145	181
2 500	780	0.26	− 18	113	184	244	299	350	118	235	355	470	590
2 500	780	0.26	− 18	113	184	244	299	350	118	235	355	470	590
3 900	970	0.50	− 23	166	270	360	440	515	181	360	540	720	905
2 800	830	0.31	− 20	133	216	287	350	410	142	283	425	565	710
3 900	970	0.50	− 23	166	270	360	440	515	181	360	540	720	905
3 900	970	0.50	− 23	166	270	360	440	515	181	360	540	720	905
5 200	1 120	0.78	− 26	218	355	470	575	670	242	485	725	965	1 210
4 280	1 060	0.68	− 24	190	310	410	500	585	210	420	630	840	1 050
5 200	1 120	0.78	− 26	218	355	470	575	670	242	485	725	965	1 210
8 050	1 400	1.5	− 33	305	495	660	805	940	390	775	1 170	1 550	1 940
6 400	1 250	1.1	− 29	262	425	565	690	810	305	615	920	1 230	1 530
7 230	1 330	1.3	− 31	283	460	610	750	875	345	690	1 040	1 380	1 730
8 050	1 400	1.5	− 33	305	495	660	805	940	390	775	1 170	1 550	1 940
1 240	880	0.15	− 6	420	685	910	1 110	1 300	510	1 020	1 530	2 040	2 550
1 240	880	0.15	− 6	420	685	910	1 110	1 300	510	1 020	1 530	2 040	2 550
1 620	1 050	0.21	− 7	495	810	1 070	1 310	1 530	680	1 360	2 040	2 720	3 400
1 620	1 050	0.21	− 7	495	810	1 070	1 310	1 530	680	1 360	2 040	2 720	3 400
1 710	1 130	0.24	− 9	605	985	1 310	1 600	1 870	794	1 590	2 380	3 200	3 950
1 710	1 130	0.24	− 9	605	985	1 310	1 600	1 870	794	1 590	2 380	3 200	3 950
1 850	1 240	0.27	− 10	690	1 120	1 490	1 820	2 130	1 040	2 080	3 100	4 150	5 200
1 850	1 240	0.27	− 10	690	1 120	1 490	1 820	2 130	1 040	2 080	3 100	4 150	5 200
1 940	1 310	0.30	− 12	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	− 12	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

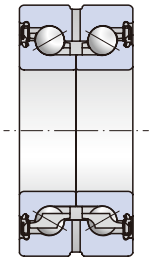
The BSBD Series are double-row bearing units for the support of ball screws that can accurately and quickly position a work piece or a spindle unit.



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

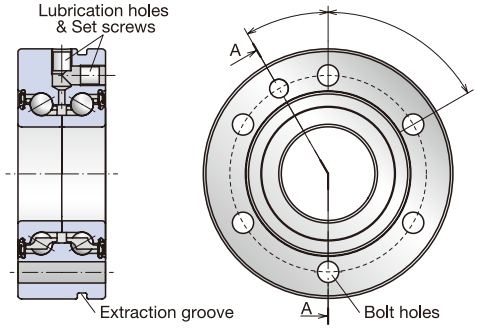


The BSN series of ball screw support bearings are double-row angular contact thrust ball bearings in a back-to-back arrangement, with a single outer ring. The bearings are prepacked with high performance grease. Lubrication holes allow for relubrication during operation if necessary. The contact seal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

Designation	Boundary Dimensions (mm)					Abutment and Fillet Dimensions (mm)		Contact Angle (°)	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_{oa} (Static)					Grease	H (2)	
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

(1) Permissible axial load equals 0.7 times of limiting axial load.
(2) The values indicate starting torque of preloaded bearings, not including seal torque.

NSKHPS BSBD Series

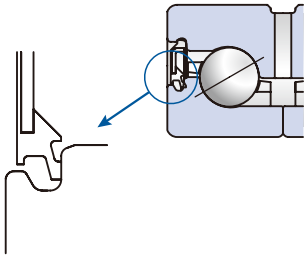
Designation example: **BS F 30 80 DDU H P2B DT**

- Bearing type
- F: Flange type
  N: No flange
- Bore diameter
- Outside diameter
- Seal type
- Preload
- Accuracy
- Arrangement

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

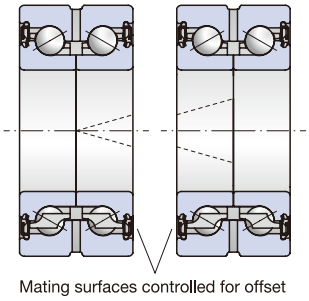
■ Seal

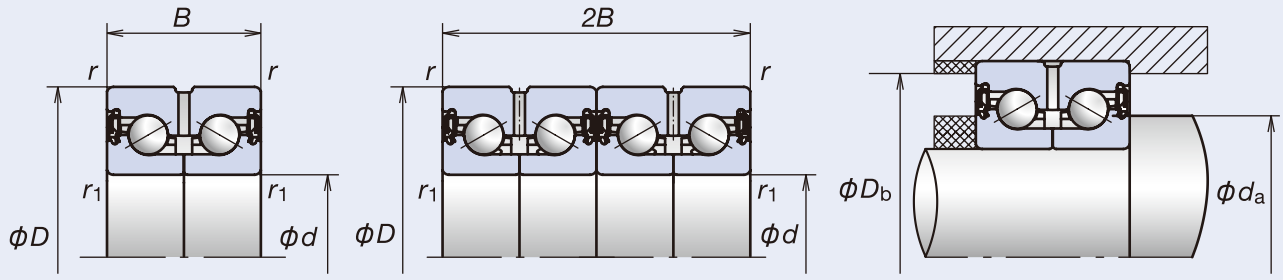
Rubber contact seal on both sides. Triple lip structure provides high grease sealing performance and dust resistance.



■ 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.





Single product　　Matched DT pairs

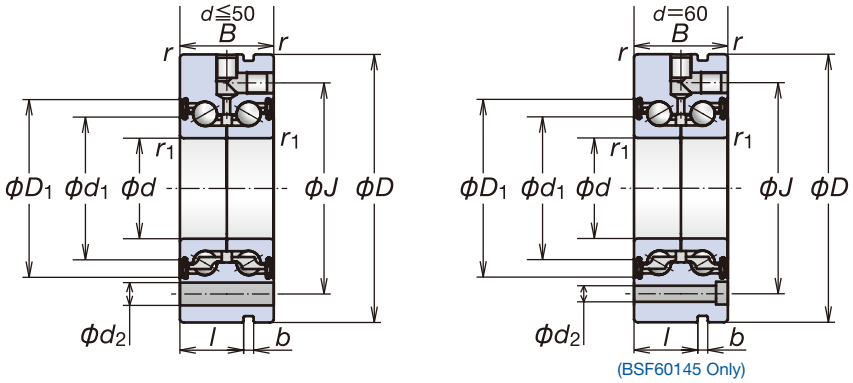
BSN Type Matched DT pairs

Designation	Boundary Dimensions (mm)					Abutment and Fillet Dimensions (mm)		Contact Angle (°)	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_{oa} (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

(3) Inner rings can be separable easily. Please push or pull bearings by clamping innerring at mounting and dismounting.
(4) Abutment and fillet simensionsare recommendable values for the use of standard Machine tool applications. For heavy load applications, please ask NSK

4. Ball Screw Support Bearings

NSKHPS™ BSBD Series



(BSF60145 Only)

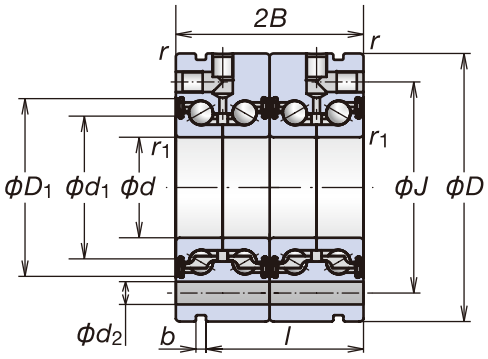
BSF Type Single product

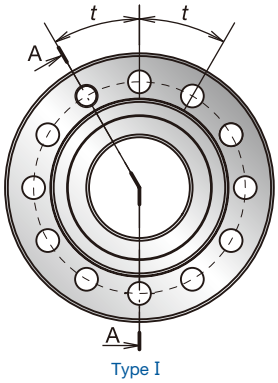
Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Limiting static axial load (1) (kN)	Axial Rigidity (N/μm)	Mass (kg)	Limiting Speeds (min^{-1})
	d	*D*	*B*	*r* (min.)	r_1 (min.)	C_a (Dynamic)	C_{oa} (Static)				Grease
BSF1255	**12**	**55**	**25**	0.6	0.3	18.5	24.0	17.6	375	0.37	8 000
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

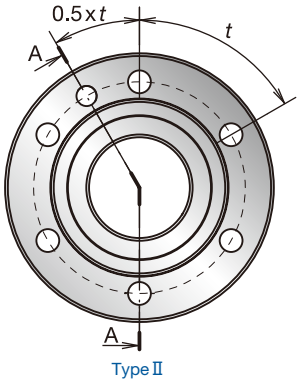
Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Limiting static axial load (1) (kN)	Axial Rigidity (N/μm)	Mass (kg)	Limiting Speeds (min^{-1})
	d	*D*	*2B*	*r* (min.)	r_1 (min.)	C_a (Dynamic)	C_{oa} (Static)				Grease
BSF1762-DT	**17**	**62**	**50**	0.6	0.6	33.0	59.5	42.5	790	0.890	6 700
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.





Type Ⅰ



Type Ⅱ

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		H	
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	H	
28.1	37.7	48	6.8	42	3	6 x 60°	Ⅰ	M6	5	0.10	4 400
32.6	43	53	6.8	47	3	8 x 45°	Ⅰ	M6	7	0.26	7 600
37.6	48	58	6.8	47	3	8 x 45°	Ⅰ	M6	7	0.32	8 100
42.6	53	63	6.8	47	3	12 x 30°	Ⅰ	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°	Ⅰ	M8	7	0.41	13 500
55.1	67.2	80	8.8	59	3	8 x 45°	Ⅰ	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°	Ⅰ	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

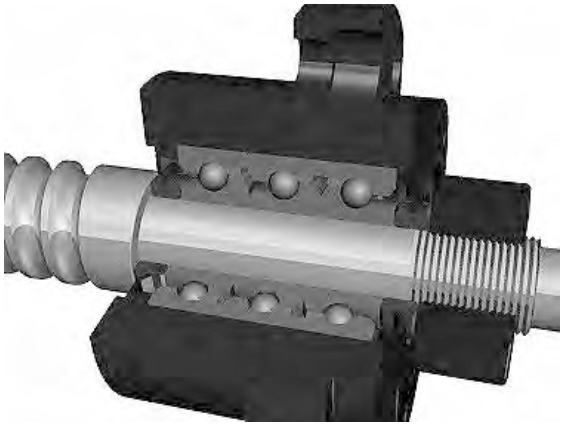
Ball Screw Support Units

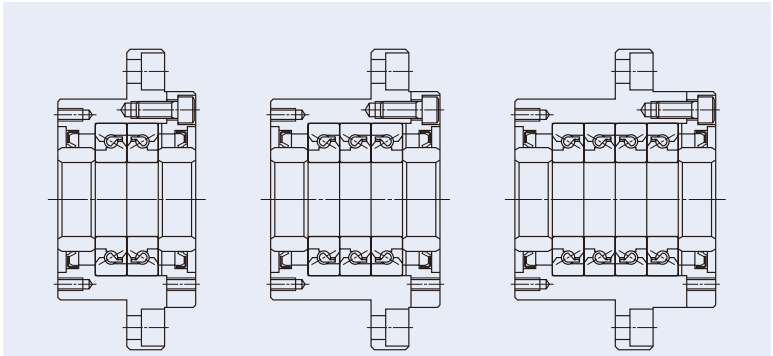


This unit for ball screw support in heavy-load and machine tool applications features NSKTAC C Series high-accuracy, high-rigidity angular contact thrust ball bearings. Three types of arrangement are available, as shown below.

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.





DF arrangement
WBK···DF-31

DFD arrangement
WBK···DFD-31H

DFF arrangement
WBK···DFF-31H

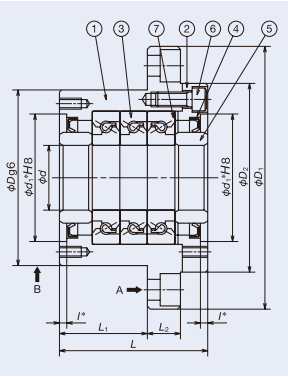
Support Unit Numbers	Support Unit Parts (mm)																
	d	*D*	D_1	D_2	*L*	L_1	L_2	*A*	*W*	*X*	*Y*	*Z*	d_1*	*l**	*V**	*P**	*Q**
WBK17DF-31H	17	70	106	72	60	32	15	80	88	9	14	8.5	45	3	58	M5	10
WBK20DF-31H	20	70	106	72	60	32	15	80	88	9	14	8.5	45	3	58	M5	10
WBK25DF-31H	25	85	130	90	66	33	18	100	110	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 outside diameter at bearing seat; h5 Class is recommended for the shaft outside diameter at the support unit's bearing seat.

Numbering system of support units

Designation example: **WBK 30 DFD - 31H**

- WBK: Support unit code
- 30: Nominal bearing bore
- DFD: Bearing arrangement code
  - DF: Double row arrangement
  - DFD: Triple row arrangement
  - DFF: Quadruple row arrangement
- 31H: Serial numbers

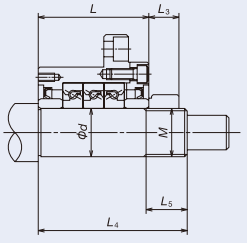


Components of support unit

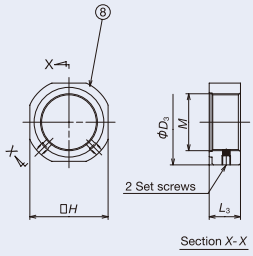
Part No.	Name of Part	Quantities
①	Housing	1
②	Retaining cover	1
③	Angular contact thrust ball bearings for Ball Screw Support	1 set
④	Dust seal	2
⑤	Collar	2
⑥	Preload securing bolt	6 or 8
⑦	Shim	1 set
⑧	Locknut	1

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.

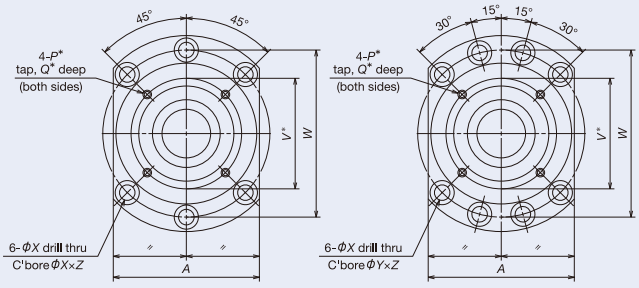
   The locknut is also available separately. For further information on angular contact thrust ball bearings for ball screw support (NSKTAC C Series), please refer to Page 144.



Dimension of bearing seat



Lock nut



Bearing bore $d \leqq 30$ / Bearing bore $d \geqq 35$

Basic Dynamic Load Rating *Ca* [N]	Limiting axial load [N]	Preload [N]	Axial Rigidity [N/μm]	Starting Torque [N·cm]	Locknut					Bearing seat for unit [mm]			Limiting Speeds [min⁻¹]	Mass [kg]
					Reference Dimensions [mm]				Tightening torque [N·cm] (Ref.)					
					M	*H*	D_3	L_3		*d*	L_4	L_5		
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

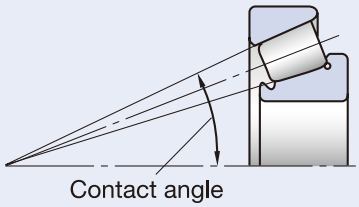
Tapered roller bearings

Tapered Roller Bearings ·····158-161
- Features
- Numbering System
- Bearing Tables

Tapered Roller Bearings

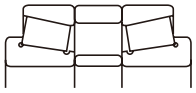
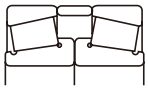
Design, Types and Features

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 codes for matching. Components with the same serial number need to be assembled with regard to these matching codes.
	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.

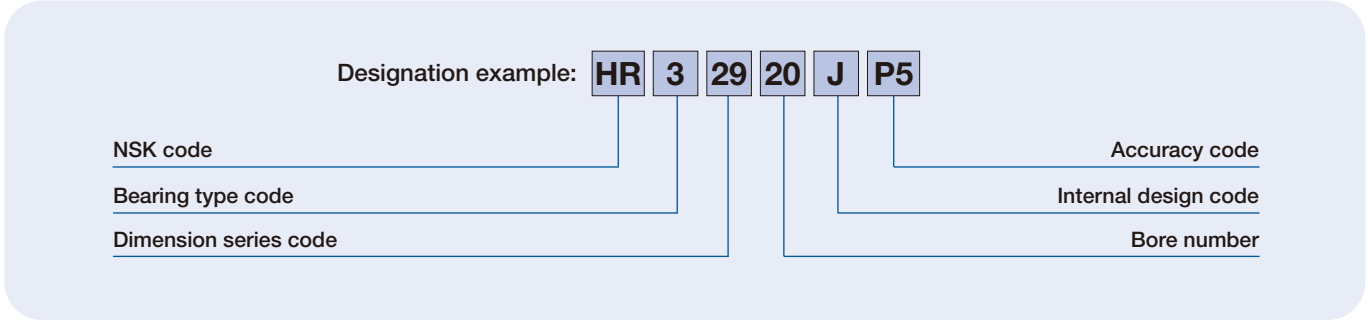
Permissible Misalignment

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.

Numbering System of Tapered Roller Bearings

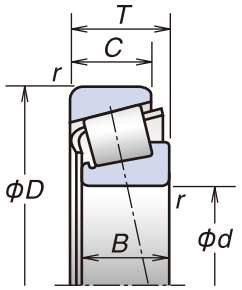


HR	NSK code	HR: High load capacity
3	Bearing type	3: Tapered roller bearing
29	Dimension series	20: 20 Series 29: 29 Series
20	Bore number	Bearing bore = Bore number ×5 (mm)
J	Internal design	X: Bearing boundary dimensions conform to ISO specifications (20 Series) J: Cup back face raceway diameter, cup width, and contact angle conform to ISO specifications
P5	Accuracy	P5: ISO Class 5, P4: ISO Class 4

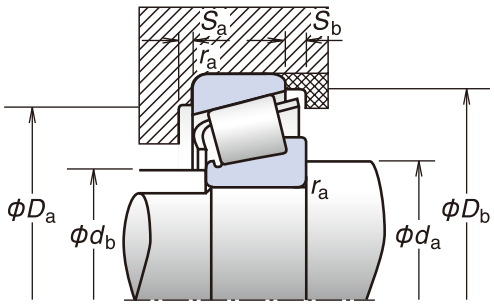
5. Tapered Roller Bearings

Bore Diameter **100-360** mm

Single-Row Tapered Roller Bearings



Designation	Boundary Dimensions (mm)							Basic Load Ratings (kN)		Effective Load Center (mm)	Mass (kg) (approx.)	Limiting Speeds (min^{-1})	
						Cone	Cup						
	d	*D*	*T*	*B*	*C*	*r* (min.)		C_r (Dynamic)	C_{0r} (Static)	*a*		Grease	Oil
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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, 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	d_b	D_a		D_b	S_a	S_b	内輪	外輪
	Y_1	Y_0	(min.)	(max.)	(max.)	(min.)	(min.)	(min.)	(min.)	r_a (max.)	r_a(max.)
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

Part 4

Thrust Bearings

Thrust Bearings ·····164-175

- Features
- Numbering System
- Bearing Tables
  - Single-Direction Thrust Ball Bearings
  - Thrust Cylindrical Roller Bearings
  - ROBUSTSLIM

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 designation, 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

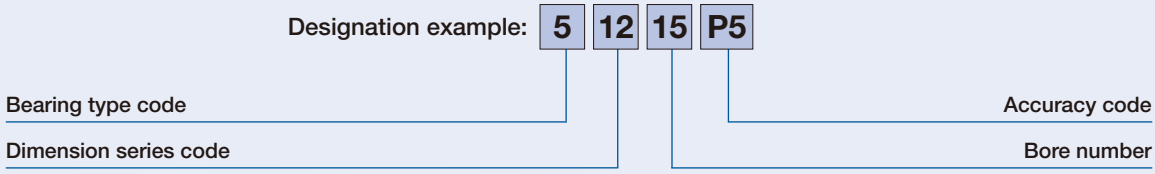
These are thrust bearings containing cylindrical rollers. They can sustain only axial loads, but they are suitable for heavy loads and have high axial rigidity.

The cages are machined brass.

Minimum Axial Load

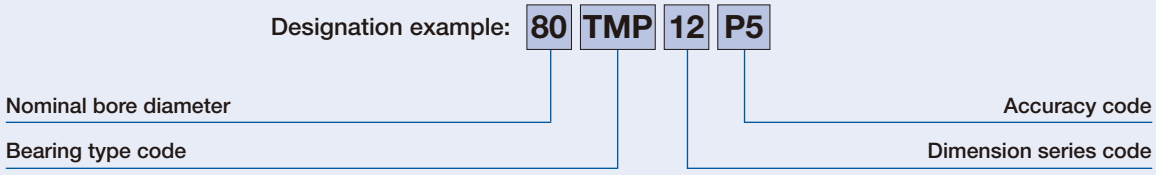
It is necessary to apply some axial load to thrust bearings to prevent slippage between the rolling elements and the raceways. For more details please refer to page 215.

Numbering 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

Numbering System of Thrust Cylindrical Roller Bearings

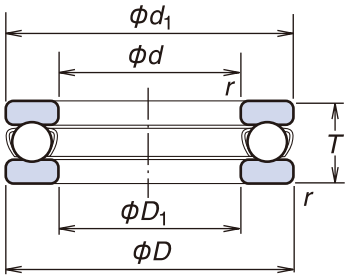


80	Nominal bore diameter	Bore diameter (mm)
TMP	Bearing type	TMP: Thrust cylindrical roller bearing
12	Dimension series	11: 11 Series 12: 12 Series 93: 93 Series
P5	Accuracy	P5: Class 5, P4: Class 4

6. Thrust Bearings

Bore Diameter **30-160** mm

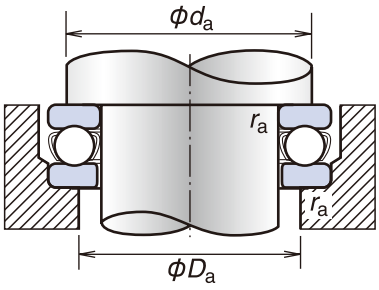
Single-Direction Thrust Ball Bearings



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_{oa} (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 215.

(2) Designation 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.

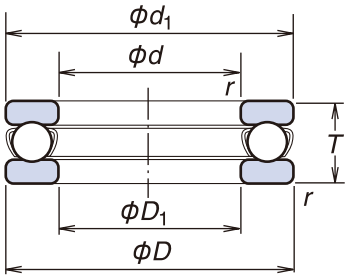


Designation	Boundary Dimensions (mm)						Basic Load Ratings (kN)		Mass (kg) (approx.)	Limiting Speeds (min^{-1})		Minimum Load Factor (1) M ($x10^{-6}$)	Abutment and Fillet Dimensions (2) (mm)		
	d	*D*	*T*	d_1	D_1	*r* (min.)	C_a (Dynamic)	C_{oa} (Static)		Grease	Oil		d_a (min.)	D_a (max.)	r_a (max.)
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

Bore Diameter 170-1 700 mm

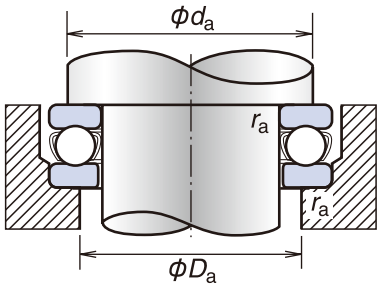
Single-Direction Thrust Ball Bearings



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_{oa} (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 215.

(2) Designation 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.

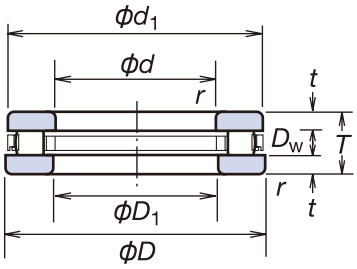


Designation	Boundary Dimensions (mm)						Basic Load Ratings (kN)		Mass (kg) (approx.)	Limiting Speeds (min^{-1})		Minimum Load Factor (1) M ($x10^{-6}$)	Abutment and Fillet Dimensions (2) (mm)		
	d	*D*	*T*	d_1	D_1	*r* (min.)	C_a (Dynamic)	C_{oa} (Static)		Grease	Oil		d_a (min.)	D_a (max.)	r_a (max.)
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

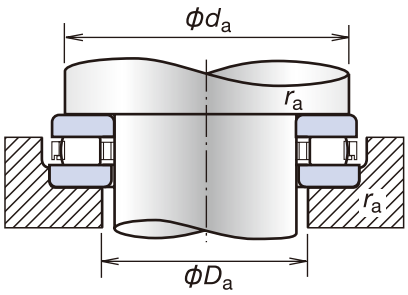
Bore Diameter **40-500** mm

Thrust Cylindrical Roller Bearings



Designation	Boundary Dimensions (mm)				Reference Dimensions (mm)				Basic Load Ratings (kN)		Mass (kg) (approx.)	Limiting Speeds (min^{-1})		Minimum Load Factor (1)	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	M ($x10^{-6}$)	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 215.

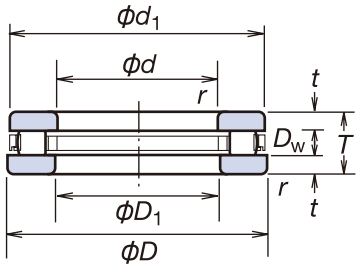


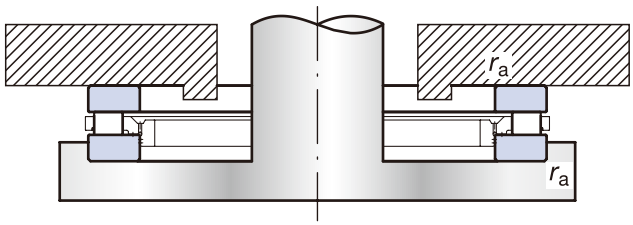
Designation	Boundary Dimensions (mm)				Reference Dimensions (mm)				Basic Load Ratings (kN)		Mass (kg) (approx.)	Limiting Speeds (min^{-1})		Minimum Load Factor (1)	Abutment and Fillet Dimensions (mm)		
	d	D	T	r (min.)	d_1	D_1	D_w	t	C_a (Dynamic)	C_{oa} (Static)		Grease	Oil	M ($\times 10^{-6}$)	d_a (最小)	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

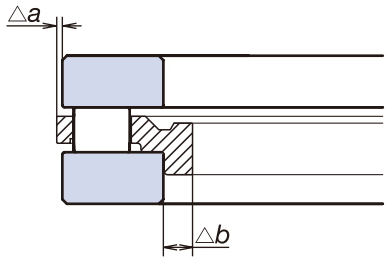
Cylindrical Roller Thrust Bearings for Vertical Lathe Table





Designation	Boundary Dimensions (mm)				Reference Dimensions (mm)				Basic Load Ratings (kN)		Mass (kg) (approx.)	Minimum Load Factor (1) M (x10⁻⁶)	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 215.
(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.

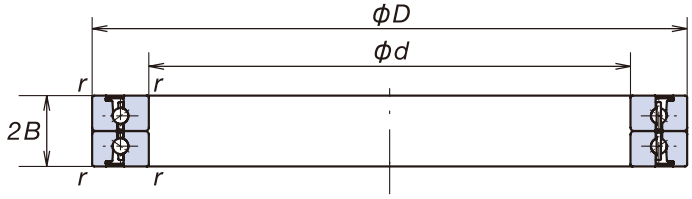
High Accuracy NRRO (Non-repeatable runout) of 0.5μm or lower was archived with BRSA130 .

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



Designation (1)	Boundary Dimensions (mm)				Basic Load Ratings (kN)		Permissible Axial Load (kN)	Contact Angle α (°)	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

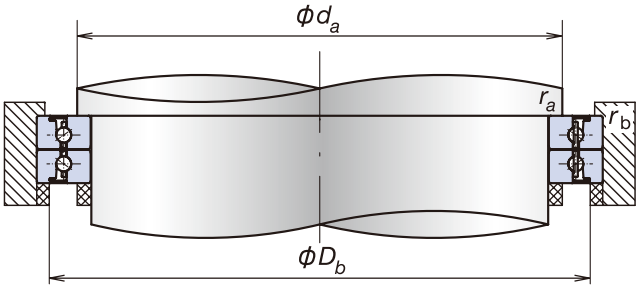
Note: The values given in the table for preload, limiting speeds, axial rigidity, radial rigidity and moment rigidity are reference values based on the axial clearance specified in the "Designation" column.

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

Designation example: **BRSA 130 S T21 V DB CP45 P5**

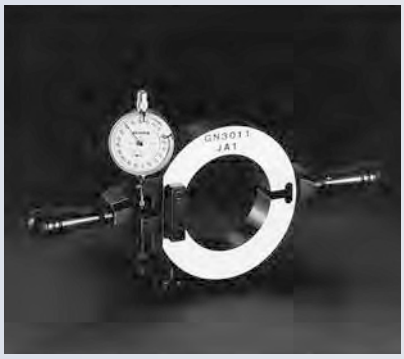
- BRSA — Bearing type code
- 130 — Nominal bore diameter
- S — Material code
- T21 — Cage code
- V — Seal code
- DB — Arrangement code
- CP45 — Preload code
- P5 — Accuracy code

			Reference pages
BRSA	Bearing type	BRSA: contact angle 35°	44-45
130	Nominal bore diameter	Bore dimensions (mm): 130, 170, 220, 340,400	174-175
S	Material	S: Inner/outer ring SUJ2 or SUJ3, balls SUJ2	14-15
T21	Cage	T21: Ring guided resin cage No code: Ring guided machined brass cage	—
V	Seal	V: Non-contact rubber seal on one side	—
DB	Arrangement	DB: Back-to-back arrangement	200-201
CP45	Preload	CP: Special preload gap	210
P5	Accuracy	P5: Class 5	222-225



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.)		Grease			
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









Part 4

Peripheral Equipment

Gauges ····· 178-181

GR Gauges

Features

Numbering System

GN Gauges

Features

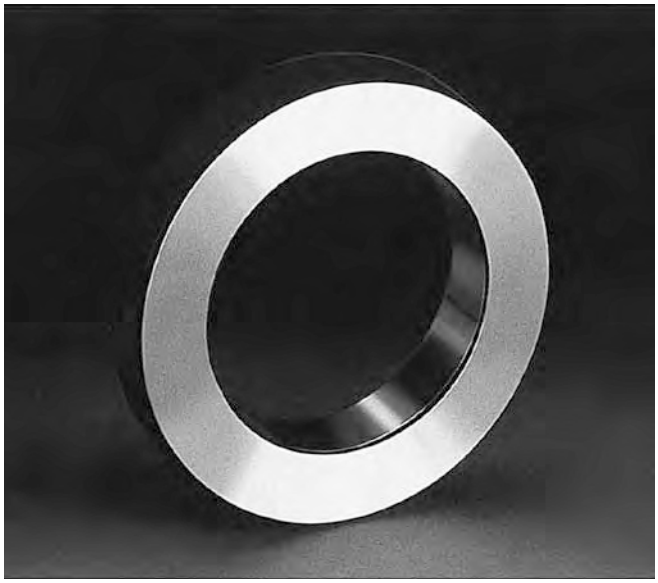
Numbering System

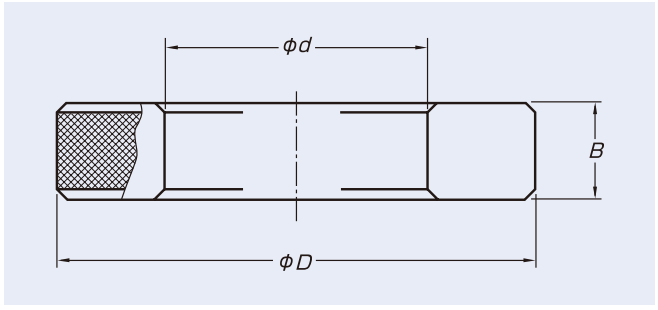
NSK Induction Bearing Heaters ····· 182-183

Grease Replenishing System FINE-LUB Ⅱ ····· 184-185

High Speed Built-In Motor Spindle ····· 186-187

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.

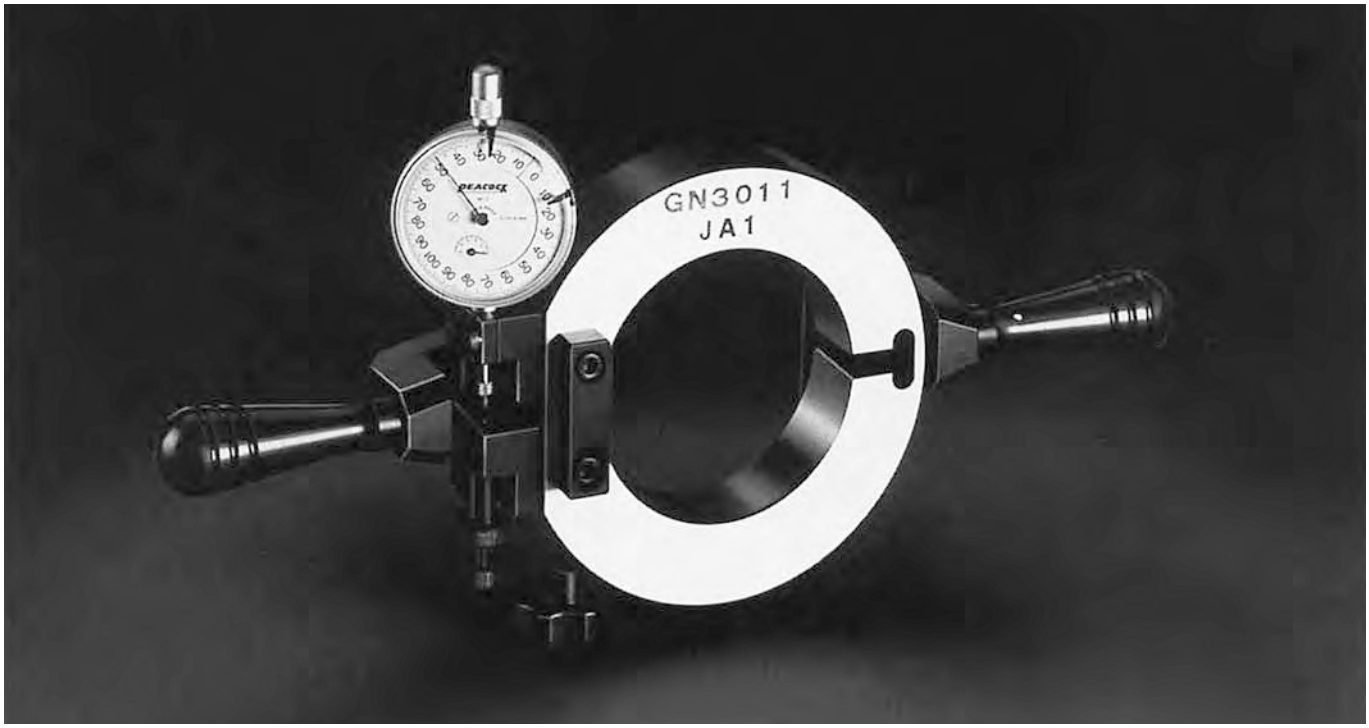
NSK Ring Gauges GR series are master gauges for measuring the bore diameters of housings within an accuracy of 0.001 mm.

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

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 215).

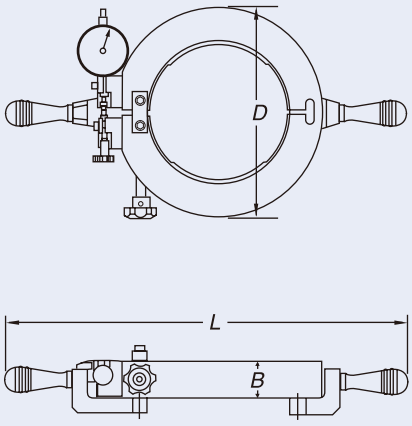
With the recent trends toward higher speed and higher precision, it is necessary to control residual radial internal clearance more carefully. In the past, radial clearance measuring methods were very difficult and required much skill. GN gauges developed by NSK for residual radial internal clearance 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 250.

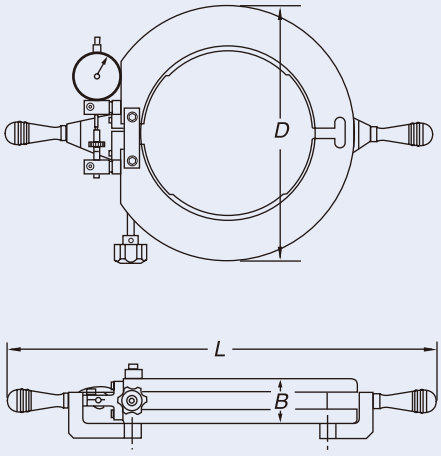
Features

- 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)
			D	*B*	*L*	(approx.)
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.

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.

Type/Capacity

Model Number Example

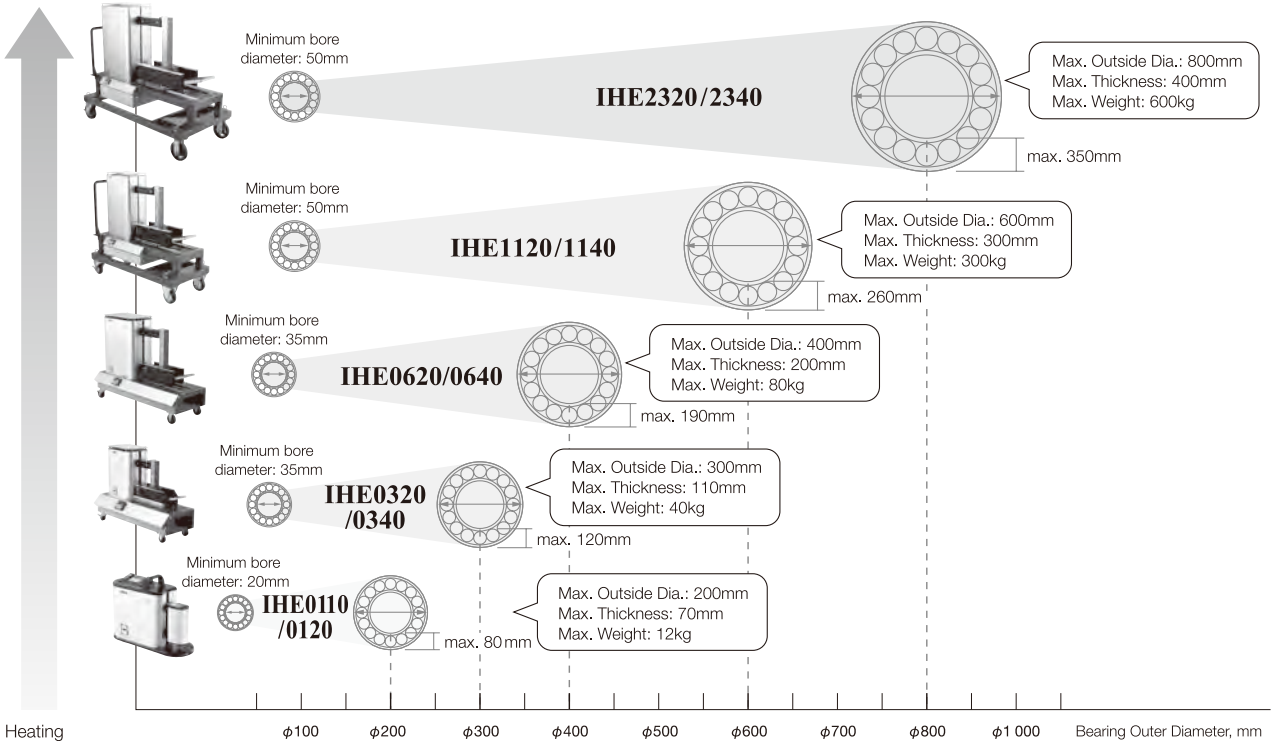
IHE 01 10
a b

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	

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 Outside 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

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 impacts far exceed those of conventional high-speed spindles.





Bearing Technology

Incorporates the NSKROBUST Series, proven bearings for machine tools. Ceramic balls are used for higher speed, high rigidity, and high reliability.

Cool running
Optimization of internal design realizes cool running.

Improved anti-seizure property
Improved heat robustness to handle changes in ambient temperatures.

Ceramic ball
Adopts a high-precision ceramic ball for the rolling element to provide high speed, high precision, and high rigidity.



Lubrication Technology

Supports 10 000 hours of maintenance-free performance with grease replenishing lubrication. NSK's new proprietary, environmentally friendly lubrication method automatically delivers a small quantity of grease into the bearing interior at intermittent intervals.

Improved grease life
Continuous fresh supply of lubricant to components improves grease life.

Ultra low noise
Eliminates grating wind noise caused by oil-air lubrication.

Reduced energy consumption
With air consumption lowered by at least 70%, as little as 50 NL/min of air is required.

Environmentally sound
No oil is consumed, and therefore no oil particles are released into the air.



Design Technology

Adopts a built-in motor structure optimized to limit vibration. A direct-drive system with no gears or couplings produces low vibration.

Low vibration
Provides improved quality in cut surface and extends tool life.

Compact
The spindle incorporates motor between bearings at front and rear and is therefore lighter and more compact than direct-coupled units.

Simplified assembly
Incorporating spindle shaft and motor into single unit eliminates need for centering and aligning spindle shaft and motor.

Easier maintenance
Unique cartridge structure allows components to be quickly replaced.

NSK Built-In Motor Spindles

POWER

Top Class Rigidity

12,000 min^{-1}
High-Rigidity / High-Power Type

Lubrication Grease replenishing system
Brg. Bore ϕ80mm ($d_m n$ 123×10^4)
Preload Position preload



Ideal for machining automotive parts

World's Top Speed

25,000 min^{-1}
High-Speed / High-Power Type

Lubrication Grease replenishing system
Brg. Bore ϕ70mm ($d_m n$ 225×10^4)
Preload Constant pressure preload



Ideal for machining aluminum and metal molds

High-performance spindles that deliver unmatched capabilities in high-speed Class #40 machining centers. Our elite lineup offers heavy cutting power, extremely quiet operation, and low environmental impacts.

15,000/20,000 min^{-1}
Standard / High-Speed Type

Lubrication Packed grease / Grease replenishing system
Brg. Bore ϕ70mm ($d_m n$ 128×10^4/$d_m n$ 170×10^4)
Preload Position preload



Suits a wide range of applications

SPEED

Features

Low noise and vibration

NSK's grease replenishing system eliminates the wind noise associated with oil-air lubrication. A direct drive without gears or couplings employs balance correction technologies that result in low noise and low vibration.

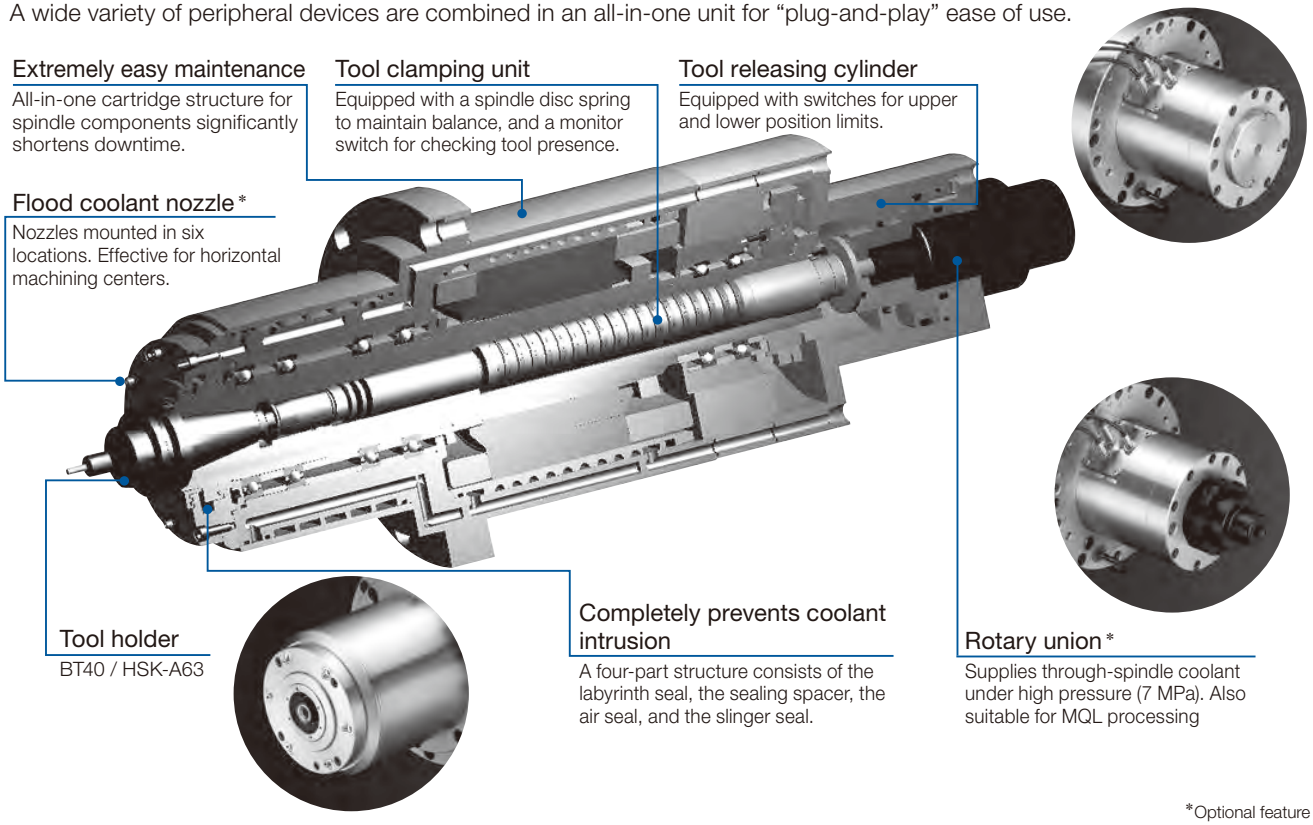
Low environmental load

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.
- Standard spindles in the series offer BT40 or HSK A63 options, S and L type configurations, and grease replenishing or packed grease specifications. In addition, various options such as through-spindle coolant or flood coolant specifications are available.

A wide variety of peripheral devices are combined in an all-in-one unit for "plug-and-play" ease of use.



*Optional feature



Reduced production lead time

- Significantly reduces time from order to completion of spindle adjustment.
- Reduces running stock.

Cut maintenance costs

- Spindles can be used for different machines in the factory.
- Reduces spare unit inventory.

7. Peripheral Equipment

Specifications of Built –in Motor Spindle

Designation will be included in the specification drawings of supplied products. When ordering, please provide the designation for the product you would like to purchase.

Designation 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, High-Speed / High-Power Types

Flange 0: Standard position

Main Shaft Taper/ Rotational Speed
0: BT40/15 000/12 000 1: BT40/20 000
2: HSK-A63/15 000/12 000 4: HSK-A63/20 000/25000

Lubrication 0: Packed grease 1: Grease replenishing system
Packed grease (0) can only be used in following configurations:
W-B1100-00＊＊＊＊ W-B1100-03＊＊＊＊
W-B1200-00＊＊＊＊ W-B1200-03＊＊＊＊

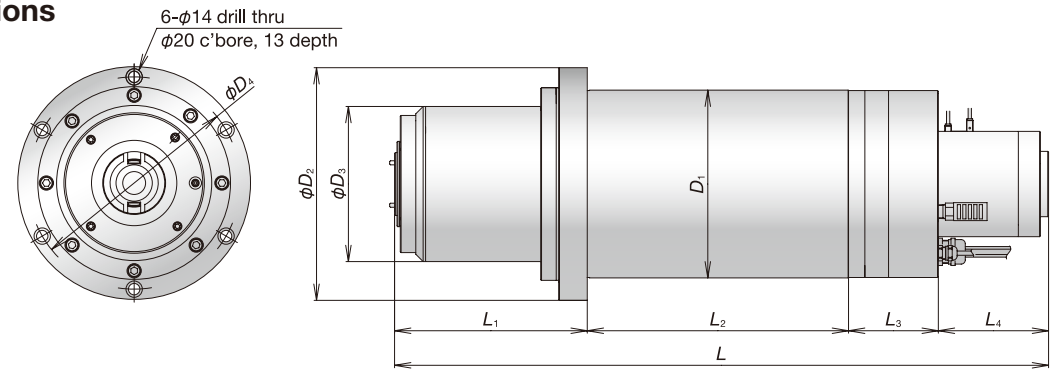
Seal 0: Standard seal

Monitor switch
3: Tool presence checker and release cylinder with upper and lower limits

Coolant (Option)
0: None 1: Through-spindle coolant
2: Flood coolant
3: Combined through-spindle / flood coolant

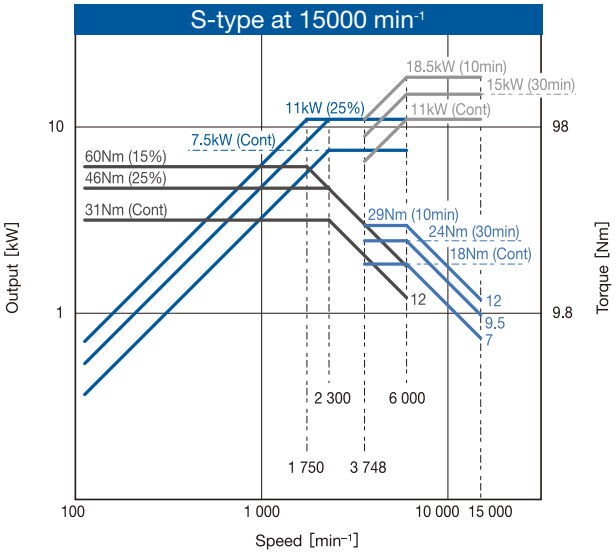
Note: The High-Speed / High-Power Type (W-F1200) is not compatible with flood coolant specifications, and therefore requires a code of 0 or 1.

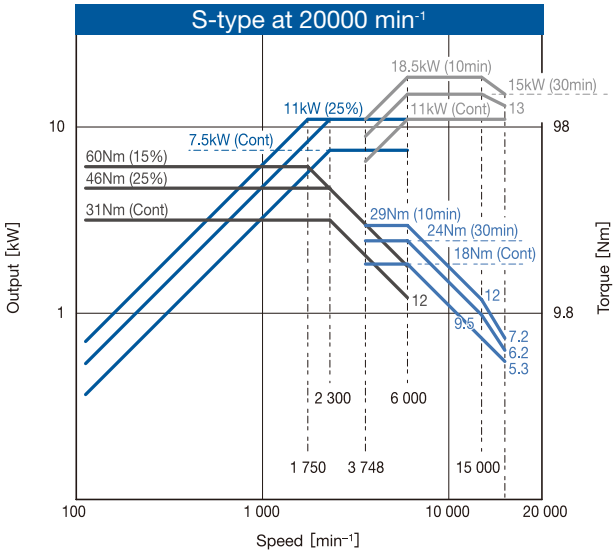
Dimensions

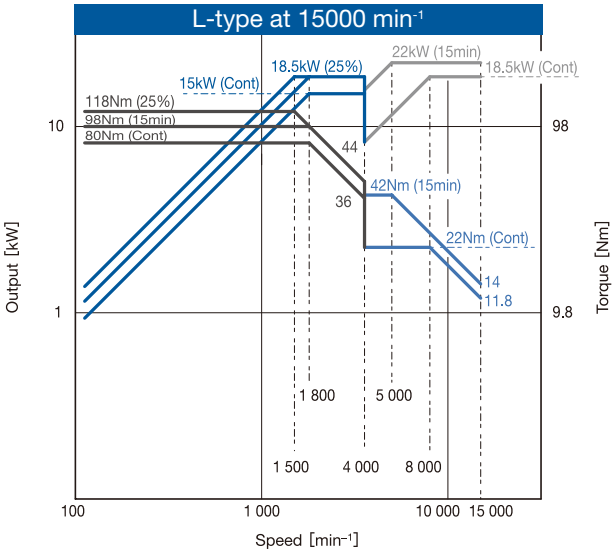


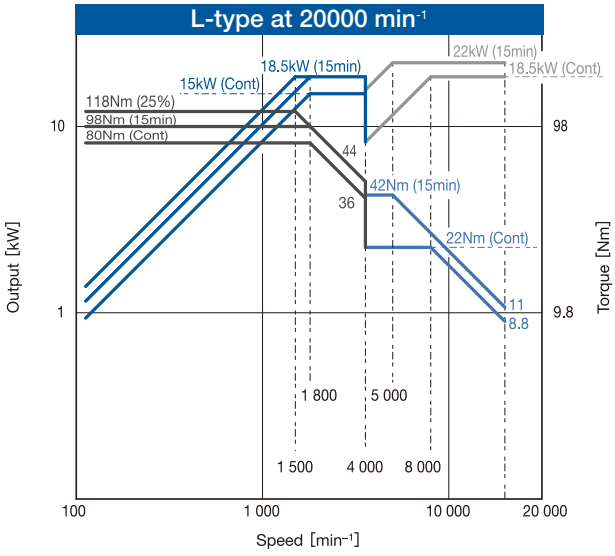
	Item	Unit	S-type		L-type		High-Rigidity / High-Power Type	High-Speed / High-Power Type
			Standard	High-Speed	Standard	High-Speed		
Main specifications	Bearing bore	(mm)	ø70	ø70	ø70	ø70	ø80	ø70
	Speed	(min^{-1})	15 000	20 000	15 000	20 000	12 000	25 000
	Tool shank	—	BT40 HSK-A63	←	BT40 HSK-A63	←	BT40 HSK-A63	HSK-A63
	Bearing lubrication	—	Packed grease	Grease replenishing	Packed 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

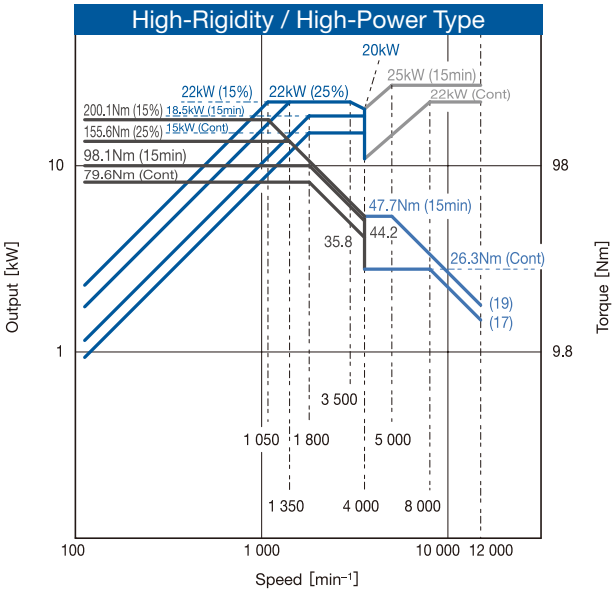
Specifications of Built –in Motor

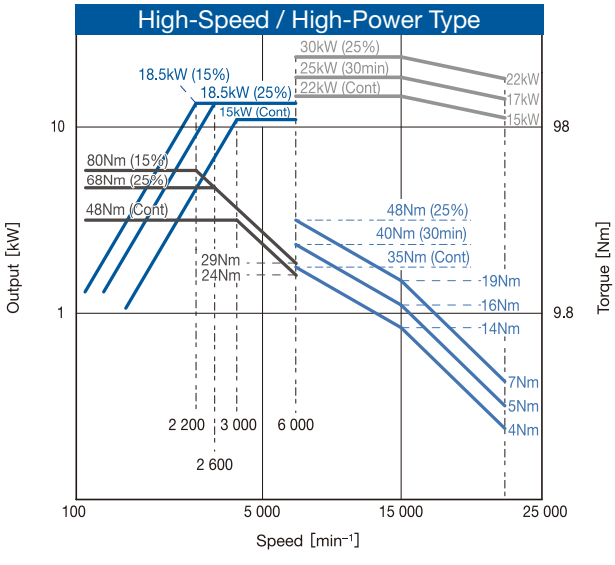






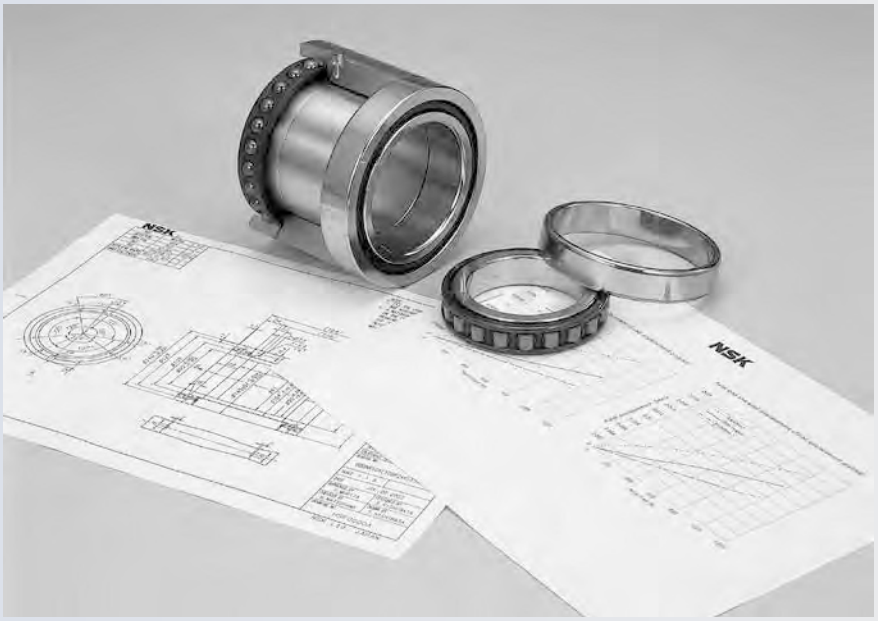






Note: A Bil- series FANUC BUILT-IN SPINDLE MOTOR is used.
Please prepare an amplifier, NC, etc. as necessary.

Technical Guide



Part 5

Technical Guide

1. Life ····· 190-197
   · Rolling Fatigue Life and Basic Dynamic Load Rating
   · New Life Theory
2. Static Load Ratings and Static Equivalent Loads ··· 198-199
3. Angular Contact Ball Bearing Combinations ····· 200-205
   · Features of Each Combination
   · Universal Arrangement
4. Preload and Rigidity ····· 206-215
   · Types of Preload and Rigidity
5. Limiting Speeds ····· 216-217
6. Lubrication ····· 218-221
7. Bearing Tolerances ····· 222-231
   · Tolerances for Radial Bearings
   · Tolerances for Tapered Bores
   · Tolerances for Thrust Ball Bearings
8. Designing of Shafts and Housings ····· 232-236
   · Fitting of Shafts and Housings
   · Shaft and Housing Tolerances
   · Chamfer Dimensions
9. Spacers ····· 237-241
   · Spacer Dimensions
   · Position of Spray Nozzle

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:

for ball bearings: $C_j = j^{0.7} \times C_1$

for roller bearings: $C_j = j^{7/9} \times C_1$

where j : Number of rows ($j \geqq 2$)
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 $j = 2$.

Steel ball bearings are specified by ISO 281 and hybrid bearings (ceramic ball bearings) by ISO 20056-1.

Basic Rating Life

The following relationships exist between basic dynamic load rating, dynamic equivalent load, and basic rating life:

for ball bearings: $L_{10}=\left(\frac{C}{P}\right)^3$ (10^6 rev)

$L_{10}=\frac{10^6}{60n}\left(\frac{C}{P}\right)^3$ (h)

for roller bearings: $L_{10}=\left(\frac{C}{P}\right)^{10/3}$ (10^6 rev)

$L_{10}=\frac{10^6}{60n}\left(\frac{C}{P}\right)^{10/3}$ (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
Y : Axial load factor
} see Table 1.1

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 $\alpha \neq 90°$ 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:

Load on rolling element = Fa/(number of balls × sin α).

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.

Fig. 1.1

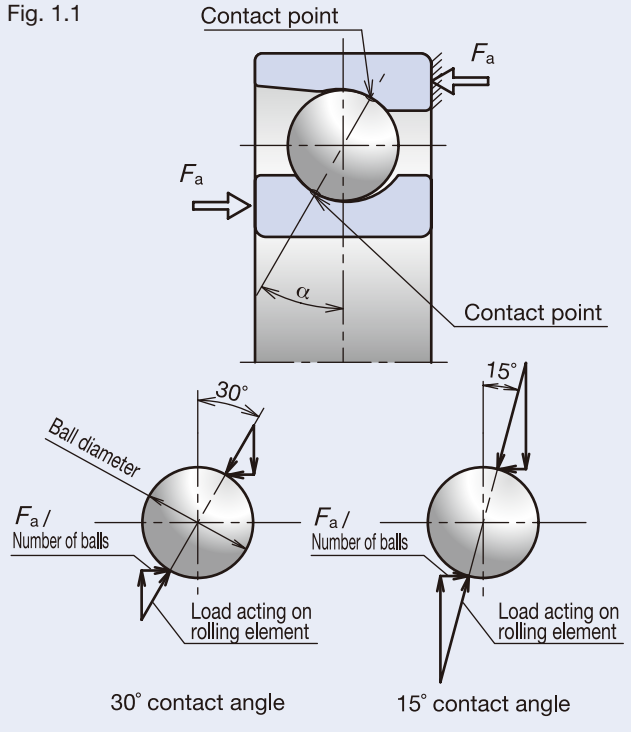


Table 1.1 Value of Factors X and Y for Calculation of Equivalent Load $P = XF_r + YF_a$

Bearing type		if_oF_a/C_{or}	e	Single row (i=1), DT (i=1), DTD (i=1), DTT (i=1)				DB (i=2), DF (i=2), DBB (i=2), DFF (i=2)			
				$F_a/F_r \leqq e$		$F_a/F_r > e$		$F_a/F_r \leqq e$		$F_a/F_r > e$	
				X	Y	X	Y	X	Y	X	Y
Angular contact ball bearings ($C=C_r$)	15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	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				1.23		1.38		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
	18°	0.181	0.44	1	0	0.43	1.30	1	1.42	0.70	2.11
		0.363	0.46				1.25		1.37		2.03
		0.726	0.48				1.18		1.30		1.92
		1.09	0.50				1.14		1.25		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
	25°	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
	30°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
	40°	—	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 (†)		—	1.5tan α	1	0	0.4	0.4cot α	1	0.45cot α	0.67	0.67cot α

Bearing type		e	DBBD, DFFD							
			Axial load supported by 3 rows				Axial load supported by 2 rows			
			$F_a/F_r \leqq e$		$F_a/F_r > e$		$F_a/F_r \leqq e$		$F_a/F_r > e$	
			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 160 and 161.

DBD
DFD

Axial load supported by 2 rows					Axial load supported by 1 row				
i	$F_a/F_r \leqq e$		$F_a/F_r > e$		i	$F_a/F_r \leqq e$		$F_a/F_r > e$	
	X	Y	X	Y		X	Y	X	Y
$\frac{3}{2}$	1	0.87	0.59	1.97	3	1	3.07	0.95	3.19
		0.83		1.86			2.91		3.02
		0.77		1.73			2.71		2.82
		0.73		1.65			2.58		2.68
		0.70		1.58			2.48		2.57
		0.66		1.49			2.33		2.42
		0.61		1.37			2.14		2.22
		0.56		1.27			1.98		2.06
$\frac{3}{2}$	1	0.75	0.57	1.72	3	1	2.63	0.93	2.80
		0.72		1.66			2.53		2.69
		0.68		1.57			2.40		2.55
		0.65		1.51			2.31		2.45
		0.63		1.46			2.24		2.38
		0.60		1.39			2.12		2.26
		0.56		1.29			1.97		2.10
—	1	0.48	0.54	1.16	—	1	1.71	0.89	1.88
—	1	0.41	0.52	1.01	—	1	1.45	0.84	1.64
—	1	0.29	0.46	0.76	—	1	1.02	0.76	1.23
—	0.91	0.41	0.48	1	—	0.56	0.89	0.48	1
—	1.24	0.39	0.60	1	—	0.76	0.84	0.60	1
—	1.95	0.36	0.81	1	—	1.20	0.78	0.81	1
—	2.32	0.35	0.92	1	—	1.43	0.76	0.92	1

—

DBT
DFT

Axial load supported by 3 rows					Axial load supported by 1 row				
i	$F_a/F_r \leqq e$		$F_a/F_r > e$		i	$F_a/F_r \leqq e$		$F_a/F_r > e$	
	X	Y	X	Y		X	Y	X	Y
$\frac{4}{3}$	1	0.59	0.54	1.81	4	1	4.35	1.17	3.90
		0.56		1.71			4.12		3.70
		0.52		1.60			3.84		3.45
		0.50		1.52			3.65		3.28
		0.48		1.46			3.51		3.15
		0.45		1.37			3.30		2.96
		0.41		1.26			3.02		2.71
		0.40		1.22			2.94		2.64
$\frac{4}{3}$	1	0.51	0.53	1.57	4	1	3.73	1.15	3.38
		0.49		1.51			3.59		3.26
		0.46		1.43			3.41		3.09
		0.45		1.38			3.28		2.97
		0.43		1.34			3.18		2.88
		0.41		1.27			3.02		2.74
		0.40		1.22			2.91		2.64
—	1	0.33	0.50	1.08	—	1	2.45	1.08	2.33
—	1	0.28	0.48	0.93	—	1	2.05	1.03	2.01
—	1	0.20	0.42	0.71	—	1	1.46	0.92	1.54
—	0.98	0.30	0.48	1	—	0.46	1.04	0.48	1
—	1.35	0.29	0.60	1	—	0.62	0.98	0.60	1
—	2.12	0.27	0.81	1	—	0.98	0.90	0.81	1
—	2.52	0.26	0.92	1	—	1.17	0.88	0.92	1

—

DBTD
DFTD

Axial load supported by 4 rows				Axial load supported by 1 row			
$F_a/F_r \leqq e$		$F_a/F_r > e$		$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y	X	Y	X	Y
1.03	0.64	0.48	1	0.39	0.64	0.48	1
1.41	0.60	0.60	1	0.53	0.60	0.60	1
2.22	0.56	0.81	1	0.84	0.56	0.81	1
2.63	0.55	0.92	1	1.00	0.55	0.92	1

DBTT
DFTT

Axial load supported by 5 rows				Axial load supported by 1 row			
$F_a/F_r \leqq e$		$F_a/F_r > e$		$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y	X	Y	X	Y
1.06	0.64	0.48	1	0.34	0.64	0.48	1
1.45	0.60	0.60	1	0.47	0.60	0.60	1
2.28	0.56	0.81	1	0.74	0.56	0.81	1
2.71	0.55	0.92	1	0.88	0.55	0.92	1

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.

$$ln\frac{1}{S} \propto \frac{\tau_o^c \cdot N^e \cdot V}{Z_o^h} \cdots (1)$$

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:

$$ln\frac{1}{S} \propto N^e \int_V \frac{(\tau - \tau_u)^c}{Z_o^h} dV \cdots (2)$$

Fig. 1.2 Life Test Results Under Clean Lubrication Conditions

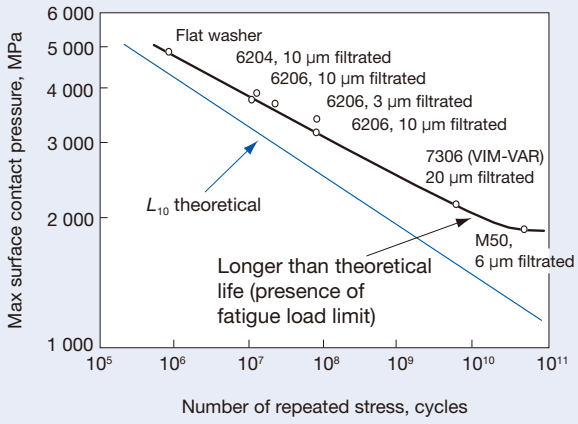
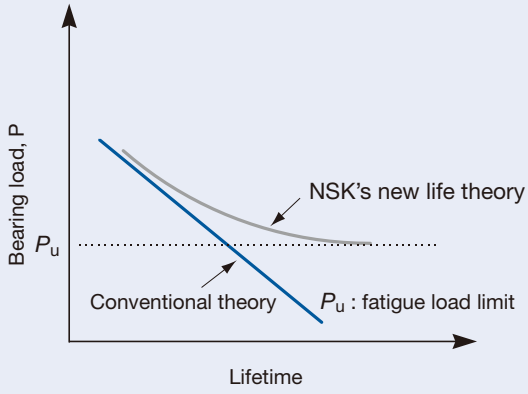


Fig. 1.3 NSK's New Life Theory That Considers Fatigue Limit



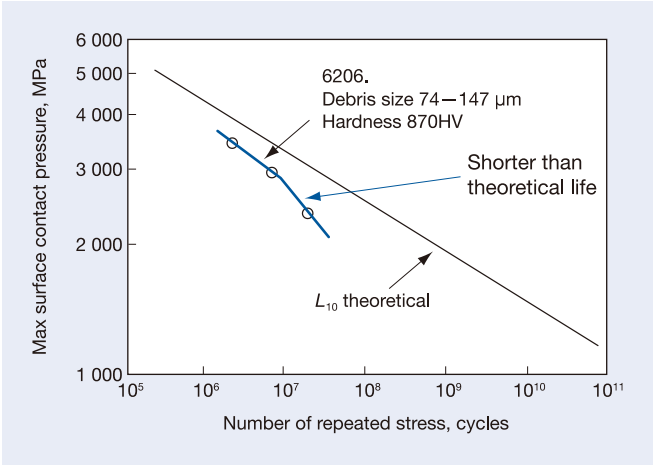
(2) Surface-originated flaking

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 $(P\text{-}P_u)/C$. 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 $(P\text{-}P_u)/C \cdot 1/a_c$.

Based on the above concept, the calculation formula for surface-originated flaking is as follows:

$$\ln\frac{1}{S} \propto N^e \int_V \frac{(\tau-\tau_u)^c}{Z_o^h} dV \times \left\{\frac{1}{f(a_c, a_L)} - 1\right\} \cdots (3)$$

(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.

(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:

$$\ln\frac{1}{S} \propto N^{e}\int_{V}\frac{(\tau-\tau_{u})^{c}}{Z_{o}^{h}}dV \times \left\{\frac{1}{f(a_c, a_L)}\right\} \cdots(4)$$

From this equation (4), another equation (5) can be derived:

$$L_{able} = a_1 \cdot a_{NSK} \cdot L_{10} \cdots(5)$$

Reliability factor a_1 is shown in Table 1.3. The theory also utilizes viscosity ratio κ ($\kappa = \nu / \nu_1$ where ν is the operational viscosity and ν_1 is the required viscosity). The lubrication parameter a_L is a function of κ. The theory indicates that the better the lubrication conditions (the higher the κ 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 $(P\text{-}P_u)/C \cdot 1/a_c$.

$$a_{NSK} \propto F\left\{\frac{P-P_u}{C}\cdot\frac{1}{a_c}, a_L\right\} \cdots(6)$$

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 codes 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

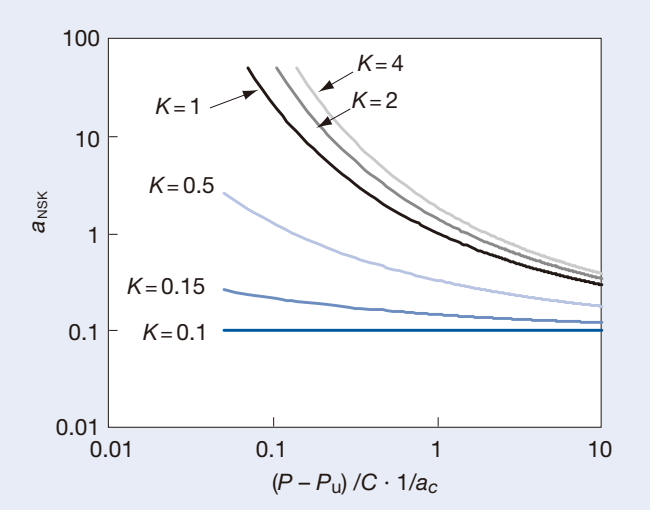
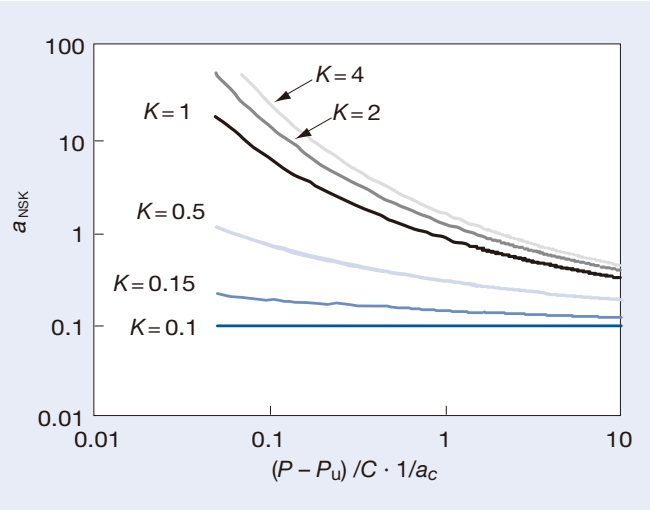


Fig. 1.6 New Life Calculation Graph for Roller Bearings



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 190, 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.

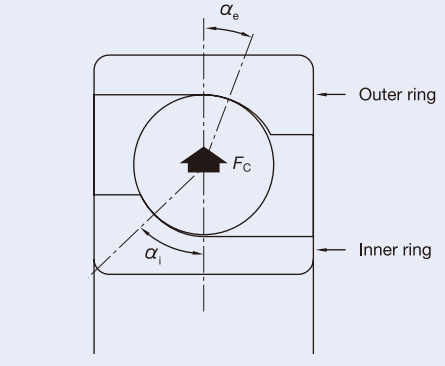
Please contact NSK for life calculations regarding bearings used in high-speed applications.

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 190 for details on the definition of bearing life.

Life of Ceramic Ball Bearings

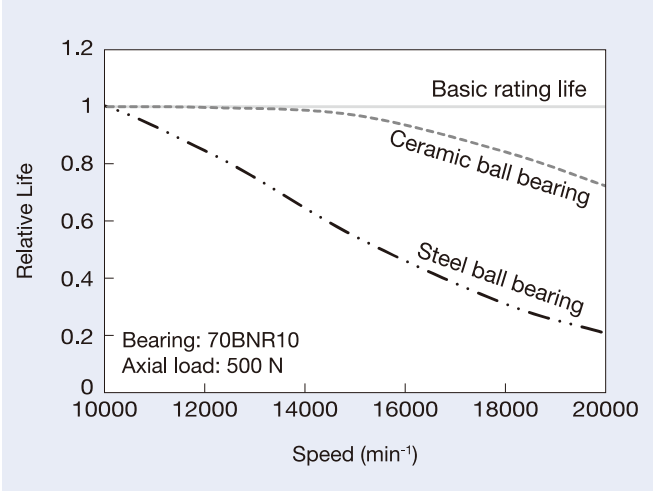
As ceramic balls have a lower density than steel balls, the increase in internal load due to centrifugal force in high-speed operation is less than with steel balls. Thus, the life calculation will show a longer life.

Fig. 1.7 Change in Contact Angle Due to Centrifugal Force



F_C : Centrifugal force acting on the rolling elements

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 ... and the basic rating life of the entire group of bearings as L, the relationship may be expressed by the following equation:

$$L = \frac{1}{\left(\frac{1}{L_1^{1.1}} + \frac{1}{L_2^{1.1}} + \frac{1}{L_3^{1.1}} + \cdots\right)^{\frac{1}{1.1}}}$$

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 steel ball bearings : 4 200 Mpa
for ceramic ball bearings : 4 600 Mpa
for roller bearings : 4 000 Mpa

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.

Steel ball bearings are specified by ISO 281 and hybrid bearings (ceramic ball bearings) by ISO 20056-2.

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:

$$P_0 = X_0 F_r + Y_0 F_a \quad \cdots\cdots (1)$$

$$P_0 = F_r \quad \cdots\cdots (2)$$

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

$$P_0 = X_0 F_r + F_a \quad \alpha \neq 90° \quad \cdots\cdots (3)$$

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 $\alpha = 90°$.

Table 2.1 Static Equivalent Loads

Bearing type		Single row		Double row	
		X_0	Y_0	X_0	Y_0
Angular contact ball bearings	$\alpha=15°$	0.5	0.46	1	0.92
	$\alpha=18°$	0.5	0.46	1	0.92
	$\alpha=25°$	0.5	0.38	1	0.76
	$\alpha=30°$	0.5	0.33	1	0.66
Tapered roller bearings	$\alpha\neq0$	0.5	0.22cot α	1	0.44cot α
Cylindrical roller bearings	$\alpha=0$	$P_0 = F_r$			
Thrust ball bearings Thrust roller bearings	$\alpha=90°$ $\alpha=90°$	$P_{0a} = F_a$			
Thrust ball bearings Thrust roller bearings	$\alpha\neq90°$ $\alpha\neq90°$	$P_{0a} = F_a + 2.3F_r \tan\alpha$ (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 produces shoulder override
   The limiting load at which the contact ellipse generated between the ball and the raceway overrides the shoulder of the raceway groove (Fig. 2.1)

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 as defined in the basic static load rating (Fig. 2.2)

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. 2.3). 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. 2.1 Limiting Axial Load that Produces Shoulder Override

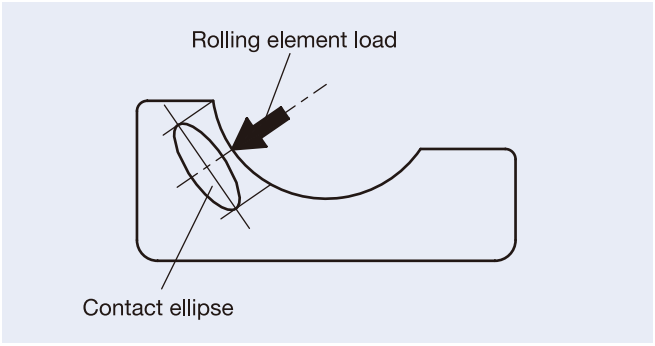


Fig. 2.2 Limiting Axial Load in Terms of Surface Pressure

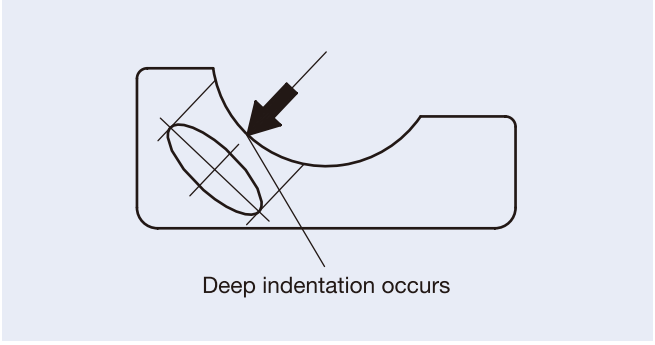
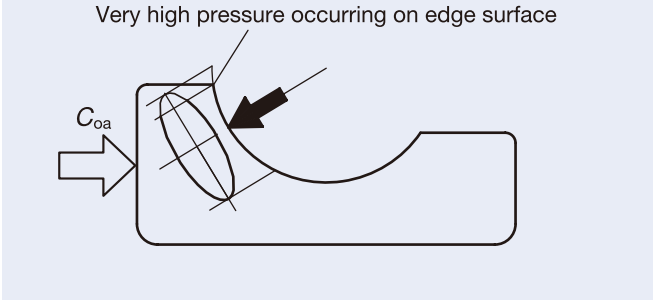


Fig. 2.3 C_{0a} and Limiting Axial Load



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 outside 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 low bending stiffness of the shaft.

● Tandem Arrangement, DT

Axial loads in one direction and combined 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

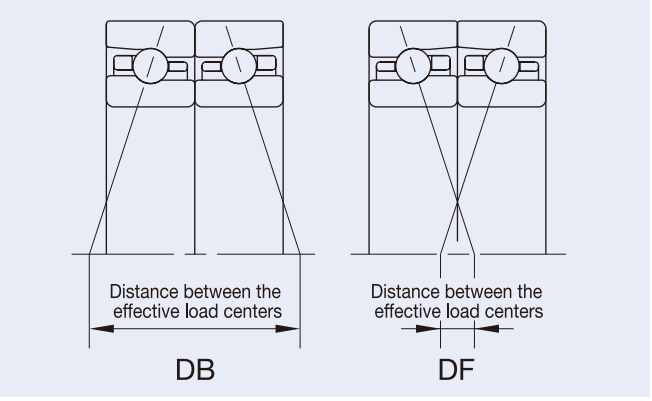


Fig. 3.2 Load Application Direction in Back-to-Back and Tandem Arrangements

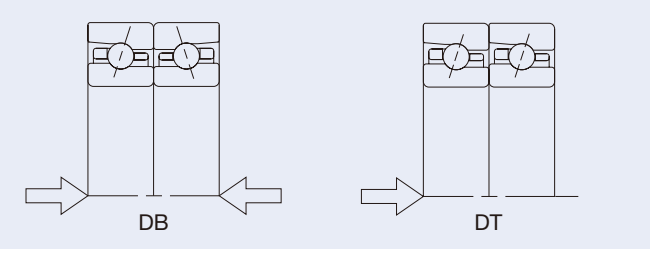
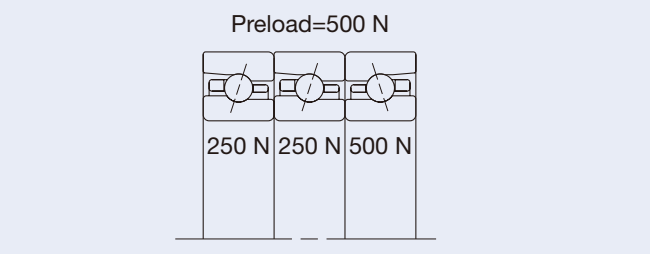


Fig. 3.3 Internal Preload in DBD Arrangement



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 (75BNR10XET) 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:

$$\sigma_{DB} = 2.4079 \times 10^{-2} \text{ (mm)}$$
$$\sigma_{DF} = 2.9853 \times 10^{-2} \text{ (mm)}$$

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 side surface or chamfered part of the inner rings, the symbol "○" is marked to indicate the position of maximum radial run-out. Optimum accuracy is achieved when the bearing is mounted so the "○" 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

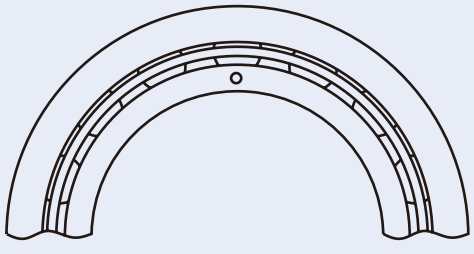


Fig. 3.4 Spindle Deflection Curve

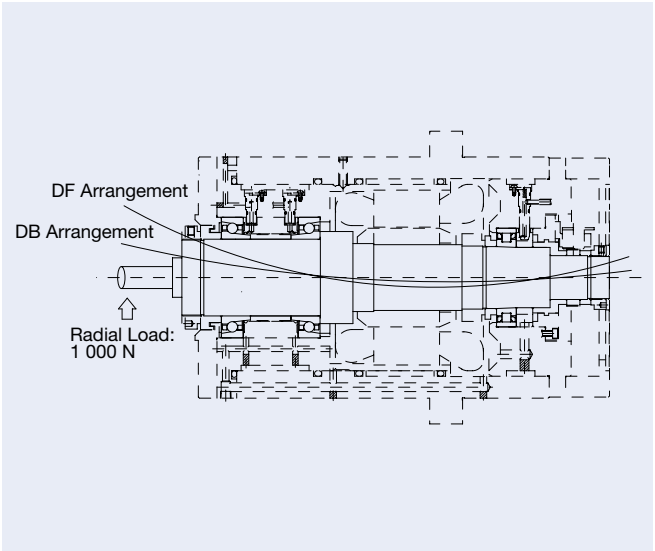
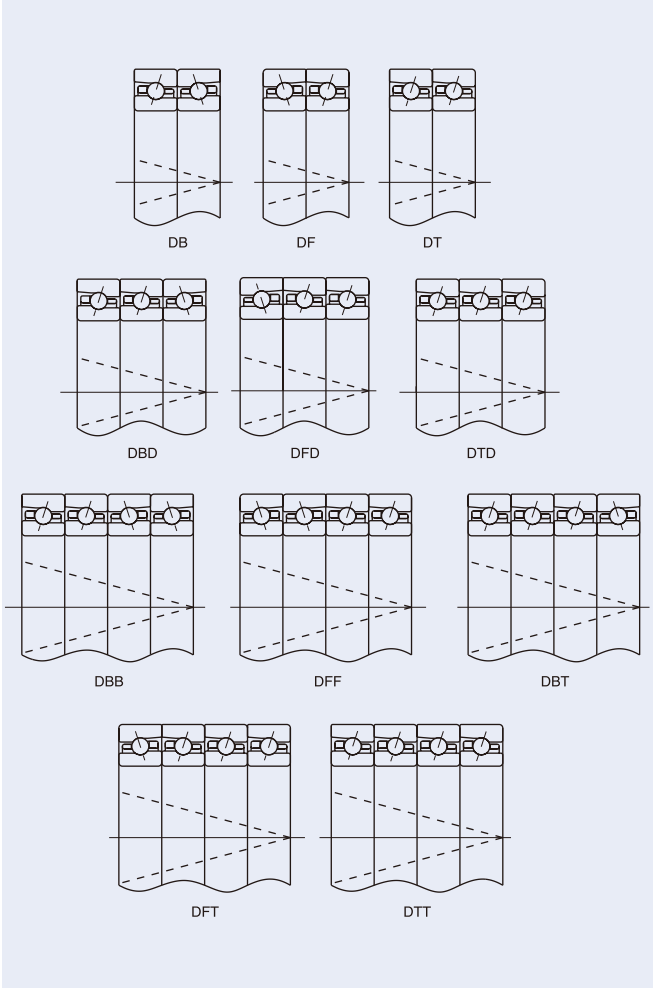


Fig. 3.6 Combinations of Angular Contact Ball Bearings



3. Angular Contact Ball Bearing Combinations

Important Points to Consider When Using Matched Bearings

The axial clearance (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 stand-out (offset) 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 arrangement bearings rather than sets of matched bearings prepared for specific arrangements. Universal arrangement bearings are ready for use in different arrangements. For more information on universal arrangement bearings, please refer to page 204.

Fig. 3.7 DT Combination

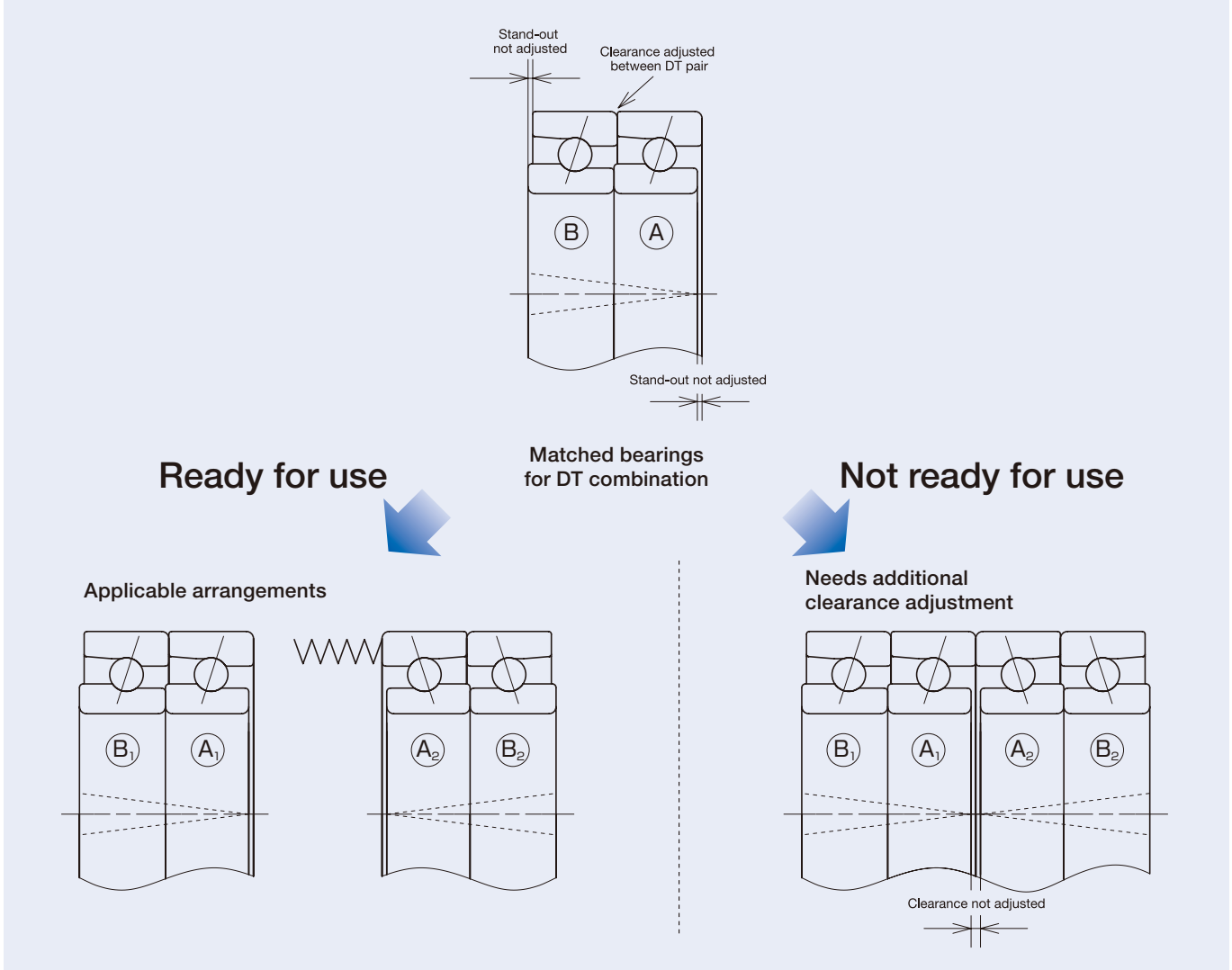
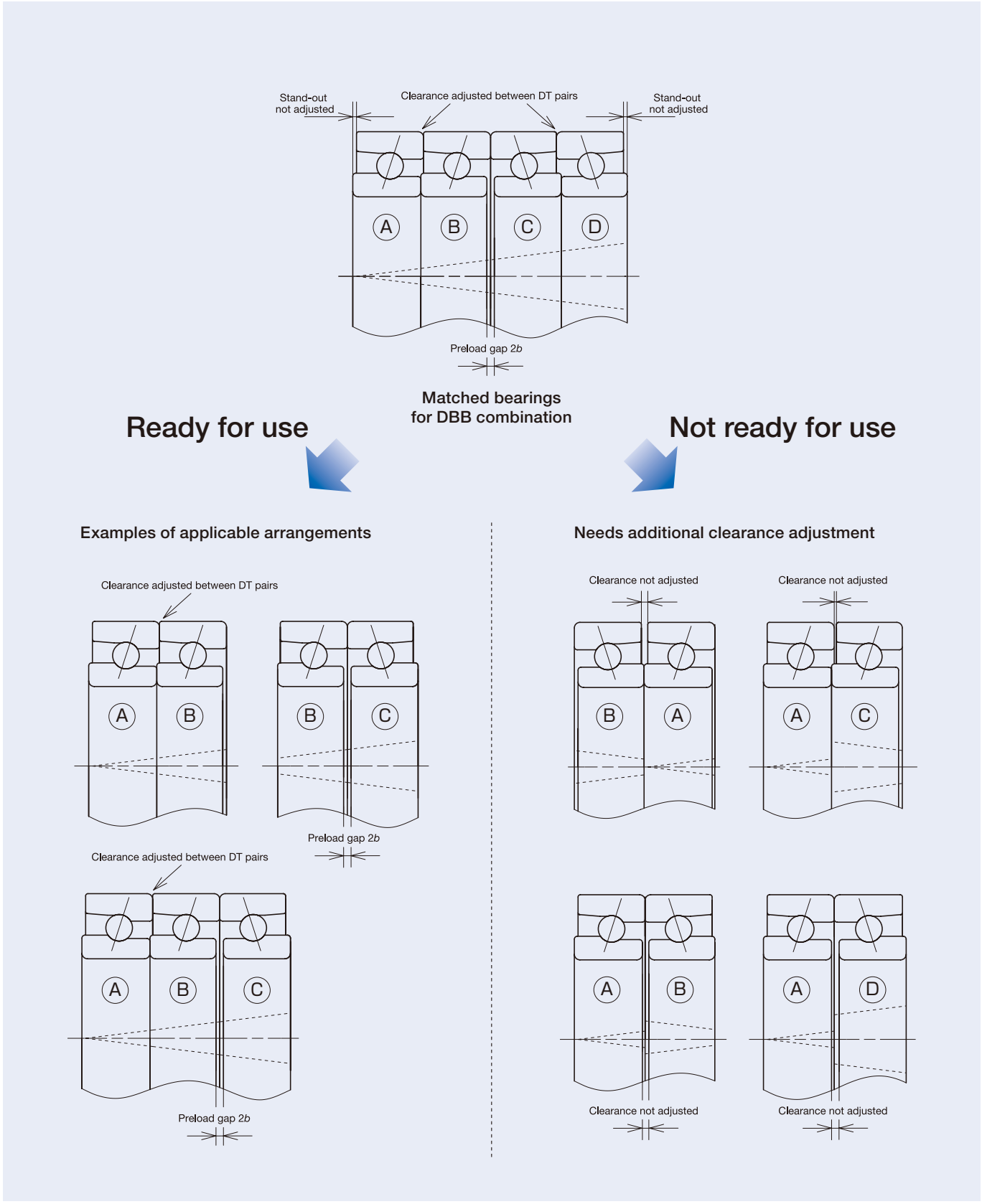


Fig. 3.8 DBB Combination

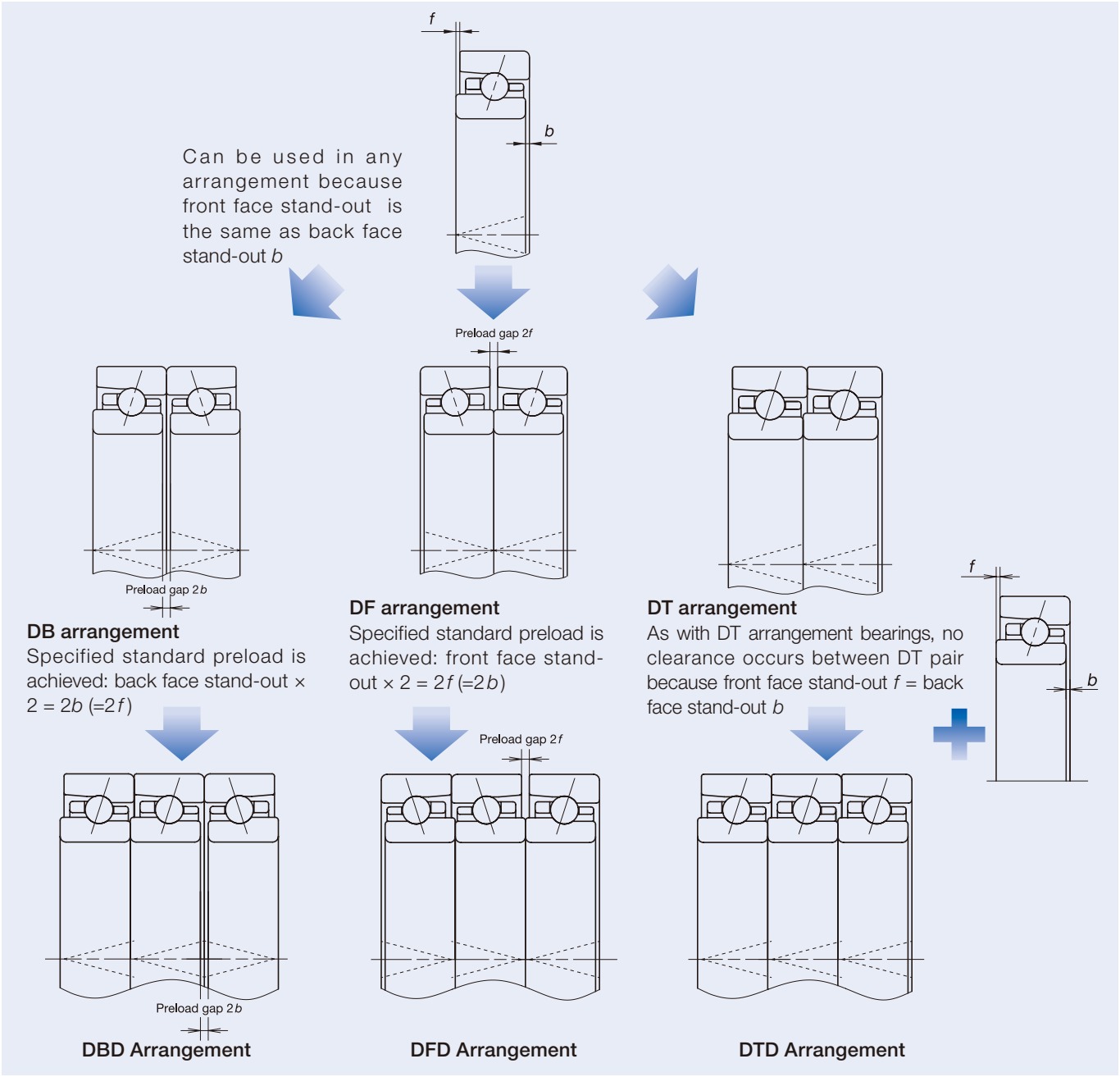


3. Angular Contact Ball Bearing Combinations

Universal Arrangement Bearings

NSK manufactures universal arrangement 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 designation, users will achieve the specified amount for each standard preload, regardless of which combination they chose. Each universal arrangement 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 Arrangement



Types of Universal Arrangement Bearings

NSK supplies four types of universal arrangement bearings, as shown in Table 3.2. Variation of bore and outside diameter are controlled for multiple-row universal arrangement bearings.

Table 3.2 Types of Universal arrangement Bearings and Their Features

	SU	DU	DUD	QU
Number of rows	1	2	3	4
Variation of bore and outside 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 outside diameter within each set are controlled. However, when using single row universal arrangement bearings (SU), users should check the actual bore/outside diameter variation printed on the box of each bearing and make sure variation of these dimensions 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 outside 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 outside diameter are strictly controlled, these bearings are suitable for custom matching.

Fig. 3.10 Tolerances of P4 and P4Y Accuracy

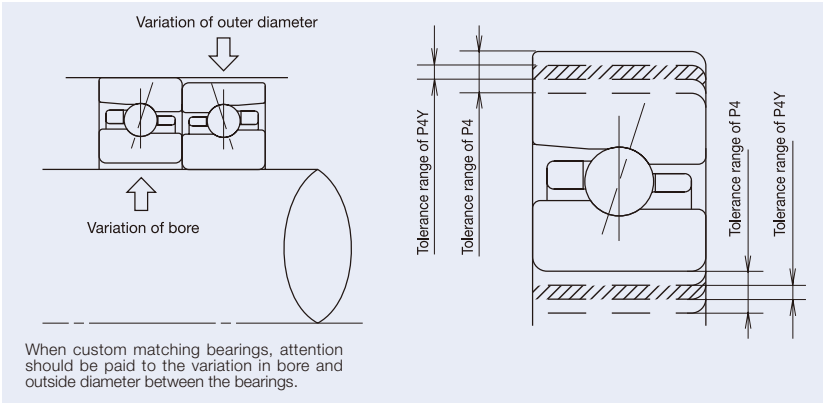
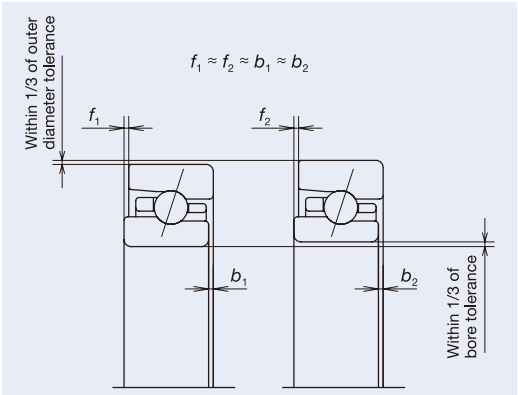
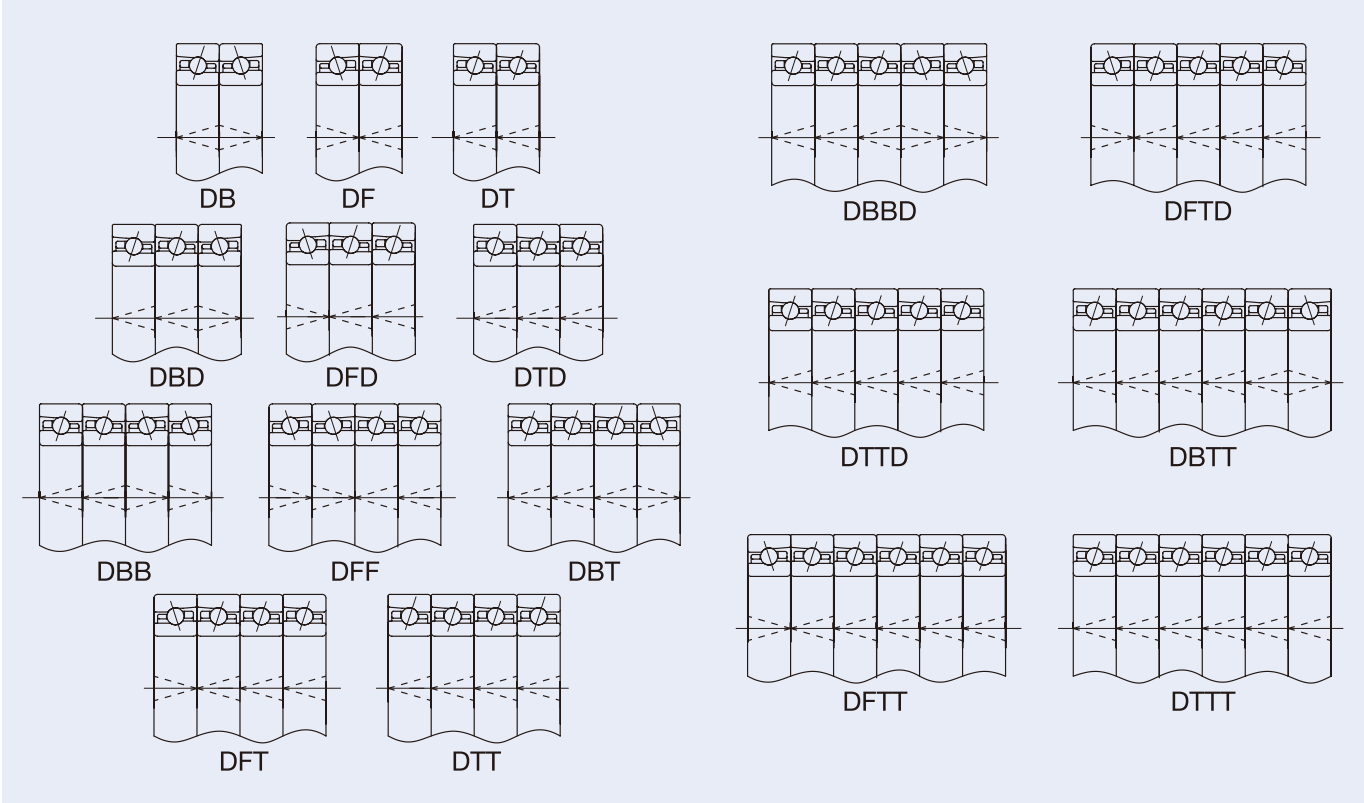


Fig. 3.11 DU Combination



Combination Mark and Matching Method for Universal Arrangement Bearings

Fig. 3.12 Arrangements of Universal arrangement 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

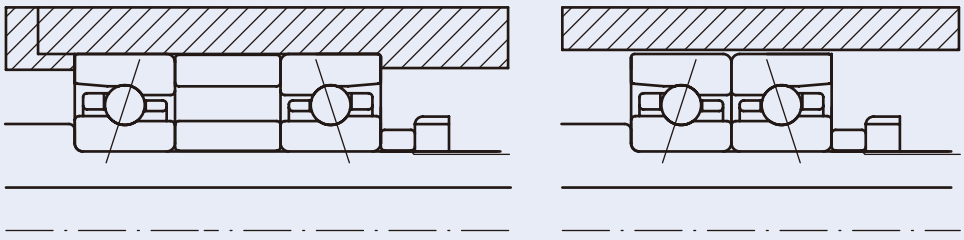
Usually a preload is applied to bearings by using two or more bearings in combination, such as angular contact ball bearings or tapered roller bearings. Cylindrical roller bearings can be preloaded by making the radial internal clearance negative.

(1) Position Preload

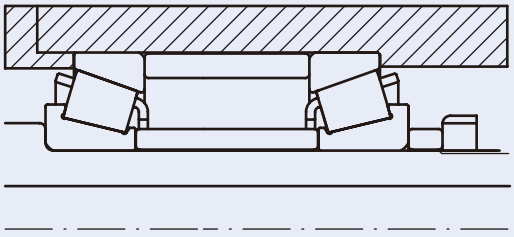
A position preload is achieved by fixing two axially opposed bearings so that their position relative to one another remains unchanged during operation. In practice, the following three methods are generally used to obtain a position preload.

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 axial clearance, 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

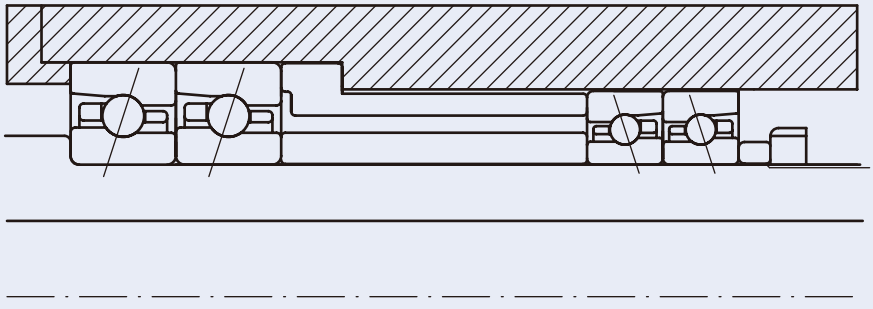


(a) Angular contact ball bearings in position preload

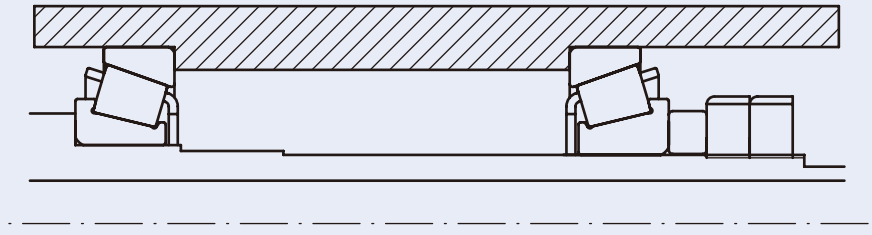


Note: The cages of tapered roller bearings usually protrude from the bearing's end faces. Customers who wish to reduce bearing span, please bear in mind the required minimum amount of spacer width.

(b) Tapered roller bearings in position preload



(c) Bearing combinations of differently sized bearings in position preload



(d) Position preload without spacers

Axial Load and Displacement in Position Preload (DB Arrangement)

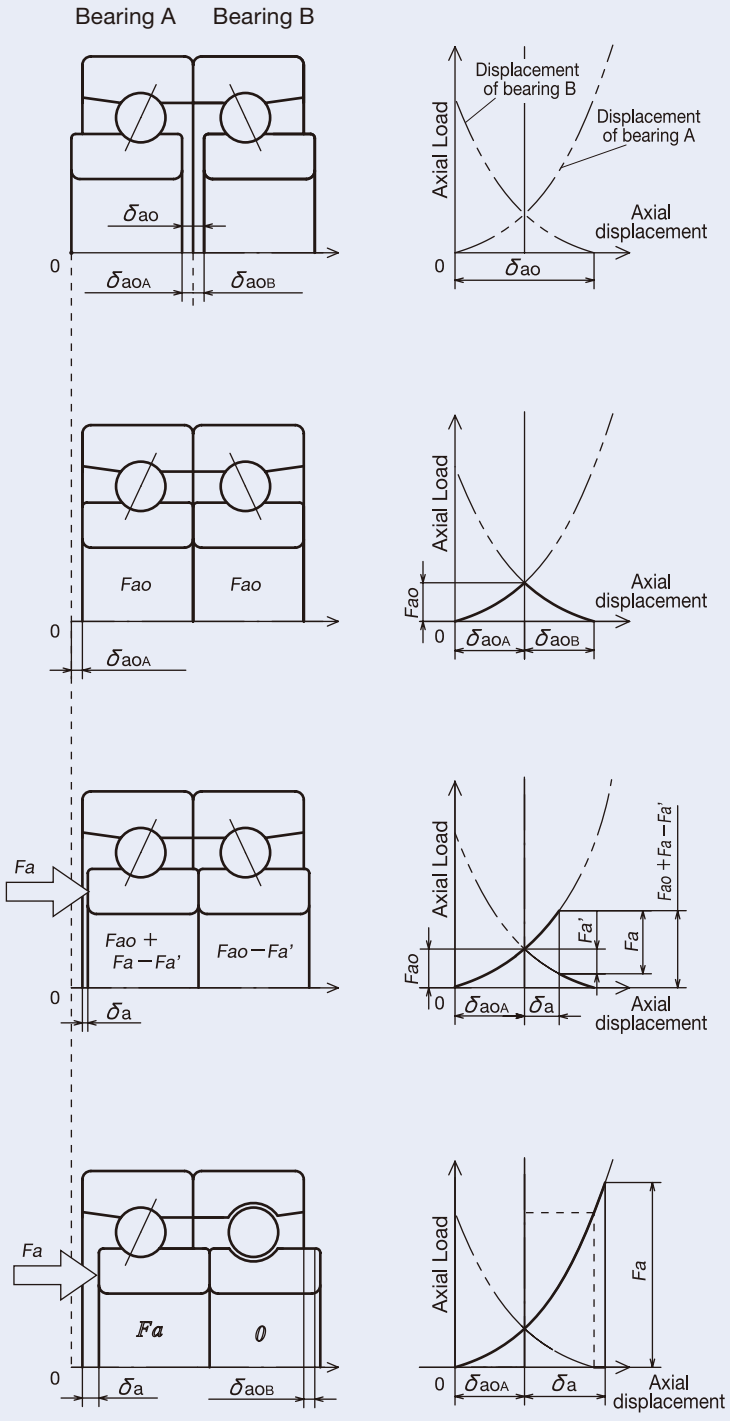
Fig 4.2 illustrates the mechanism of preload and axial load in bearing combinations.

Fig 4.2 Axial Displacement in Position Preload (DB Arrangement)

(1) When the inner rings are fixed axially, bearings A and B are displaced by δ_{a0A} and δ_{a0B}, respectively. Thus, the axial clearance (preload gap) δ_{a0} between the inner rings is eliminated. In this condition, preload F_{a0} is imposed on each bearing.

(2) When an axial load F_a is applied to the preloaded bearing combination as shown, the inner ring of bearing A will be displaced by δ_a. A balance between the loads acting on each bearing will be achieved in the point where the amount of displacement of bearing A equals that of bearing B.

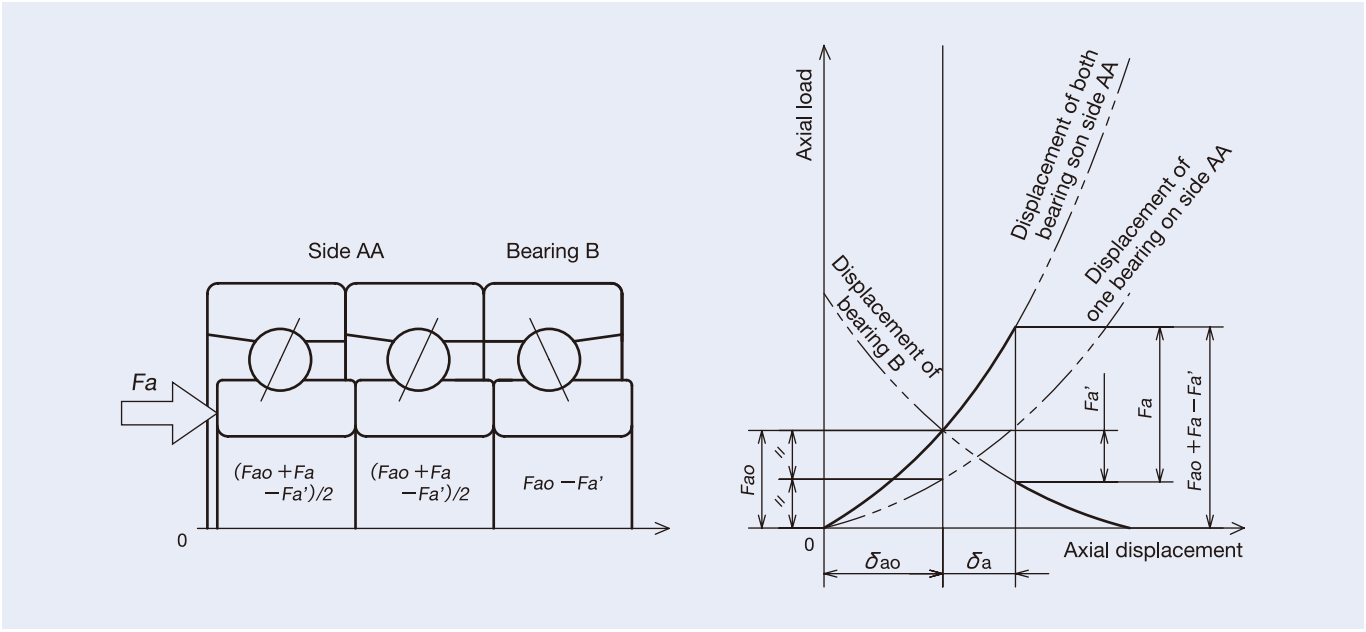
(3) When a large axial load is applied so that the displacement of the inner ring of bearing B exceeds δ_{a0B}, bearing B will no longer sustain axial load. Axial load will be sustained by bearing A only. Therefore axial rigidity will decrease.



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)

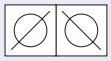
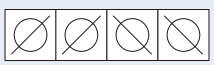
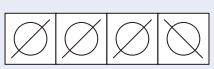
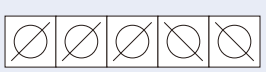


Preload Loss

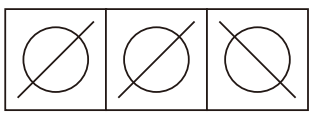
As Fig 4.2 (3) shows, when a preloaded bearing arrangement receives a large axial load, the bearing on the opposite side becomes unloaded. This can cause sliding between the rolling elements and raceways, and may cause excessive wear or bearing damage under high-speed rotation.

When angular contact ball bearings of the same type are used in an arrangement, preload loss will occur when a load 3 times the preload of a single DB or DF arrangement is applied. For tapered roller bearings, this loss-causing load is 2 times the preload of a single DB or DF arrangement. Preload loss factors for angular contact ball bearings and example calculations are shown below.

Table 4.1 Approximate Values for Load Causing Preload Loss

Combination	Arrangement code	Direction of force	Preload loss (multiply with preload of DB/DF arrangements)
	DB	⇨	3
		⇦	3
	DBD	⇨	6
		⇦	3
	DBB	⇨	6
		⇦	6
	DBT	⇨	9
		⇦	3
	DBBD	⇨	9
		⇦	6

Example calculations of preload loss for 7014A5TYNDBD with L preload:
Preload for DB/DF arrangements: 500 N
(See Page 79.)



Direction of force	Load causing preload loss
⇨	500×6 = 3 000N
⇦	500×3 = 1 500N

4. Preload and Rigidity

Standard Clearance

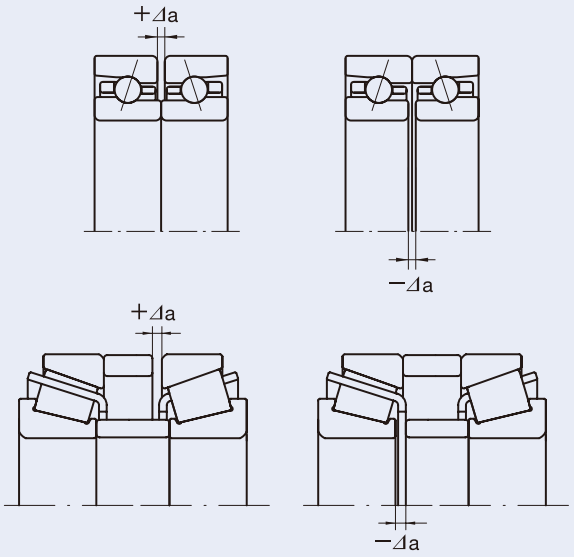
NSK supplies matched angular contact ball bearings in four standard preload classes:

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: Special Measured (+) Axial Clearance
CP: Special Measured (–) Axial Clearance
…(preload is generated)

Fig 4.4 Special Clearances



CA: Special Measured (+) Axial Clearance

CP: Special Measured (–) Axial Clearance

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.

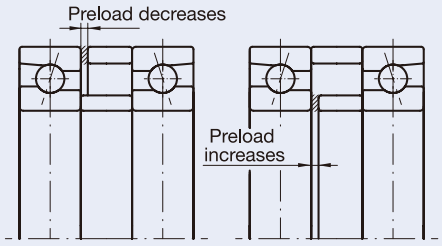
In the case of universal arrangement bearings, the following applies:

When using a DB combination, the amount of axial clearance between the bearings equals the sum of the back face stand-out values of each bearing.

In a DF combination, the amount of axial clearance 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 4.5 Adjustment of Axial Clearance with Spacers



Example of adjustment by spacers:
100BER10ETDBELP4, change preload from EL → L
EL: 0
L: -12
Inner-ring spacer should be 12μm less in width than outer-ring spacer.

Table 4.2 Measuring Loads for Axial Clearance Measurement

Nominal bearing outside 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) Outside 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.

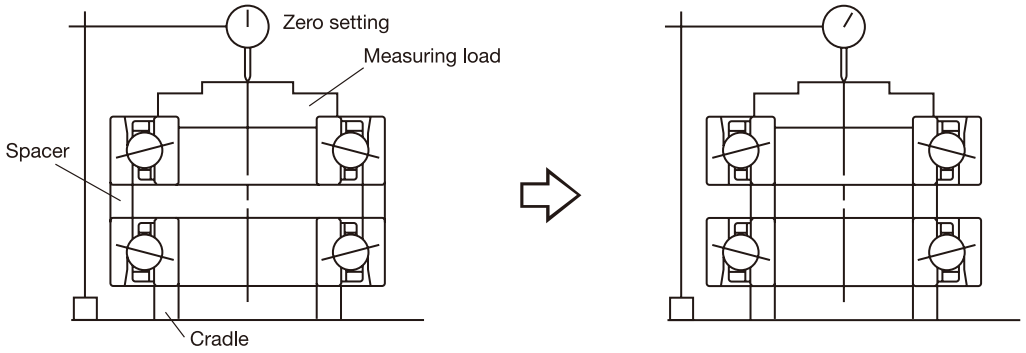
Next, after removing the outer-ring spacer, place the bearing with the inner-ring spacer on the cradle and apply measuring load in the same way as described above. The reading on the dial gauge now indicates the axial clearance. A positive reading signifies a CA clearance (positive clearance in axial 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.

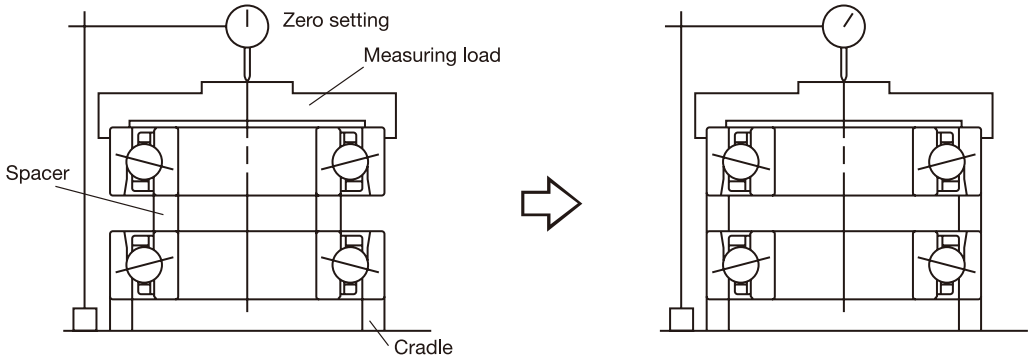
With a DT arrangement, the sum of front face stand-out and back face stand-out of the combined bearings at the mating surfaces should be zero.

For single-row bearings, axial clearance of a double-row arrangement can be obtained by adding the measured values of each bearing.

DB Arrangement

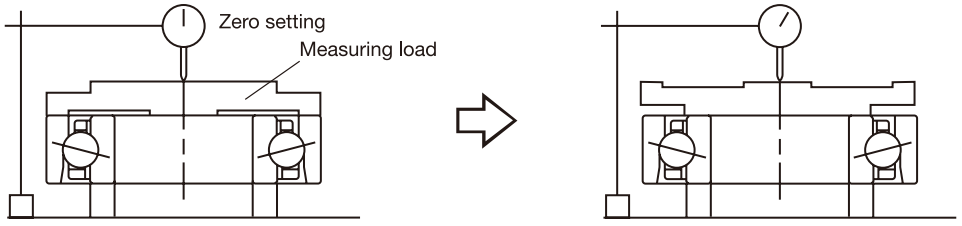


DF Arrangement

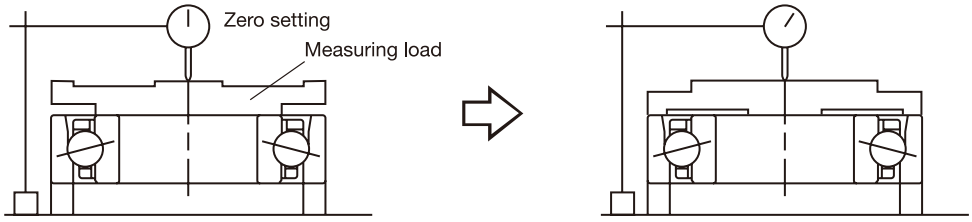


Single Row

Back face stand-out



Front face stand-out



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.

$$\Delta_a = (L\text{-}K)\text{-}(f_A + f_B) = (L\text{-}K)\text{-}[(T_A\text{-}B_A)+(T_B\text{-}B_B)]$$

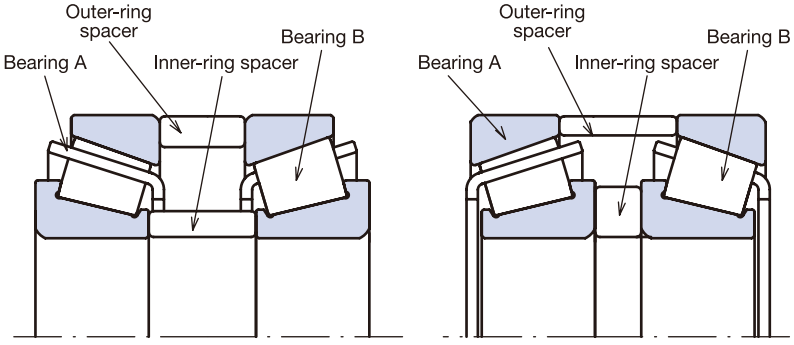
$\Delta_a < 0$ signifies a preload.

In the case of a DF arrangement, measure the outer ring instead of the inner ring. This gives the following equation for axial clearance:

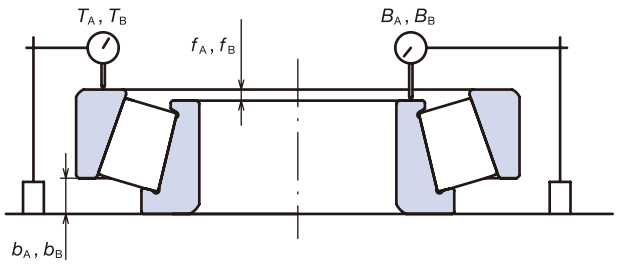
$$\Delta_a = (K\text{-}L)\text{-}(b_A + b_B) = (K\text{-}L)\text{-}[(T_A\text{-}C_A)+(T_B\text{-}C_B)]$$

Tapered rolling 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, $L = 0$.

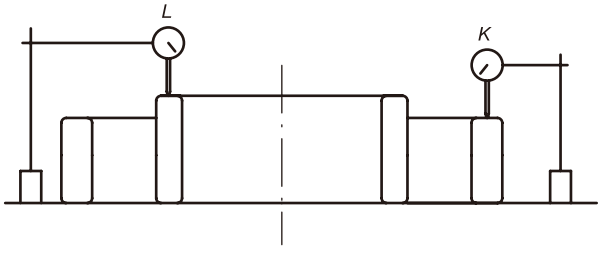
Since the cages protrude, please make sure you place the bearings with the correct side onto the cradle when measuring tapered roller bearings and take care to avoid mechanical interaction with other parts so as to prevent cage deformation.

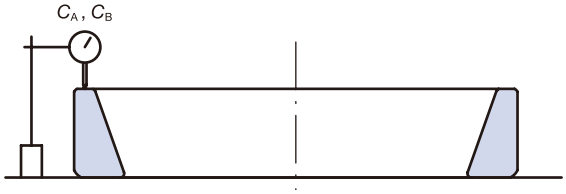


DB Arrangement　　DF Arrangement



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





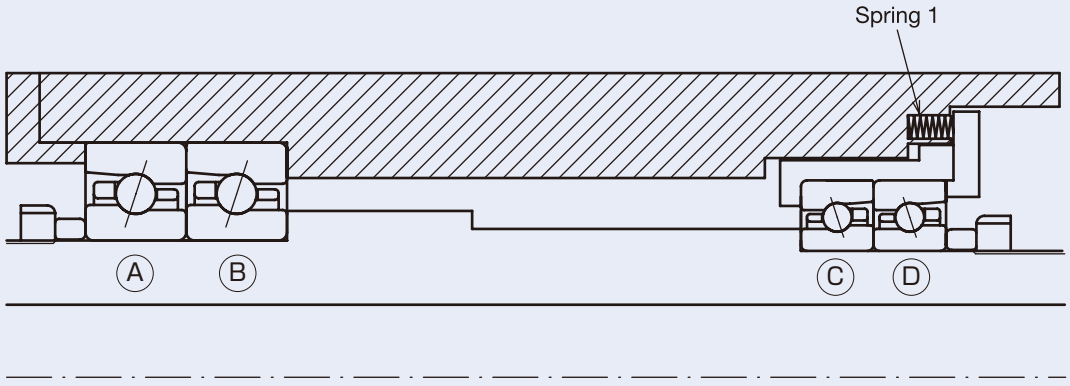
(2) Constant Pressure Preload

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.

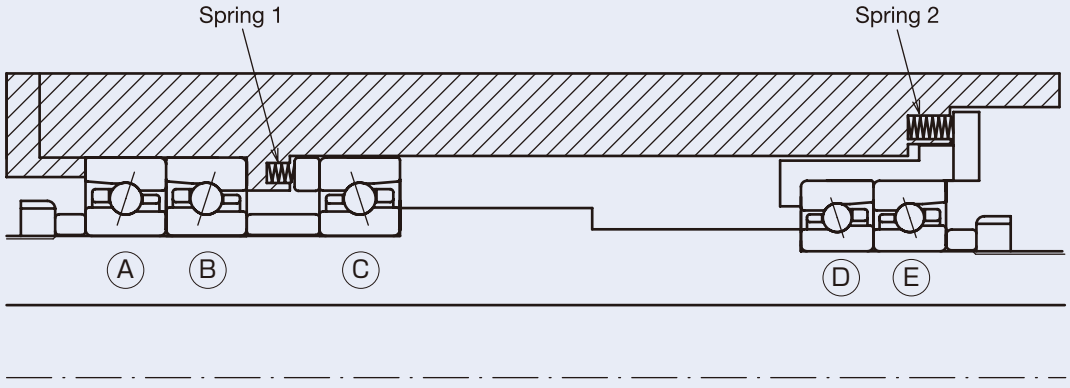
However, in addition to the forces of each spring, bearings A and B will also be affected by the dead weight of the shaft in vertical operation. Axial loads exerted from the free end towards the fixed end (from right to left in the figure below) will reduce preload of bearings A and B. It is necessary 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: $\delta_a = cF_a^{2/3}$

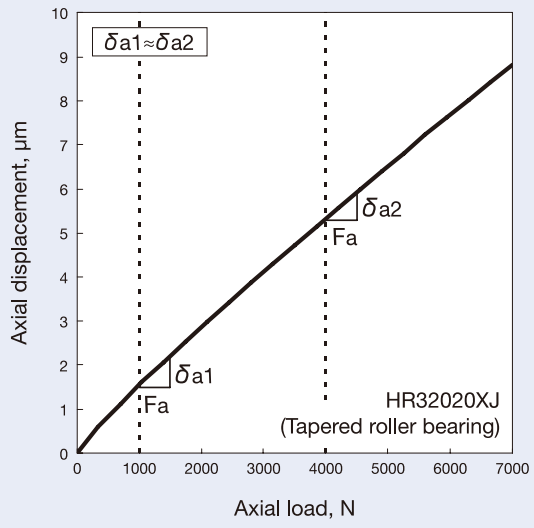
For tapered roller bearings: $\delta_a = cF_a^{0.9}$

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



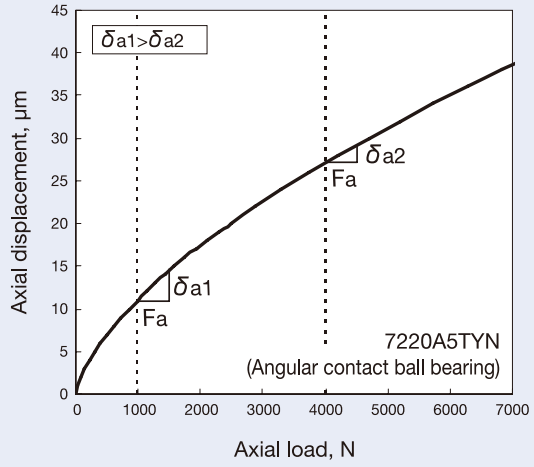
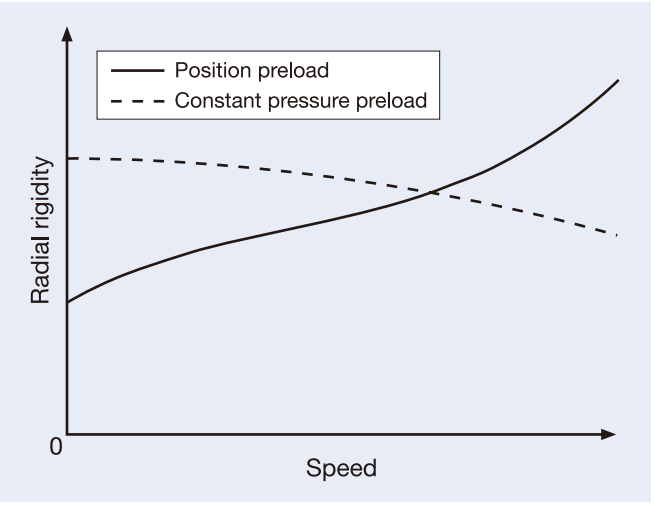


Fig. 4.8 Comparison of Rigidity under each Preloading Method



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 changes due to centrifugal force acting on the balls (Fig. 1.7 on page 197) 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: $F_{a\,min} = 0.0005C_{0a} + Mn^2$

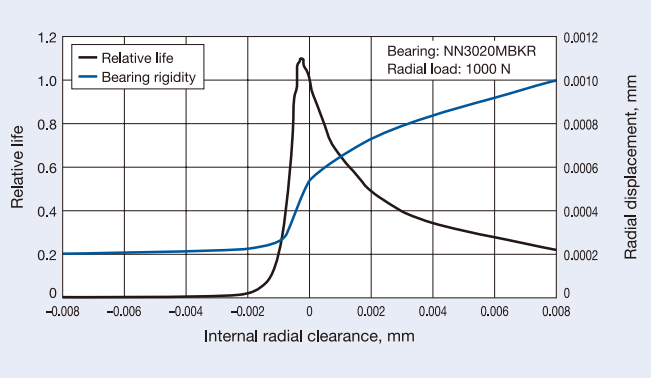
where $F_{a\,min}$: Minimum axial load (kN)
M : Minimum load factor (listed in bearing tables)
C_{0a} : Basic static axial load rating (kN)
n : Maximum speed during operation (min^{-1})

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 256 for grease application procedures, page 268 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 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.

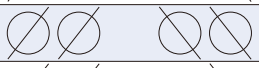
(5) Mounting Conditions

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 46)

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

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 × (EL) 0.85 × (safety factor) 0.75 = 12750min^{-1}

Factors that Change Preload

Fig. 5.1 Preload Setting Study Flow

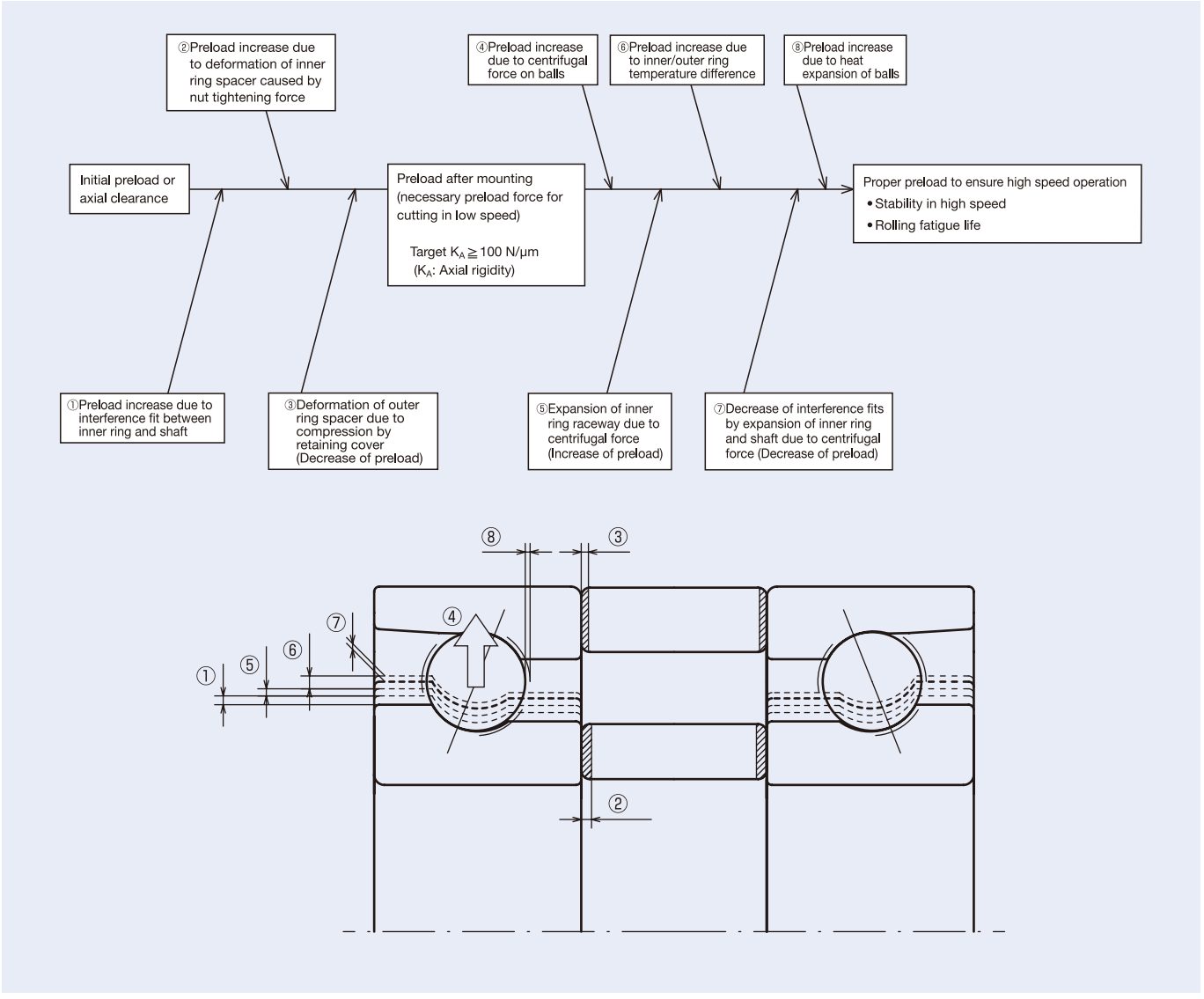


Fig. 5.2 The Influence of the Jacket Cooling on Limiting Speed

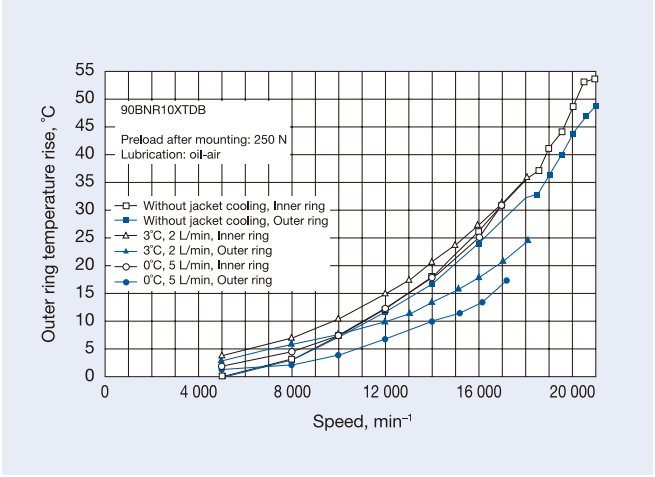
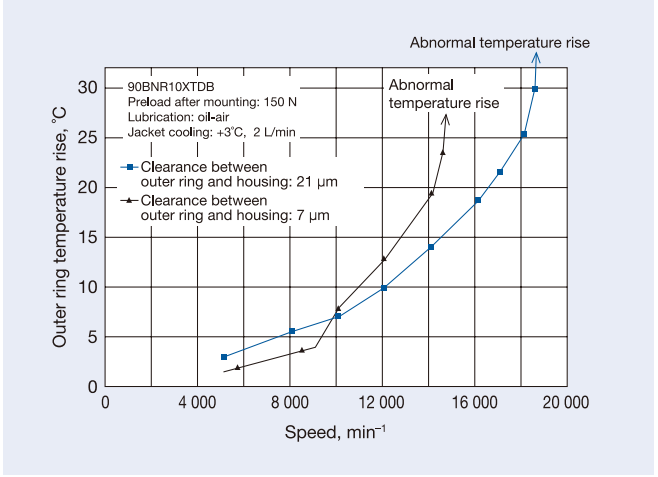


Fig. 5.3 The Influence of the Clearance between the Bearing & the Housing on Limiting Speed



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.

Dynamic friction torque of bearing (heat generation)

$M = Ml + Mv$

- Load term (Determined by bearing type and load)

  $Ml = f_1 F d_m$

  where f_1 : Coefficient determined by bearing type and load
  F : Load
  d_m : Pitch circle diameter of rolling element
- Speed term (Determined by oil Viscosity, oil amount, and speed)

  $Mv = f_0 (\nu_0 n)^{2/3} dm^3$

  where f_0 : Coefficient determined by bearing and lubricating method
  ν_0 : Kinematic viscosity of oil
  n : Speed

Fig. 6.1 Oil Quantity and Temperature Rise

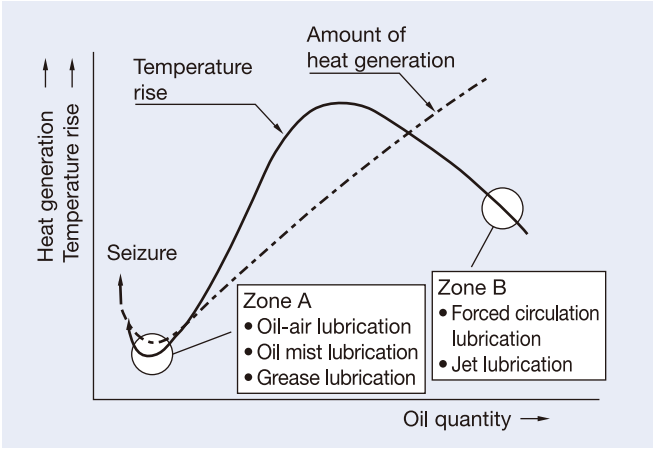


Table 6.1 Comparison of Lubricating Methods

Lubricating Method	Advantages	Disadvantages
Grease Lubrication	☐ Cost is low. ☐ Limitation of temperature rise is possible. ☐ Maintenance free.	☐ If packed grease deteriorates, seizure may occur. ☐ May allow penetration of dust or cutting fluid.
Oil Mist Lubrication	☐ Since new oil is always fed, no fear of oil deterioration. ☐ Dust and cutting fluid cannot easily enter.	☐ 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	☐ 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.	☐ Cost is rather high. ☐ Confirmation of whether oil is actually fed to bearing is difficult.
Jet Lubrication	☐ 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.	☐ 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 No.2 or No.3 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 257.

(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℃)	Dropping Point (℃)	Working (1) Temperature Range (℃)	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

When lubricating bearings with oil, highly purified mineral and synthetic oils that perform well under high loads and offer good anti-oxidative and anti-corrosive properties are used.

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 sprays oil by turning it into a mist using compressed air.

Oil-air lubrication meanwhile feeds 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.Additionally, note that high-speed operations require oil supply adjustments as high speeds typically increase the quantity of oil needed for proper lubrication.

For the position of the spray nozzle, please refer to pages 240-241.

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 68 cSt

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 outside diameter etc.)

Please refer to the instruction manual of your lubrication device manufacturer etc. for details.

Table 6.3 Required Viscosity of Lubricating Oil by 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 for Lubricating Oil

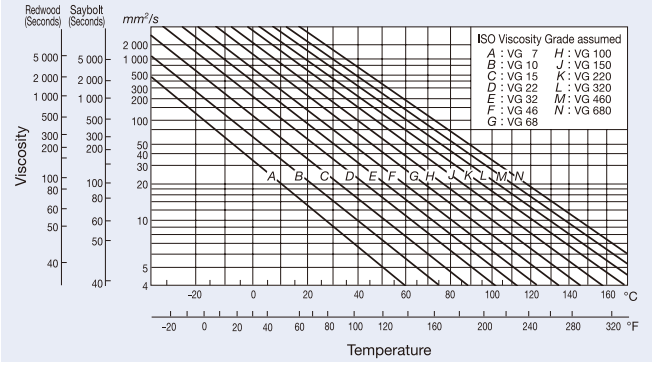


Fig. 6.3 Recommended Oil Quantity by Bearing Bore Size (Minimal Oil Quantity Lubrication)

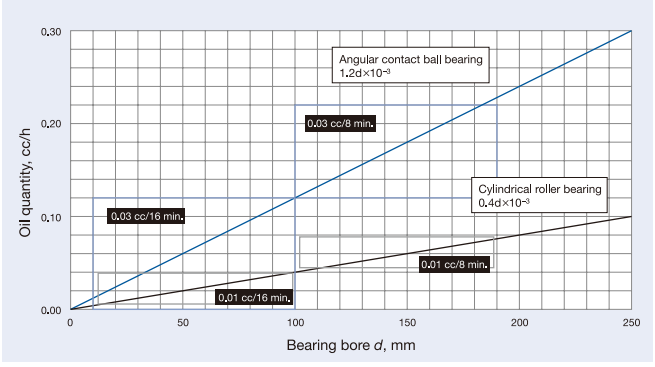
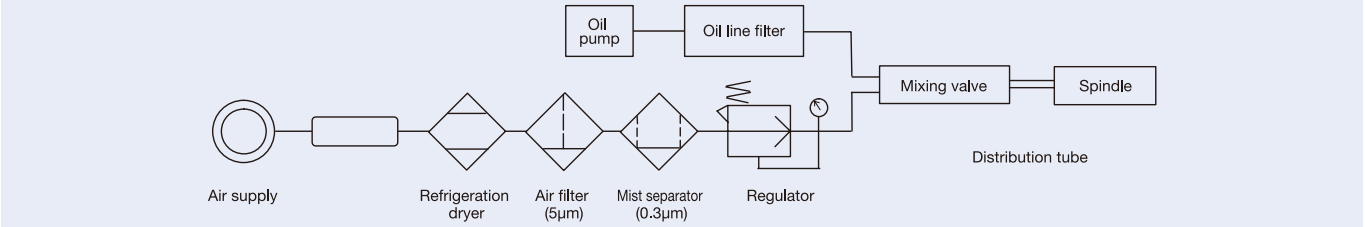


Fig. 6.4 Oil-Air Lubrication System (Example)

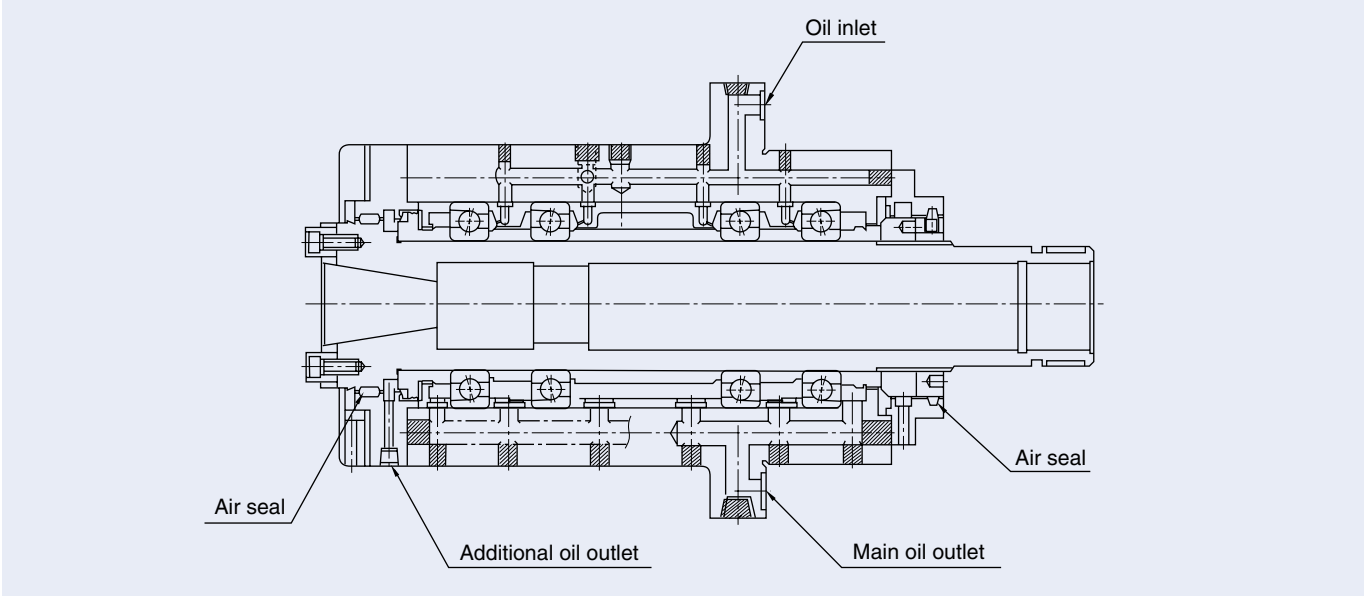


(2) Jet Lubrication

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 240-241.

Fig. 6.5 Jet Lubrication Spindle (Example)



Oil Amount in Forced-Circulation Lubrication

The equation below can be used to estimate the amount of oil needed for a bearing with forced-circulation lubrication.

$$Q = \frac{0.19 \times 10^{-5}}{T_2 - T_1} d\mu nF \text{ (N)} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

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 tolerances for 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)		Single Plane Mean Bore Dia. Deviation Δ_{dmp} (2)		Bore Dia. Variation in a Single Radial Plane V_{dp} (2) Diameter Series		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}
				9	0, 2, 3					Single Bearing Combined Bearing	Single Bearing	Combined Bearings (1)	
Over	Incl.	High	Low	Max.		Max.	Max.	Max.	Max.	High	Low		Max.
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) Diameter Series		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}
						9	0, 2, 3					Single Bearing Combined Bearing	Single Bearing	Combined Bearings (1)	
Over	Incl.	High	Low	High	Low	Max.		Max.	Max.	Max.	Max.	High	Low		Max.
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 outside 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

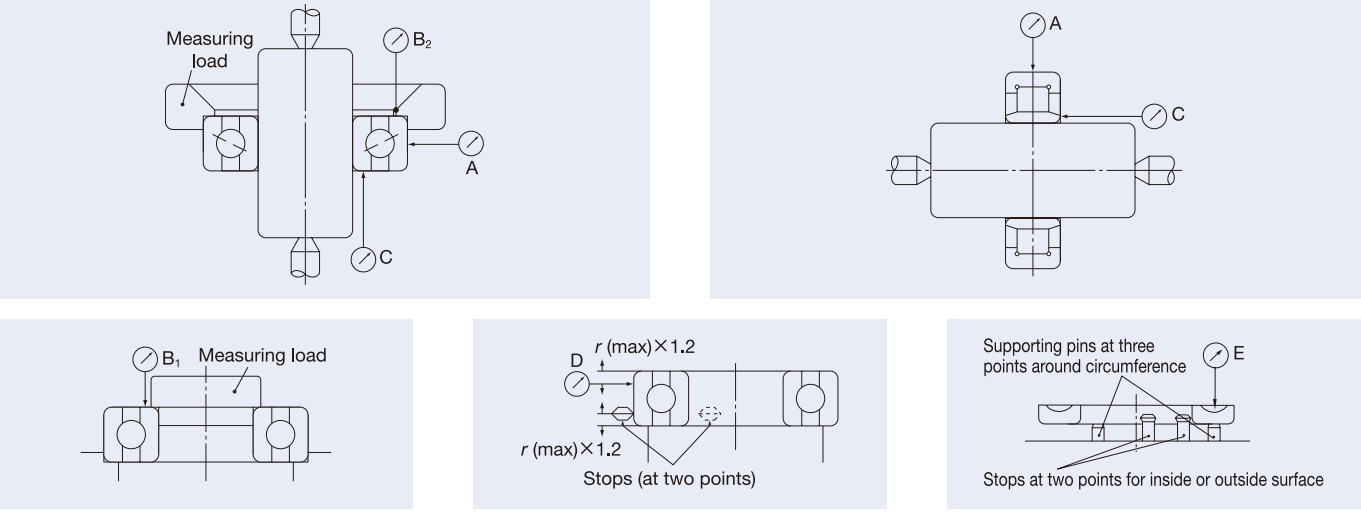


Table 7.4 Inner Ring (Class 3) (3) Unit: μm

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}
											Single Bearing Combined Bearing	Single Bearing	Combined (1) Bearing	
Over	Incl.	High	Low	High	Low	Max.	Max.	Max.	Max.	Max.	High	Low		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}
											Single Bearing Combined Bearing	Single Bearing	Combined (1) Bearing	
Over	Incl.	High	Low	High	Low	Max.	Max.	Max.	Max.	Max.	High	Low		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 Tolerances for Bore Diameter of Inner Ring Unit: μm

Bore Diameter (mm)		Class 4		Class 4Y (Median Specification)	
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 an NSK proprietary standard in which the tolerances for the bearing bore diameter and outside diameter are in a special class (controlled to a median specification), while other tolerances are per Class 4. Since this minimizes variation in bearing bore diameter and outer ring outside diameter, P4Y is the most suitable tolerance class for universal arrangement 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							
				9	0, 2						
Over	Incl.	High	Low	Max.		Max.	Max.	Max.	Max.		Max.
6	18	0	− 5	5	4	3	5	8	8		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	Equal to the	8
120	150	0	− 11	11	8	6	11	10	13	value of inner	8
150	180	0	− 13	13	10	7	13	10	14	ring (Δ_{Bs}) of	8
180	250	0	− 15	15	11	8	15	11	15	the same	10
250	315	0	− 18	18	14	9	18	13	18	designation.	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}
						Diameter Series							
						9	0, 2						
Over	Incl.	High	Low	High	Low	Max.		Max.	Max.	Max.	Max.		Max.
6	18	0	− 4	0	− 4	4	3	2	3	4	5		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	Equal to the	3
80	120	0	− 8	0	− 8	8	6	4	6	5	6	value of inner	4
120	150	0	− 9	0	− 9	9	7	5	7	5	7	ring (Δ_{Bs}) of	5
150	180	0	− 10	0	− 10	10	8	5	8	5	8	the same	5
180	250	0	− 11	0	− 11	11	8	6	10	7	10	designation.	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 outside 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} (1)	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 designation.	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} (1)	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 designation.	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 Tolerances for Outside Diameter of Outer Ring

Unit: μm

Outside Diameter (mm)		Class 4		Class 4Y (Median Specification)	
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 an NSK proprietary standard in which the tolerances for the bearing bore diameter and outside diameter are in a special class (controlled to a median specification), while other tolerances are per Class 4. Since this minimizes variation in the bearing bore diameter and outer ring outside diameter, P4Y is the most suitable tolerance class for universal arrangement bearings.

Outer / Inner Ring (Class 3W)

Table 7.12 Tolerances for Outside Diameter of Inner / Outer Rings

Unit: μm

Outside Diameter (mm)		Class 3		Class 3W (Median Specification)	
		Combined Bearings		Combined Bearings	
Over	Incl.	High	Low	High	Low
50	**80**	0	–250	0	–100
80	**120**	0	–380	0	–100
120	**140**	0	–380	0	–100
145	**150**	0	–380	0	–100
165	**170**	0	–380	0	–100

* Class 3W is an NSK proprietary standard in which the tolerances for the inner and outer ring width are in a special class, while other tolerances are per Class 3. The width tolerances are the same for the inner and outer rings. This standard can apply to universal arrangement bearings (SU, DU, DUD, and QU). Minimizing differences in width improves assembly and reduces the need for adjustments.

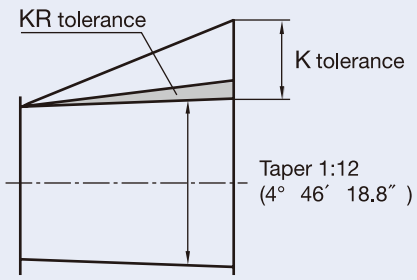
7. Bearing Tolerances

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

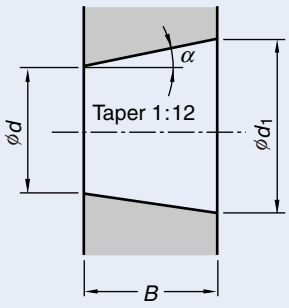


KR : A very narrow range positioned towards the lower limit of ISO tolerance for easier adjustment of taper angle during mounting. KR tolerance is NSK's standard tolerance for bore diameters up to 400mm.

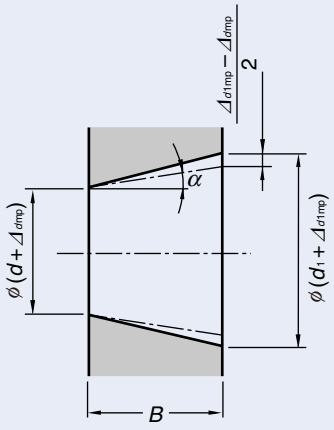
K : Positioned midrange of ISO tolerance, this accuracy class offers bore dimensional accuracy identical to the ISO specification. K tolerance is NSK's standard tolerance for bore diameters over 400mm.

Fig. 7.3 Tapered Bore Tolerances

Nominal tapered bore



Tapered bore with deviation in single plane mean bore diameter



d : Nominal bore diameter

d_1 : Theoretical diameter of larger end of tapered bore
$d_1 = d + \frac{1}{12}B$

Δ_{dmp} : Deviation of single plane mean bore diameter of smaller end of tapered bore from the nominal diameter

Δ_{d1mp} : Deviation of single plane mean bore diameter of larger end of tapered bore from the theoretical diameter

V_{dp} : Bore diameter variation in a single radial plane

B : Nominal inner ring width

α : Half of taper angle of tapered bore
$\alpha = 2°23'9.4''$
$= 2.38594°$
$= 0.041643\text{rad}$

Table 7.12 KR Tapered Bores

Unit: μm

d (1) (mm)		Δ_{dmp}		(Reference) (3) $\Delta_{d1mp}-\Delta_{dmp}$		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, $4^\circ 46' 18.8'' \, {}^{+25''}_{0}$

Table 7.13 K Tapered Bores

Unit: μm

d (mm)		Δ_{dmp}		$\Delta_{d1mp}-\Delta_{dmp}$		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}	
						Diameter Series							Combined Bearing	
						9	0							
Over	Incl.	High	Low	High	Low	Max.	Max.	Max.	Max.	Max.	Max.	Max.	High	Low
–	**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}		
						Diameter Series							Combined Bearing		
						9	0								
Over	Incl.	High	Low	High	Low	Max.	Max.	Max.	Max.	Max.	Max.	Max.	High	Low	
–	**80**	− 30	− 37	− 30	− 37	7	5	3.5	5	4	5	3			
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	Equal to the value of inner ring (Δ_{Bs}) of the same designation.		
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	Max.	Max.	Max.
–	**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	− 1 200	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 Δ_{dmp}		Deviation of Single Bore Diameter Δ_{ds}		Single Plane Mean Outside Diameter Deviation Δ_{Dmp}		Deviation of Single Outside Diameter Δ_{Ds}		Deviation of Single Inner Ring Width Δ_{Bs}		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 Δ_{dmp}		Single Plane Mean Outside Diameter Deviation Δ_{Dmp}		Deviation of Single Inner Ring Width Δ_{Bs}		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 BSBD Series double-row bearings (Class P2B (5) of BSF and BSN types)

Table 7.20 BSBD Series double-row bearings (BSF and BSN types)

Unit: μm

Nominal Bore Diameter (mm)		Single Plane Mean Bore Diameter Deviation Δ_{dmp}		Single Plane Mean Outside Diameter Deviation Δ_{Dmp}		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(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(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(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(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(mm)		Single Plane Mean Bore Diameter Deviation Δ_{dmp}		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(mm)		Single Plane Mean Bore Diameter Deviation Δ_{dmp}		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(mm)		Single Plane Mean Outside Diameter Deviation Δ_{Dmp}		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(mm)		Single Plane Mean Outside Diameter Deviation Δ_{Dmp}		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 Outside diameter (mm)		Tolerance of shaft outside 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 outside diameter and housing bore minimum and maximum for custom 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 (target: below 1/5000)

Eccentricity is below 0.020mm

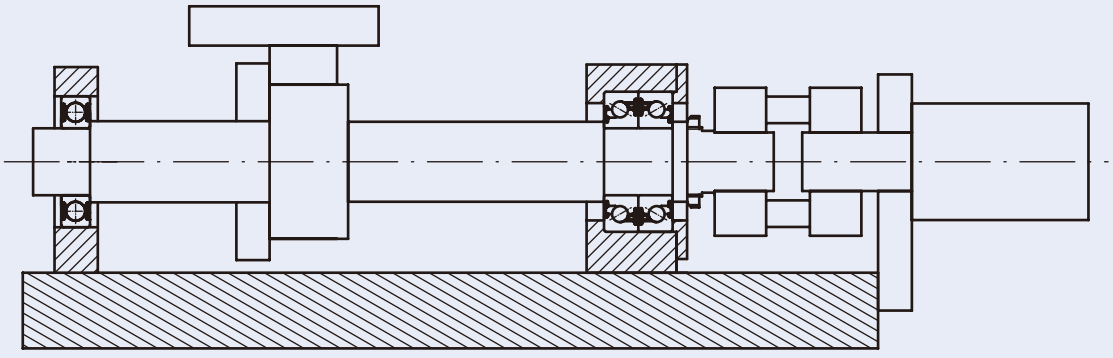
Table 8.3 Fits on Shafts

Bearing type	Shaft Outside Diameter (mm)		Tolerance of Shaft Outside 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 248 for a description and details on the gauging of shaft tapers.

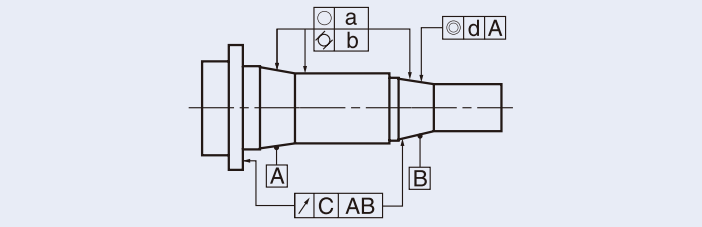


Table 8.5 Tolerance for and Mean Roughness of Shafts

Shaft Diameter (mm)		Tolerance Grades and Mean Roughness (μm)							
		Out-of-roundness (○)		Cylindricity (⌭)	Runout (↗)		Coaxiality (◎)		Roughness
		a		b	c		d		R_a
		Bearing Accuracy		Bearing Accuracy	Bearing Accuracy		Bearing Accuracy		Bearing Accuracy
Over	Incl.	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

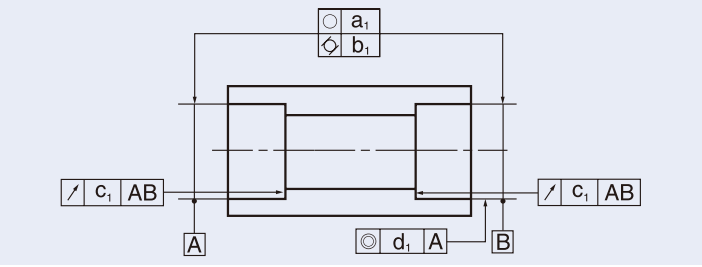


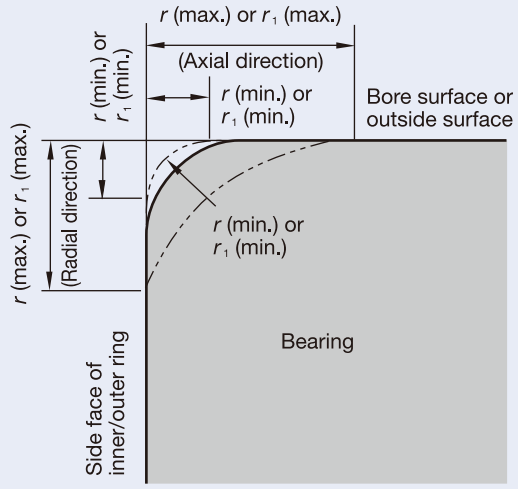
Table 8.6 Tolerance for and Mean Roughness of Housings

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
		Bearing Accuracy		Bearing Accuracy	Bearing Accuracy		Bearing Accuracy		Bearing Accuracy
Over	Incl.	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



r : chamfer dimension of inner/outer ring
r_1: chamfer dimension of inner/outer ring (Front side)

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	Nominal bore diameter d		Largest permissible chamfer dimension		For reference
			r (max.) or r_1 (max.)		Corner radius of shaft or housing r_a
r (min.) or r_1 (min.)	Over	Incl.	Radial direction	Axial direction (1)	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	Nominal bore diameter or nominal outside diameter d or D		Largest permissible chamfer dimension r (max.)		For reference
					Corner radius of shaft or housing r_a
r (min.)	Over	Incl.	Radial direction	Axial direction (1)	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

(1) For inner ring chamfer, locate d in "Over"/"Incl." columns; for outer ring chamfer, locate D in "Over"/"Incl." columns.

Table 8.9 Chamfer Dimension Limits for Thrust Bearings

Unit: mm

Smallest permissible chamfer dimension	Largest permissible chamfer dimension r (max.)	For reference
		Corner radius of shaft or housing r_a
r (min.) or r_1 (min.)	Radial and axial direction	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

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
			Outside diameter (1)	Bore diameter	Outside diameter	Bore diameter (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 outside 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
			Outside diameter (1)	Bore diameter	Outside diameter	Bore diameter (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 outside 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
			Outside diameter (1)	Bore diameter	Outside diameter	Bore diameter (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 outside 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

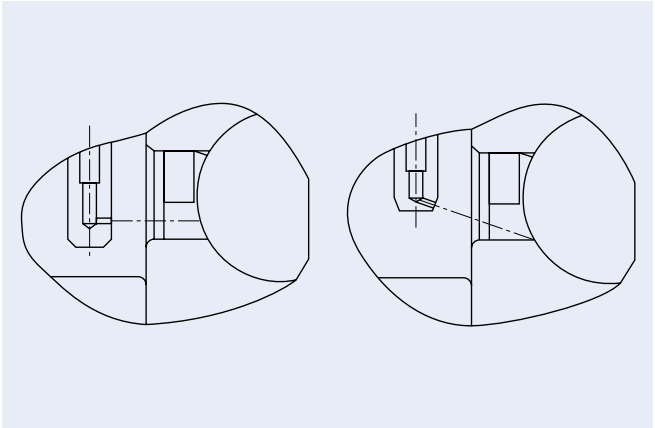
Bore number	Nominal bearing bore	79 Series		70 Series		72 Series		N10XXMR (Standard Series)		N10XXR (NSKROBUST Series)	
		ϕA (1)	B	ϕA (1)	B	ϕA	B	ϕA	B	ϕA	B
00	10	14.5	0.4	16.1	0.5	18.1	0.5	–	–	–	–
01	12	16.5	0.4	18.3	0.5	19.6	0.5	–	–	–	–
02	15	20.0	0.5	21.3	0.5	22.6	0.7	–	–	–	–
03	17	21.8	0.5	23.5	1.0	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) ϕA 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 220 for an example of an oil-air lubrication system.

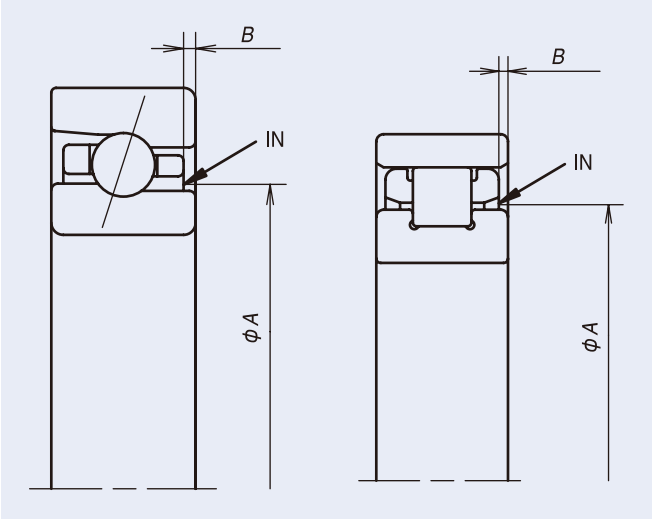
Fig. 9.1 Angle of Spray Nozzle



Unit: mm

Nominal bearing bore	BNR19 BER19		BNR10 BER10		BSR19		BSR10		BSR02		BAR10 BTR10	
	ϕA	B	ϕA	B	ϕA	B	ϕA	B	ϕA	B	ϕA	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



Part 6

Bearing Handling

1. Mounting ·····244-265
   1. Cleaning the Bearings and Related Parts
   2. Checking Dimensions of Related Parts
   3. Mounting Procedures
   4. Inspection after Mounting
2. Operational Inspection ·····266-267
3. Running-in Procedures ·····268-269

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 246-247 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 outside diameter will be achieved. Refer to pages 232-234 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 235.

■ 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 249.

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 263 and page 264, 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 266.

Static unbalance of a shaft can be checking 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 268.

Typical irregularities of operating spindle and the countermeasures for them are listed on page 275.

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.



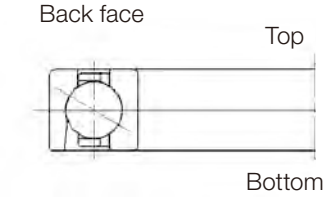
2 Without rotating it, pour cleaning oil over the bearing to remove anti-corrosion agent



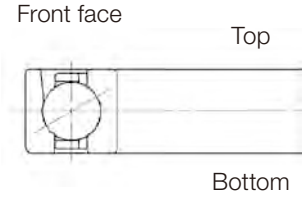
Handle bearings with care

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

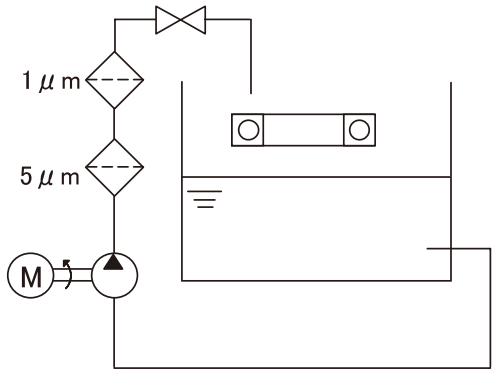
Always use a circulating filtration system to filter the cleaning fluid.

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.

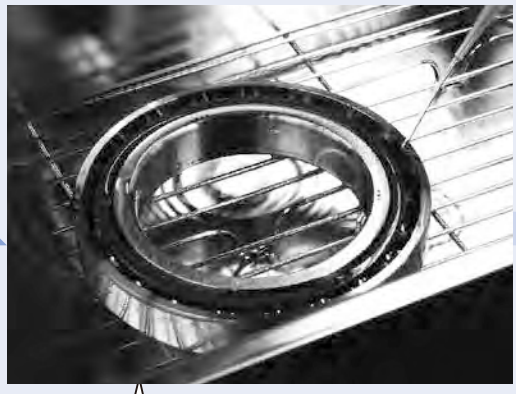
Replace the cleaning oil at regular intervals.

Circulating filtration system (Example)

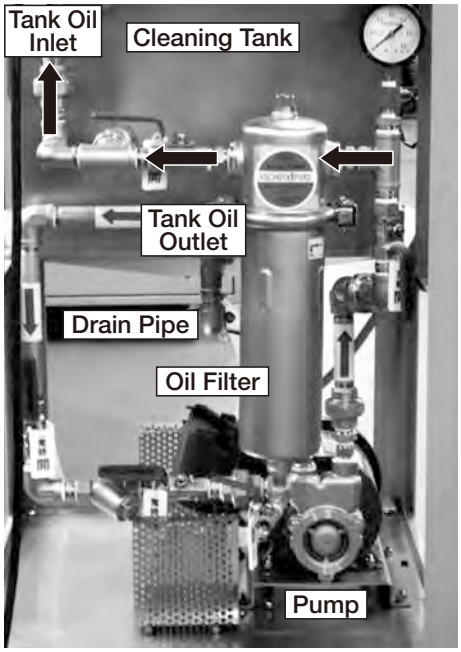


3 Rotate the bearing while allowing cleaning oil to flow between the inner and outer ring, thereby removing anti-corrosion agent from the bearing interior. Make sure the bearing runs smoothly after cleaning.

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.

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 272.

■ Taper angle

Please refer to pages 226-227 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

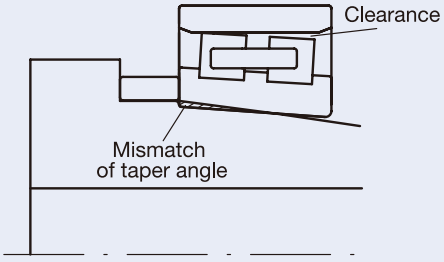
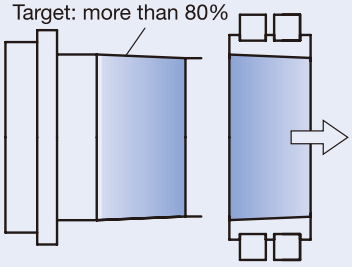
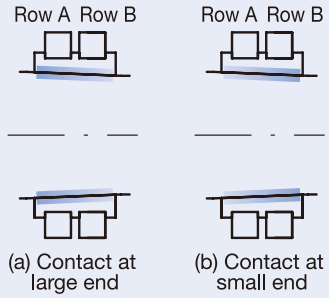


Fig. 1.2 Confirmation of Taper Angle with Coloured Paste



(The example of small end contact with blue dyed inner ring.)

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 246-247 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 250 and page 252, 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

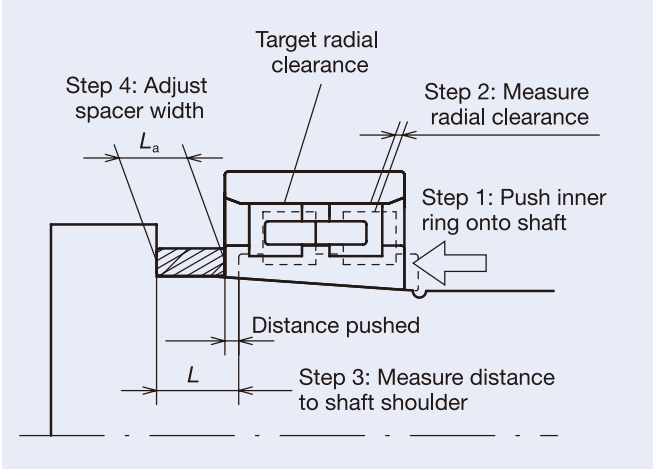


Fig. 1.5 Pushing the Inner Ring in Place

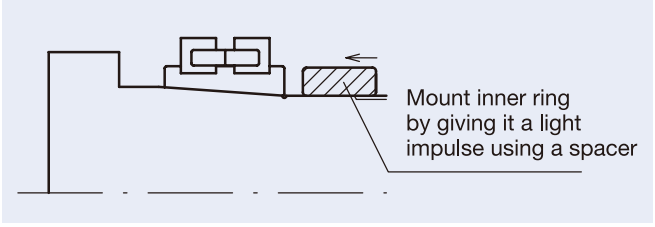
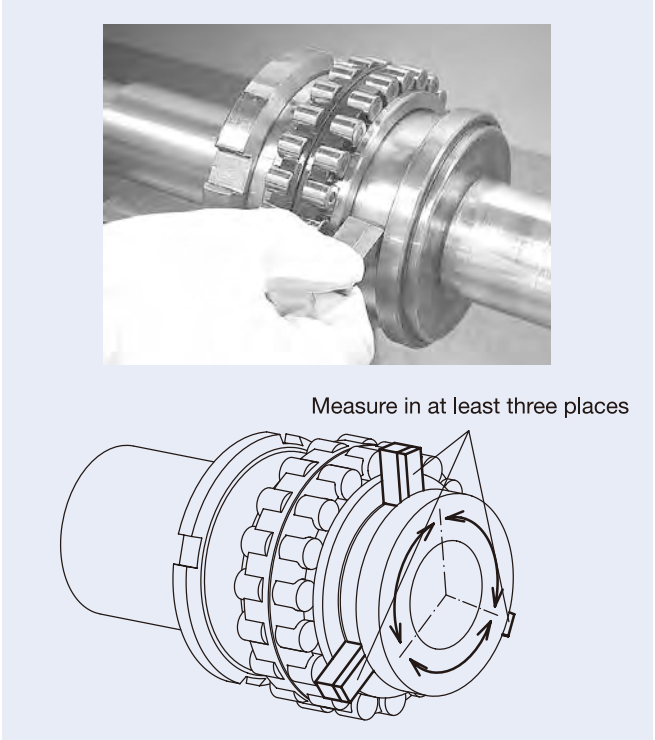


Fig. 1.6 Measuring the Required Spacer Width

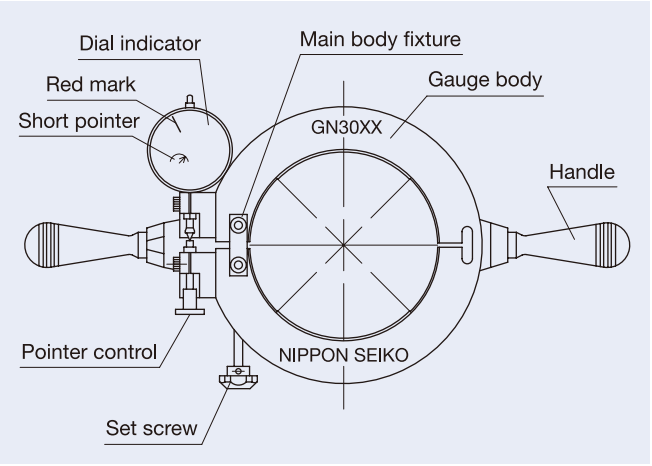


(1) Measuring Radial Clearance of Cylindrical Roller Bearings (GN Gauge Method)

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 233.

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

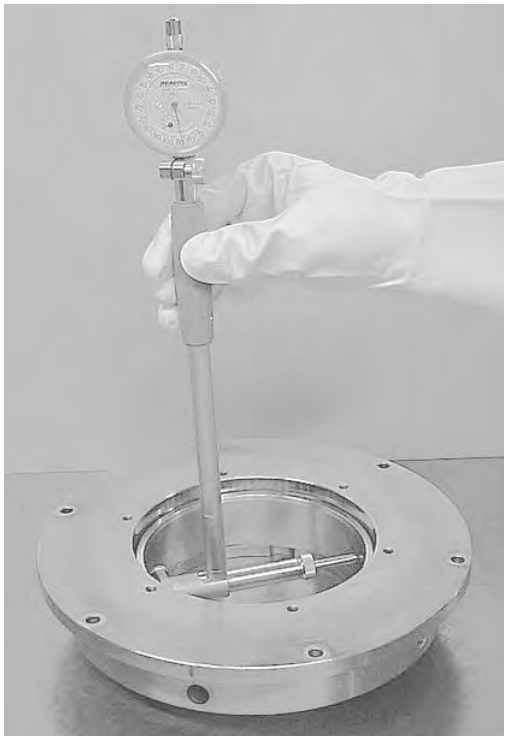
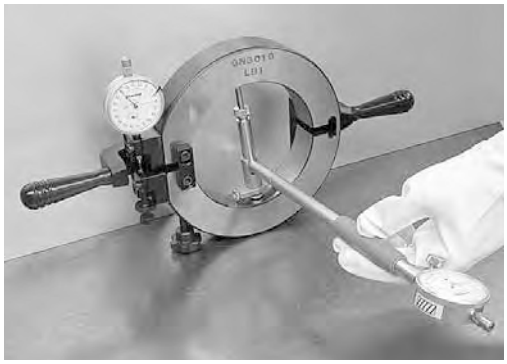


Fig. 1.9 Adjusting the GN Gauge Bore



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.

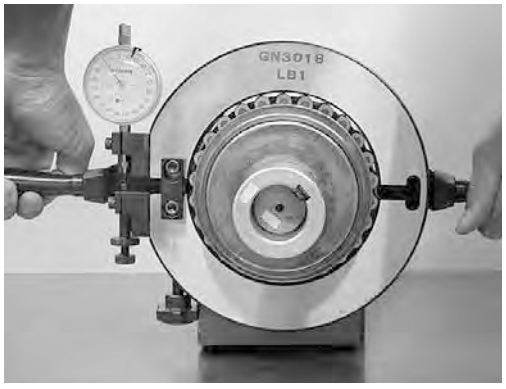
Fig. 1.10 Correcting the GN Gauge



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).

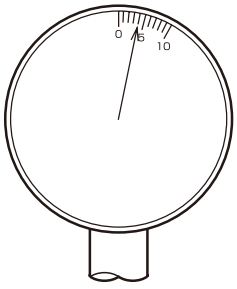
Fig. 1.11 Setting the GN Gauge



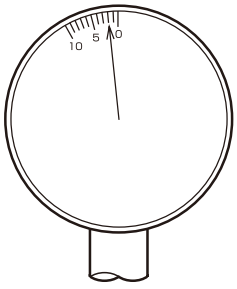
⑥ Read the dial

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 ½ the reading.

Examples:

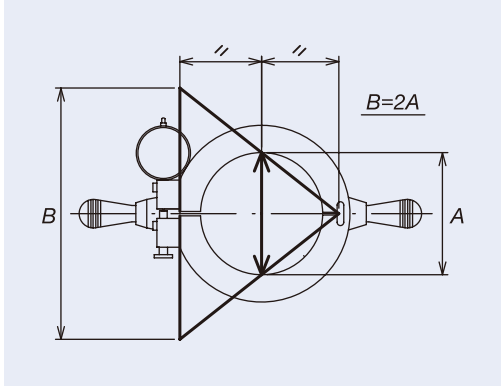


Example 1:
A reading of 4 (clockwise) indicates a radial clearance of +2μm



Example 2:
A reading of 2 (anti-clockwise) indicates a radial clearance of -1μm

Fig. 1.11 Geometrical Structure of the GN Gauge



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 249, step 3.

⑨ Adjust the spacer width

Finish the spacer width to the dimension obtained in ⑧.

(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.

$$L_a = L - K\,(\Delta r_m - \Delta r + \Delta r_e)$$

①Based 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

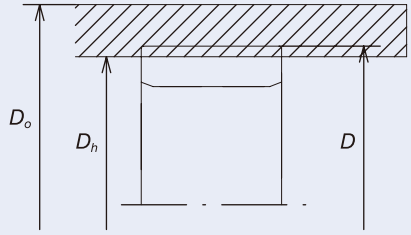
Housing wall thickness ratio h_o ($=D_o/D_h$)	Shrinkage factor H
110%	0.32
120%	0.47
130%	0.56
140%	0.61
150%	0.65
160%	0.68
170%	0.70
180%	0.71

②Place the outer ring over the rollers. Apply a dial gauge to the outside diameter of the outer ring. Then lightly tighten the shaft locknut.

③Moving the outer ring up and down by hand, measure the free radial play Δr_m with the dial gauge.

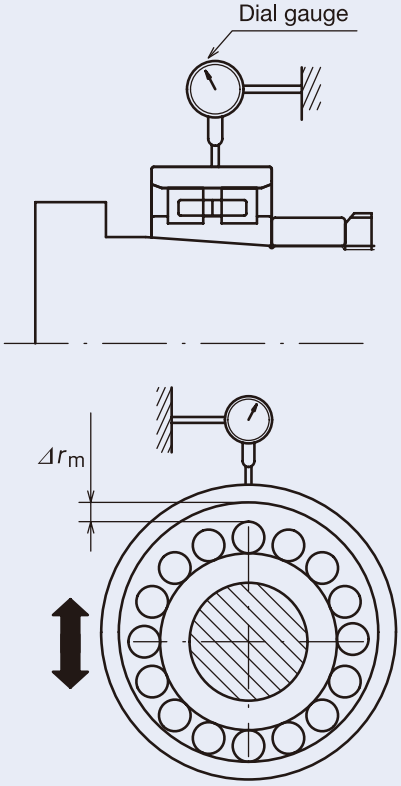
Body temperature may increase the temperature of the outer ring, resulting in an erroneous measurement. Therefore we recommend you wear gloves and finish the measurement quickly.

Fig 1.13 Explanation of Variables



D_o : Outside diameter of housing
D_h : Housing bore
D : Outside diameter of outer ring (Refer to bearing inspection sheet)
H : Outer ring raceway shrinkage factor

Fig 1.14 Measuring the Free Radial Play of the Outer Ring



④Repeat ② and ③ until Δr_m = 5μm

Note: We adopted 5 μm 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 μm 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.

⑤Measure the distance between the inner ring end face and the shaft shoulder L as described on page 249 , step 3.

⑥Using 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_O and Coefficient K

Hollow shaft ratio k_O ($=d_o/d$)	Coefficient K	Hollow shaft ratio k_O ($=d_o/d$)	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		

⑦Calculate the required length L_a for the clearance adjustment spacer according to the results obtained in ⑤ and ⑥:

$$L_a = L - \Delta L_i$$

Fig 1.15 Deformation of the Outer Ring Due to Measuring Force

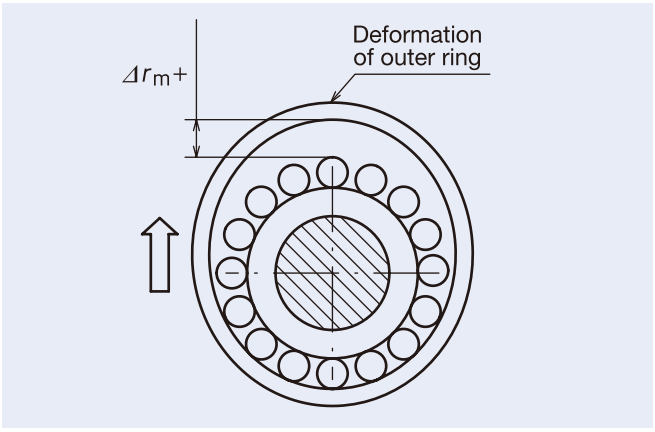
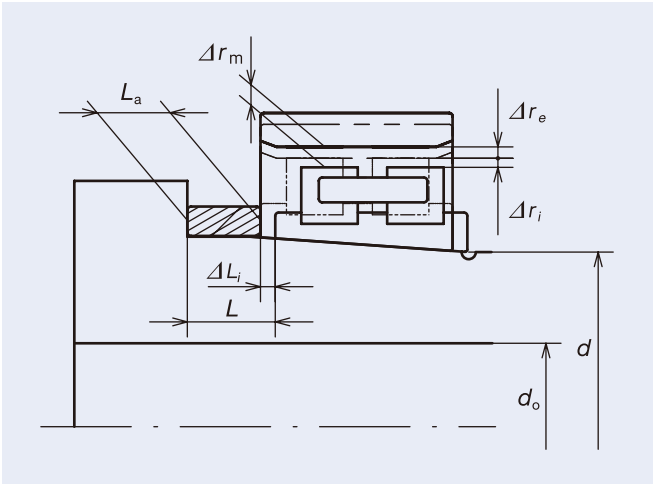


Fig 1.16 Explanation of Variables



(Example calculation)

Setting radial clearance after mounting to Δr = -0.002 mm for NN3020MBKR:

$h_O = D_O/D$ = 225/150 = 150% ⇒ H = 0.65

Shrinkage of outer ring raceway diameter due to fitting

Δr_e = (149.993-149.998) × 0.65 = -0.003 mm

Amount of inner ring expansion necessary to achieve target clearance value

Δr_i = 0.005-0.003- (-0.002) =0.004 mm

$k_O = d_O/d$ = 50/100 = 50% ⇒ K = 15.2

Distance that the inner ring needs to be pushed up the tapered shaft

ΔL_i=15.2×0.004 = 0.061 mm

Width of clearance adjustment spacer

L_a = 20.55-0.061 = 20.489 mm

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

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 261 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. 1.18 Example of Outer Ring Deformation Due to Clearance Between Retaining Cover and Housing

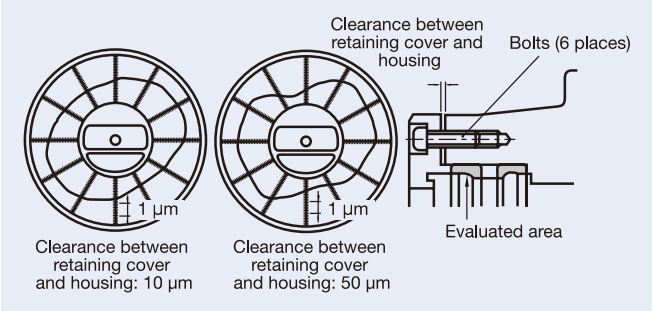


Fig. 1.19 Example of Outer Ring Deformation Caused by Tightening of Retaining Cover

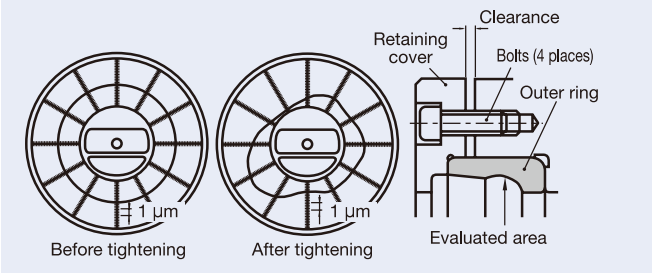


Fig. 1.17 Adjusting the Retaining Cover

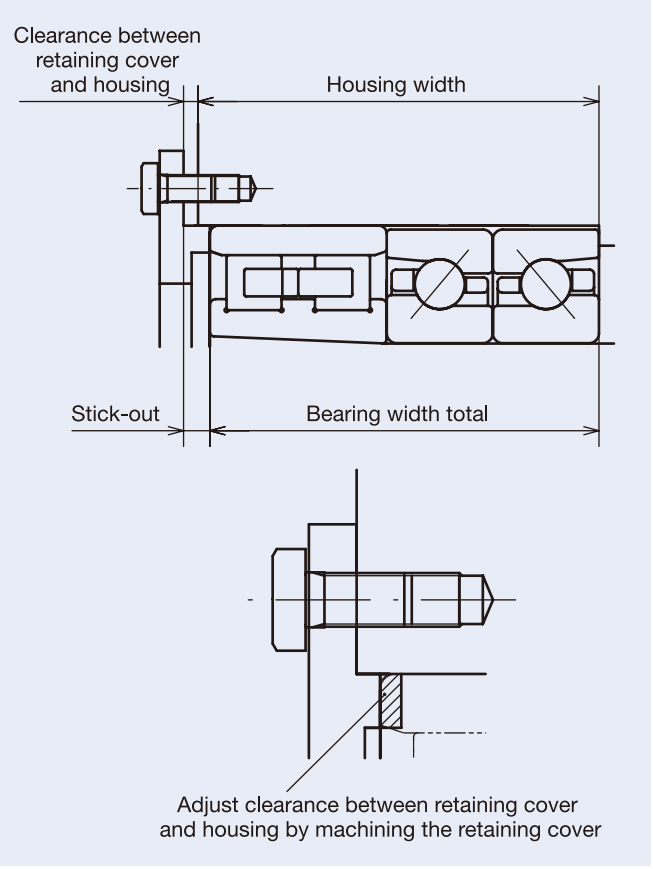
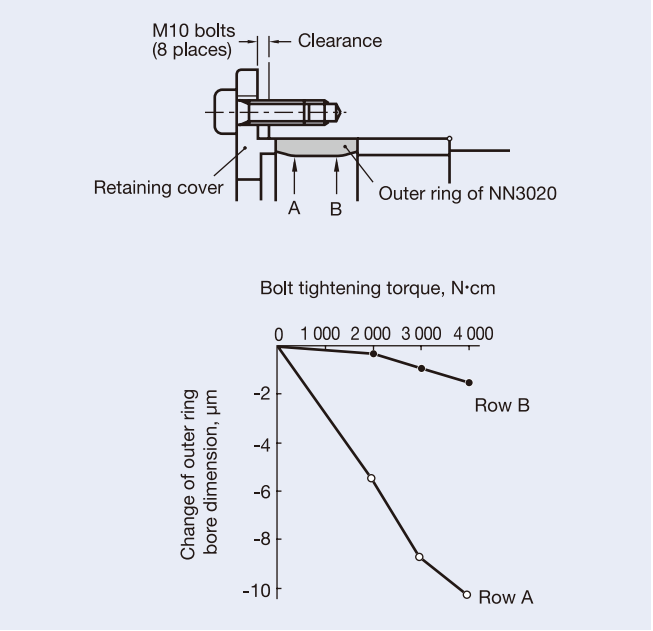


Fig. 1.20 Example of Outer Ring Deformation of a Double-Row Cylindrical Roller Bearing Caused by Tightening Force of Retaining Cover

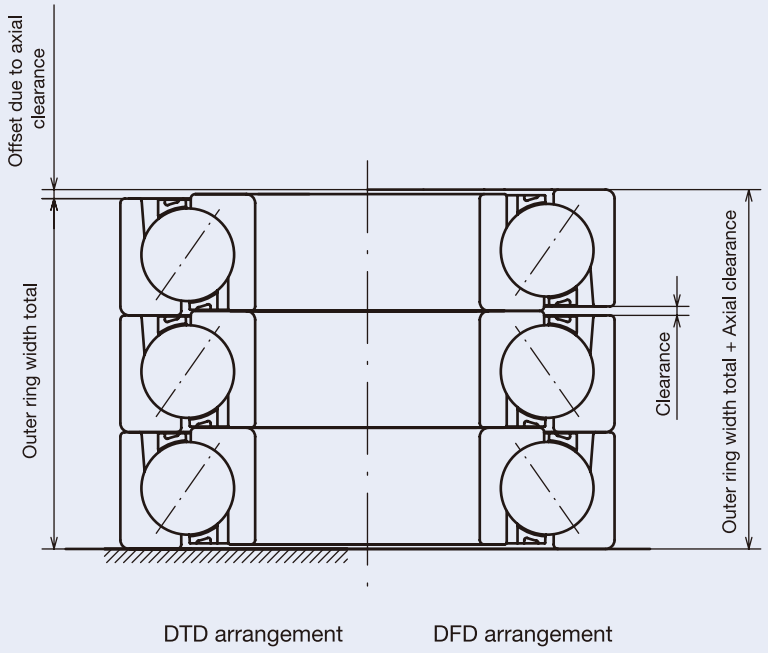


Note concerning the adjustment of clearance between the retaining cover and housing in DF arrangements

When using bearings in DF arrangement (including DFD, DFF, DFT arrangements etc.), there is axial clearance 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:

①Measure the outer ring width of each bearing individually.
②Rearrange bearings so that there is no axial clearance: e.g. DT, DTT etc.
③Measure the outer ring width of your bearing arrangement, then correct for the amount of axial clearance.

Fig. 1.21 Influence of Arrangement Type on Measurement of Outer Ring Width Total



Note for method ①: When using universal arrangement 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, axial clearance 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.

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	—	1.7	—	—	1.4	1.1
11	55	1.1	2.4	3.9	1.7	—	2.4	—	—	2	1.5
12	60	1.2	2.6	4.8	1.8	—	2.5	—	—	2.1	1.6
13	65	1.3	2.6	5.7	1.9	—	2.7	—	—	2.2	1.6
14	70	2.1	3.6	6.5	2.8	—	3.9	—	—	3.2	2.4
15	75	2.3	3.6	7	2.9	—	4.2	—	—	3.5	2.5
16	80	2.4	5.1	8.7	3.8	—	5.3	—	—	4.7	3.5
17	85	3.5	5.3	11	4	—	5.5	—	—	4.9	3.7
18	90	3.6	6.6	13	5.5	—	7.6	—	—	6.5	4.5
19	95	3.6	6.8	16	5.7	—	8	—	—	6.6	4.7
20	100	4.9	7.2	19	6.1	5.3	8.3	5.4	4.5	6.8	4.9
21	105	5.1	9	23	7.6	—	10	5.6	4.6	9.3	5.9
22	110	5.2	12	27	9.1	5.7	12	5.7	4.8	11	7.5
24	120	7.9	12	31	9.8	7.6	13	8.4	6.5	13	8.1
26	130	9	18	34	15	9.5	19	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 219.
· Please refer to page 146 for the recommended grease quantities for angular contact thrust ball bearings for ball screw support.
· For bore diameters larger than 280mm, please contact NSK.

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

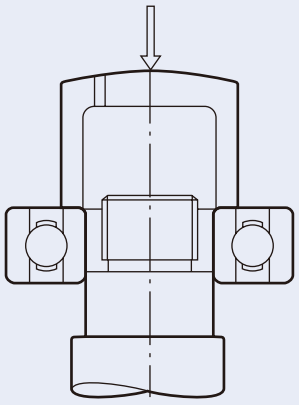
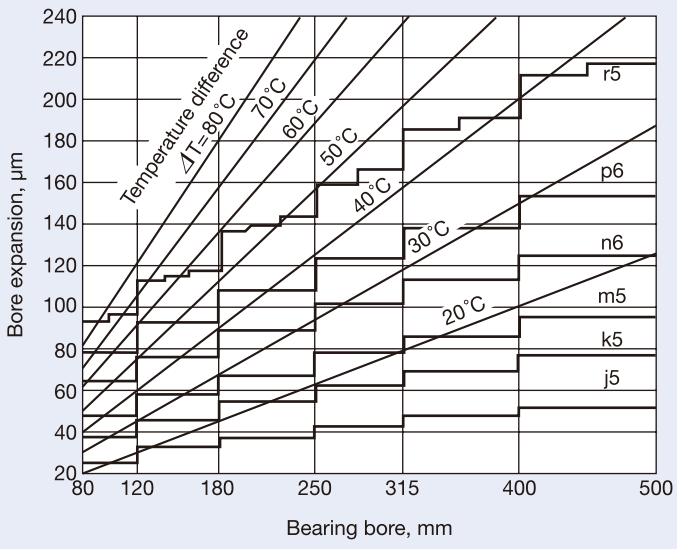


Fig 1.25 Temperature and Thermal Expansion of Inner Ring



Using NSK Bearing Heaters makes the shrink fit process more efficient. For more information, refer to Pages 182-183

Fig 1.26 Additional Pressing

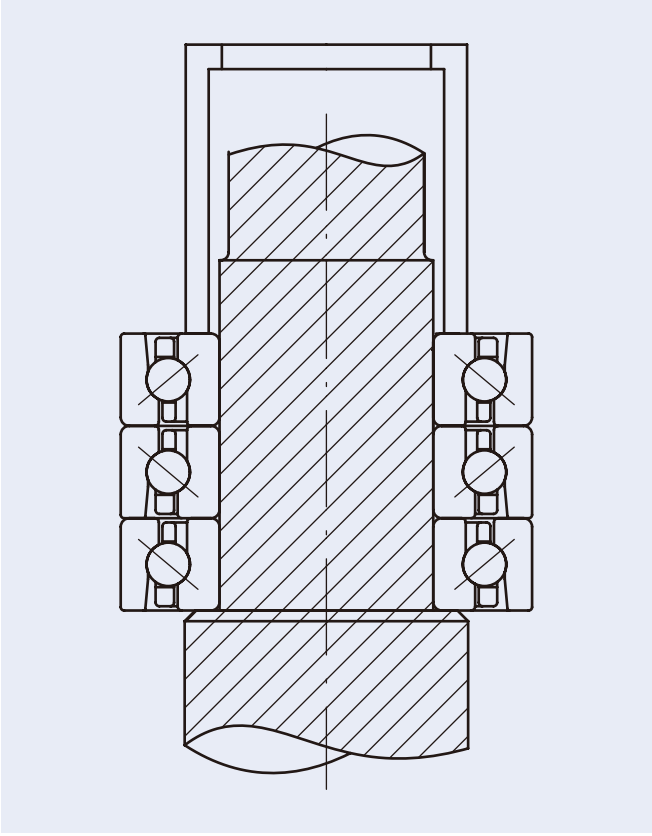
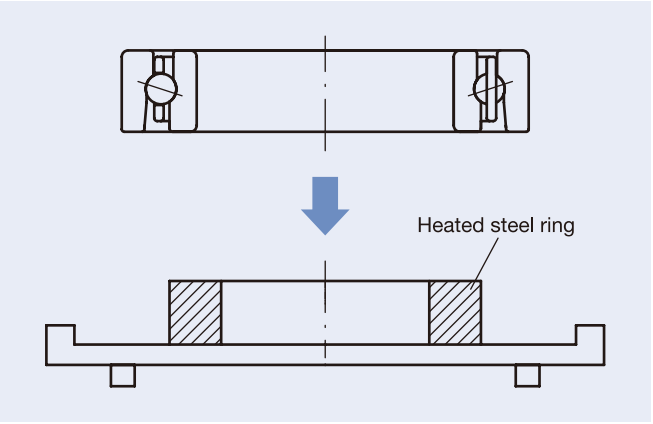


Fig 1.27 Heating the Inner Ring by means of a Hot Plate



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

$$T = 0.5F\{d_p \cdot \tan(p^* + \beta) + d_w \cdot \mu_w\} \times 10^{-3} \quad [\mathrm{N \cdot m}]$$

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
$\beta = \tan^{-1}(\mathrm{pitch}/(3.142\, d_p))$

Equation of press-fit force (insertion pressure)

$$K = \mu \cdot p_m \cdot \pi \cdot d \cdot B \ [\mathrm{N}]$$

$$P_m = \frac{E}{2} \frac{\Delta d}{d} \frac{(1-k^2)(1-k_0^2)}{1-k^2 k_0^2}$$

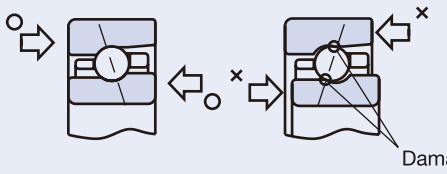
μ : Friction coefficient at fitting surface [=0.12]
p_m : Surface pressure [MPa]
d : Shaft diameter [mm]
B : Bearing width [mm]
Δd : Effective interference [mm]
E : Young's modulus of steel [MPa]
k : Wall thickness ratio of inner ring ($k=d/D_i$)
D_i : Raceway diameter of inner ring [mm]
k_0 : Wall thickness ratio of hollow shaft ($k_0=d_0/d$)
d_0 :Bore diameter of hollow shaft [mm]

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

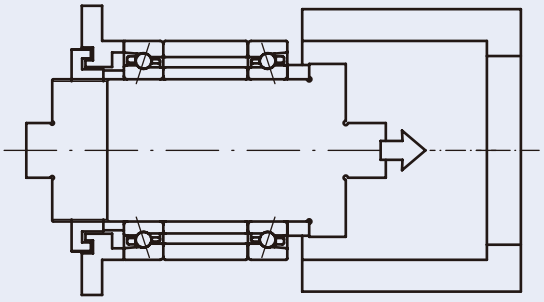


Load applied in direction "x" may cause damage to the balls.
○ : Right ✕ : Wrong

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.

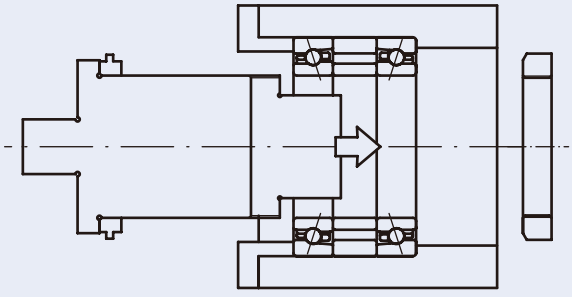
Fig 1.29 Mounting of Back-to-back Arrangement



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.

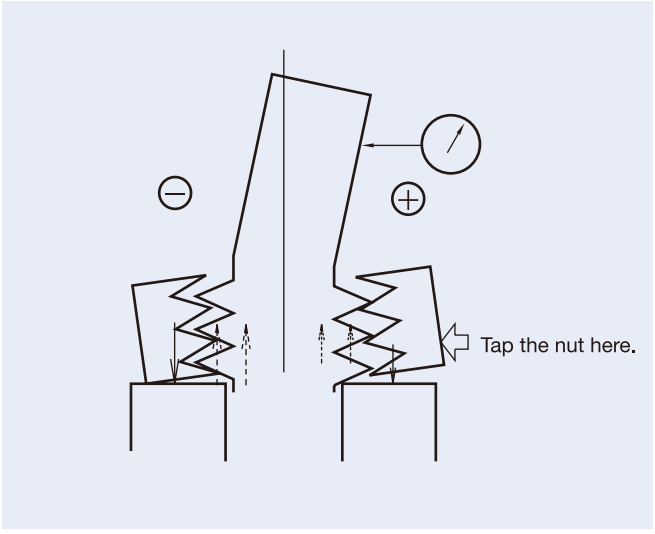
4. Inspection after Mounting

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.

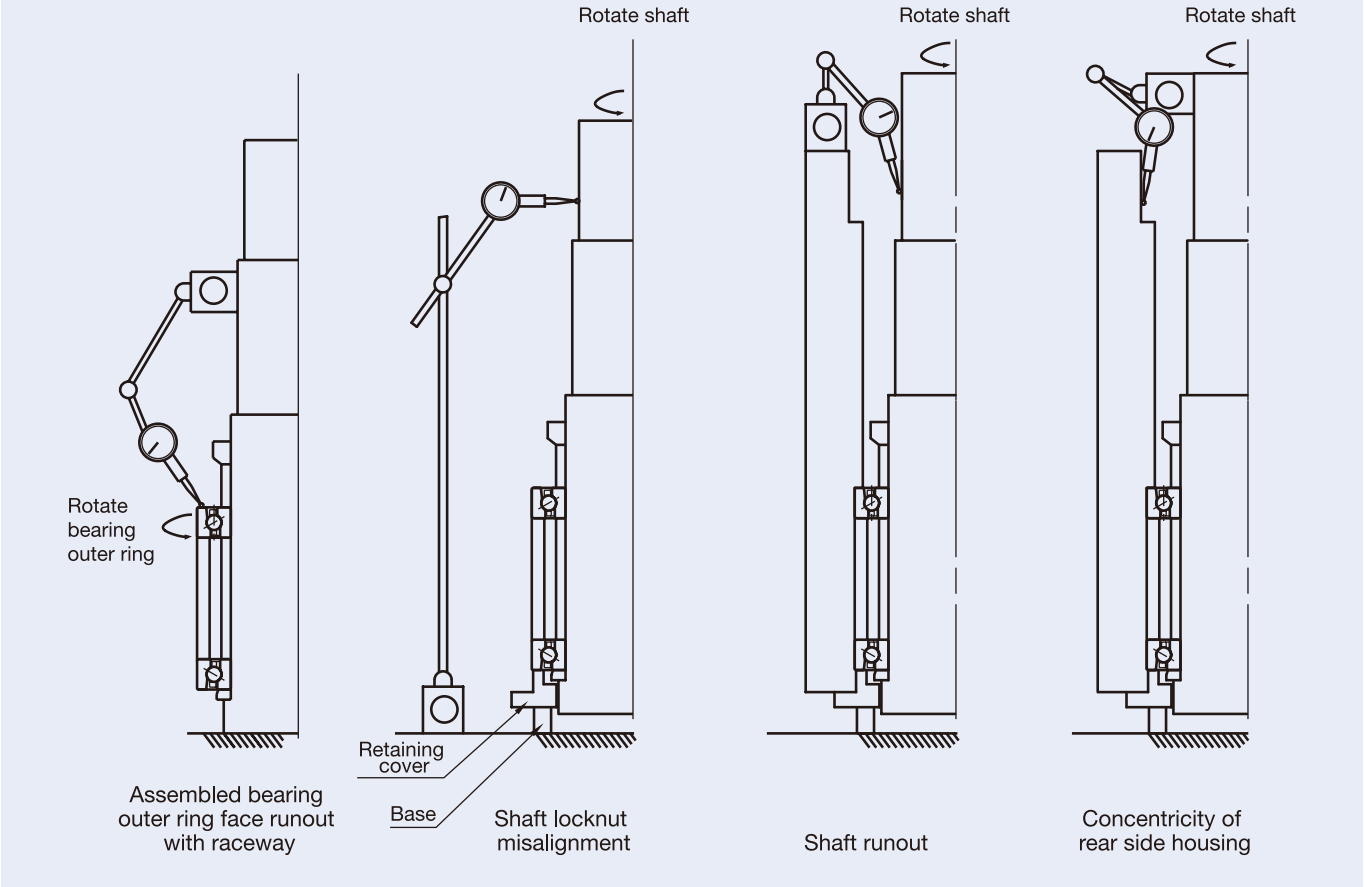
1: Assembled bearing outer ring face runout with raceway for angular contact ball bearings:
Adjust to 0.002 mm or less by lightly tapping on the outer ring end face.
2: Shaft locknut misalignment:
Adjust shaft nut misalignment to 0.005 mm or less (Fig. 1.31)
3: Shaft runout:
0.005 mm or less
4: Concentricity of rear side housing:
0.015 mm or less

Fig 1.31 Adjusting Misaligned Shaft Locknut



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 1.32 Measuring Spindle Runout



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 250).

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 214 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.

$$T = F \times d/2$$

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

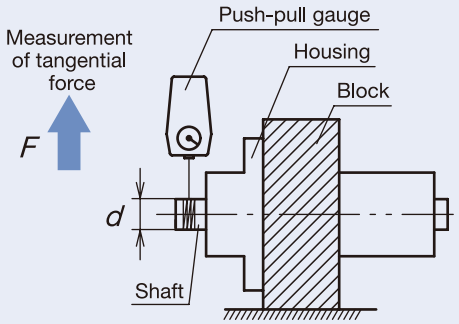
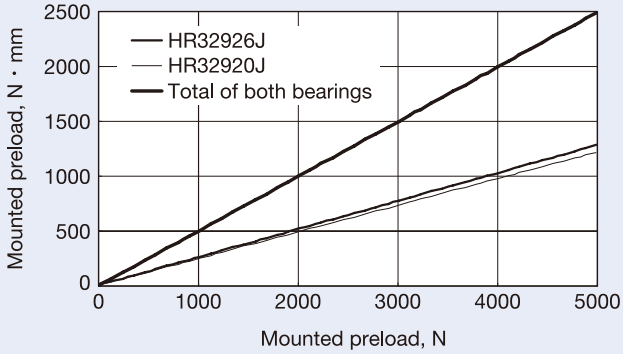


Fig. 1.34 Relationship between Starting Torque and Preload



(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

↓

Mounted preload

$$K_a = m\left(\frac{\pi \cdot F_z}{500}\right)^2$$

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

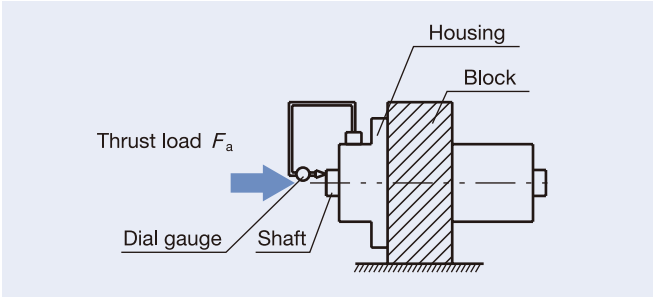


Fig. 1.36 Relationship between Axial Displacement and Preload

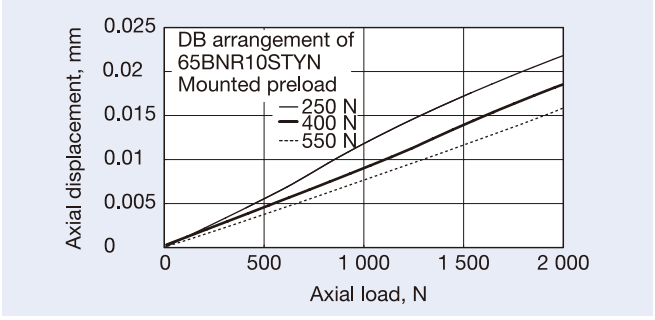


Fig. 1.37 Natural Frequency Method

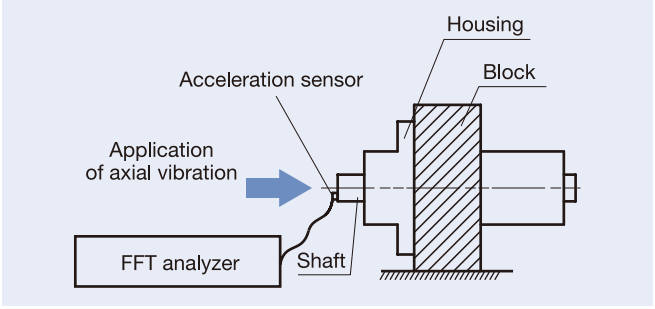
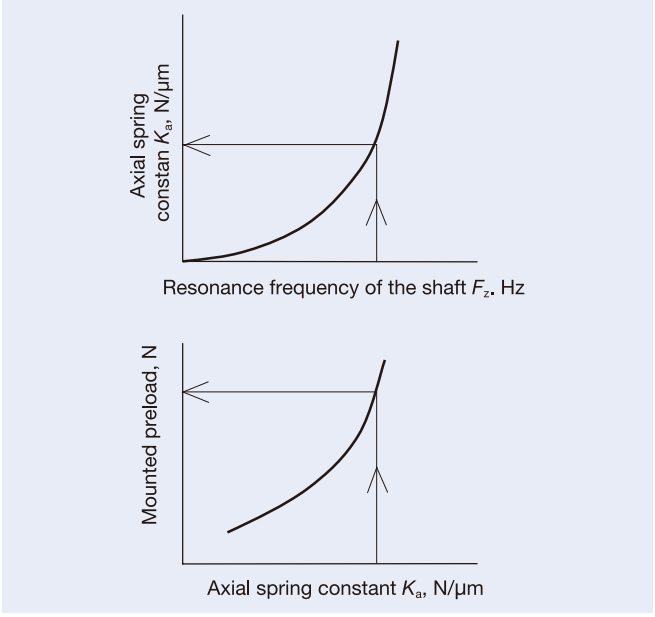


Fig. 1.38 Relationship between Resonance Frequency of Shaft and Axial Spring Constant of Bearing



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

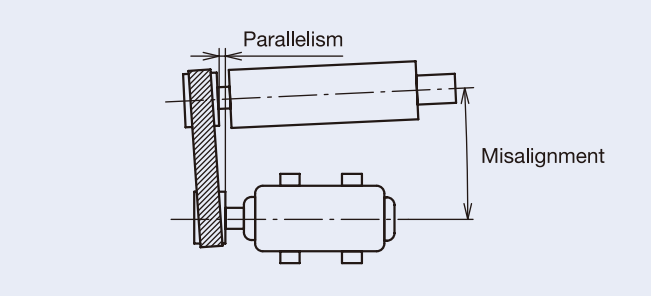
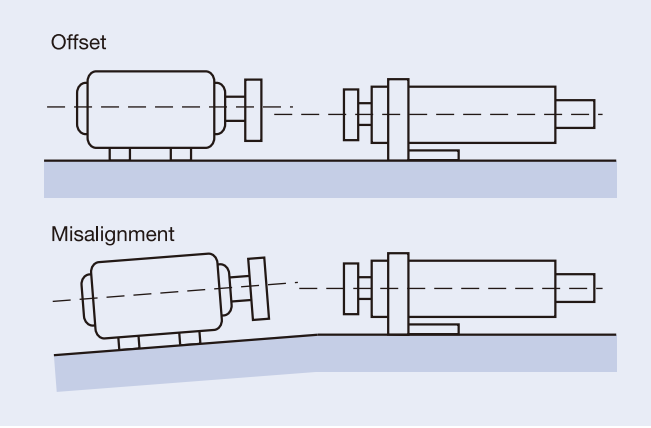


Fig. 2.2 Coupling Drive



■ 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

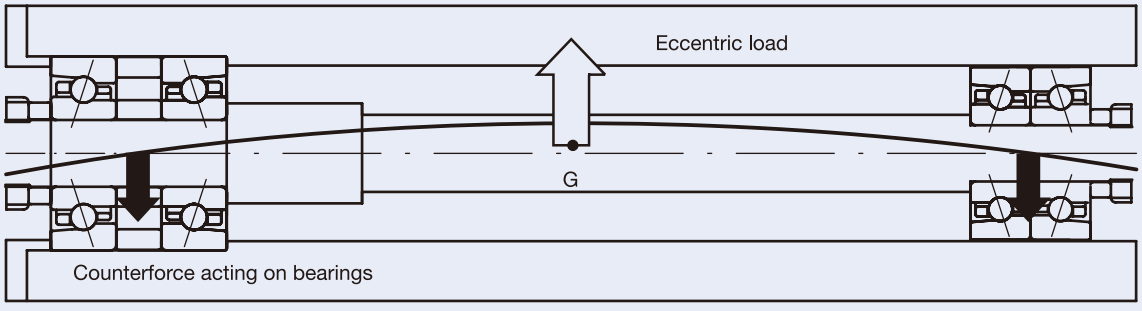
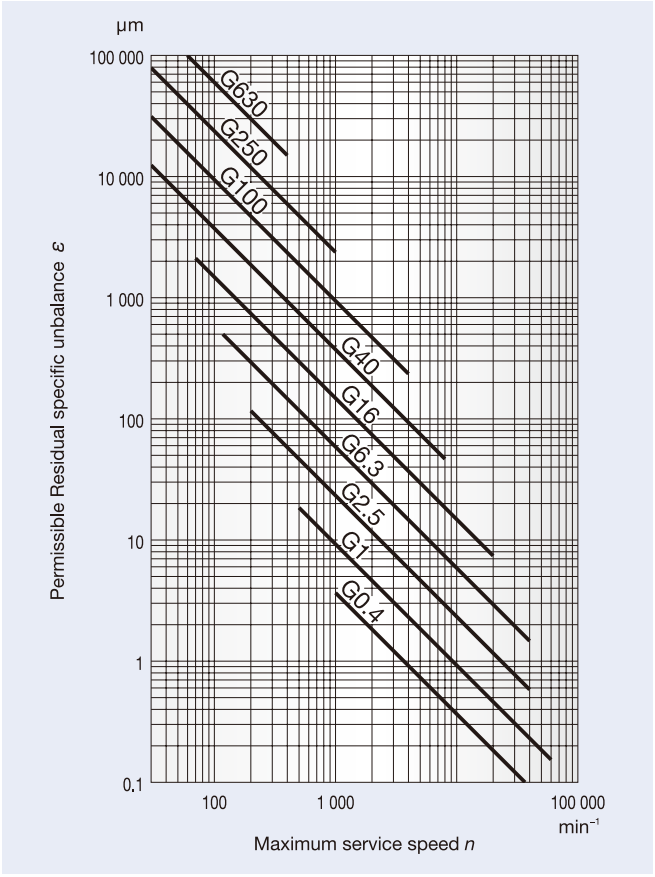


Table 2.1 Balance Quality Grades and Examples of Rotor Types

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 268-269). 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 275.

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

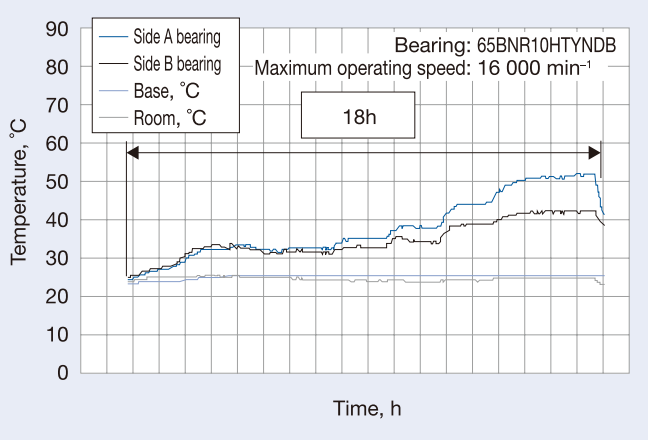
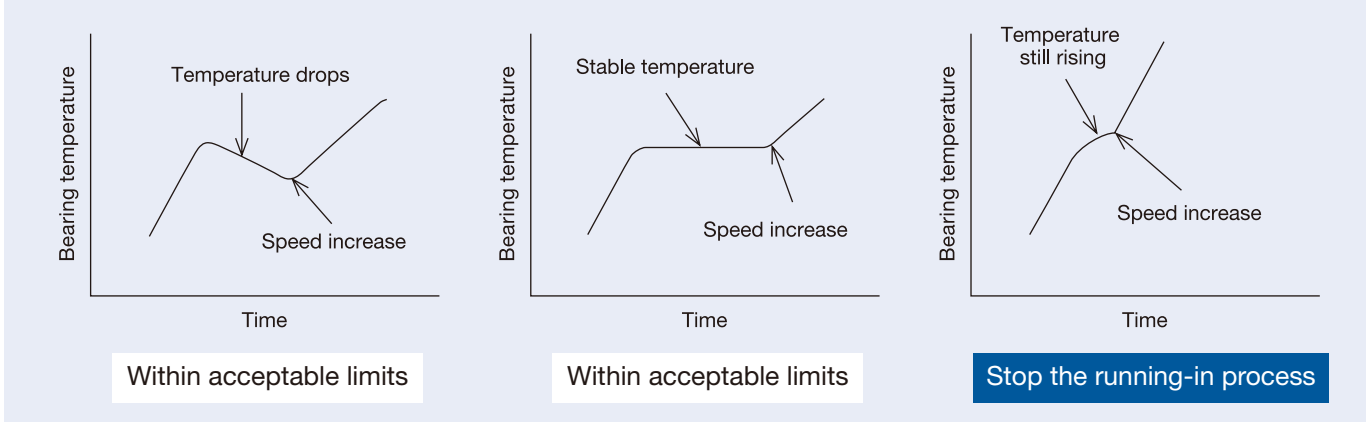


Fig. 3.2 Bearing Temperature Change during Running-in



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.

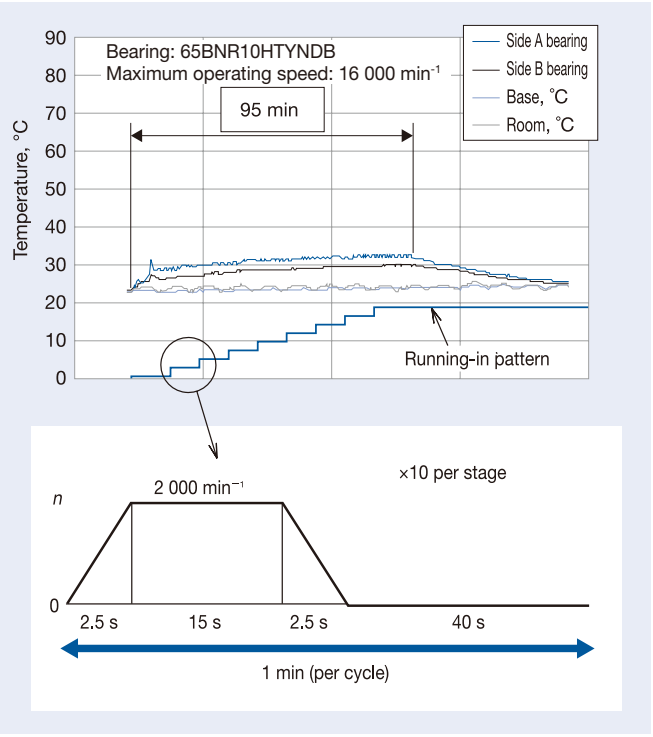
1. Each stage is divided into 10 cycles that are approximately one minute long.
2. During each cycle, rapidly accelerate the spindle to the target speed for the current stage, then decelerate back to zero, and then rest for a period of 40 seconds.
3. Repeat this cycle about 10 times.
4. Continue moving 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

Part 7

Bearing Failure Diagnosis

1. Bearing Failure and Countermeasures ·····272-277
2. Diagnosis with Sound and Vibration ·····278-279

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 275. If necessary, bearings should be dismounted and examined in detail.

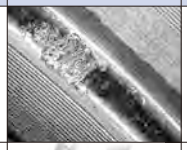
Bearing Failure and Countermeasures

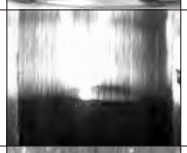
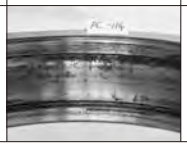
In general, if rolling bearings are used correctly they will continue to perform to their predicted fatigue life. However, bearings often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting, handling or lubrication, ingress of 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.		·Abnormal axial load (sliding failure of free-side bearing).	·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.		·Improper mounting, bending of shaft ·Inadequate centering ·Inadequate tolerances for shaft and housing.	·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.		·Large shock load during mounting ·Rusting while bearing is out of operation for prolonged period ·Damage to cylindrical roller bearings during mounting	·Use care in mounting ·Apply a rust preventative when machine operation is suspended for a long time.
	Premature flaking of raceway and rolling element.		·Insufficient clearance ·Excessive load ·Improper lubrication, rust, etc.	·Select proper fit, bearing clearance, and lubricant.
	Premature flaking of combined bearings.		·Excessive preload.	·Adjust the preload.
Scoring	Scoring or smearing between raceway and rolling surface.		·Inadequate initial lubrication ·Excessively hard grease ·High acceleration when starting operation.	·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.		·Inadequate lubrication ·Incorrect mounting ·Large axial load.	·Select proper lubricant ·Modify the mounting.
Cracks	Crack in outer or inner ring.		·Excessive shock load ·Excessive interference in fitting ·Poor shaft cylindricity ·Large fillet radius ·Development of thermal cracks ·Increased flaking.	·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.		·Increased flaking ·Shock applied to rib during mounting ·Dropped during handling.	·Use care in mounting and handling a bearing.
	Fracture of cage.		·Abnormal loading on cage due to incorrect mounting. ·Improper lubrication	·Correct mounting ·Examine the lubrication method and lubricant.
Indentations	Indentations on raceway with the same spacing as rolling element (Brinelling).		·Shock load during mounting ·Excessive load while stationary	·Use care in handling the bearing.
	Indentations on raceway and rolling elements.		·Ingress of contamination such as metallic particles or grit.	·Clean the housing ·Improve the seals and use clean lubricant.
Abnormal wear	False brinelling (phenomenon similar to brinelling).		·Vibration of a stationary bearing during such times as transport ·Oscillating motion with small amplitude.	·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.		·Sliding wear at a minute gap in the fitting surface.	·Increase interference ·Apply oil.
	Wearing on raceway, rolling surfaces, rib and cage.		·Ingress of contamination ·Incorrect lubrication and rust.	·Improve sealing capabilities ·Clean the housing ·Use a clean lubricant.
	Creep, scoring wear at fitting surface.		·Insufficient interference ·Insufficiently secured sleeve.	·Modify fit ·Tighten the sleeve properly.
Seizure	Wear of raceway, rolling elements, rib and cage. Discoloration and melting of rib surface.		·Insufficient clearance ·Incorrect lubrication ·Improper mounting.	·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.		·Condensation due to humidity, fretting, ·Entry of corrosive substances (especially varnish solvents etc.)	·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.

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 dismounted.

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

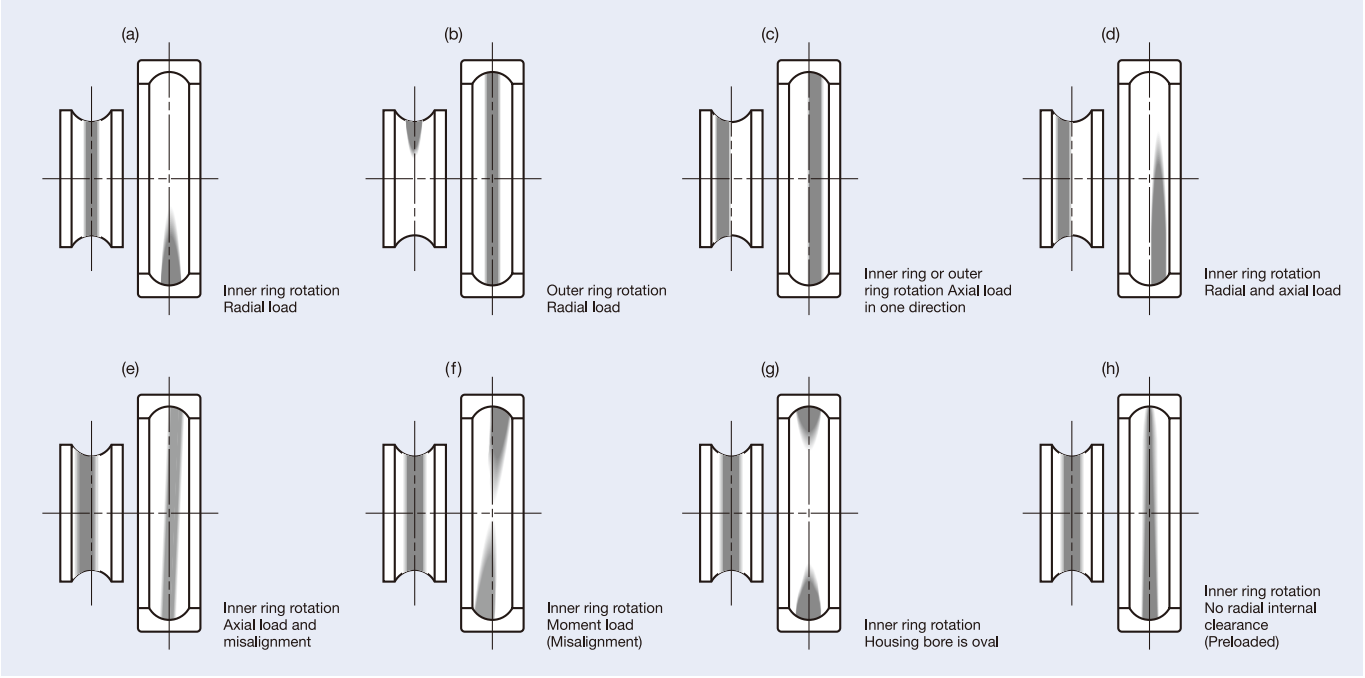


Fig. 1.2 Typical Running Paths of Roller Bearings

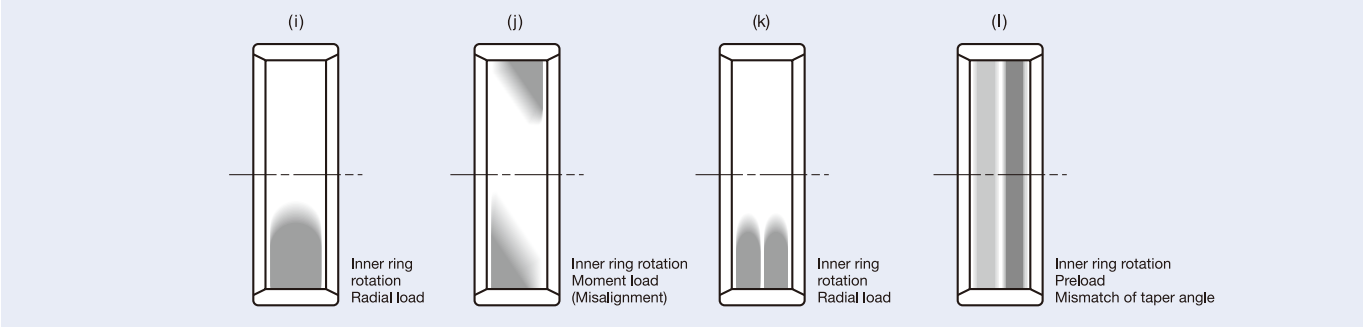


Table 1.2 Causes and Countermeasures for Operating Irregularities

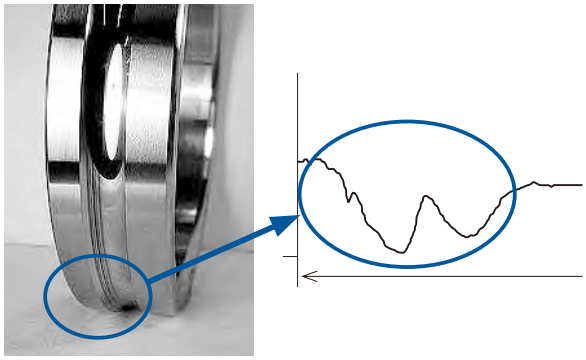
Irregularities		Possible causes	Countermeasures
Noise	High-pitched metallic sound (1)	Abnormal load	Improve fit, examine internal clearance, adjust preload, correct position of housing shoulder, etc.
		Incorrect mounting	Improve machining accuracy of shaft and housing, mounting accuracy and mounting 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

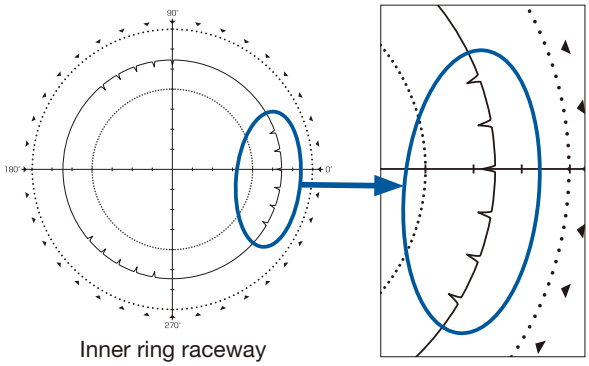
Some examples of bearing damage are shown in detail below.

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

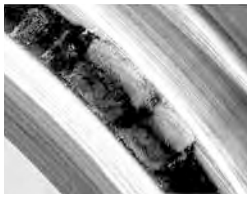
Example 2

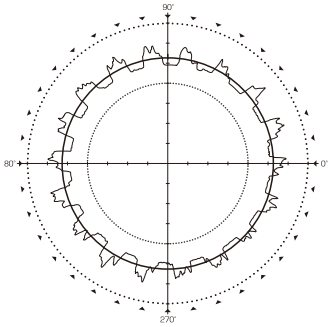


Inner ring raceway
out-of-roundness

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			
		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 accelaration	Oscillation, Vibration, Stationary	Bearing selection	
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

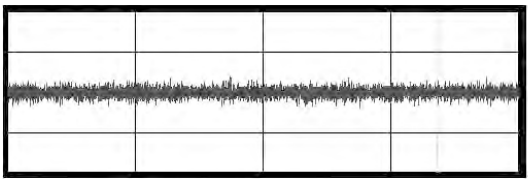
Sound and vibration accompany the rotation of rolling bearings. The tone and amplitude of such sound and vibration vary depending on the type of bearing, mounting conditions, operating conditions, etc. The sound and vibration of a rolling bearing can be classified under the following four chief categories 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.

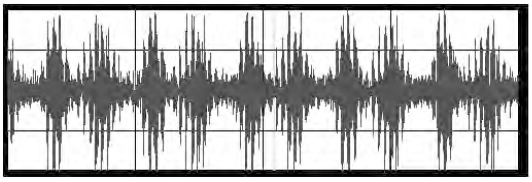
Table 2.1 Classification of sounds and vibrations in rolling bearings

	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, Hz



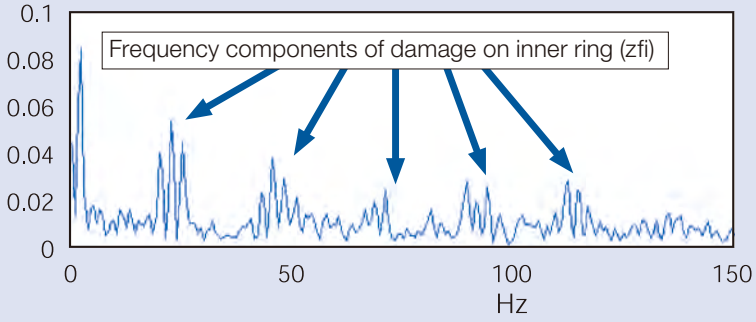
Sound waveform of a normal bearing



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
Natural frequency of cage				
($\approx f_{R2N}$, 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
$nZf_i \pm f_r$ ($nZ \pm 1$ peaks)	nZf_i (nZ peaks)	—	Inner ring raceway waviness, irregularity of shaft exterior	High-quality bearings, improve shaft accuracy
nZf_c ($nZ \pm 1$ peaks)	nZf_c (nZ peaks)	—	Outer ring raceway waviness, irregular bore of housing	High-quality bearings, improve housing bore accuracy
$2nf_b \pm f_c$ ($2n$ peaks)	$2nf_b$ ($2n$ 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 inner 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

f_r: 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: $f_i = f_r - f_c$, Hz
f_b: Rotation frequency of rolling element around its center, Hz

Appendices

Part 8

Appendices

Tolerances for Shaft Diameters ····· 282-283

Tolerances for Housing Bore Diameters ····· 284-285

Values of Standard Tolerances for IT Grades ····· 286-287

Conversion Tables from SI (International Unit) System ····· 288

Physical and Mechanical Properties of Material ····· 289-290

Bearing Inspection Request Form ····· 291

Bearing Specifications Request Form ····· 292

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 − 2	− 6 − 2	− 8 − 4	+ 6 + 1	+ 9 + 1	+ 13 + 1	+ 9 + 4	+ 12 + 4	+ 16 + 8	+ 20 + 12	+ 23 + 15	+ 27 + 15	3	6
+ 4 − 2	+ 7 − 2	+ 10 − 5	+ 7 + 1	+ 10 + 1	+ 16 + 1	+ 12 + 6	+ 15 + 6	+ 19 + 10	+ 24 + 15	+ 28 + 19	+ 34 + 19	6	10
+ 5 − 3	+ 8 − 3	+ 12 − 6	+ 9 + 1	+ 12 + 1	+ 19 + 1	+ 15 + 7	+ 18 + 7	+ 23 + 12	+ 29 + 18	+ 34 + 23	+ 41 + 23	10	18
+ 5 − 4	+ 9 − 4	+ 13 − 8	+ 11 + 2	+ 15 + 2	+ 23 + 2	+ 17 + 8	+ 21 + 8	+ 28 + 15	+ 35 + 22	+ 41 + 28	+ 49 + 28	18	30
+ 6 − 5	+ 11 − 5	+ 15 − 10	+ 13 + 2	+ 18 + 2	+ 27 + 2	+ 20 + 9	+ 25 + 9	+ 33 + 17	+ 42 + 26	+ 50 + 34	+ 59 + 34	30	50
+ 6 − 7	+ 12 − 7	+ 18 − 12	+ 15 + 2	+ 21 + 2	+ 32 + 2	+ 24 + 11	+ 30 + 11	+ 39 + 20	+ 51 + 32	+ 60 + 41	+ 71 + 41	50	65
										+ 62 + 43	+ 73 + 43	65	80
+ 6 − 9	+ 13 − 9	+ 20 − 15	+ 18 + 3	+ 25 + 3	+ 38 + 3	+ 28 + 13	+ 35 + 13	+ 45 + 23	+ 59 + 37	+ 73 + 51	+ 86 + 51	80	100
										+ 76 + 54	+ 89 + 54	100	120
+ 7 − 11	+ 14 − 11	+ 22 − 18	+ 21 + 3	+ 28 + 3	+ 43 + 3	+ 33 + 15	+ 40 + 15	+ 52 + 27	+ 68 + 43	+ 88 + 63	+103 + 63	120	140
										+ 90 + 65	+105 + 65	140	160
										+ 93 + 68	+108 + 68	160	180
+ 7 − 13	+ 16 − 13	+ 25 − 21	+ 24 + 4	+ 33 + 4	+ 50 + 4	+ 37 + 17	+ 46 + 17	+ 60 + 31	+ 79 + 50	+106 + 77	+123 + 77	180	200
										+109 + 80	+126 + 80	200	225
										+113 + 84	+130 + 84	225	250
+ 7 − 16	± 16	± 26	+ 27 + 4	+ 36 + 4	+ 56 + 4	+ 43 + 20	+ 52 + 20	+ 66 + 34	+ 88 + 56	+126 + 94	+146 + 94	250	280
										+130 + 98	+150 + 98	280	315
+ 7 − 18	± 18	+ 29 − 28	+ 29 + 4	+ 40 + 4	+ 61 + 4	+ 46 + 21	+ 57 + 21	+ 73 + 37	+ 98 + 62	+144 +108	+165 +108	315	355
										+150 +114	+171 +114	355	400
+ 7 − 20	± 20	+ 31 − 32	+ 32 + 5	+ 45 + 5	+ 68 + 5	+ 50 + 23	+ 63 + 23	+ 80 + 40	+108 + 68	+166 +126	+189 +126	400	450
										+172 +132	+195 +132	450	500
—	—	—	—	+ 44 0	+ 70 0	—	+ 70 + 26	+ 88 + 44	+122 + 78	+194 +150	+220 +150	500	560
										+199 +155	+225 +155	560	630
—	—	—	—	+ 50 0	+ 80 0	—	+ 80 + 30	+100 + 50	+138 + 88	+225 +175	+255 +175	630	710
										+235 +185	+265 +185	710	800
—	—	—	—	+ 56 0	+ 90 0	—	+ 90 + 34	+112 + 56	+156 +100	+266 +210	+300 +210	800	900
										+276 +220	+310 +220	900	1 000
—	—	—	—	+ 66 0	+105 0	—	+106 + 40	+132 + 66	+186 +120	+316 +250	+355 +250	1 000	1 120
										+326 +260	+365 +260	1 120	1 250
—	—	—	—	+ 78 0	+125 0	—	+126 + 48	+156 + 78	+218 +140	+378 +300	+425 +300	1 250	1 400
										+408 +330	+455 +330	1 400	1 600
—	—	—	—	+ 92 0	+150 0	—	+150 + 58	+184 + 92	+262 +170	+462 +370	+520 +370	1 600	1 800
										+492 +400	+550 +400	1 800	2 000

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	$kgf \cdot s^2/m$	s	°C	m/s^2	kgf	kgf/m^2	kgf/m^2	kgf·m	kgf·m/s

Prefixes Used in SI System

Multiples	Prefix	Code	Multiples	Prefix	Code
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_2O	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: $1Pa=1N/m^2$

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

Thermal Conductivity

*W/(m·K)	$kcal_{IT}/(h\cdot m\cdot°C)$
1	8.59845×10^{-1}
1.16300	1

Note: $1Pa=1dyn\cdot s/cm^2=1g/cm\cdot s$, $1Pa\cdot s=1N\cdot s/m^2$, $1cP=1mPa\cdot s$

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

Heat Transfer Coefficient

*$W/(m^2\cdot K)$	$kcal_{IT}/(h\cdot m^2\cdot°C)$
1	8.59845×10^{-1}
1.16300	1

Note: $1St=1cm^2/s$, $1cSt=1mm^2/s$,

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: $1J=1W\cdot s$, $1W\cdot h=3600W\cdot s$ $1cal_{IT}=4.186\ 8J$

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/cm³	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
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 ($HBsC1$)		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	Elong-ation %	Hard-ness 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			45	23			Min. *784	Min. *930	Min. *13	*269 –331
	Chrome Molybdenum steel SCM420	Quenching, 150 to 200 °C air cooling		0.47	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	27	143
	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
Housing	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
(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.)	

●Bearing:

Front-side (fixed side) bearing	Rear-side (free side) bearing
Serial No.:	Serial No.:
Designation:	Designation:
Mounted clearance/preload, amount of adjustment by spacers:	Mounted clearance/preload, amount of adjustment by spacers:
Jacket cooling: ☐ Yes ☐ No Sleeve: ☐ Yes ☐ No	Jacket cooling: ☐ Yes ☐ No Sleeve: ☐ Yes ☐ No
Spacer Width: 1st Spacer ____ mm, 2nd Spacer ____ mm, 3rd Spacer ____ mm	Spacer Width: 1st Spacer ____ mm, 2nd Spacer ____ mm, 3rd Spacer ____ mm
Shaft bore: ____ mm Housing outside diameter: ____ mm	Shaft bore: ____ mm Housing outside diameter: ____ mm
Inner ring temp.: ____ °C Outer ring temp.: ____ °C	Inner ring temp.: ____ °C Outer ring temp.: ____ °C
Shaft fit: ____ Housing fit: ____	Shaft fit: ____ Housing fit: ____

● Comments, suspected causes, further observations:

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.)

●Specification:

Attachments: ☐ Yes ☐ No

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 ∅ Cylindrical roller bearing □□ , □ Spacers ∅=∅ Spring WWW)

(If currently using bearings, please provide the designation)

Front side bearings	Rear side bearings

Shaft material: _____ Housing material: _____

Front-side (fixed side) bearing	Rear-side (free side) bearing
Designation:	Designation:
Bore diameter: mm Outside diameter: mm	Bore diameter: mm Outside diameter: mm
Combined width: mm Accuracy class:	Combined width: mm Accuracy class:
Clearance/Preload: (e.g. EL, 800N, CC9)	Clearance/Preload: (e.g. EL, 800N, CC9)
Jacket cooling: ☐ Yes ☐ No Sleeve: ☐ Yes ☐ No	Jacket cooling: ☐ Yes ☐ No Sleeve: ☐ Yes ☐ No
Spacer Width: 1st Spacer mm, 2nd Spacer mm, 3rd Spacer mm	Spacer Width: 1st Spacer mm, 2nd Spacer mm, 3rd Spacer mm
Shaft bore: mm Housing outside diameter: mm	Shaft bore: mm Housing outside diameter: mm
Inner ring temp.: ˚C Outer ring temp.: ˚C	Inner ring temp.: ˚C Outer ring temp.: ˚C
Shaft fit:	Shaft fit:
Housing 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/ μ m, 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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