

MOTION & CONTROL™

**NSK**



**ROLLING  
BEARINGS**  
for  
**INDUSTRIAL  
MACHINERY**

## **Part A**

### **1.TYPES AND FEATURES OF ROLLING BEARINGS**

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### **2.SELECTION OF BEARING TYPE**

---

### **3.SELECTION OF BEARING ARRANGEMENT**

---

### **4.SELECTION OF BEARING SIZE**

---

### **5.SPEEDS**

---

### **6.BOUNDARY DIMENSIONS AND BEARING DESIGNATIONS**

---

### **7.BEARING TOLERANCES**

---

### **8.FITS AND INTERNAL CLEARANCES**

---

### **9.PRELOAD**

---

### **10.FRICTION**

---

### **11.LUBRICATION**

---

### **12.BEARING MATERIALS**

---

### **13.DESIGN OF SHAFTS AND HOUSINGS**

## **Part B**

### **1.BEARING HANDLING**

---

### **2.BEARING DAMAGE AND COUNTERMEASURES (Bearing Doctor)**

---

## **Part C**

### **1.DEEP GROOVE BALL BEARINGS**

---

### **2.EXTRA SMALL BALL BEARINGS AND MINIATURE BALL BEARINGS**

---

### **3.ANGULAR CONTACT BALL BEARINGS**

---

### **4.SELF-ALIGNING BALL BEARINGS**

---

### **5.CYLINDRICAL ROLLER BEARINGS**

---

### **6.TAPERED ROLLER BEARINGS**

---

### **7.SPHERICAL ROLLER BEARINGS**

---

### **8.THRUST BEARINGS**

---

### **9.NEEDLE ROLLER BEARINGS** BALL BEARING UNITS / PLUMMER BLOCKS

---

### **10.ACCESSORIES FOR ROLLING BEARINGS**

---

## **Part D**

### **INDUSTRY SOLUTIONS**

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## **Part E**

### **APPENDICES**



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# **ROLLING BEARINGS** **for INDUSTRIAL MACHINERY**

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CAT. No. E1103



## **Introduction to the Revised NSK Rolling Bearings Catalog (CAT.No.E1103)**

Thank you for your interest in this edition of our *Rolling Bearings* catalog.

Rolling bearings are vital components in improving the efficiency and reliability of machines, and as technology advances, the requirements of bearings become ever more challenging.

NSK celebrated its 100<sup>th</sup> anniversary in 2016. As a leading bearing manufacturer, we have continued to make breakthroughs in the research and development of bearings alongside our customers and have actively contributed to the advancement of society and the preservation of the environment.

This catalog is a culmination of all our technological expertise acquired over our 100-year history and is intended to provide you with all the information necessary to make your bearing selection, no matter the application.

The catalog is divided into five parts, labelled A through E. Part A contains general information for bearing selection. Part B provides information on bearing handling. Part C lists product information relating to bearing type and dimensions, where you can also find information on our new High Performance Standard Bearing Series (NSKHPS™). Part D covers industry-related product information. Lastly, part E contains appendices with reference information and conversion tables.

We hope this catalog provides you with all the information you need to select the optimal bearing for your application. However, please don't hesitate to contact us should you require any assistance.

# CONTENTS

## Part A TECHNICAL INFORMATION

	Pages		Pages
<b>1 TYPES AND FEATURES OF ROLLING BEARINGS</b> .....	A 005	6.1 Boundary Dimensions and Dimensions of Snap Ring Grooves .....	A 104
1.1 Design and Classification .....	A 006	6.2 Formulation of Bearing Designations ...	A 120
1.2 Characteristics of Rolling Bearings .....	A 006	<b>7 BEARING TOLERANCES</b> .....	A 125
1.3 Contact Angle and Bearing Types .....	A 016	7.1 Bearing Tolerance Standards .....	A 126
1.4 Types of Load on Bearings .....	A 017	7.2 Selection of Tolerance Classes .....	A 151
<b>2 SELECTION OF BEARING TYPE</b> .....	A 019	<b>8 FITS AND INTERNAL CLEARANCES</b> .....	A 153
2.1 Bearing Selection Procedure .....	A 020	8.1 Fits .....	A 154
2.2 Allowable Bearing Space .....	A 022	8.2 Bearing Internal Clearances .....	A 168
2.3 Load Capacity and Bearing Types .....	A 022	8.3 Technical Data .....	A 176
2.4 Permissible Speed and Bearing Types ..	A 022	<b>9 PRELOAD</b> .....	A 191
2.5 Misalignment of Inner/Outer Rings and Bearing Types .....	A 022	9.1 Purpose of Preload .....	A 192
2.6 Rigidity and Bearing Types .....	A 023	9.2 Preloading Methods .....	A 192
2.7 Noise and Torque of Various Bearing Types .....	A 023	9.3 Preload and Rigidity .....	A 192
2.8 Running Accuracy and Bearing Types ..	A 023	9.4 Selection of Preloading Method and Amount of Preload .....	A 193
2.9 Mounting and Dismounting of Various Bearing Types .....	A 023	9.5 Amount of Preload .....	A 194
<b>3 SELECTION OF BEARING ARRANGEMENT</b> .....	A 025	9.6 Technical Data .....	A 200
3.1 Fixed-End and Free-End Bearings .....	A 026	<b>10 FRICTION</b> .....	A 215
3.2 Example Bearing Arrangements .....	A 027	10.1 Coefficients of Dynamic Friction .....	A 216
<b>4 SELECTION OF BEARING SIZE</b> .....	A 030	10.2 Empirical Equations for Running Torque .....	A 216
4.1 Bearing Life .....	A 032	10.3 Technical Data .....	A 216
4.2 Basic Load Rating and Fatigue Life .....	A 032	<b>11 LUBRICATION</b> .....	A 227
4.3 Calculation of Bearing Loads .....	A 044	11.1 Purposes of Lubrication .....	A 228
4.4 Equivalent Load .....	A 050	11.2 Lubricating Methods .....	A 228
4.5 Static Load Ratings and Static Equivalent Loads .....	A 052	11.3 Lubricants .....	A 236
4.6 Example Bearing Calculations .....	A 054	11.4 Technical Data .....	A 240
4.7 Bearing Type and Allowable Axial Load .....	A 058	<b>12 BEARING MATERIALS</b> .....	A 243
4.8 Technical Data .....	A 066	12.1 Materials for Bearing Rings and Rolling Elements .....	A 244
<b>5 SPEEDS</b> .....	A 097	12.2 Cage Materials .....	A 245
5.1 Limiting Speed (Grease/Oil) .....	A 098	12.3 Characteristics of Bearing, Shaft, and Housing Materials .....	A 246
5.2 Thermal Reference Speed .....	A 099	12.4 Technical Data .....	A 248
5.3 Limiting Speed (Mechanical) .....	A 099	<b>13 DESIGN OF SHAFTS AND HOUSINGS</b> .....	A 269
5.4 Technical Data .....	A 100	13.1 Accuracy and Surface Finish of Shafts and Housings .....	A 270
<b>6 BOUNDARY DIMENSIONS AND BEARING DESIGNATIONS</b> .....	A 103	13.2 Shoulder and Fillet Dimensions .....	A 270
		13.3 Bearing Seals .....	A 272

## Part B BEARING HANDLING AND MAINTENANCE

	Pages
<b>1 BEARING HANDLING</b> .....	B 005
1.1 Precautions for Proper Handling of Bearings .....	B 006
1.2 Bearing Storage .....	B 006
1.3 Mounting .....	B 006
1.4 Operation Inspection .....	B 008
1.5 Dismounting .....	B 011
1.6 Inspection of Bearings .....	B 013
1.7 Checking the Shaft and Housing .....	B 014
1.8 Maintenance and Inspection .....	B 017
<b>2 BEARING DAMAGE AND COUNTERMEASURES (Bearing Doctor)</b> .....	B 021
2.1 Bearing Damage .....	B 022
2.2 Running Traces and Applied Loads .....	B 022
2.3 Bearing Damage and Countermeasures ..	B 024
Appendix : Bearing Diagnostic Chart .....	B 052

## Part C BEARING TABLES

<b>1 DEEP GROOVE BALL BEARINGS</b> .....	C 005
<b>2 EXTRA SMALL BALL BEARINGS AND MINIATURE BALL BEARINGS</b> .....	C 053
<b>3 ANGULAR CONTACT BALL BEARINGS</b> .....	C 071
<b>4 SELF-ALIGNING BALL BEARINGS</b> .....	C 115
<b>5 CYLINDRICAL ROLLER BEARINGS</b> .....	C 125
<b>6 TAPERED ROLLER BEARINGS</b> .....	C 181
<b>7 SPHERICAL ROLLER BEARINGS</b> .....	C 257
<b>8 THRUST BALL BEARINGS</b> .....	C 295
<b>9 THRUST CYLINDRICAL ROLLER BEARINGS</b> .....	C 313
<b>10 THRUST TAPARED ROLLER BEARINGS</b> .....	C 321
<b>11 THRUST SPHERICAL ROLLER BEARINGS</b> ..	C 331
<b>12 NEEDLE ROLLER BEARINGS</b> .....	C 341
<b>13 BALL BEARING UNITS</b> .....	C 343
<b>14 PLUMMER BLOCKS</b> .....	C 345
<b>15 ACCESSORIES FOR ROLLING BEARINGS</b> ..	C 347

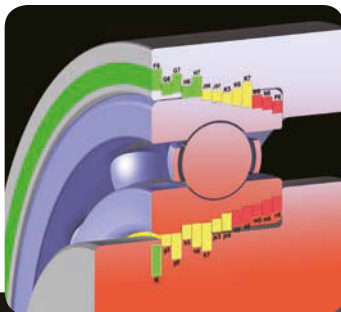
## Part D INDUSTRY SOLUTIONS

	Pages
<b>1 AIR TURBINE BEARINGS FOR DENTAL HANDPIECES</b> .....	D 004
<b>2 PUMPS &amp; COMPRESSORS</b> .....	D 010
<b>3 AGRICULTURAL MACHINERY</b> .....	D 026
<b>4 CONSTRUCTION MACHINERY</b> .....	D 034
<b>5 MINING MACHINERY</b> .....	D 040
<b>6 RAILWAY ROLLING STOCK</b> .....	D 048
<b>7 PAPERMAKING MACHINES</b> .....	D 066
<b>8 WIND POWER INDUSTRY</b> .....	D 086
<b>9 STEEL INDUSTRY</b> .....	D 094

<b>Part E APPENDICES</b> .....	E 001
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# TECHNICAL INFORMATION



## Part A

### TECHNICAL INFORMATION

<b>1. TYPES AND FEATURES OF ROLLING BEARINGS .....</b>	<b>A 005</b>
<b>2. SELECTION OF BEARING TYPES .....</b>	<b>A 019</b>
<b>3. SELECTION OF BEARING ARRANGEMENT .....</b>	<b>A 025</b>
<b>4. SELECTION OF BEARING SIZE .....</b>	<b>A 030</b>
<b>5. SPEEDS .....</b>	<b>A 097</b>
<b>6. BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS .....</b>	<b>A 103</b>
<b>7. BEARING TOLERANCES .....</b>	<b>A 125</b>
<b>8. FITS AND INTERNAL CLEARANCES .....</b>	<b>A 153</b>
<b>9. PRELOAD .....</b>	<b>A 191</b>
<b>10. FRICTION .....</b>	<b>A 215</b>
<b>11. LUBRICATION .....</b>	<b>A 227</b>
<b>12. BEARING MATERIALS .....</b>	<b>A 243</b>
<b>13. DESIGN OF SHAFTS AND HOUSINGS .....</b>	<b>A 269</b>



# 1. TYPES AND FEATURES OF ROLLING BEARINGS

<b>1.1</b>	<b>Design and Classification .....</b>	<b>A 006</b>
<b>1.2</b>	<b>Characteristics of Rolling Bearings .....</b>	<b>A 006</b>
<b>1.3</b>	<b>Contact Angle and Bearing Types .....</b>	<b>A 016</b>
<b>1.4</b>	<b>Types of Load on Bearings .....</b>	<b>A 017</b>

# 1. TYPES AND FEATURES OF ROLLING BEARINGS

## 1.1 Design and Classification

Rolling bearings generally consist of rolling elements, two rings, and a cage. They are classified into radial bearings or thrust bearings depending on the direction of the main load. In addition, depending on the type of rolling elements, they are classified into ball bearings or roller bearings and further divided by differences in their design or specific purpose.

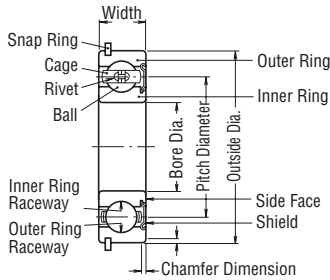
The most common bearing types and part names are shown in Fig. 1.1, and a general classification of rolling bearings is shown in Fig. 1.2.

## 1.2 Characteristics of Rolling Bearings

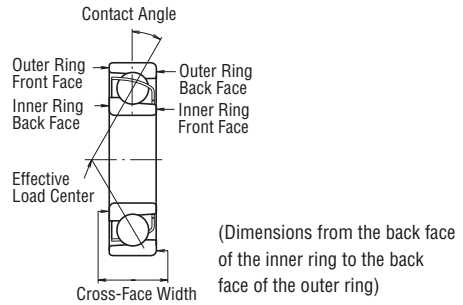
Compared with plain bearings, rolling bearings have the following major advantages:

- (1) Their starting torque or friction is low and the difference between the starting torque and running torque is small.
- (2) With the advancement of worldwide standardization, rolling bearings are internationally available and interchangeable.
- (3) Maintenance, replacement, and inspection are easy because of the simple structure surrounding rolling bearings.
- (4) Many rolling bearings are capable of taking both radial and axial loads simultaneously or independently.
- (5) Rolling bearings can be used under a wide range of temperatures.
- (6) Rolling bearings can be preloaded to produce a negative clearance and achieve greater rigidity.

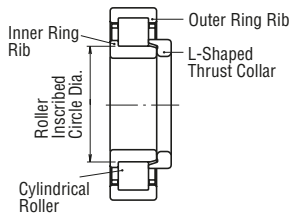
Furthermore, different types of rolling bearings have their own individual advantages. The features of the most common rolling bearings are described on Pages A010 to A013 and in Table 1.1 (Pages A014 and A015).



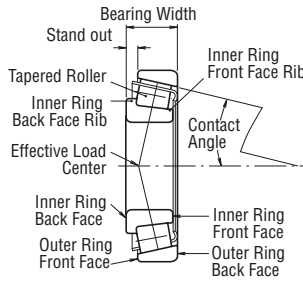
**Single-Row Deep Groove Ball Bearing**



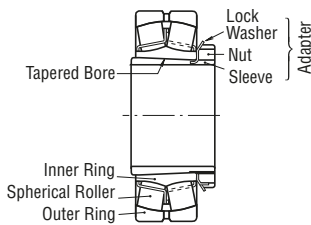
**Single-Row Angular Contact Ball Bearing**



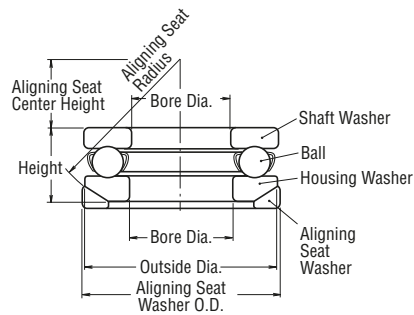
**Cylindrical Roller Bearing**



**Tapered Roller Bearing**

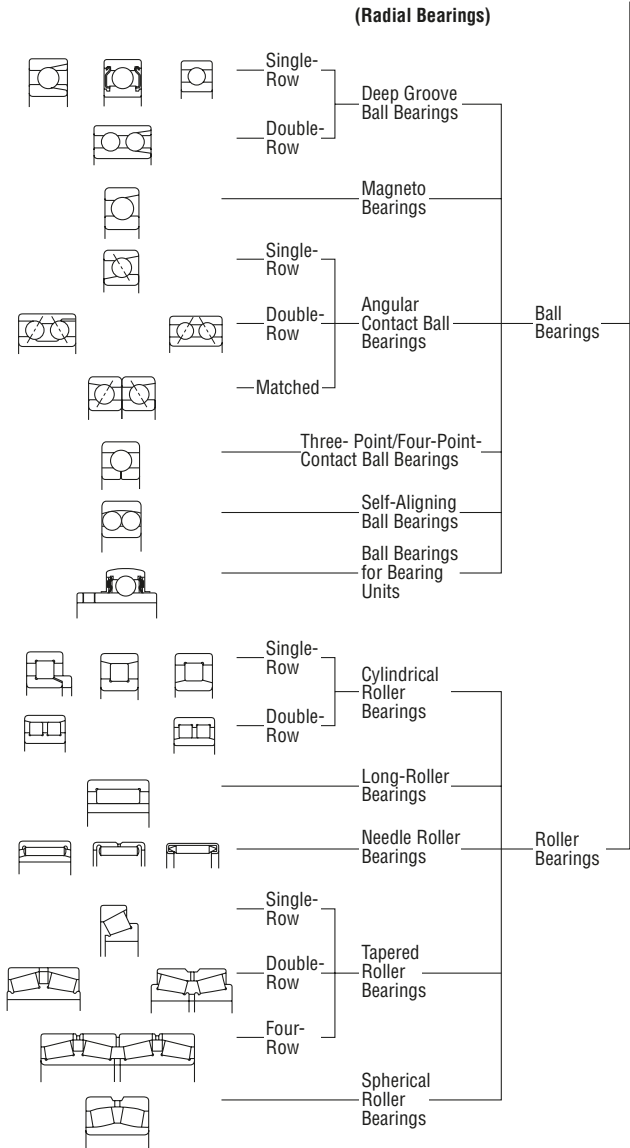


**Spherical Roller Bearing**



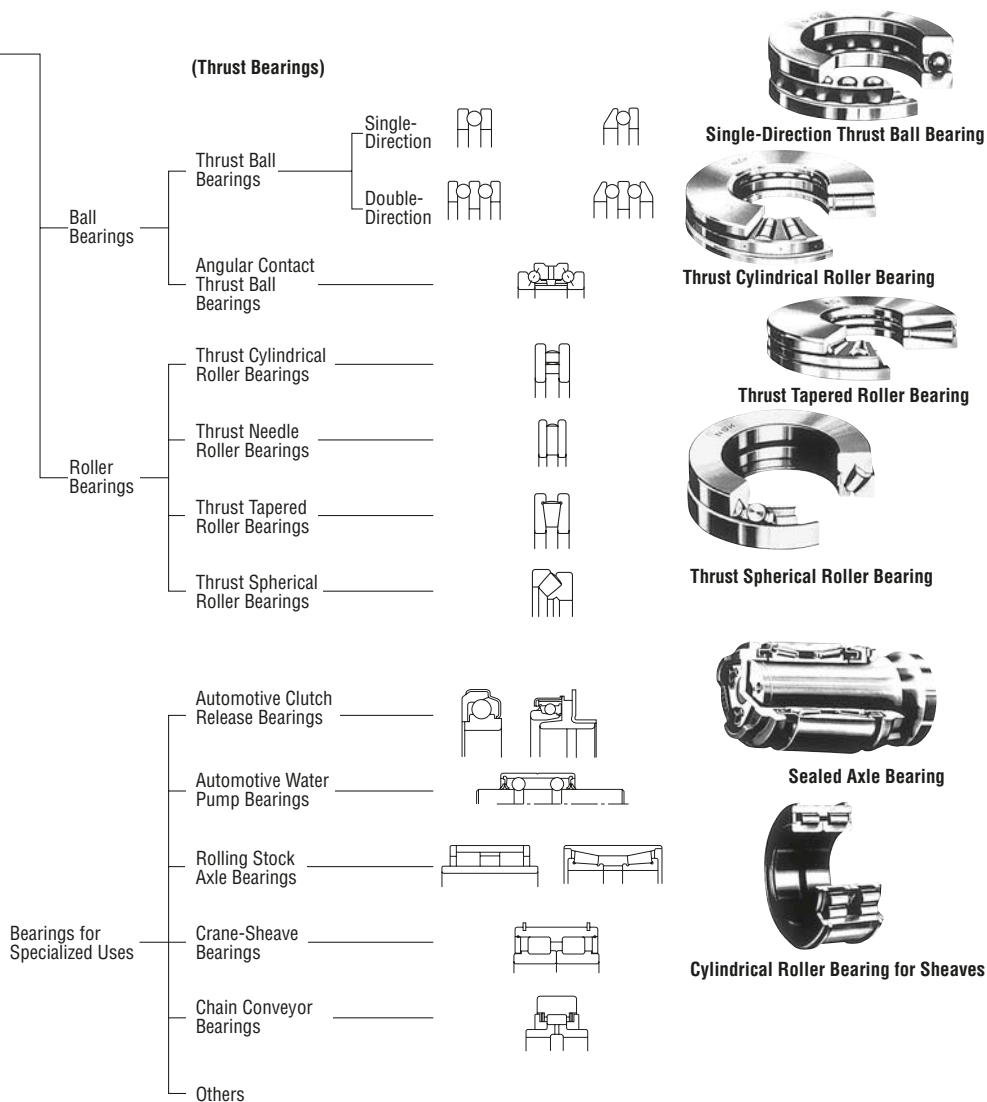
**Single-Direction Thrust Ball Bearing**

**Fig. 1.1 Names of Bearing Parts**

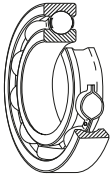


## ROLLING BEARINGS

Fig. 1.2 Classification of



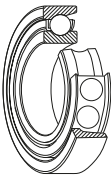
### Single-Row Deep Groove Ball Bearings



Single-row deep groove ball bearings are the most common type of rolling bearing and are in widespread use. The raceway grooves on both the inner and outer rings have circular arcs of slightly larger radii than those of the balls. They are capable of taking radial loads. In addition, axial loads can be applied in either direction. Because of their low torque, they are highly suitable for applications where high speeds and low power loss are required.

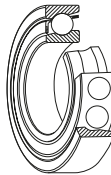
While they can be used as open bearings, single-row deep groove bearings often have steel shields or rubber seals installed on one or both sides and are prelubricated with grease. In addition, snap rings are sometimes used on the periphery. Pressed-steel cages are most commonly used.

### Magneto Bearings



The inner groove of magneto bearings is slightly more shallow than that of deep groove bearings. Since the outer ring has a shoulder on only one side, the outer ring may be removed, which is often advantageous for mounting. In general, two such bearings are used in a paired mounting. Magneto bearings are small bearings with a bore diameter of 4 to 20 mm and are mainly used for small magnetos, gyroscopes, instruments, etc. Pressed-brass cages are generally used.

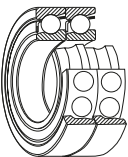
### Single-Row Angular Contact Ball Bearings



Individual bearings of this type are capable of taking axial loads in one direction and radial loads. Four contact angles of 15°, 25°, 30°, and 40° are available. The larger the contact angle, the higher the axial load capacity. For high-speed operation however, smaller contact angles are preferred. Usually, two bearings are used in a paired mounting, and the clearance between them must be adjusted properly.

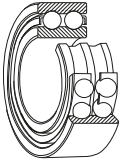
Pressed-steel and machined-brass cages are commonly used; however, for high precision bearings with a contact angle less than 30°, polyamide resin cages are often used.

### Paired Mounting



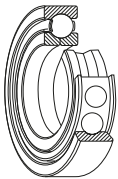
A combination of two radial bearings is called a paired mounting. Usually, they are formed using angular contact ball bearings or tapered roller bearings. Possible arrangements include: face-to-face (type DF), in which the outer ring faces are oriented towards each other; back-to-back (type DB); or same-direction (type DT), in which both front faces are oriented in the same direction. DF and DB arrangements are capable of taking radial loads and axial loads in both directions. Type DT is used when there is a strong axial load in one direction and it is necessary to divide the load equally across each bearing.

### Double-Row Angular Contact Ball Bearings



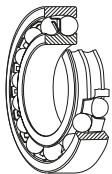
Double-row angular contact ball bearings are like two single-row angular contact ball bearings mounted back-to-back, except that they have only one inner ring and one outer ring. They have a narrower width than two single bearings, and can take thrust loads in both directions.

### Four-Point-Contact Ball Bearings



The inner and outer rings of four-point-contact ball bearings are separable because the inner ring is split in a radial plane. They can take axial loads from either direction, and the balls have a contact angle of  $35^\circ$  with each ring. Radial loads are not recommended. Just one bearing of this type can replace a combination of face-to-face or back-to-back angular contact bearings. Machined-brass cages are generally used.

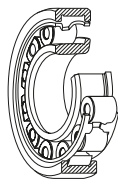
### Self-Aligning Ball Bearings



The inner ring of this type of bearing has two raceways, and the outer ring has a single spherical raceway with its center of curvature coincident with the bearing axis. Therefore, the axis of the inner ring, balls, and cage can deflect to some extent around the bearing center. Consequently, minor angular misalignment of the shaft and housing caused by machining or mounting error is automatically corrected.

This type of bearing often has a tapered bore for mounting using an adapter sleeve.

### Cylindrical Roller Bearings



In bearings of this type, the cylindrical rollers are in linear contact with the raceways. They have a high radial load capacity and are suitable for high speeds.

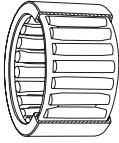
NU, NJ, NUP, N, and NF are single-row bearing types, while NNU and NN are double-row bearing types, with designations depending on the design or absence of side ribs.

The outer and inner rings of all types are separable.

Some cylindrical roller bearings have no ribs on either the inner or outer ring, so that the rings can move axially relative to each other. These can be used as free-end bearings. Cylindrical roller bearings, in which either the inner or outer ring has two ribs and the other ring has one, are capable of taking some axial load in one direction. Double-row cylindrical roller bearings have high radial rigidity and are used primarily for precision machine tools.

Pressed steel or machined brass cages are generally used, but sometimes molded polyamide cages are employed.

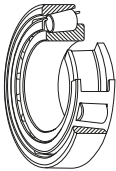
### **Needle Roller Bearings**



Needle roller bearings contain many slender rollers with a length 3 to 10 times their diameter. As a result, the ratio of the bearing outside diameter to the inscribed circle diameter is small, and they have a rather high radial load capacity.

There are numerous types available, and many have no inner ring. The drawn-cup type has a pressed-steel outer ring and the solid type has a machined outer ring. There are also cage and roller assemblies without rings. Most bearings have pressed-steel cages, but some do not use cages.

### **Tapered Roller Bearings**

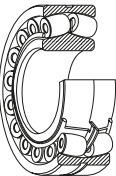


Bearings of this type use conical rollers guided by a back-face rib on the inner ring. These bearings are capable of taking high radial loads and also axial loads in one direction. The HR Series features a greater quantity of larger rollers, allowing for even higher load capacity.

They are generally mounted in pairs in a manner similar to single-row angular contact ball bearings. In this case, the proper internal clearance can be obtained by adjusting the axial distance between the inner or outer rings of the two opposed bearings. Since they are separable, the inner ring assemblies and outer rings can be mounted independently.

Tapered roller bearings are divided into three types depending on contact angle; these are normal angle, medium angle, and steep angle. Double-row and four-row tapered roller bearings are also available. Pressed-steel cages are generally used.

### **Spherical Roller Bearings**

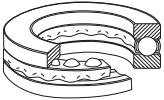


These bearings have barrel-shaped rollers between the inner ring, which has two raceways, and the outer ring, which has one spherical raceway. Since the center of curvature of the outer ring raceway surface coincides with the bearing axis, they are self-aligning in a manner similar to that of self-aligning ball bearings. Therefore, if there is deflection of the shaft or housing or misalignment of their axes, it is automatically corrected so that excessive force is not applied to the bearings.

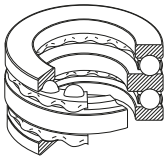
Spherical roller bearings can take not only heavy radial loads, but also some axial loads in either direction. They have excellent radial load-carrying capacity and are suitable for use where there are heavy or impact loads.

Some bearings have tapered bores and may be mounted directly on tapered shafts or cylindrical shafts using adapters or withdrawal sleeves.

Pressed-steel and machined-brass cages are used.

**Single-Direction Thrust Ball Bearings**

Single-direction thrust ball bearings are composed of washer-like bearing rings with raceway grooves. The ring attached to the shaft is called the shaft washer (or inner ring) while the ring attached to the housing is called the housing washer (or outer ring).

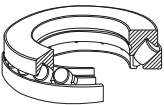
**Double-Direction Thrust Ball Bearings**

Double-direction thrust ball bearings have three rings with the middle ring (center ring) fixed to the shaft.

As their names imply, single-direction thrust bearings can take axial loads in one direction, while double-direction thrust bearings can take axial loads in both directions.

There are also thrust ball bearings with an aligning seat washer beneath the housing washer in order to compensate for shaft misalignment or mounting error.













































































































































Pressed-steel cages are usually used in smaller bearings and machined cages in larger bearings.








**Spherical Thrust Roller Bearings**

These bearings have a spherical raceway in the housing washer and barrel-shaped rollers obliquely arranged around it. Since the raceway in the housing washer is spherical, these bearings are self-aligning. They have a very high axial load capacity and are capable of taking moderate radial loads when an axial load is applied.

Pressed-steel cages or machined-brass cages are usually used.




















































**Table 1. 1 Types and Characteristics**

Bearing Type		Deep Groove Ball Bearings	Magneto Bearings	Angular Contact Ball Bearings	Double-Row Angular Contact Ball Bearings	Duplex Angular Contact Ball Bearings	Four-Point-Contact Ball Bearings	Self-Aligning Ball Bearings	Cylindrical Roller Bearings	Double-Row Cylindrical Roller Bearings	Cylindrical Roller Bearings with Single Rib
Features											
Load Capacity	Radial Loads										
	Axial Loads										
	Combined Loads										
High Speeds											
High Accuracy											
Low Noise and Torque											
Rigidity											
Angular Misalignment											
Self-Aligning Capability											
Ring Separability											
Fixed-End Bearing											
Free-End Bearing											
Inner Ring Tapered Bore											
Remarks			Two bearings are usually mounted in opposition.	Contact angles of 15°, 25°, 30° and 40°. Two bearings are usually mounted in opposition. Clearance adjustment is necessary.		Combination of DF and DT pairs is possible, but not for use on free-end.	Contact angle of 35°		Including N type	Including NUU type	Including NF type
Page No.		C005 C053	C005 C050	C072	C072 C106	C072	C072 C108	C114	C124	C124 C158	C124

 Excellent  
  Good  
  Fair  
  Poor  
  Unsuitable  
  One direction only  
  Two directions

☆ Applicable  
 ★ Applicable, allow for shaft contraction/elongation at bearing fitting surfaces.

## of Rolling Bearings

Cylindrical Roller Bearings with Thrust Collars	Needle Roller Bearings	Tapered Roller Bearings	Double- and Multi-Row Tapered Roller Bearings	Spherical Roller Bearings	Thrust Ball Bearings	Thrust Ball Bearings with Aligning Seat	Double-Direction Angular Contact Thrust Ball Bearings	Thrust Cylindrical Roller Bearings	Thrust Tapered Roller Bearings	Thrust Spherical Roller Bearings	Page No.
											
					×	×	×	×	×	○	—
	×										—
	×				×	×	×	×	×	○	—
					×	×		○	○	○	A022 A098
											A023 A126 A151
											A023
											A023 A192
	○		○		×		×	×	×		A022 Blue pages of each brg. type
				☆		☆				☆	A022
☆	☆	☆	☆		☆	☆	☆	☆	☆	☆	A023 A024
☆			☆	☆							A026 to A029
	☆		★	★							A026 to A029
				☆							A150 B008 B012
Including NUP type		Two bearings are usually mounted in opposition. Clearance adjustment is necessary.	KH and KV types are also available but not for use on free-end.					Including needle roller thrust bearings		To be used with oil lubrication	
C124	C341	C182	C182 C246	C258	C296	C296	—	C314	C322	C332	

## 1.3 Contact Angle and Bearing Types

The contact angle ( $\alpha$ ) refers to the angle between a vertical plane of the rotation axis of the bearing and a straight line between the points where the rolling element comes in contact with the inner ring raceway and outer ring raceway.

Radial bearings and thrust bearings are classified depending on the size of the contact angle.

Figure 1.3 shows the relation between contact angle and loading direction on the bearing.

Radial bearing  $\alpha$ : Less than  $45^\circ$   
(A primarily radial load is applied.)

Thrust bearing  $\alpha$ : Over  $45^\circ$   
(A primarily axial load is applied.)

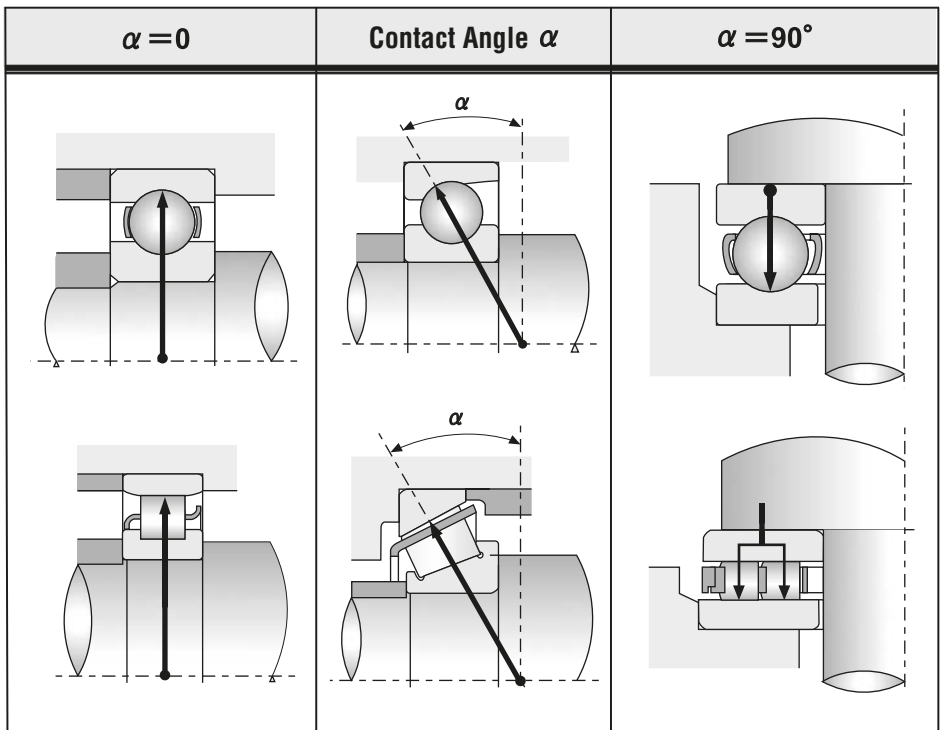


Fig. 1.3 Contact Angle  $\alpha$

## 1.4 Types of Load on Bearings

An example deep groove ball bearing is shown below in Figure 1.4 along with the types of load applied to a rolling bearing. These are:

- (a) Radial load
- (b) Axial load
- (c) Combined radial and axial load
- (d) Moment load

It is important to select the optimum bearing type according to the type and magnitude of the load.

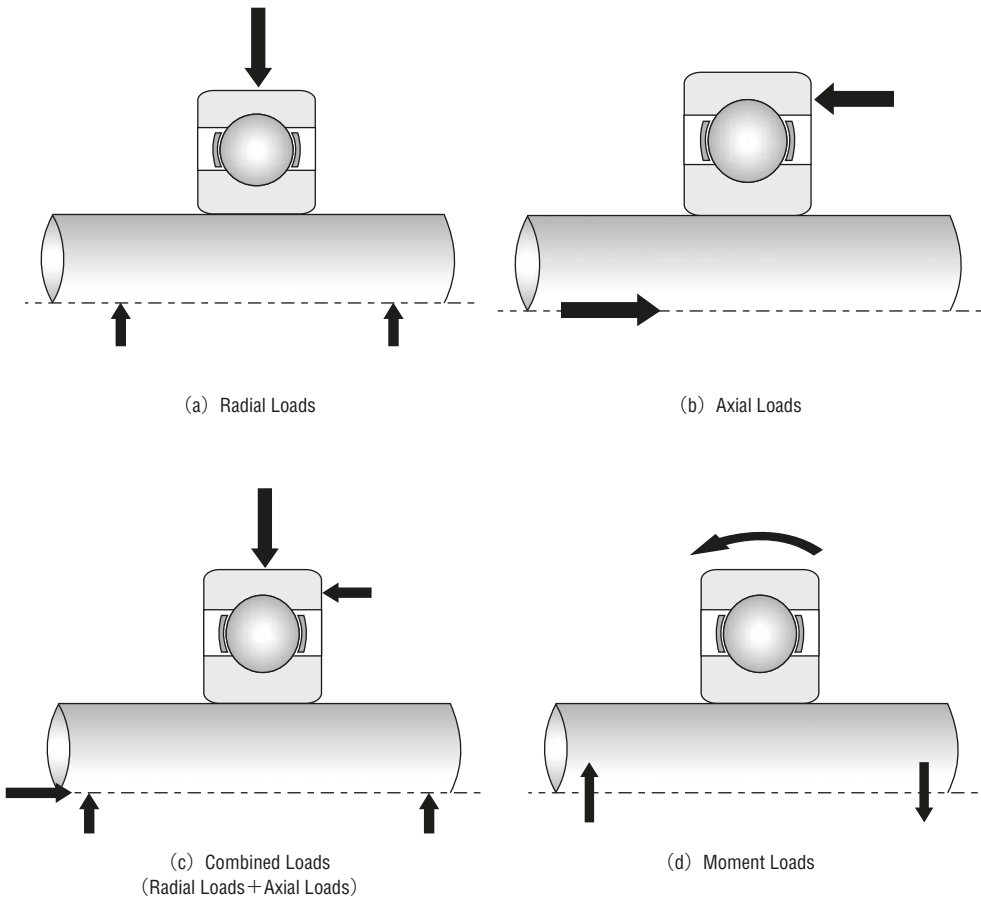


Fig. 1.4 Types of Load



## **2. SELECTION OF BEARING TYPE**

- 2.1 Bearing Selection Procedure ..... A 020**
- 2.2 Allowable Bearing Space ..... A 022**
- 2.3 Load Capacity and Bearing Types ..... A 022**
- 2.4 Permissible Speed and Bearing Types ..... A 022**
- 2.5 Misalignment of Inner/Outer Rings and Bearing Types .. A 022**
- 2.6 Rigidity and Bearing Types ..... A 023**
- 2.7 Noise and Torque of Various Bearing Types ..... A 023**
- 2.8 Running Accuracy and Bearing Types ..... A 023**
- 2.9 Mounting and Dismounting of Various Bearing Types .... A 023**

## 2. SELECTION OF BEARING TYPE

### 2.1 Bearing Selection Procedure

There are nearly countless applications for rolling bearings; therefore, operating conditions and environments vary greatly. In addition, the diversity of operating conditions and bearing requirements continues to grow with the rapid advancement of technology. Bearings must be carefully studied from many angles to select the best choice from the thousands of types and sizes available.

Usually, a bearing type is provisionally chosen considering operating conditions, mounting arrangement, ease of mounting in the machine, allowable space, cost, availability, and other factors.

Then the size of the bearing is chosen to satisfy the

desired life requirement. When doing this, in addition to fatigue life, be sure to consider grease life, noise and vibration, wear, and other factors.

There is no fixed procedure for selecting bearings. It is good to investigate experience with similar applications and studies relevant to any special requirements for the specific application. When selecting bearings for new machines, unusual operating conditions, or harsh environments, please consult with NSK.

The following diagram (Fig.2.1) shows an example bearing selection procedure.

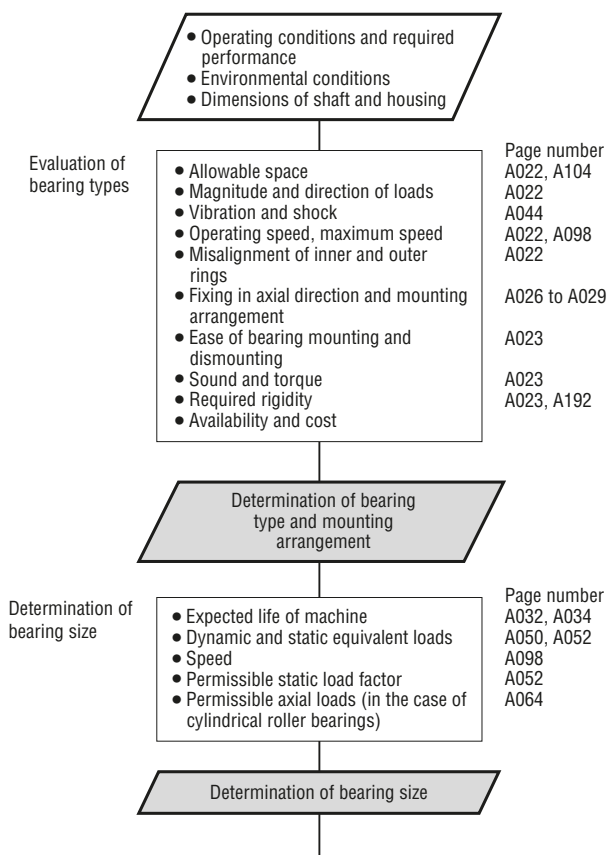
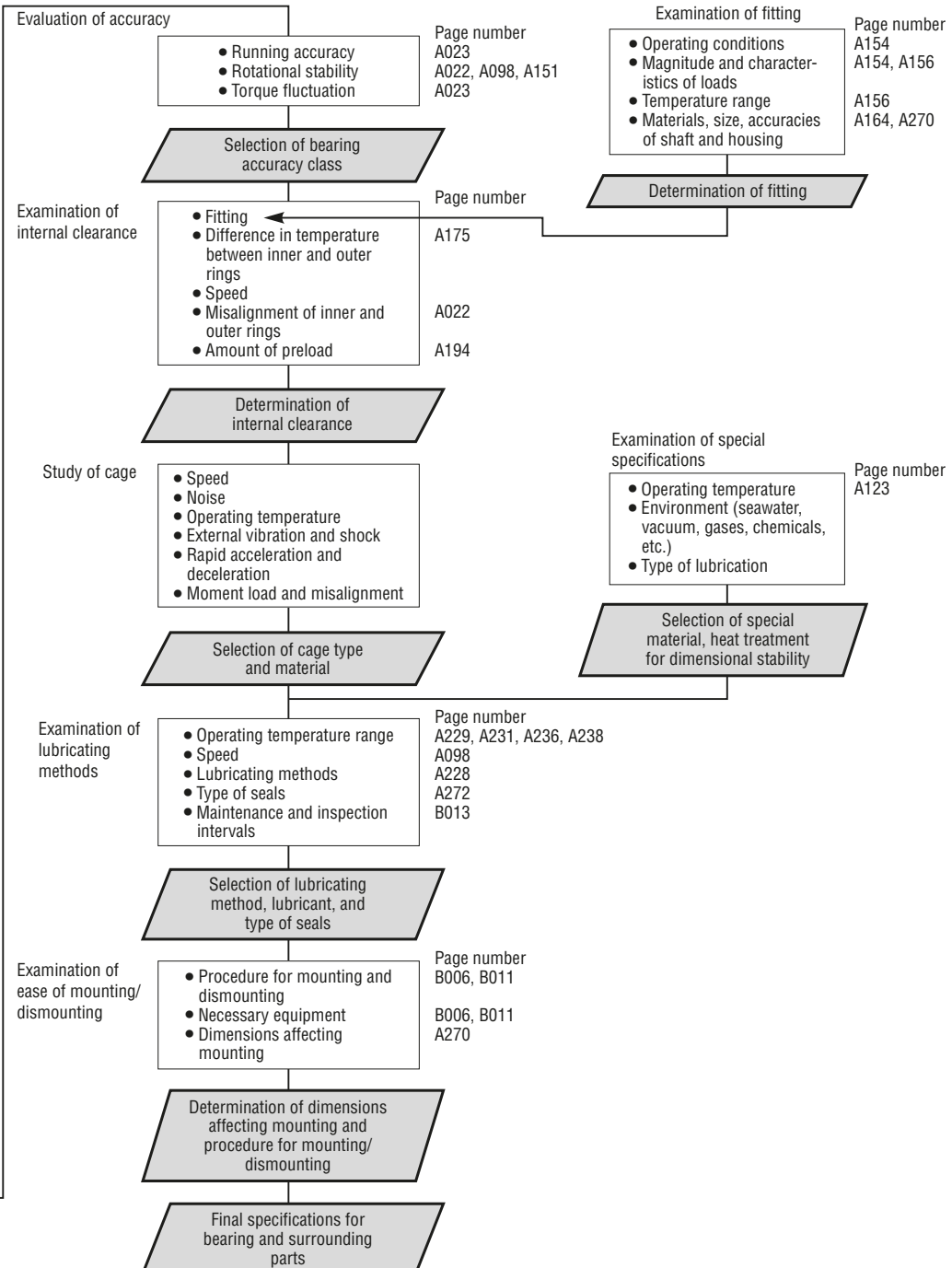


Fig. 2.1 Flowchart for Selection of Rolling Bearings



2.2 Allowable Bearing Space

The allowable space for a rolling bearing and its adjacent parts is generally limited, so the type and size of the bearing must be selected within such limits. In most cases, the shaft diameter is fixed first by the machine design; therefore, the bearing is often selected based on bore size. Rolling bearings have numerous standardized Dimension Series and types from which to select the optimum bearing. Fig. 2.2 shows the Dimension Series of radial bearings and corresponding bearing types.

2.3 Load Capacity and Bearing Types

The axial load-carrying capacity of a bearing is closely related to radial load capacity based on the bearing design, as shown in Fig. 2.3. This figure shows that when bearings of the same Dimension Series are compared, roller bearings have a higher load capacity than ball bearings and are superior if shock loads exist.

2.4 Permissible Speed and Bearing Types

The maximum speed of rolling bearings varies not only with the type of bearing, but also with size, cage type, loads, lubricating method, heat dissipation, etc. Assuming the common oil bath lubrication method, the bearing types are roughly ranked from higher speed to lower speed as shown in Fig. 2.4.

2.5 Misalignment of Inner/Outer Rings and Bearing Types

Because of shaft deflection caused by applied loads, dimensional errors of the shaft and housing, and mounting errors, the inner and outer rings are slightly misaligned. The permissible misalignment varies depending on the bearing type and operating conditions, but usually it is less than 0.0012 radian (4').

When a large misalignment is expected, bearings with self-aligning capability, such as self-aligning ball bearings, spherical roller bearings, and certain bearing units should be selected (Figs. 2.5 and 2.6).

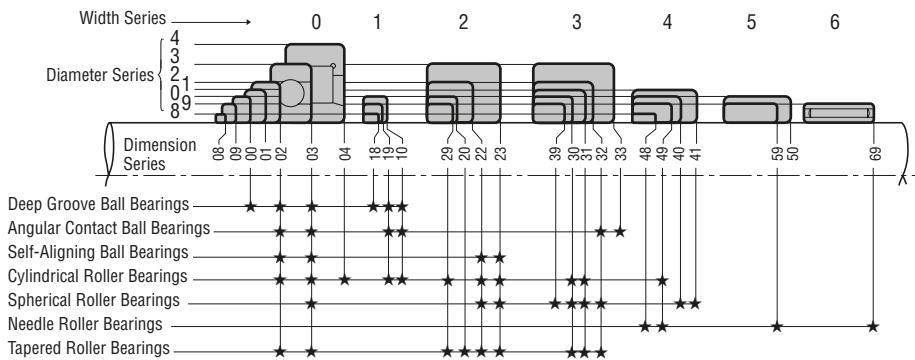
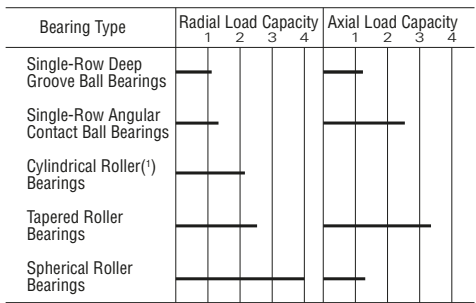
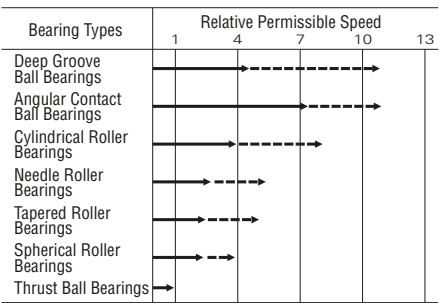


Fig. 2.2 Dimension Series of Radial Bearings



Note(\*) Bearings with ribs can take some axial loads.

Fig. 2.3 Relative Load Capacities of Various Bearing Types



Remarks ————— Oil bath lubrication  
----- With special measures to increase speed limit

Fig. 2.4 Relative Permissible Speeds of Various Bearing Types

Permissible bearing misalignment is given at the beginning of the dimensional tables for each bearing type.

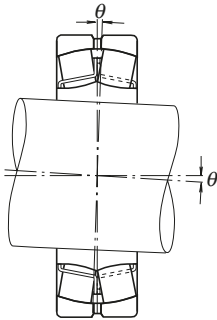


Fig. 2.5 Permissible Misalignment of Spherical Roller Bearings

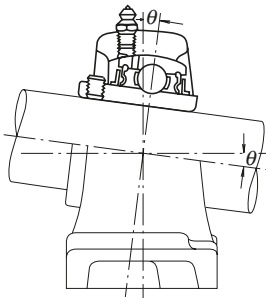


Fig. 2.6 Permissible Misalignment of Ball Bearing Units

## 2.6 Rigidity and Bearing Types

When loads are imposed on a rolling bearing, some elastic deformation occurs in the contact areas between the rolling elements and raceways. The rigidity of the bearing is determined by the ratio of bearing load to the amount of elastic deformation of the inner and outer rings and rolling elements. The main spindles of machine tools must have highly rigid bearings together with the rest of the spindle. Consequently, since roller bearings are deformed less by load, they are selected more often than ball bearings. When extra-high rigidity is required, bearings are given a preload, which means they have a negative clearance. Angular contact ball bearings and tapered roller bearings are often preloaded.

## 2.7 Noise and Torque of Various Bearing Types

Since rolling bearings are manufactured with very high precision, noise and torque are minimal. For deep groove ball bearings and cylindrical roller bearings in particular, the noise level is sometimes specified depending on their purpose. For high-precision miniature ball bearings, the starting torque can be specified. Deep groove ball bearings are recommended for applications in which low noise and torque are required, such as in motors or instruments.

## 2.8 Running Accuracy and Bearing Types

For the main spindles of machine tools that require high running accuracy or high-speed applications like superchargers, high-precision bearings of Accuracy Class 5, 4 or 2 are usually used.

The running accuracy of rolling bearings is specified in various ways, and specified accuracy classes vary depending on the bearing type. A comparison of the inner ring radial runout for the highest running accuracy specified for each bearing type is shown in Fig. 2.7.

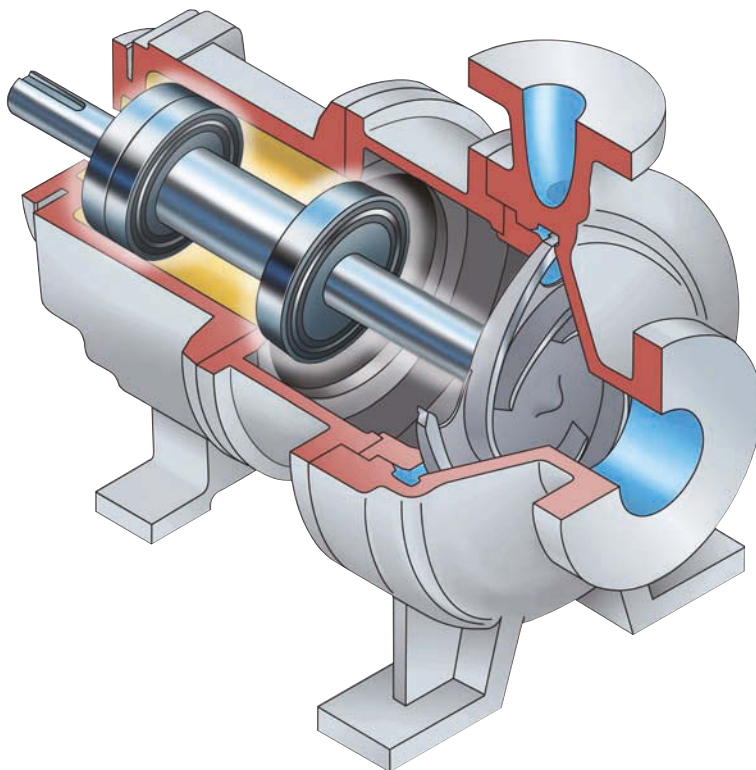
Deep groove ball bearings, angular contact ball bearings, and cylindrical roller bearings are most suitable for applications requiring high running accuracy.

## 2.9 Mounting and Dismounting of Various Bearing Types

Separable bearings, such as cylindrical roller bearings, needle roller bearings, and tapered roller bearings are convenient for mounting and dismounting. These types of bearings are recommended for machines in which bearings are mounted and dismounted rather often for periodic inspection. In addition, self-aligning ball bearings and spherical roller bearings (small-sized) with tapered bores can be mounted and dismounted relatively easily using sleeves.

Bearing Types	Highest Accuracy Specified	Tolerance Comparison of Inner Ring Radial Runout				
		1	2	3	4	5
Deep Groove Ball Bearings	Class 2	→				
Angular Contact Ball Bearings	Class 2	→				
Cylindrical Roller Bearings	Class 2	→				
Tapered Roller Bearings	Class 4	→				
Spherical Roller Bearings	Normal	→	→	→	→	→

Fig. 2.7 Relative Inner Ring Radial Runout of Highest Accuracy Class for Various Bearing Types



### **3. SELECTION OF BEARING ARRANGEMENT**

**3.1 Fixed-End and Free-End Bearings ..... A 026**

**3.2 Example Bearing Arrangements ..... A 027**

## 3. SELECTION OF BEARING ARRANGEMENT

In general, shafts are supported by only two rolling bearings. When considering the bearing mounting arrangement, the following items must be investigated:

- (1) Expansion and contraction of the shaft caused by temperature variations
- (2) Ease of bearing mounting and dismounting
- (3) Misalignment of the inner and outer rings caused by deflection of the shaft or mounting error
- (4) Rigidity of the entire system, including bearings and preloading method
- (5) Capability to sustain loads at their proper positions and to transmit them

### 3.1 Fixed-End and Free-End Bearings

Usually only one "fixed-end" bearing on a shaft is used to fix the shaft axially. For this fixed-end bearing, a bearing type that can carry both radial and axial loads must be selected.

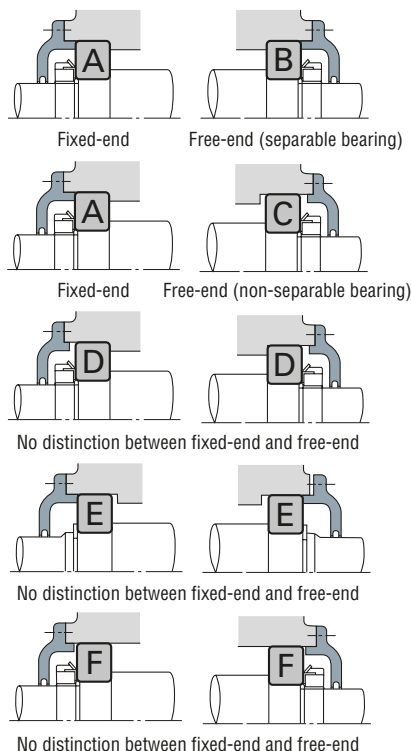
Other bearings must be "free-end" bearings that carry only radial loads to relieve the shaft's thermal elongation and contraction.

If measures to relieve a shaft's thermal elongation and contraction are insufficient, abnormal axial loads will be applied to the bearings, which can cause premature failure.

For free-end bearings, cylindrical roller bearings or needle roller bearings with separable inner and outer rings that are free to move axially (NU, N types, etc.) are recommended. Mounting and dismounting are also easier with these types.

When non-separable types are used as free-end bearings, usually the fit between the outer ring and housing is loose to allow axial movement of the running shaft together with the bearing. Sometimes, such elongation is relieved by a loose fit between the inner ring and shaft.

When the distance between the bearings is short and the influence of the shaft elongation and contraction is negligible, two opposed angular contact ball bearings or tapered roller bearings are used. The axial clearance (possible axial movement) after the mounting is adjusted using nuts or shims.



#### BEARING A

- Deep Groove Ball Bearing
- Matched Angular Contact Ball Bearing
- Double-Row Angular Contact Ball Bearing
- Self-Aligning Ball Bearing
- Cylindrical Roller Bearing with Ribs (NH, NUP types)
- Double-Row Tapered Roller Bearing
- Spherical Roller Bearing

#### BEARING D,E<sup>(2)</sup>

- Angular Contact Ball Bearing
- Tapered Roller Bearing
- Magneto Bearing
- Cylindrical Roller Bearing (NJ, NF types)

#### BEARING B

- Cylindrical Roller Bearing (NU, N types)
- Needle Roller Bearing (NA type, etc.)

#### BEARING C<sup>(1)</sup>

- Deep Groove Ball Bearing
- Matched Angular Contact Ball Bearing (back-to-back)
- Double-Row Angular Contact Ball Bearing
- Self-Aligning Ball Bearing
- Double-Row Tapered Roller Bearing (KBE type)
- Spherical Roller Bearing

#### BEARING F

- Deep Groove Ball Bearing
- Self-Aligning Ball Bearing
- Spherical Roller Bearing

Notes: <sup>(1)</sup> In the figure, shaft elongation and contraction are relieved at the outside surface of the outer ring, but sometimes this is done at the bore.

<sup>(2)</sup> For each type, two bearings are used in an opposed arrangement.

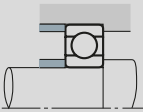
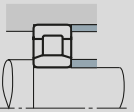
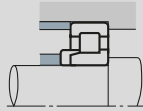
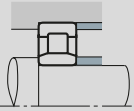
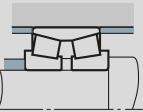
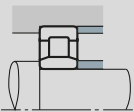
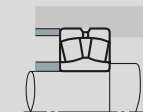
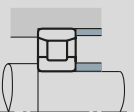
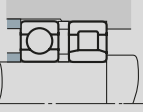
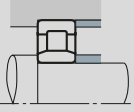
Fig. 3.1 Bearing Mounting Arrangements and Bearing Types

The distinction between free-end and fixed-end bearings and some possible bearing mounting arrangements for various bearing types are shown in Fig. 3.1.

### 3.2 Example Bearing Arrangements

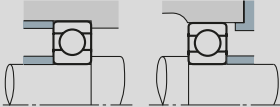
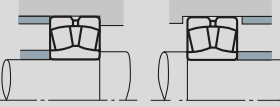
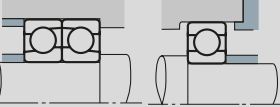
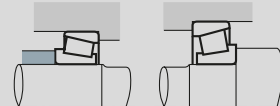
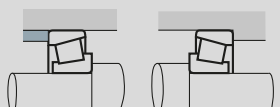
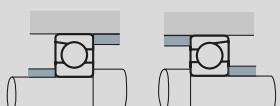
Some representative bearing mounting arrangements considering preload and rigidity of the entire assembly, shaft elongation and contraction, mounting error, etc. are shown in Table 3.1.

**Table 3. 1 Representative Bearing Mounting Arrangements and Application Examples**

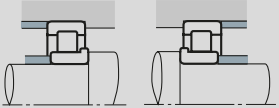
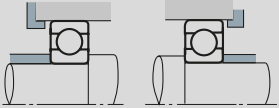
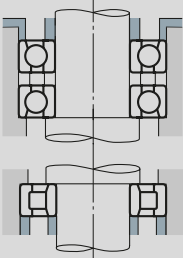
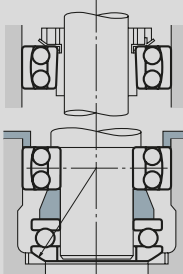
Bearing Arrangements		Remarks	Application Examples
Fixed-end	Free-end		
		<ul style="list-style-type: none"> <li>○ This is a common arrangement in which abnormal loads are not applied to bearings even if the shaft expands or contracts.</li> <li>○ If mounting error is small, this is suitable for high speeds.</li> </ul>	Medium-sized electric motors, blowers
		<ul style="list-style-type: none"> <li>○ This arrangement can withstand heavy loads and shock loads and can take some axial load.</li> <li>○ All cylindrical roller bearings are separable. This is helpful when interference is necessary for both the inner and outer rings.</li> </ul>	Traction motors for rolling stock
		<ul style="list-style-type: none"> <li>○ This arrangement is used when loads are relatively heavy.</li> <li>○ A back-to-back type is used for maximum rigidity as a fixed-end bearing.</li> <li>○ Both the shaft and housing must have high accuracy and the mounting error must be small.</li> </ul>	Table rollers for steel mills, main spindles of lathes
		<ul style="list-style-type: none"> <li>○ This arrangement is suitable when interference is necessary for both the inner and outer rings. Heavy axial loads cannot be applied.</li> </ul>	Calender rolls of paper making machines, axles of diesel locomotives
		<ul style="list-style-type: none"> <li>○ This arrangement is suitable for high speeds and heavy radial loads. Moderate axial loads can also be applied.</li> <li>○ Some clearance is necessary between the outer ring of the deep groove ball bearing and the housing bore in order to avoid subjecting it to radial loads.</li> </ul>	Reduction gears in diesel locomotives

Continued on next page

**Table 3. 1 Representative Bearing Mounting Arrangements and Application Examples (cont'd)**

Bearing Arrangements		Remarks	Application Examples
Fixed-end	Free-end		
		<ul style="list-style-type: none"> <li>○ This is the most common arrangement.</li> <li>○ It can sustain not only radial loads, but also moderate axial loads.</li> </ul>	Double-suction volute pumps, automotive transmissions
		<ul style="list-style-type: none"> <li>○ This is the most suitable arrangement when there is mounting error or shaft deflection.</li> <li>○ It is often used for general and industrial applications in which heavy loads are applied.</li> </ul>	Speed reducers, table rollers of steel mills, wheels for overhead travelling cranes
		<ul style="list-style-type: none"> <li>○ This is suitable when there are rather heavy axial loads in both directions.</li> <li>○ Double-row angular contact bearings may be used instead of an arrangement of two angular contact ball bearings.</li> </ul>	Worm gear reducers
When there is no distinction between fixed-end and free-end		Remarks	Application Examples
 <p>Back-to-back mounting</p>  <p>Face-to-face mounting</p>		<ul style="list-style-type: none"> <li>○ This arrangement is widely used since it can withstand heavy loads and shock loads.</li> <li>○ The back-to-back arrangement is especially good when the distance between bearings is short and moment loads are applied.</li> <li>○ Face-to-face mounting makes mounting easier when interference is necessary for the inner ring. In general, this arrangement is good when there is mounting error.</li> <li>○ To use this arrangement with a preload, take extra care to ensure the correct amount of preload and clearance adjustment.</li> </ul>	Pinion shafts of automotive differential gears, automotive front and rear axles, worm gear reducers
 <p>Back-to-back mounting</p>		<ul style="list-style-type: none"> <li>○ This arrangement is used at high speeds when radial loads are not so heavy and axial loads are relatively heavy.</li> <li>○ It provides good rigidity of the shaft by preloading.</li> <li>○ For moment loads, back-to-back mounting is better than face-to-face mounting.</li> </ul>	Grinding wheel shafts

Continued on next page

When there is no distinction between fixed-end and free-end	Remarks	Application Examples
 <p>NJ + NJ mounting</p>	<ul style="list-style-type: none"> <li>○ This arrangement can withstand heavy loads and shock loads.</li> <li>○ It can be used if interference is necessary for both the inner and outer rings.</li> <li>○ Take care to ensure sufficient axial clearance during operation.</li> <li>○ NF type + NF type mounting is also possible.</li> </ul>	<p>Final reduction gears of construction machines</p>
	<ul style="list-style-type: none"> <li>○ Sometimes a spring is used on the side of the outer ring of one bearing.</li> </ul>	<p>Small electric motors, small speed reducers, small pumps</p>
Vertical arrangements	Remarks	Application Examples
	<ul style="list-style-type: none"> <li>○ Matched angular contact ball bearings are used on the fixed end.</li> <li>○ A cylindrical roller bearing is used on the free end.</li> </ul>	<p>Vertical electric motors</p>
	<ul style="list-style-type: none"> <li>○ The spherical center of the self-aligning seat must coincide with that of the self-aligning ball bearing.</li> <li>○ The upper bearing is on the free end.</li> </ul>	<p>Vertical openers (spinning and weaving machines)</p>

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## 4. SELECTION OF BEARING SIZE

4.1	Bearing Life .....	A 032
4.1.1	Rolling Fatigue Life and Basic Rating Life .....	A 032
4.2	Basic Load Rating and Fatigue Life .....	A 032
4.2.1	Basic Load Rating .....	A 032
4.2.2	Machinery in Which Bearings are Used and Projected Life.....	A 034
4.2.3	Selection of Bearing Size Based on Basic Load Rating .....	A 035
4.2.4	Temperature Adjustment for Basic Load Rating .....	A 035
4.2.5	Correction of Basic Rating Life .....	A 037
4.2.6	Life Calculation of Multiple Bearings as a Group .....	A 038
4.2.7	New Life Theory .....	A 040
4.3	Calculation of Bearing Loads .....	A 044
4.3.1	Load Factor .....	A 044
4.3.2	Bearing Loads in Belt or Chain Transmission Applications .....	A 044
4.3.3	Bearing Loads in Gear Transmission Applications .....	A 045
4.3.4	Load Distribution on Bearings .....	A 045
4.3.5	Average Fluctuating Load .....	A 046
4.3.6	Combination of Rotating and Stationary Loads .....	A 048
4.4	Equivalent Load .....	A 050
4.4.1	Calculation of Equivalent Loads .....	A 050
4.4.2	Axial Load Components in Angular Contact Ball Bearings and Tapered Roller Bearings .....	A 051
4.5	Static Load Ratings and Static Equivalent Loads .....	A 052
4.5.1	Static Load Ratings .....	A 052
4.5.2	Static Equivalent Loads .....	A 052
4.5.3	Permissible Static Load Factor .....	A 052

<b>4.6</b>	<b>Example Bearing Calculations</b> .....	A 054
<b>4.7</b>	<b>Bearing Type and Allowable Axial Load</b> .....	A 058
<b>4.7.1</b>	<b>Change in Contact Angle of Radial Ball Bearings and Allowable Axial Load</b> .....	A 058
(1)	Change in Contact Angle Due to Axial Load .....	A 058
(2)	Allowable Axial Load for a Deep Groove Ball Bearing .....	A 062
<b>4.7.2</b>	<b>Allowable Axial Load (Rib Breakdown Strength) for Cylindrical Roller Bearings</b> .....	A 064
<b>4.8</b>	<b>Technical Data</b> .....	A 066
<b>4.8.1</b>	<b>Fatigue Life and Reliability</b> .....	A 066
<b>4.8.2</b>	<b>Radial Clearance and Fatigue Life</b> .....	A 068
<b>4.8.3</b>	<b>Misalignment of Inner/Outer Rings and Fatigue Life of Deep Groove Ball Bearings</b> .....	A 070
<b>4.8.4</b>	<b>Misalignment of Inner/Outer Rings and Fatigue Life of Cylindrical Roller Bearings</b> .....	A 072
<b>4.8.5</b>	<b>Oil Film Parameters and Rolling Fatigue Life</b> .....	A 074
<b>4.8.6</b>	<b>EHL Oil Film Parameter Calculation Diagram</b> .....	A 076
(1)	Oil Film Parameter .....	A 076
(2)	Oil Film Parameter Calculation Diagram .....	A 076
(3)	Effect of Oil Shortage and Shearing Heat Generation .....	A 080
<b>4.8.7</b>	<b>Load Calculation for Gears</b> .....	A 082
(1)	Calculation of Loads on Spur, Helical, and Double-Helical Gears .....	A 082
(2)	Calculation of Load on Straight Bevel Gears .....	A 086
(3)	Calculation of Load on Spiral Bevel Gears .....	A 088
(4)	Calculation of Load on Hypoid Gears .....	A 090
(5)	Calculation of Load on Worm Gears .....	A 094

## 4. SELECTION OF BEARING SIZE

### 4.1 Bearing Life

The various functions required of rolling bearings vary according to the bearing application and 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.

Bearing life, in a broad sense of the term, is the period during which bearings continue to operate and satisfy their required functions. This bearing life may be defined as noise life, abrasion life, grease life, or rolling fatigue life, depending on which causes loss of bearing service.

Aside from the failure of bearings to function due to natural deterioration, bearings may fail when conditions such as heat-seizure, fracture, scoring of the rings, damage to the seals or cage, or other damage occurs.

Conditions such as these should not be interpreted as normal bearing failure since they often occur as a result of errors in bearing selection, improper design or manufacture of the bearing surroundings, incorrect mounting, or insufficient maintenance.

#### 4.1.1 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. Because of metal fatigue of the rolling contact surfaces of the raceways and rolling elements, scaly particles may separate from the bearing material (Fig. 4.1). This phenomenon is called "flaking". Rolling fatigue life is represented by the total number of revolutions at which the bearing surface will start flaking due to stress. This is called fatigue life. As shown in Fig. 4.2, 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, "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 of time, 10 % of them 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 or, 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, the grease

life of grease-lubricated bearings (refer to Section 11, Lubrication, Page A228) can be estimated. Since noise life and abrasion life are judged according to individual standards for different applications, specific values for noise or abrasion life must be determined empirically.

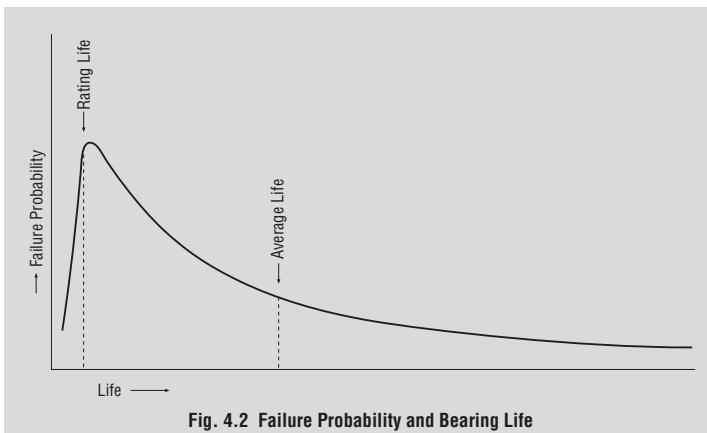
### 4.2 Basic Load Rating and Fatigue Life

#### 4.2.1 Basic Load Rating

The basic load rating is defined as the constant load applied on bearings with stationary outer rings that the inner rings can endure for a rating life of one million revolutions ( $10^6$  rev). The basic load rating of radial bearings is defined as a central radial load of constant direction and magnitude, while the basic load rating of thrust bearings is defined as an axial load of constant magnitude in the same direction as the central axis. The load ratings are listed under  $C_r$  for radial bearings and  $C_a$  for thrust bearings in the dimension tables.



**Fig. 4.1 Flaking Example**



**Fig. 4.2 Failure Probability and Bearing Life**

## 4.2.2 Machinery in Which Bearings are Used and Projected Life

Selecting bearings with unnecessarily high load ratings is not advised, as such bearings may be too large and uneconomical. In addition, the bearing life alone should not be the deciding factor in the selection of bearings. The strength, rigidity, and design of the shaft

on which the bearings will be mounted should also be considered. Bearings are used in a wide range of applications and the design life varies with specific applications and operating conditions. Table 4.1 gives empirical fatigue life factors derived from typical operating experience for various machines. Formulae for various life parameters can be found in Table 4.2.

**Table 4.1 Fatigue Life Factor  $f_h$  for Various Bearing Applications**

Operating Period	Fatigue Life Factor $f_h$				
	~3	2~4	3~5	4~7	6~
Infrequently used or only for short periods	• Small motors for home appliances, such as vacuum cleaners and washing machines • Power tools	• Agricultural equipment			
Used only occasionally but reliability is important		• Motors for home heaters and air conditioners • Construction equipment	• Conveyors • Elevator cable sheaves		
Used intermittently for relatively long periods	• Rolling mill roll necks	• Small motors • Deck cranes • General cargo cranes • Pinion stands • Passenger cars	• Factory motors • Machine tools • Transmissions • Vibrating screens • Crushers	• Crane sheaves • Compressors • Specialized transmissions	
Used intermittently for more than eight hours daily		• Escalators	• Centrifugal separators • Air conditioning equipment • Blowers • Woodworking machines • Large motors • Axle boxes on railway rolling stock	• Mine hoists • Press flywheels • Railway traction motors • Locomotive axle boxes	• Paper making machines
Used continuously and high reliability is important					• Waterworks pumps • Electric power stations • Mine draining pumps

**Table 4.2 Basic Rating Life, Fatigue Life Factor, and Speed Factor**

Life Parameter	Ball Bearings	Roller Bearings
Basic Rating Life	$L_h = \frac{10^6}{60n} \left( \frac{C}{P} \right)^3 = 500 f_h^3$	$L_h = \frac{10^6}{60n} \left( \frac{C}{P} \right)^{\frac{10}{3}} = 500 f_h^{\frac{10}{3}}$
Fatigue Life Factor	$f_h = f_n \frac{C}{P}$	$f_h = f_n \frac{C}{P}$
Speed Factor	$f_n = \left( \frac{10^6}{500 \cdot 60n} \right)^{\frac{1}{3}}$ $= (0.03n)^{-\frac{1}{3}}$	$f_n = \left( \frac{10^6}{500 \cdot 60n} \right)^{\frac{3}{10}}$ $= (0.03n)^{-\frac{3}{10}}$

$n, f_n$ .....Fig. 4.3 (See Page A036), Appendix Table 12 (See Page E018)  
 $L_h, f_h$ .....Fig. 4.4 (See Page A036), Appendix Table 13 (See Page E019)

#### 4.2.3 Selection of Bearing Size Based on Basic Load Rating

The following relation exists between bearing load and basic rating life:

$$\text{For ball bearings } L = \left(\frac{C}{P}\right)^3 \dots\dots\dots (4.1)$$

$$\text{For roller bearings } L = \left(\frac{C}{P}\right)^{\frac{10}{3}} \dots\dots\dots (4.2)$$

where  $L$  : Basic rating life ( $10^6$  rev)  
 $P$  : Bearing load (equivalent load) (N), {kgf}  
 .....(Refer to Page A30)  
 $C$  : Basic load rating (N), {kgf}  
 For radial bearings,  $C$  is written  $C_r$   
 For thrust bearings,  $C$  is written  $C_a$

It is convenient to express the fatigue life in terms of hours for bearings that run at a constant speed. In general, the fatigue life of bearings used in automobiles and other vehicles is given in terms of mileage.

By designating the basic rating life as  $L_h$  (h), bearing speed as  $n$  ( $\text{min}^{-1}$ ), fatigue life factor as  $f_h$ , and speed factor as  $f_n$ , the relations shown in Table 4.2 are obtained.

If the bearing load  $P$  and speed  $n$  are known, it's possible to determine a fatigue life factor  $f_h$  appropriate for the desired life of the machine and then calculate the minimum basic load rating  $C$  with the following Equation:

$$C = \frac{f_h \cdot P}{f_n} \dots\dots\dots (4.3)$$

A bearing that satisfies this value of  $C$  should then be selected from the bearing tables.

#### 4.2.4 Temperature Adjustment for Basic Load Rating

If rolling bearings are used at high temperatures, the hardness of the bearing steel decreases. Consequently, the basic load rating, which depends on the physical properties of the material, also decreases; therefore, the basic load rating should be adjusted for higher temperatures through the following equation:

$$C_t = f_t \cdot C \dots\dots\dots (4.4)$$

where  $C_t$  : Basic load rating after temperature correction  
 (N), {kgf}

$f_t$  : Temperature factor  
 (See Table 4.3.)

$C$  : Basic load rating before temperature adjustment  
 (N), {kgf}

If bearings are used above 120 °C, they must be given a special dimensional stability heat treatment to prevent excessive dimensional changes. The basic load rating of bearings after such special dimensional stability heat treatment may become lower than the basic load rating listed in the bearing tables.

**Table 4.3 Temperature Factor  $f_t$**

Bearing Temperature °C	125	150	175	200	250
Temperature Factor $f_t$	1.00	1.00	0.95	0.90	0.75

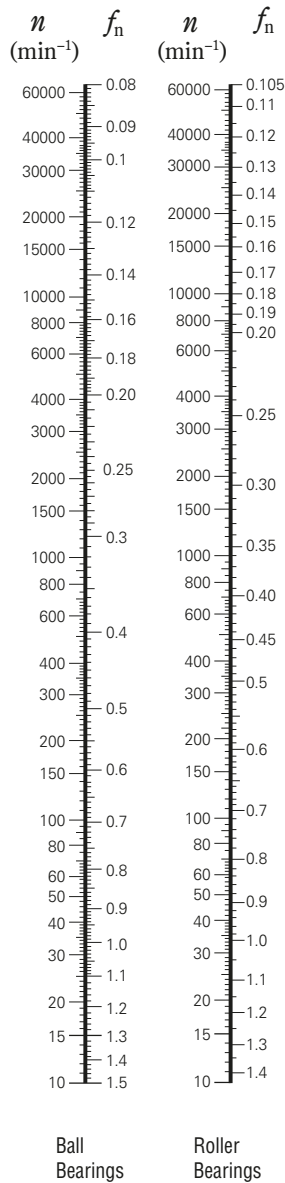


Fig. 4.3 Bearing Speed and Speed Factor

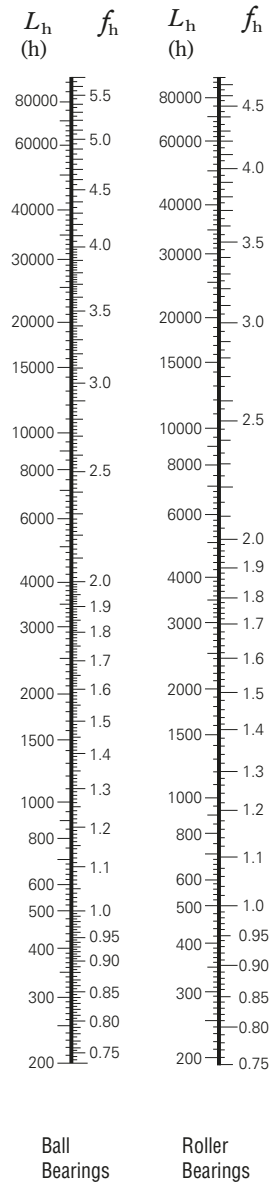


Fig. 4.4 Fatigue Life Factor and Fatigue Life

#### 4.2.5 Correction of Basic Rating Life

As described previously, the basic equations for calculating basic rating life are as follows:

$$\text{For ball bearings } L_{10} = \left(\frac{C}{P}\right)^3 \dots\dots\dots (4.5)$$

$$\text{For roller bearings } L_{10} = \left(\frac{C}{P}\right)^{\frac{10}{3}} \dots\dots\dots (4.6)$$

$L_{10}$  life is defined as the basic rating life with a statistical reliability of 90%. Depending on the machines in which the bearings are used, sometimes a reliability higher than 90% may be required. However, recent improvements in bearing material have greatly extended fatigue life. In addition, the development of the Elasto-Hydrodynamic Theory of Lubrication proves that the thickness of the lubricating film in the contact zone between rings and rolling elements greatly influences bearing life. To reflect such improvements in the calculation of fatigue life, the basic rating life is adjusted using the following adjustment factors:

$$L_{na} = a_1 a_2 a_3 L_{10} \dots\dots\dots (4.7)$$

where  $L_{na}$ : Adjusted rating life in which reliability, material improvements, lubricating conditions, etc. are considered

$L_{10}$ : Basic rating life with a reliability of 90%

$a_1$ : Life adjustment factor for reliability

$a_2$ : Life adjustment factor for special bearing properties

$a_3$ : Life adjustment factor for operating conditions

The life adjustment factor for reliability  $a_1$ , is listed in Table 4.4 for reliabilities higher than 90%.

The life adjustment factor for special bearing properties  $a_2$  is used to reflect improvements in bearing steel.

NSK now uses vacuum-degassed bearing steel, and test results show that life is greatly improved compared with earlier materials. The basic load ratings  $C_r$  and  $C_a$  listed in the bearing tables were calculated considering the extended life achieved by improvements in materials and manufacturing techniques. Consequently, when estimating life using Equation (4.7), you may assume that  $a_2$  is greater than one.

The life adjustment factor for operating conditions  $a_3$  is used to adjust for various factors, particularly lubrication. If there is no misalignment between the inner and outer rings and the thickness of the lubricating film in the contact zones of the bearing is sufficient, it is possible for  $a_3$  to be greater than one; however,  $a_3$  is less than one in the following cases:

- When the viscosity of the lubricant in the contact zones between the raceways and rolling elements is low.
- When the circumferential speed of the rolling elements is very slow.
- When bearing temperature is high.
- When lubricant is contaminated by water or foreign matter.
- When misalignment of the inner and outer rings is excessive.

It is difficult to determine the proper value of  $a_3$  for specific operating conditions because there are still many unknowns. Since the special bearing property factor  $a_2$  is also influenced by the operating conditions, there is a proposal to combine  $a_2$  and  $a_3$  into one quantity ( $a_2 \cdot a_3$ ), and not consider them independently. In this case, under normal lubricating and operating conditions, the product ( $a_2 \cdot a_3$ ) should be assumed equal to one. However, if the viscosity of the lubricant is too low, the value drops to as low as 0.2.

If there is no misalignment and a lubricant with high viscosity is used so that a sufficient fluid-film thickness is secured, the product of ( $a_2 \cdot a_3$ ) may be about two.

When selecting a bearing based on the basic load rating, it is best to choose an  $a_1$  reliability factor appropriate for the projected use and an empirically determined  $C/P$  or  $f_h$  value derived from past results for lubrication, temperature, mounting conditions, etc. in similar machines.

The basic rating life Equations (4.1), (4.2), (4.5), and (4.6) give satisfactory results for a broad range of bearing loads. However, extra-heavy loads may cause detrimental plastic deformation at ball/raceway contact points. When  $P_r$  exceeds  $C_{or}$  (basic static load rating) or  $0.5 C_r$ , whichever is smaller, for radial bearings or  $P_a$  exceeds  $0.5 C_a$  for thrust bearings, please consult NSK to establish the applicability of the rating fatigue life equations.

**Table 4.4 Reliability Factor  $a_1$**

Reliability (%)	90	95	96	97	98	99
$a_1$	1.00	0.64	0.55	0.47	0.37	0.25

## 4.2.6 Life Calculation of 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. However, a machine generally 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 the bearings varies greatly and our fatigue life calculation equation

$L = \left( \frac{C}{P} \right)^p$  applies to the 90% life (also called the rating

fatigue life, which is either the gross number of revolutions or hours that 90% of multiple similar bearings operated under similar 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 rating fatigue life of a group of multiple bearings is not determined solely from the shortest rating fatigue life among the individual bearings. In fact, the group life is much shorter than the life of the bearing with the shortest fatigue life.

Assuming the rating fatigue life of individual bearings as  $L_1, L_2, L_3 \dots$  and the rating fatigue life of the entire group of bearings as  $L$ , the equation below is obtained:

$$\frac{1}{L^e} = \frac{1}{L_1^e} + \frac{1}{L_2^e} + \frac{1}{L_3^e} + \dots \quad (4.8)$$

where  $e=1.1$  (both for ball and roller bearings)

$L$  of Equation (4.8) can be determined easily by using Fig. 4.5.

To use this chart, find the  $L_1$  value from Equation (4.8) on the  $L_1$  scale and the value of  $L_2$  on the  $L_2$  scale, connect them with a straight line, and read where the line intersects the  $L$  scale. In this way, the value of  $L_A$  in

$$\frac{1}{L_A^e} = \frac{1}{L_1^e} + \frac{1}{L_2^e}$$

can be determined. Take this value  $L_A$  on the  $L_1$  scale and the  $L_3$  value on the  $L_2$  scale, connect them with a straight line, and read where the line intersects the  $L$  scale. In this way, the value  $L$  in

$$\frac{1}{L^e} = \frac{1}{L_1^e} + \frac{1}{L_2^e} + \frac{1}{L_3^e}$$

can be determined.

### Example

Assume that the calculated fatigue life values of automotive front wheel bearings are as follows:

280 000 km for inner bearing

320 000 km for outer bearing

Then, the fatigue life of the wheel bearings can be determined as 160 000 km from Fig. 4.5.

If the fatigue life of the bearing of the right-hand wheel bearing takes this value, the fatigue life of the left-hand wheel bearing will be the same. As a result, the fatigue life of the front wheels as a group is 85 000 km.

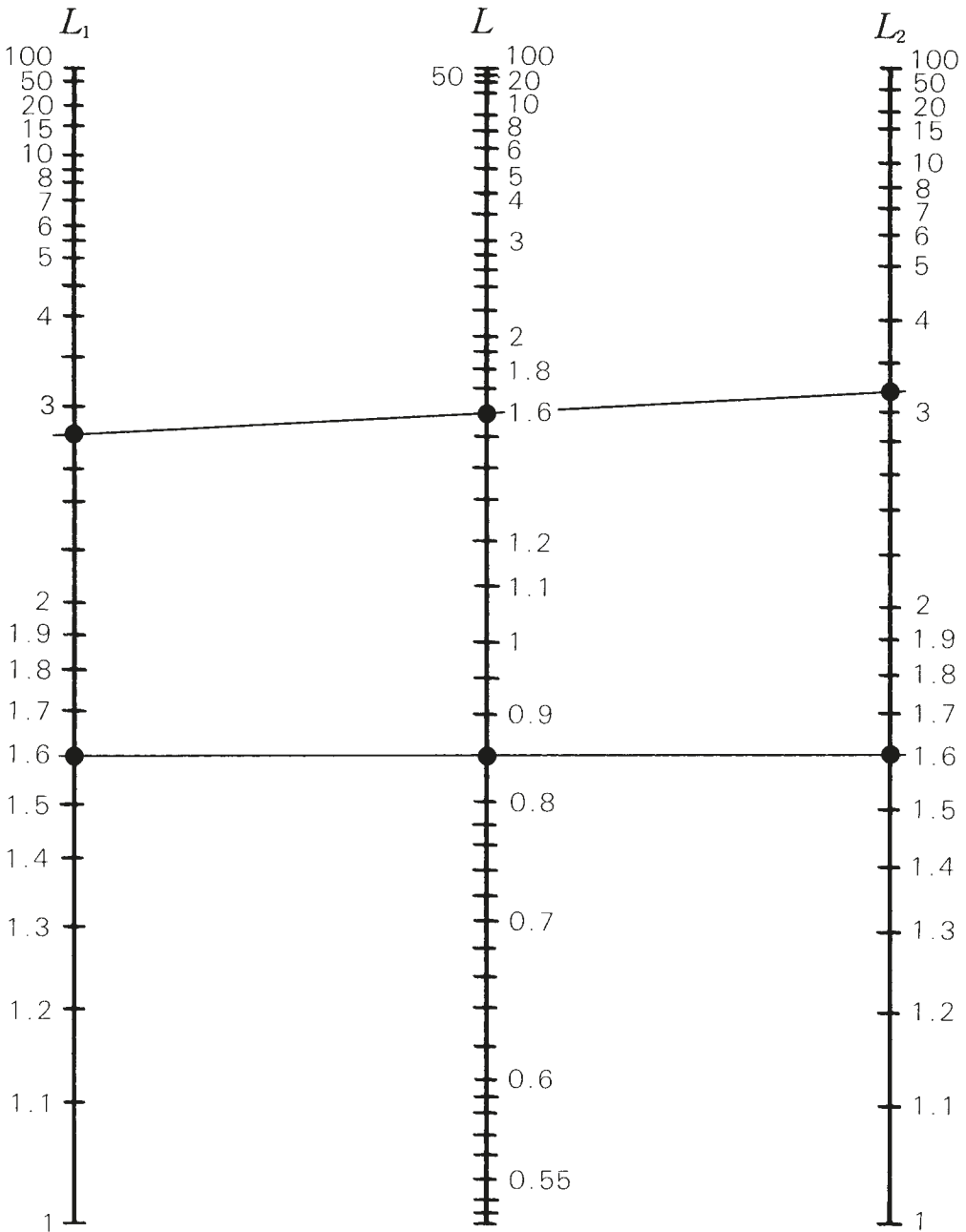


Fig. 4.5 Life Calculation Chart

## 4.2.7 New Life Theory

Bearing technology has advanced rapidly in recent years, particularly in the areas of dimensional accuracy and material cleanliness. As a result, bearings in a clean environment can now have a longer rolling fatigue life than the life obtained by the traditional ISO life calculation formula. This extended life is partly due to the important advancements in bearing-related technology, such as lubrication, cleanliness, and filtration.

The conventional life calculation formula (Equation 4.9) based on the theories of G. Lundberg and A. Palmgren (L-P theory, hereafter) addresses only subsurface-originated flaking. In this phenomenon, cracks initially occur due to dynamic shear stress immediately below the rolling surface and progressively reach the surface in the form of flaking.

$$\ln \frac{1}{S} \propto \frac{\tau_0^c \cdot N^e \cdot V}{Z_0^h} \dots \dots \dots (4.9)$$

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.

### NSK New Life Calculation Formula

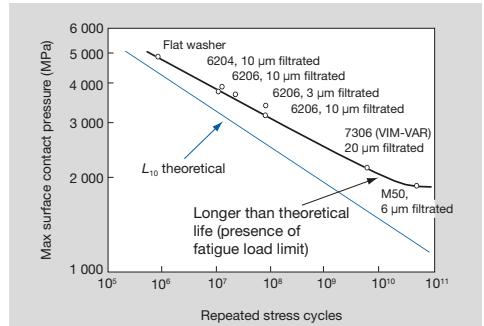
#### (1) Subsurface-originated flaking

A precondition of subsurface-originated flaking in rolling bearings is contact of the rolling elements with the raceway via a sufficient and continuous oil film under clean lubrication conditions.

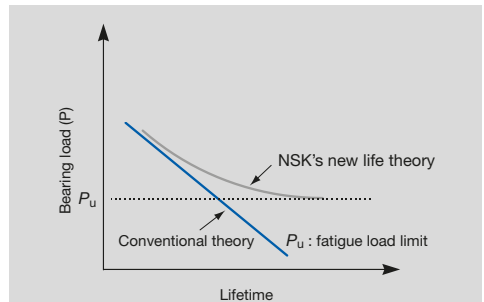
Fig. 4.6 plots the  $L_{10}$  life for each test condition with maximum surface contact pressure ( $P_{\max}$ ) and the number of repeated stresses cycles.

In the figure, line  $L_{10}$  theoretical refers to the theoretical line obtained using the conventional life calculation formula. As maximum surface contact pressure decreases, the line representing actual life separates from the conventionally calculated theoretical line towards longer life. This separation suggests the presence of a fatigue load limit  $P_u$  below which no rolling fatigue occurs. The difference between NSK's revised theory (Equation 4.10) and the conventional theory is better illustrated in Fig. 4.7.

$$\ln \frac{1}{S} \propto N^e \int_V \frac{(\tau - \tau_u)^c}{Z_0^h} dV \dots \dots \dots (4.10)$$



**Fig. 4.6 Life Test Results Under Clean Lubrication**



**Fig. 4.7 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, cast sand, etc.

When foreign particles are mixed in the lubricant, they become pressed onto the raceways by the rolling elements and dents occur on the surfaces of the raceways and rolling elements. Stress concentrations occur 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. 4.8, actual life is shorter than conventional calculated life under contaminated lubrication conditions at low maximum surface pressure. This result shows that the actual life under contaminated lubrication is further shortened compared to the theoretical life because of the decrease in maximum surface contact pressure.

Table 4.5 Values 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	10 $\mu\text{m}$ filtration	10–30 $\mu\text{m}$ filtration	30–100 $\mu\text{m}$ filtration	Greater than 100 $\mu\text{m}$ filtration 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, railway axle boxes, machine tools, etc.	Normal usage, automotive hub unit bearings, etc.	Bearings for automotive transmissions, industrial gearboxes, construction machines, etc.	—

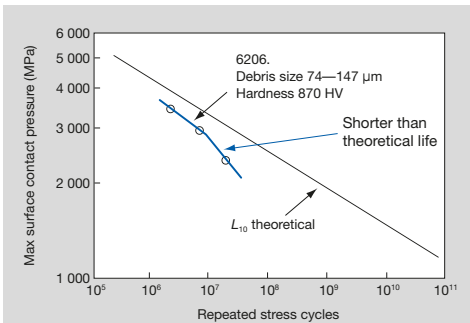


Fig. 4.8 Life Test Results Under Contaminated Lubrication Conditions

### (3) Calculation of Contamination Coefficient $a_c$

The contamination coefficient in Table 4.5 is determined in terms of lubrication cleanliness. Test results on ball and roller bearings with grease and filtered lubrication show life as a number of times longer than the conventional calculation would suggest. Yet, hardness becomes a factor when foreign particles harder than Hv350 enter the bearing, causing dents on the raceway. Fatigue damage from these dents can progress to flaking in a short time. Test results on ball and roller bearings under foreign particle contamination show from 1/3 to 1/10 the conventionally calculated life.

Based on these test results, the contamination coefficient  $a_c$  for NSK's new life theory is classified into five levels.

Therefore, the new NSK life calculation formula considers the trend of results in life tests under clean conditions and low load. Based on these results, the new life equation is a function of  $(P-P_u)/C$  affected by specific lubrication conditions identified by the lubrication parameter. In addition, the effects of different types and shapes of foreign particles are assumed to be strongly influenced by bearing load and lubrication conditions. Such a relationship can be expressed as a function of the load parameter. This relationship of the new life calculation formula is defined as  $(P-P_u)/C \cdot 1/a_c$ .

The Equation for calculating surface-originated flaking based on the above concept is as follows:

$$\ln \frac{1}{S} \propto N^c \int_V \frac{(\tau - \tau_u)^c}{Z_o^h} dV \times \left\{ \frac{1}{f(a_c, a_L)} - 1 \right\} \dots \dots (4.11)$$

## (4) New life calculation formula $L_{\text{able}}$

The following formula, which combines subsurface-originated flaking and surface-originated flaking, is proposed as the new life calculation formula:

$$\ln \frac{1}{S} \propto N^c \int_V \frac{(\tau - \tau_u)^c}{Z_o^h} dV \times \left\{ \frac{1}{f(a_c, a_L)} \right\} \dots \dots \dots (4.12)$$

$$L_{\text{able}} = a_1 \cdot a_{\text{NSK}} \cdot L_{10} \dots \dots \dots (4.13)$$

### Life Correction Factor $a_{\text{NSK}}$

The life correction factor  $a_{\text{NSK}}$  is the function of lubrication parameter  $(P - P_u)/C \cdot 1/a_c$  as shown below:

$$a_{\text{NSK}} \propto F \left\{ \frac{P - P_u}{C} \cdot \frac{1}{a_c}, a_L \right\} \dots \dots \dots (4.14)$$

NSK's new life theory considers the life-extending effect of improved material and heat treatment by correcting contamination factor  $a_c$ . The theory also utilizes viscosity ratio  $K$  ( $K = \nu/\nu_1$  where  $\nu$  is the operational viscosity and  $\nu_1$  the required viscosity) because the lubrication parameter  $a_L$  changes with the degree of oil film formation based on the lubricant and operating temperature. The theory indicates that the better the lubrication conditions (higher  $K$ ), the longer the life.

Figures 4.9 and 4.10 show the diagrams of correction factor  $a_{\text{NSK}}$  as a function of the new life calculation formula. In addition, point contact and line contact are considered separately for ball and roller bearings respectively in this new formula.

List of symbols used:

$S$  : Probability that flaking does not occur after stress has been repeated  $N$  times

$N$  : Number of repeated stresses

$\tau$  : Internal stress

$\tau_u$  : 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  $K$ )

$P$  : Load applied to bearing

$P_u$  : Fatigue load limit

$C$  : Basic dynamic load rating

$e, c, h$  : Constants

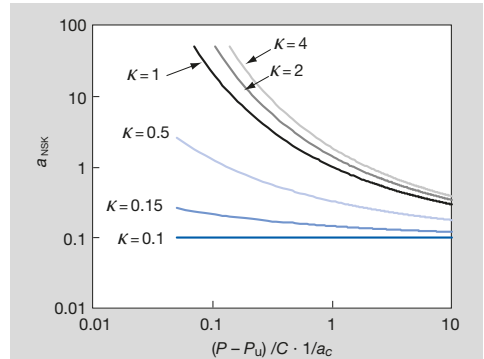


Fig. 4.9 New Life Calculation Diagram for Ball Bearings

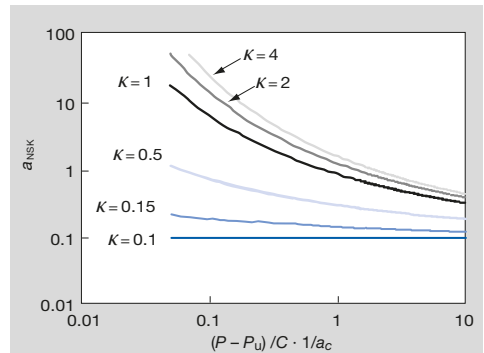


Fig. 4.10 New Life Calculation Diagram for Roller Bearings

Table 4.5 Reliability Factor  $a_1$  Used in New Life Calculation Formula  $L_{\text{able}}$

Reliability (%)	90	95	96	97	98	99
$a_1$	1.00	0.62	0.53	0.44	0.33	0.21

### To Access NSK Calculation Tools

Visit our website at <http://www.nsk.com>



## 4.3 Calculation of Bearing Loads

The loads applied on bearings generally include the weight of the body to be supported by the bearings, the weight of the rotating elements themselves, the transmission power of gears and belting, the load produced by operation of the machine in which the bearings are used, and so on. These loads can be theoretically calculated, but some of them are difficult to estimate. Therefore, be sure to correct estimates using empirically derived data.

### 4.3.1 Load Factor

When a radial or axial load has been mathematically calculated, the actual load on the bearing may be greater than the calculated load because of vibration and shock present during machine operation. The actual load may be calculated using the following equation:

$$\left. \begin{array}{l} F_r = f_w \cdot F_{rc} \\ F_a = f_w \cdot F_{ac} \end{array} \right\} \dots\dots\dots (4.15)$$

where  $F_r, F_a$  : Loads applied on bearing (N), {kgf}

$F_{rc}, F_{ac}$  : Theoretically calculated load (N), {kgf}

$f_w$  : Load factor

The values given in Table 4.6 are usually used for the load factor  $f_w$ .

**Table 4.6 Values of Load Factor  $f_w$**

Operating Conditions	Typical Applications	$f_w$
Smooth operation free from shocks	Electric motors, Machine tools, Air conditioners	1 to 1.2
Normal operation	Air blowers, Compressors, Elevators, Cranes, Paper making machines	1.2 to 1.5
Operation accompanied by shock and vibration	Construction equipment, Crushers, Vibrating screens, Rolling mills	1.5 to 3

### 4.3.2 Bearing Loads in Belt or Chain Transmission Applications

The force acting on the pulley or sprocket wheel when power is transmitted with a belt or chain is calculated using the following equations:

$$\left. \begin{array}{l} M = 9\,550\,000H / n \dots (N \cdot mm) \\ = 974\,000H / n \dots \{kgf \cdot mm\} \end{array} \right\} \dots\dots\dots (4.16)$$

$$P_k = M / r \dots\dots\dots (4.17)$$

where  $M$  : Torque acting on pulley or sprocket wheel (N·mm), {kgf·mm}

$P_k$  : Effective force transmitted by belt or chain (N), {kgf}

$H$  : Power transmitted(kW)

$n$  : Speed (min<sup>-1</sup>)

$r$  : Effective radius of pulley or sprocket wheel (mm)

When calculating the load on a pulley shaft, belt tension must be included. Thus, to calculate actual load  $K_b$  for belt transmissions, the effective transmitting power is multiplied by the belt factor  $f_b$ , which represents belt tension. The values of the belt factor  $f_b$  for different types of belts are shown in Table 4.7.

$$K_b = f_b \cdot P_k \dots\dots\dots (4.18)$$

For chain transmissions, values corresponding to  $f_b$  should be 1.25 to 1.5.

**Table 4.7 Belt Factor  $f_b$**

Type of Belt	$f_b$
Toothed belts	1.3 to 2
V belts	2 to 2.5
Flat belts with tension pulley	2.5 to 3
Flat belts	4 to 5

### 4.3.3 Bearing Loads in Gear Transmission Applications

The loads imposed on gears in gear transmissions vary according to the type of gears used. In the simplest case of spur gears, the load is calculated as follows:

$$\left. \begin{aligned} M &= 9\,550\,000H / n \dots (\text{N} \cdot \text{mm}) \\ &= 974\,000H / n \dots (\text{kgf} \cdot \text{mm}) \end{aligned} \right\} \dots (4.19)$$

$$P_k = M / r \dots (4.20)$$

$$S_k = P_k \tan \theta \dots (4.21)$$

$$K_c = \sqrt{P_k^2 + S_k^2} = P_k \sec \theta \dots (4.22)$$

where  $M$ : Torque applied to gear  
( $\text{N} \cdot \text{mm}$ ), ( $\text{kgf} \cdot \text{mm}$ )

$P_k$ : Tangential force on gear (N), {kgf}

$S_k$ : Radial force on gear (N), {kgf}

$K_c$ : Combined force imposed on gear  
(N), {kgf}

$H$ : Power transmitted (kW)

$n$ : Speed ( $\text{min}^{-1}$ )

$r$ : Pitch circle radius of drive gear (mm)

$\theta$ : Pressure angle

In addition to the theoretical load calculated above, vibration and shock, which depend on how accurately the gear is finished, should be included by multiplying the theoretically calculated load by gear factor  $f_g$ .

The values of  $f_g$  should generally fall within the ranges in Table 4.8. When vibration from other sources occurs, the actual load is obtained by multiplying the load factor by this gear factor.

**Table 4.8 Values of Gear Factor  $f_g$**

Gear Finish Accuracy	$f_g$
Precision ground gears	1 ~ 1.1
Ordinary machined gears	1.1 ~ 1.3

### 4.3.4 Load Distribution on Bearings

In the simple examples shown in Figs. 4.11 and 4.12, the radial loads on bearings I and II can be calculated using the following equations:

$$F_{CI} = \frac{b}{c} K \dots (4.23)$$

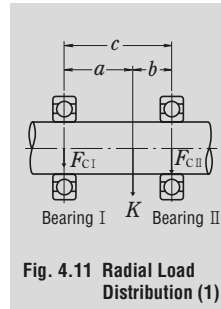
$$F_{CII} = \frac{a}{c} K \dots (4.24)$$

where  $F_{CI}$ : Radial load applied on bearing I  
(N), {kgf}

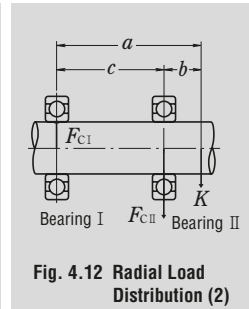
$F_{CII}$ : Radial load applied on bearing II  
(N), {kgf}

$K$ : Shaft load (N), {kgf}

When these loads are applied simultaneously, first the radial load for each should be obtained, then the sum of the vectors may be calculated according to the load direction.



**Fig. 4.11 Radial Load Distribution (1)**



**Fig. 4.12 Radial Load Distribution (2)**

## 4.3.5 Average Fluctuating Load

When the load applied on bearings fluctuates, an average load that will yield the same bearing life as the fluctuating load should be calculated.

- (1) When the relation between load and rotating speed is divided into the following steps (Fig. 4.13),

Load  $F_1$  : Speed  $n_1$  ; Operating time  $t_1$   
 Load  $F_2$  : Speed  $n_2$  ; Operating time  $t_2$   
 $\vdots$   
 Load  $F_n$  : Speed  $n_n$  ; Operating time  $t_n$

the average load  $F_m$  may be calculated using the following equation:

$$F_m = \sqrt[p]{\frac{F_1^p n_1 t_1 + F_2^p n_2 t_2 + \dots + F_n^p n_n t_n}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}} \quad (4.25)$$

where  $F_m$  : Average fluctuating load (N), {kgf}

$p = 3$  for ball bearings

$p = 10/3$  for roller bearings

The average speed  $n_m$  may be calculated as follows:

$$n_m = \frac{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}{t_1 + t_2 + \dots + t_n} \quad (4.26)$$

- (2) When the load fluctuates almost linearly (Fig. 4.14), the average load may be calculated as follows:

$$F_m \doteq \frac{1}{3} (F_{\min} + 2F_{\max}) \quad (4.27)$$

where  $F_{\min}$  : Minimum fluctuating load value (N), {kgf}

$F_{\max}$  : Maximum fluctuating load value (N), {kgf}

- (3) When the load fluctuation is similar to a sine wave (Fig. 4.15), an approximate value for the average load  $F_m$  may be calculated from the following equation:

In the case of Fig. 4.15 (a)

$$F_m \doteq 0.65 F_{\max} \quad (4.28)$$

In the case of Fig. 4.15 (b)

$$F_m \doteq 0.75 F_{\max} \quad (4.29)$$

- (4) When both a rotating load and a stationary load are applied (Fig. 4.16),

$F_R$  : Rotating load (N), {kgf}

$F_S$  : Stationary load (N), {kgf}

an approximate value for the average load  $F_m$  may be calculated as follows:

- a) Where  $F_R \geq F_S$

$$F_m \doteq F_R + 0.3F_S + 0.2 \frac{F_S^2}{F_R} \quad (4.30)$$

- b) Where  $F_R < F_S$

$$F_m \doteq F_S + 0.3F_R + 0.2 \frac{F_R^2}{F_S} \quad (4.31)$$

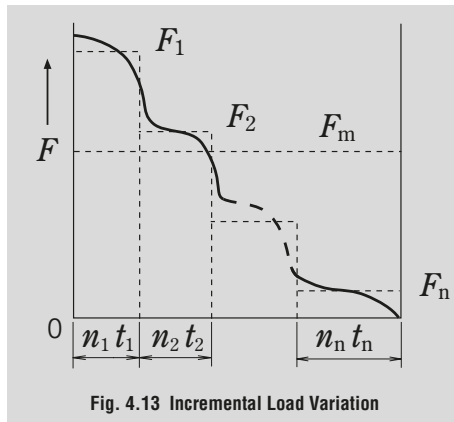


Fig. 4.13 Incremental Load Variation

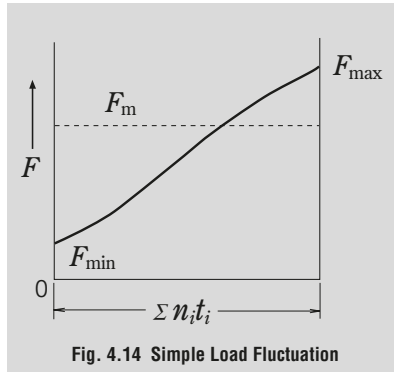


Fig. 4.14 Simple Load Fluctuation

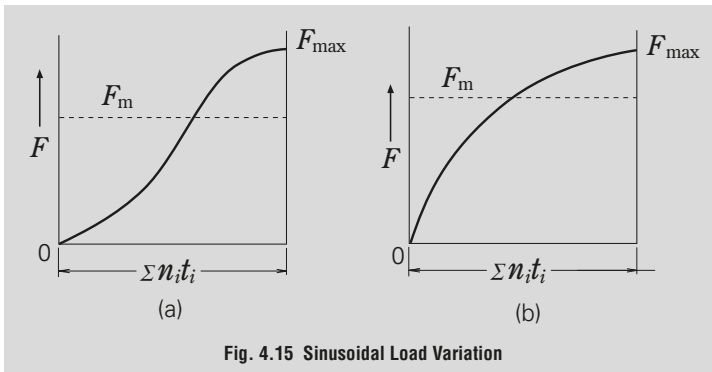


Fig. 4.15 Sinusoidal Load Variation

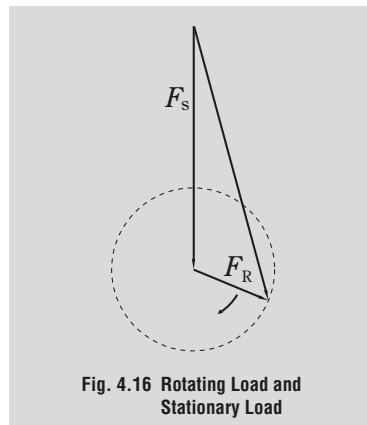


Fig. 4.16 Rotating Load and Stationary Load

## 4.3.6 Combination of Rotating and Stationary Loads

Generally, rotating, static, and indeterminate loads act on a rolling bearing. In certain cases, both the rotating load, which is caused by weight from unbalance or vibration, and the stationary load, which is caused by gravity or power transmission, may act simultaneously. The combined mean effective load can be calculated when indeterminate load is caused by rotating and static loads. There are two kinds of combined loads: rotating and stationary, which are classified depending on the magnitude of the load, as shown in Fig. 4.17.

Namely, the combined load becomes a running load with magnitude changing as shown in Fig. 4.17 (a) if the rotating load is larger than the static load. The combined load becomes an oscillating load with a magnitude changing as shown in Fig. 4.17 (b) if the rotating load is smaller than the stationary load.

In either case, the combined load  $F$  is expressed by the following equation:

$$F = \sqrt{F_R^2 + F_S^2 - 2F_R F_S \cos \theta} \quad (4.32)$$

where  $F_R$  : Rotating load (N), {kgf}  
 $F_S$  : Stationary load (N), {kgf}  
 $\theta$  : Angle defined by rotating and stationary loads

Combined load  $F$  can be approximated by Equations (4.33) and (4.34) which vary sinusoidally depending on the magnitude of  $F_R$  and  $F_S$ .  $F_R + F_S$  becomes the maximum load  $F_{\max}$  and  $F_R - F_S$  becomes the minimum load  $F_{\min}$  for  $F_R \gg F_S$  or  $F_R \ll F_S$ .

$$F_R \gg F_S, F = F_R - F_S \cos \theta \quad (4.33)$$

$$F_R \ll F_S, F = F_S - F_R \cos \theta \quad (4.34)$$

Combined load  $F$  can also be approximated by Equations (4.35) and (4.36) when  $F_R \doteq F_S$ .

$F_R > F_S$ ,

$$F = F_R - F_S + 2F_S \sin \frac{\theta}{2} \quad (4.35)$$

$F_R < F_S$ ,

$$F = F_S - F_R + 2F_R \sin \frac{\theta}{2} \quad (4.36)$$

Curves of Equations (4.32), (4.33), (4.35), and (4.36) are shown in Fig. 4.18.

The mean load variation  $F_m$  as expressed by Equations (4.33) and (4.34) or (4.35) and (4.36) can be expressed respectively by Equations (4.37) and (4.38) or (4.39) and (4.40).

$$F_m = F_{\min} + 0.65 (F_{\max} - F_{\min})$$

$$F_R \geq F_S, F_m = F_R + 0.3F_S \quad (4.37)$$

$$F_R \leq F_S, F_m = F_S + 0.3F_R \quad (4.38)$$

$$F_m = F_{\min} + 0.75 (F_{\max} - F_{\min})$$

$$F_R \geq F_S, F_m = F_R + 0.5F_S \quad (4.39)$$

$$F_R \leq F_S, F_m = F_S + 0.5F_R \quad (4.40)$$

Generally, as the value  $F$  exists somewhere along Equations (4.37), (4.38), (4.39), and (4.40), the coefficient 0.3 or 0.5 of the second terms in these equations is assumed to change linearly along with  $F_S/F_R$  or  $F_R/F_S$ . Thus, these factors may be expressed as follows:

$$0.3 + 0.2 \frac{F_S}{F_R}, 0 \leq \frac{F_S}{F_R} \leq 1$$

$$\text{or } 0.3 + 0.2 \frac{F_R}{F_S}, 0 \leq \frac{F_R}{F_S} \leq 1$$

Accordingly,  $F_m$  can be expressed by the following equation:

$$F_R \geq F_S,$$

$$F_m = F_R + (0.3 + 0.2 \frac{F_S}{F_R}) F_S$$

$$= F_R + 0.3F_S + 0.2 \frac{F_S^2}{F_R} \quad (4.41)$$

$$F_R \leq F_S,$$

$$F_m = F_S + (0.3 + 0.2 \frac{F_R}{F_S}) F_R$$

$$= F_S + 0.3F_R + 0.2 \frac{F_R^2}{F_S} \quad (4.42)$$

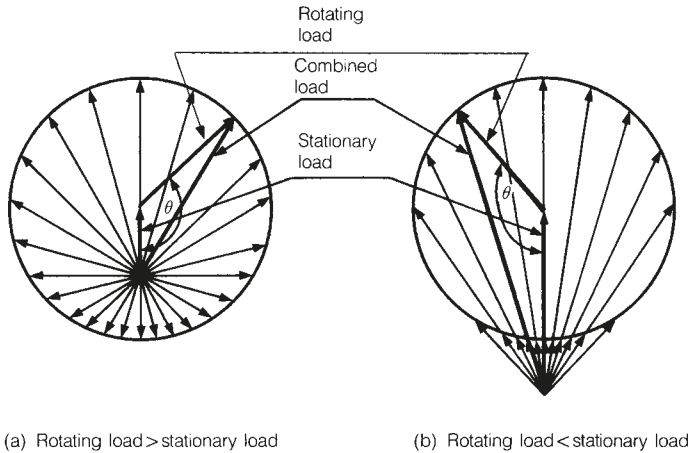


Fig. 4.17 Combined Rotating and Stationary Loads

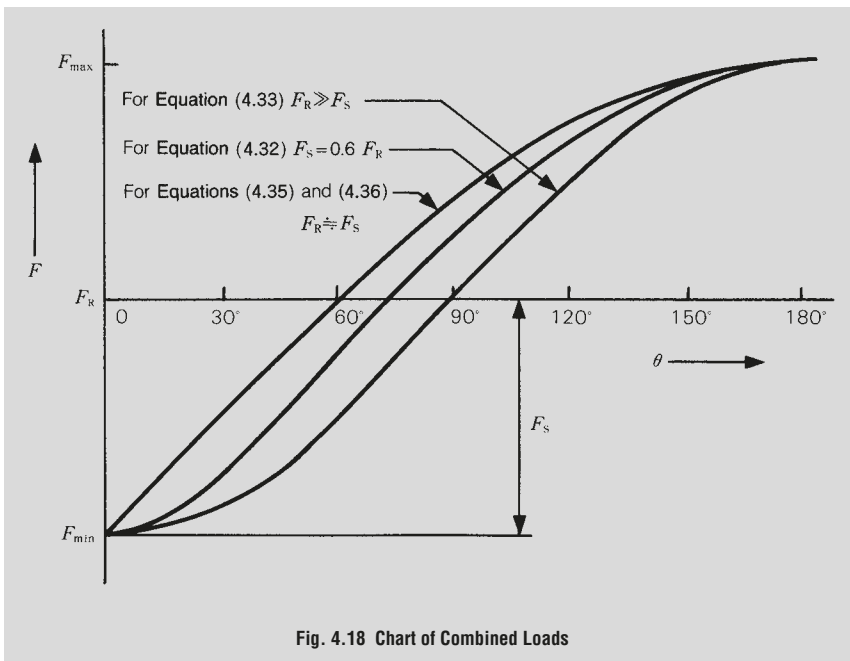


Fig. 4.18 Chart of Combined Loads

## 4.4 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 on bearings cannot be used for bearing life calculations; therefore, a hypothetical load should be estimated. This load should have a constant magnitude that passes through the center of the bearing and gives the same bearing life that the bearing would attain under actual load and rotation conditions. Such a hypothetical load is called the equivalent load.

### 4.4.1 Calculation of Equivalent Loads

The equivalent load on radial bearings may be calculated using the following equation:

$$P = XF_r + YF_a \dots\dots\dots (4.43)$$

where  $P$ : Equivalent Load (N), {kgf}  
 $F_r$ : Radial load (N), {kgf}  
 $F_a$ : Axial load (N), {kgf}  
 $X$ : Radial load factor  
 $Y$ : Axial load factor

The values of  $X$  and  $Y$  are listed in the bearing tables. The equivalent radial load for radial roller bearings with  $\alpha = 0^\circ$  is

$$P = F_r$$

In general, thrust ball bearings cannot take radial loads, but spherical thrust roller bearings can take some radial loads. In this case, the equivalent load may be calculated using the following equation:

$$P = F_a + 1.2F_r \dots\dots\dots (4.44)$$

where  $\frac{F_r}{F_a} \leq 0.55$

#### 4.4.2 Axial Load Components in Angular Contact Ball Bearings and Tapered Roller Bearings

The effective load center of both angular contact ball bearings and tapered roller bearings is at the point of intersection between the shaft center line and a line representing the load applied on the rolling element by the outer ring, as shown in Fig. 4.19. This effective load center for each bearing is listed in the bearing tables. When radial loads are applied to these types of bearings, a component load is produced in the axial direction. In order to balance this component load, bearings of the same type are used in pairs, placed face-to-face or back-to-back. These axial loads can be calculated using the following equation:

$$F_{ai} = \frac{0.6}{Y} F_r \quad (4.45)$$

where  $F_{ai}$ : Component load in the axial direction (N), {kgf}

$F_r$ : Radial load (N), {kgf}

$Y$ : Axial load factor

Assume that radial loads  $F_{rI}$  and  $F_{rII}$  are applied on bearings I and II (Fig. 4.20) respectively and an external axial load  $F_{ae}$  is applied as shown. If the axial load factors are  $Y_I$  and  $Y_{II}$  and the radial load factor is  $X$ , then the equivalent loads  $P_I$  and  $P_{II}$  may be calculated as follows:

$$\text{where } F_{ae} + \frac{0.6}{Y_{II}} F_{rII} \geq \frac{0.6}{Y_I} F_{rI}$$

$$\left. \begin{aligned} P_I &= X F_{rI} + Y_I \left( F_{ae} + \frac{0.6}{Y_{II}} F_{rII} \right) \\ P_{II} &= F_{rII} \end{aligned} \right\} \quad (4.46)$$

$$\text{where } F_{ae} + \frac{0.6}{Y_{II}} F_{rII} < \frac{0.6}{Y_I} F_{rI}$$

$$\left. \begin{aligned} P_I &= F_{rI} \\ P_{II} &= X F_{rII} + Y_{II} \left( \frac{0.6}{Y_I} F_{rI} - F_{ae} \right) \end{aligned} \right\} \quad (4.47)$$

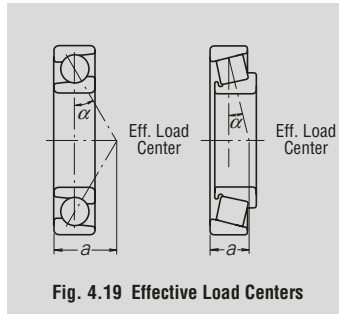


Fig. 4.19 Effective Load Centers

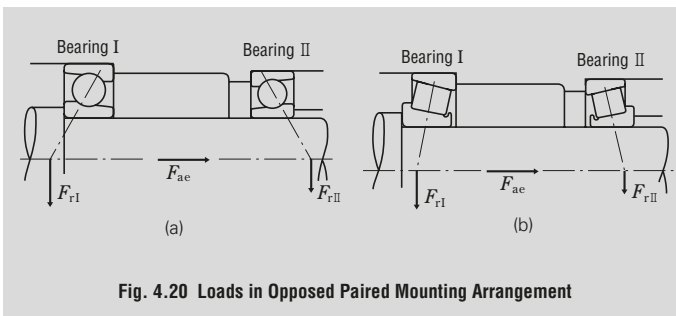


Fig. 4.20 Loads in Opposed Paired Mounting Arrangement

## 4.5 Static Load Ratings and Static Equivalent Loads

### 4.5.1 Static Load Ratings

When subjected to excessive or strong shock loads, rolling bearings may incur a local permanent deformation of the rolling elements and permanent deformation of the rolling elements and raceway surface if the elastic limit is exceeded. This nonelastic deformation increases in area and depth as load increases. When the load exceeds a certain limit, the smooth operation of the bearing is impeded.

The basic static load rating is defined as the static load that produces the following calculated contact stress between the raceway surface and center of the contact area of the rolling element subjected to the maximum stress:

For self-aligning ball bearings	4 600 MPa {469 kgf/mm <sup>2</sup> }
For other ball bearings	4 200 MPa {428 kgf/mm <sup>2</sup> }
For roller bearings	4 000 MPa {408 kgf/mm <sup>2</sup> }

In this most heavily stressed contact area, the sum of the permanent deformation of the rolling element and that of the raceway is nearly 0.0001 times the rolling element diameter. The basic static load rating  $C_0$  is defined as  $C_{or}$  for radial bearings and  $C_{oa}$  for thrust bearings in the bearing tables.

In addition, following the modification of for basic static load rating criteria by ISO, the new  $C_0$  values for NSK's ball bearings became about 0.8 to 1.3 times the past values, while those for roller bearings became about 1.5 to 1.9 times higher. Consequently, please note that the previous values of permissible static load factor  $f_s$  have also changed.

### 4.5.2 Static Equivalent Loads

The static equivalent load is a hypothetical load that produces a contact stress equal to the above maximum stress in the area of contact between the most heavily stressed rolling element and bearing raceway under actual conditions while the bearing is stationary (including very slow rotation or oscillation). The static radial load passing through the bearing center is taken as the static equivalent load for radial bearings, while the static axial load in the direction coinciding with the central axis is taken as the static equivalent load for thrust bearings.

#### (a) Static equivalent load on radial bearings

The greater of the two values calculated from the following equations should be adopted as the static equivalent load on radial bearings:

$$P_o = X_o F_r + Y_o F_a \quad (4.47)$$

$$P_o = F_r \quad (4.48)$$

where  $P_o$ : Static equivalent load (N), {kgf}  
 $F_r$ : Radial load (N), {kgf}  
 $F_a$ : Axial load (N), {kgf}  
 $X_o$ : Static radial load factor  
 $Y_o$ : Static axial load factor

#### (b) Static equivalent load on thrust bearings

$$P_o = X_o F_r + F_a \quad \alpha \neq 90^\circ \quad (4.49)$$

where  $P_o$ : Static equivalent load (N), {kgf}  
 $\alpha$ : Contact angle

When  $F_a < X_o F_r$ , this equation becomes less accurate. The values of  $X_o$  and  $Y_o$  for Equations (4.47) and (4.49) are listed in the bearing tables.

The static equivalent load for thrust roller bearings when

$$\alpha = 90^\circ \text{ is } P_o = F_a$$

### 4.5.3 Permissible Static Load Factor

The permissible static equivalent load on bearings varies depending on the basic static load rating, 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 Equation (4.50). The generally recommended values of  $f_s$  are listed in Table 4.9. The values of  $f_s$  were revised due to the modification of the basic static load rating criteria. Please keep this in mind when selecting bearings, particularly for bearings whose  $C_0$  values increased.

$$f_s = \frac{C_0}{P_o} \quad (4.50)$$

where  $C_0$ : Basic static load rating (N), {kgf}  
 $P_o$ : Static equivalent load (N), {kgf}

For spherical thrust roller bearings, the value of  $f_s$  should be greater than 4.

Table 4.9 Values of Permissible Static Load Factor  $f_s$

Operating Conditions	Lower Limit of $f_s$	
	Ball Bearings	Roller Bearings
Low-noise applications	2	3
Bearings subjected to vibration and shock loads	1.5	2
Standard operating conditions	1	1.5



## 4.6 Example Bearing Calculations

### (Example 1)

Obtain the fatigue life factor  $f_h$  of single-row deep groove ball bearing **6208** when it is used under a radial load  $F_r=2\,500\text{ N}$  and speed  $n=900\text{ min}^{-1}$ .

The basic load rating  $C_r$  of **6208** is  $29\,100\text{ N}$  (Bearing Table, Page C024). Since only a radial load is applied, the equivalent load  $P$  may be obtained as follows:

$$P = F_r = 2\,500\text{ N}$$

Since the speed is  $n = 900\text{ min}^{-1}$ , the speed factor  $f_n$  can be obtained from the equation in Table 4.2 (Page A034) or Fig. 4.3 (Page A036).

$$f_n = 0.333$$

The fatigue life factor  $f_h$ , under these conditions, can be calculated as follows:

$$f_h = f_n \frac{C_r}{P} = 0.333 \cdot \frac{29\,100}{2\,500} = 3.88$$

This value is suitable for industrial applications, air conditioners in regular use, etc., and according to the equation in Table 4.2 or Fig. 4.4 (Page A036), this corresponds to approximately 29 000 hours of service life.

### (Example 2)

Select a single-row deep groove ball bearing with a bore diameter of 50 mm and outside diameter under 100 mm that satisfies the following conditions:

Radial load  $F_r = 3\,000\text{ N}$

Speed  $n = 1\,900\text{ min}^{-1}$

Basic rating life  $L_h \geq 10\,000\text{ h}$

The fatigue life factor  $f_h$  of ball bearings with a rating fatigue life longer than 10 000 hours is  $f_h \geq 2.72$ . Because  $f_n = 0.26$ ,  $P = F_r = 3\,000\text{ N}$ ,

$$f_h = f_n \frac{C_r}{P} = 0.26 \cdot \frac{C_r}{3\,000} \geq 2.72$$

Therefore,  $C_r \geq 2.72 \cdot \frac{3\,000}{0.26} = 31\,380\text{ N}$

From the data listed in the bearing table on Page C026, **6210** should be selected, as it satisfies the above conditions.

### (Example 3)

Obtain  $C_r/P$  or fatigue life factor  $f_h$  when an axial load  $F_a=1\,000\text{ N}$  is added to the conditions of (Example 1)

When the radial load  $F_r$  and axial load  $F_a$  are applied on single-row deep groove ball bearing **6208**, the dynamic equivalent load  $P$  should be calculated in accordance with the following procedure:

Obtain the radial load factor  $X$ , axial load factor  $Y$ , and constant  $e$ , depending on the magnitude of  $f_0 F_a / C_{or}$ , from the Dynamic Equivalent Load Table above the Bearing Table on Page C025.

The basic static load rating  $C_{or}$  of ball bearing **6208** is  $17\,900\text{ N}$  (Page C024)

$$f_0 F_a / C_{or} = 14.0 \cdot 1\,000 / 17\,900 = 0.782$$

$$e \doteq 0.26$$

and  $F_a / F_r = 1\,000 / 2\,500 = 0.4 > e$

$$X = 0.56$$

$Y = 1.67$  (the value of  $Y$  is obtained by linear interpolation)

Therefore, the dynamic equivalent load  $P$  is

$$P = XF_r + YF_a$$

$$= 0.56 \cdot 2\,500 + 1.67 \cdot 1\,000$$

$$= 3\,070\text{ N}$$

$$\frac{C_r}{P} = \frac{29\,100}{3\,070} = 9.48$$

$$f_h = f_n \frac{C_r}{P} = 0.333 \cdot \frac{29\,100}{3\,070} = 3.16$$

This value of  $f_h$  corresponds approximately to 15 800 hours of service life for ball bearings.

### (Example 4)

Select a Series 231 spherical roller bearing that satisfies the following conditions:

Radial load  $F_r = 45\,000\text{ N}$

Axial load  $F_a = 8\,000\text{ N}$

Speed  $n = 500\text{ min}^{-1}$

Basic rating life  $L_h \geq 30\,000\text{ h}$

The value of the fatigue life factor  $f_h$ , which makes  $L_h \geq 30\,000\text{ h}$  is greater than 3.45, according to Fig. 4.4 (Page A036).

The dynamic equivalent load  $P$  of spherical roller bearings is as follows:

when  $F_a / F_r \leq e$

$$P = XF_r + YX_a = F_r + Y_3 F_a$$

when  $F_a / F_r > e$

$$P = XF_r + YF_a = 0.67 F_r + Y_2 F_a$$

$$F_a / F_r = 8\,000 / 45\,000 = 0.18$$

We can see in the bearing table that the value of  $e$  is about 0.3 and that of  $Y_3$  is about 2.2 for Series 231 bearings.

$$\begin{aligned} \text{Therefore, } P &= XF_r + YF_a = F_r + Y_3 F_a \\ &= 45\,000 + 2.2 \cdot 8\,000 \\ &= 62\,600 \text{ N} \end{aligned}$$

From the fatigue life factor  $f_h$ , the basic load rating can be obtained as follows:

$$f_h = f_n \frac{C_r}{P} = 0.444 \cdot \frac{C_r}{62\,600} \geq 3.45$$

Consequently,  $C_r \geq 490\,000 \text{ N}$

The smallest Series 231 spherical roller bearing satisfying this value of  $C_r$  is **23126CE4** ( $C_r = 505\,000 \text{ N}$ ).

Once the bearing is determined, substitute the value of  $Y_3$  in the equation and obtain the value of  $P$ .

$$\begin{aligned} P &= F_r + Y_3 F_a = 45\,000 + 2.4 \cdot 8\,000 \\ &= 64\,200 \text{ N} \end{aligned}$$

$$\begin{aligned} L_h &= 500 \left( f_n \frac{C_r}{P} \right)^{\frac{10}{3}} \\ &= 500 \left( 0.444 \cdot \frac{505\,000}{64\,200} \right)^{\frac{10}{3}} \\ &= 500 \cdot 3.49^{\frac{10}{3}} \doteq 32\,000 \text{ h} \end{aligned}$$

#### (Example 5)

Assume that tapered roller bearings **HR30305DJ** and **HR30206J** are used in a back-to-back arrangement as shown in Fig. 4.21, and the distance between the outer ring back faces is 50 mm.

Calculate the basic rating life of each bearing when radial load  $F_r = 5\,500 \text{ N}$  and axial load  $F_{ac} = 2\,000 \text{ N}$  are applied to **HR30305DJ** as shown in Fig. 4.21. The speed is  $600 \text{ min}^{-1}$ .

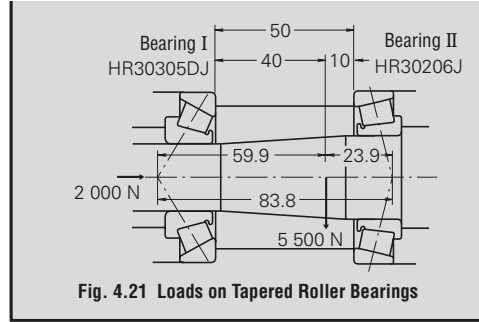


Fig. 4.21 Loads on Tapered Roller Bearings

To distribute the radial load  $F_r$  on bearings I and II, the effective load centers for tapered roller bearings must be located. Obtain the effective load center  $a$  for bearings I and II from the bearing table, then obtain the relative position of the radial load  $F_r$  and effective load centers. The result will be as shown in Fig. 4.21. Consequently, the radial load applied on bearings I (**HR30305DJ**) and II (**HR30206J**) can be obtained from the following equations:

$$F_{rI} = 5\,500 \cdot \frac{23.9}{83.8} = 1\,569 \text{ N}$$

$$F_{rII} = 5\,500 \cdot \frac{59.9}{83.8} = 3\,931 \text{ N}$$

The following values are obtained from data in the Bearing Table:

Bearings	Basic dynamic load rating $C_r$ (N)	Axial load factor $Y_1$	Constant $e$
Bearing I ( <b>HR30305DJ</b> )	38 000	$Y_I = 0.73$	0.83
Bearing II ( <b>HR30206J</b> )	43 000	$Y_{II} = 1.6$	0.38

When radial loads are applied on tapered roller bearings, an axial load component is produced and must be considered to obtain the dynamic equivalent radial load (refer to Section 4.4.2, Page A051).

This is obtained by the following:

$$F_{ae} + \frac{0.6}{Y_{II}} F_{rII} = 2\,000 + \frac{0.6}{1.6} \cdot 3\,931$$

$$= 3\,474 \text{ N}$$

$$\frac{0.6}{Y_I} F_{rI} = \frac{0.6}{0.73} \cdot 1\,569 = 1\,290 \text{ N}$$

Therefore, with this bearing arrangement, the axial load  $F_{ae} + \frac{0.6}{Y_{II}} F_{rII}$  is applied on bearing I but not on bearing II.

For bearing I,

$$F_{rI} = 1\,569 \text{ N}$$

$$F_{aI} = 3\,474 \text{ N}$$

since  $F_{aI} / F_{rI} = 2.2 > e = 0.83$

the dynamic equivalent load  $P_I = XF_{rI} + Y_I F_{aI}$

$$= 0.4 \cdot 1\,569 + 0.73 \cdot 3\,474$$

$$= 3\,164 \text{ N}$$

The fatigue life factor  $f_h = f_n \frac{C_r}{P_I}$

$$= \frac{0.42 \cdot 38\,000}{3\,164} = 5.04$$

and the rating fatigue life  $L_n = 500 \cdot 5.04^{\frac{10}{3}}$

$$= 109\,750 \text{ h}$$

For bearing II

since  $F_{rII} = 3\,931 \text{ N}$ ,  $F_{aII} = 0$

the dynamic equivalent load

$$P_{II} = F_{rII} = 3\,931 \text{ N},$$

fatigue life factor

$$f_h = f_n \frac{C_r}{P_{II}} = \frac{0.42 \cdot 43\,000}{3\,931} = 4.59$$

and rating fatigue life  $L_n = 500 \cdot 4.59^{\frac{10}{3}} = 80\,400 \text{ h}$  are obtained.

For face-to-face arrangements (DF type), please contact NSK.

In this application, heavy loads, shocks, and shaft deflection are expected; therefore, spherical roller bearings are appropriate.

The following spherical roller bearings satisfy the above size limits (refer to Page C284):

$d$	$D$	$B$	Bearing No.	Basic Dynamic Load Rating $C_r$ (N)	Constant $e$	Factor $Y_3$
300	420	90	<b>23960 CAME4</b>	1 540 000	0.19	3.5
	460	118	<b>23060 CAME4</b>	2 400 000	0.24	2.8
	460	160	<b>24060 CAME4</b>	2 890 000	0.32	2.1
	500	160	<b>23160 CAME4</b>	3 350 000	0.31	2.2
	500	200	<b>24160 CAME4</b>	3 900 000	0.38	1.8

Since  $F_a / F_r = 0.20 < e$ , the dynamic equivalent load  $P$  is

$$P = F_r + Y_3 F_a$$

Judging from the fatigue life factor  $f_h$  in Table 4.1 and example applications (refer to Page A034), a value of  $f_h$ , between 3 and 5 is appropriate.

$$f_h = f_n \frac{C_r}{P} = \frac{0.444 C_r}{F_r + Y_3 F_a} = 3 \text{ to } 5$$

Assuming that  $Y_3 = 2.1$ , then the necessary basic load rating  $C_r$  can be obtained:

$$C_r = \frac{(F_r + Y_3 F_a) \cdot (3 \text{ to } 5)}{0.444}$$

$$= \frac{(245\,000 + 2.1 \cdot 49\,000) \cdot (3 \text{ to } 5)}{0.444}$$

$$= 2\,350\,000 \text{ to } 3\,900\,000 \text{ N}$$

Bearings that satisfy this range are **23060CAME4**, **24060CAME4**, **23160CAME4**, and **24160CAME4**.

## (Example 6)

Select a bearing for a speed reducer under the following conditions:

Operating conditions

Radial load  $F_r = 245\,000 \text{ N}$

Axial load  $F_a = 49\,000 \text{ N}$

Speed  $n = 500 \text{ min}^{-1}$

Size limitation

Shaft diameter: 300 mm

Housing bore: Less than 500 mm



## 4.7 Bearing Type and Allowable Axial Load

### 4.7.1 Change in Contact Angle of Radial Ball Bearings and Allowable Axial Load

#### (1) Change in Contact Angle Due to Axial Load

When an axial load acts on a radial ball bearing, the rolling element and raceway develop elastic deformation, resulting in an increase in contact angle and width. When heat generation or seizure occurs, the bearing should be disassembled and checked for a running trace to discover whether there has been a change in contact angle during operation. In this way, it is possible to see whether an abnormal axial load has been sustained.

The relation below reflects axial load on a bearing  $F_a$ , the load on rolling element  $Q$ , and the contact angle  $\alpha$  when a load is applied. (see Equations (9.8), (9.9), and (9.10) in Section 9.6.2)

$$F_a = Z Q \sin \alpha$$

$$= K Z D_w^2 \{\sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0} - 1\}^{3/2} \cdot \sin \alpha \quad (4.51)$$

$$\alpha = \sin^{-1} \frac{\sin \alpha_0 + h}{\sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0}} \quad (4.52)$$

$$h = \frac{\delta_a}{m_0} = \frac{\delta_a}{r_e + r_i - D_w}$$

Namely,  $\delta_a$  refers to the change in Equation (4.52) to determine a contact angle  $\alpha$  corresponding to the contact angle known from observation of the raceway. Thus,  $\delta_a$  and  $\alpha$  are introduced into Equation (4.51) to estimate the axial load  $F_a$  acting on the bearing. As specifications of the bearing are necessary for calculation, the contact angle  $\alpha$  in this case was approximated from the axial load. The basic static load rating  $C_{0r}$  is expressed by Equation (4.53) for single-row radial ball bearings.

$$C_{0r} = f_0 Z D_w^2 \cos \alpha_0 \quad (4.53)$$

where  $f_0$ : Factor determined from the shape of bearing components and applicable stress level

Equation (4.54) is determined from Equations (4.51) and (4.53):

$$\frac{f_0}{C_{0r}} F_a = A F_a$$

$$= K \{\sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0} - 1\}^{3/2} \cdot \frac{\sin \alpha}{\cos \alpha_0} \quad (4.54)$$

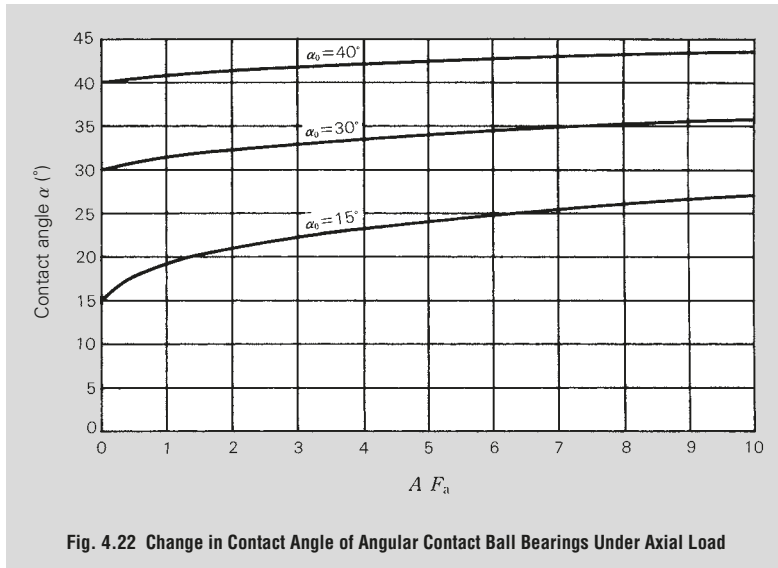
where  $K$ : Constant determined from material and design of bearing

In other words,  $h$  is assumed and contact angle  $\alpha$  is determined from Equation (4.52). Then  $h$  and  $\alpha$  are introduced into Equation (4.54) to determine  $A F_a$ . This relation is used to show the value of  $A$  for each bore number of angular contact ball bearings in Table 4.14. The relationship between  $A F_a$  and  $\alpha$  is shown in Fig. 4.22.

#### Example 1

Calculate the change in the contact angle when pure axial load  $F_a = 35.0$  kN (50% of basic static load rating) is applied to angular contact ball bearing 7215C.

$A = 0.212$  as determined from Table 4.10 and  $A F_a = 0.212 \times 35.0 = 7.42$  and  $\alpha \approx 26^\circ$  according to Fig. 4.22. The initial contact angle of  $15^\circ$  has changed to  $26^\circ$  under axial load.

Table 4.10 Constant  $A$  Value of Angular Contact Ball BearingsUnits:  $\text{kN}^{-1}$ 

Bearing Bore No.	Series 70 Bearings			Series 72 Bearings			Series 73 Bearings		
	15°	30°	40°	15°	30°	40°	15°	30°	40°
05	1.97	2.05	2.31	1.26	1.41	1.59	0.838	0.850	0.961
06	1.45	1.51	1.83	0.878	0.979	1.11	0.642	0.651	0.736
07	1.10	1.15	1.38	0.699	0.719	0.813	0.517	0.528	0.597
08	0.966	1.02	1.22	0.562	0.582	0.658	0.414	0.423	0.478
09	0.799	0.842	1.01	0.494	0.511	0.578	0.309	0.316	0.357
10	0.715	0.757	0.901	0.458	0.477	0.540	0.259	0.265	0.300
11	0.540	0.571	0.681	0.362	0.377	0.426	0.221	0.226	0.255
12	0.512	0.542	0.645	0.293	0.305	0.345	0.191	0.195	0.220
13	0.463	0.493	0.584	0.248	0.260	0.294	0.166	0.170	0.192
14	0.365	0.388	0.460	0.226	0.237	0.268	0.146	0.149	0.169
15	0.348	0.370	—	0.212	0.237	0.268	0.129	0.132	0.149
16	0.284	0.302	0.358	0.190	0.199	0.225	0.115	0.118	0.133
17	0.271	0.288	0.341	0.162	0.169	0.192	0.103	0.106	0.120
18	0.228	0.242	0.287	0.140	0.146	0.165	0.0934	0.0955	0.108
19	0.217	0.242	0.273	0.130	0.136	0.153	0.0847	0.0866	0.0979
20	0.207	0.231	0.261	0.115	0.119	0.134	0.0647	0.0722	0.0816

Values for deep groove ball bearings are similarly shown in Table 4.11 and Fig. 4.23.

## Example 2

Calculate the change in the contact angle when a pure axial load  $F_a = 24.75$  kN (50% of the basic static load rating) is applied to the deep groove ball bearing 6215. Note here that the radial internal clearance is calculated as the median (0.020 mm) of the normal clearance.

The initial contact angle of  $10^\circ$  is obtained from Fig. 3 on Page C015.  $A = 0.303$  as determined from Table 4.11 and  $A F_a = 0.303 \times 24.75 = 7.5$ , thus  $\alpha = 24^\circ$  based on Fig. 4.23.

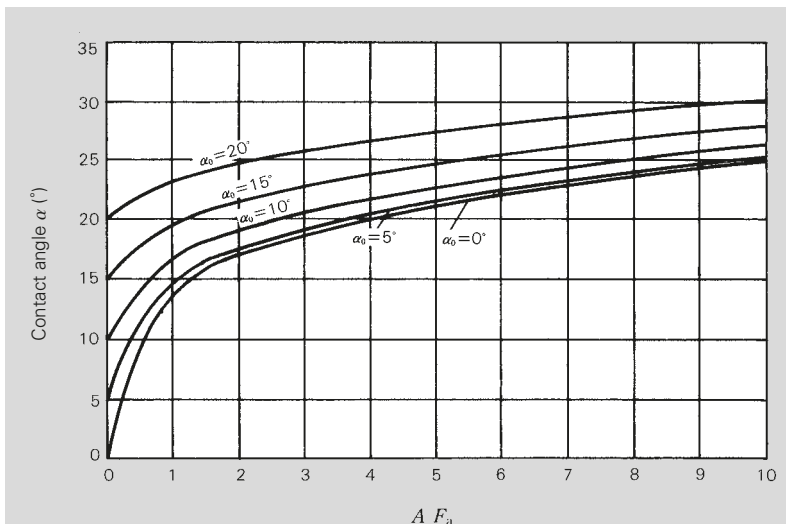


Fig. 4.23 Change in Contact Angle of Deep Groove Ball Bearings Under Axial Load

**Table 4.11 Constant  $A$  Value of Deep Groove Ball Bearing**Units:  $\text{kN}^{-1}$ 

Bearing Bore No.	Series 62 Bearings				
	0°	5°	10°	15°	20°
05	1.76	1.77	1.79	1.83	1.88
06	1.22	1.23	1.24	1.27	1.30
07	0.900	0.903	0.914	0.932	0.958
08	0.784	0.787	0.796	0.811	0.834
09	0.705	0.708	0.716	0.730	0.751
10	0.620	0.622	0.630	0.642	0.660
11	0.490	0.492	0.497	0.507	0.521
12	0.397	0.398	0.403	0.411	0.422
13	0.360	0.361	0.365	0.373	0.383
14	0.328	0.329	0.333	0.340	0.349
15	0.298	0.299	0.303	0.309	0.317
16	0.276	0.277	0.280	0.285	0.293
17	0.235	0.236	0.238	0.243	0.250
18	0.202	0.203	0.206	0.210	0.215
19	0.176	0.177	0.179	0.183	0.188
20	0.155	0.156	0.157	0.160	0.165

## (2) Allowable Axial Load for a Deep Groove Ball Bearing

The allowable axial load here refers to the limit load at which a contact ellipse is generated between the ball and raceway due to a change in the contact angle when a radial bearing, which is under an axial load, rides over the shoulder of the raceway groove. This is different from the limit value of a static equivalent load  $P_0$  which is determined from the basic static load rating  $C_0$ , using the static axial load factor  $Y_0$ . Also note that the contact ellipse may ride over the shoulder even when the axial load on the bearing is below the limit value of  $P_0$ .

The allowable axial load  $F_{a \max}$  of a radial ball bearing can be determined through equations. The contact angle  $\alpha$  for  $F_a$  is determined from the right terms of Equations (4.51) and Equation (4.52), while  $Q$  is calculated as follows:

$$Q = \frac{F_a}{Z \sin \alpha}$$

$\theta$  of Fig. 4.24 is determined as follows:

$$2a = A_2 \mu \left( \frac{Q}{\Sigma \rho} \right)^{1/3}$$

$$\therefore \theta \doteq \frac{a}{r}$$

Accordingly, the allowable axial load may be determined as the maximum axial load at which the following relation is established.

$$\gamma \geq \alpha + \theta$$

As the allowable axial load cannot be determined unless the internal specifications of a bearing are known, Fig. 4.25 shows the calculated results of allowable axial load for various deep groove radial ball bearings.

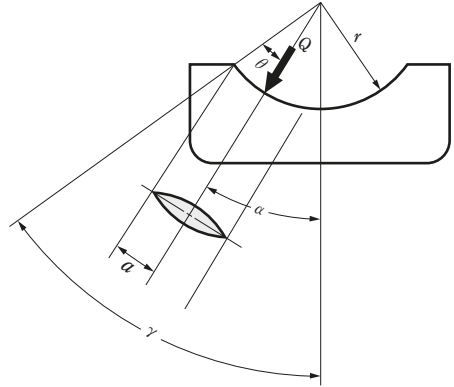


Fig. 4.24 Contact Ellipse

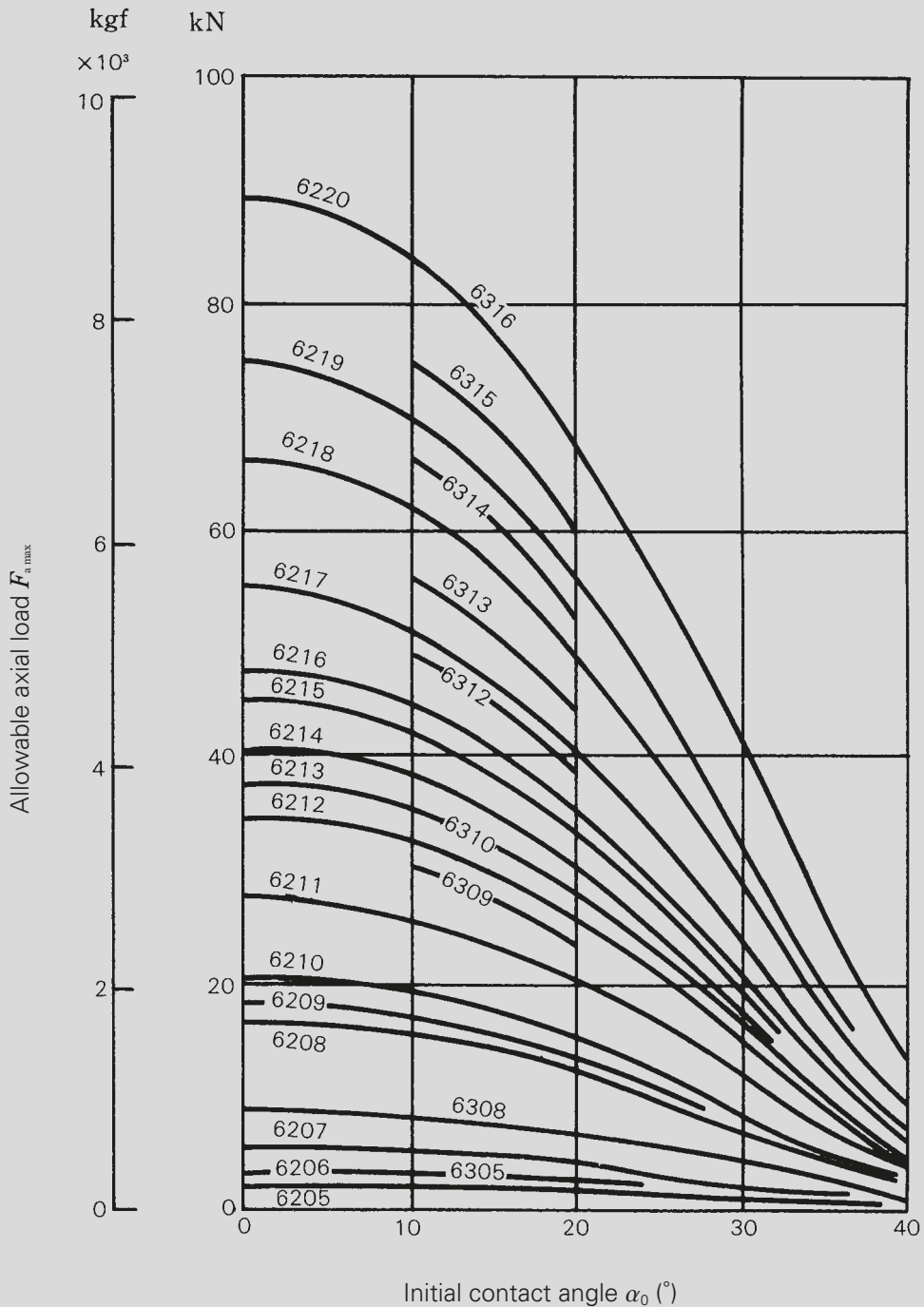


Fig. 4.25 Allowable Axial Load for Deep Groove Ball Bearings

## 4.7.2 Allowable Axial Load (Rib Breakdown Strength) for Cylindrical Roller Bearings

Both the inner and outer rings may be exposed to an axial load during rotation in a cylindrical roller bearing with ribs. The axial load capacity is limited by heat generation, seizure, etc. at the slip surface between the roller end surface and rib and rib strength.

Fig 4.26 shows the allowable axial load (the load considering heat generation between the end faces of the rollers and rib face) applied continuously on Diameter Series 3 cylindrical roller bearings with grease or oil lubrication.

Grease lubrication (Empirical equation)

$$C_A = 9.8f \left\{ \frac{900 (k \cdot d)^2}{n+1 \ 500} - 0.023 \times (k \cdot d)^{2.5} \right\} \text{ (N)}$$

$$= f \left\{ \frac{900 (k \cdot d)^2}{n+1 \ 500} - 0.023 \times (k \cdot d)^{2.5} \right\} \text{ {kgf}}$$

..... (4.55)

Oil lubrication (Empirical equation)

$$C_A = 9.8f \left\{ \frac{490 (k \cdot d)^2}{n+1 \ 000} - 0.000135 \times (k \cdot d)^{3.4} \right\} \text{ (N)}$$

$$= f \left\{ \frac{490 (k \cdot d)^2}{n+1 \ 000} - 0.000135 \times (k \cdot d)^{3.4} \right\} \text{ {kgf}}$$

..... (4.56)

where  $C_A$  : Allowable axial load (N), {kgf}  
 $d$  : Bearing bore diameter (mm)  
 $n$  : Bearing speed ( $\text{min}^{-1}$ )  
 $f$  : Load factor  
 $k$  : Dimensional factor

In Equations (4.55) and (4.56), the examination of rib strength is excluded. Please consult with NSK concerning rib strength.

To enable the cylindrical roller bearing to stably sustain the axial load capacity, be sure to take the following points, concerning the bearing and its surroundings into account.

- Radial load must be applied and the magnitude of radial load should be larger than that of axial load by 2.5 times or more.
- There should be sufficient lubricant between the roller end face and rib.
- Use a lubricant with an additive for extreme pressures.
- Running-in time should be sufficient.
- Bearing mounting accuracy should be good.
- Don't use a bearing with an unnecessarily large internal clearance.

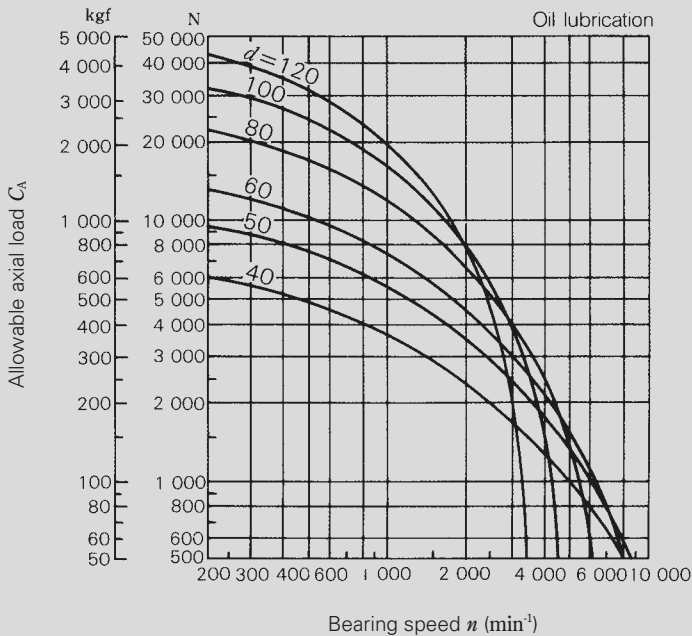
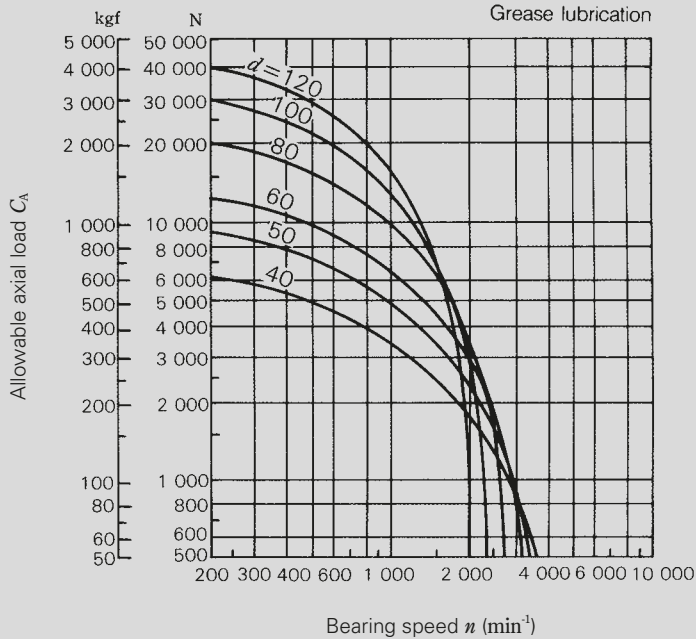
Moreover, if the bearing speed is very slow or exceeds 50 % of the allowable speed in the bearing tables or if the bearing bore diameter exceeds 200 mm, each bearing must be precisely checked for lubrication, cooling method, etc. Please contact NSK in such cases.

$f$ : Load Factor

	$f$ value
Continuous Loading	1
Intermittent Loading	2
Short-Term Loading	3

$k$ : Dimensional Factor

	$k$ value
Series 2 Bearing Diameter	0.75
Series 3 Bearing Diameter	1
Series 4 Bearing Diameter	1.2



For a Diameter Series 3 bearing ( $k = 1.0$ ) under continuous load ( $f = 1$ )

**Fig. 4.26 Allowable Axial Load for a Cylindrical Roller Bearing**

## 4.8 Technical Data

### 4.8.1 Fatigue Life and Reliability

Where any part failure may result in damage to the entire machine and repair of damage is impossible, as in aircraft, satellite, or rocket applications, greatly increased reliability is demanded of each component. Recently, such high reliability requirements have been applied more generally to durable consumer goods and may also be utilized to achieve effective preventive maintenance of machines and equipment.

The rating fatigue life of a rolling bearing is the gross number of revolutions or the gross rotating period (when the rotating speed is constant) that 90 % of a group of similar bearings running individually under similar conditions can rotate without suffering material damage due to rolling fatigue. In other words, fatigue life is normally defined at 90 % reliability. There are other ways to describe the expected life. For example, an average value is frequently employed to describe the lifespan of human beings. However, if an average were used for bearings, then too many bearings would fail before the average life value was reached. On the other hand, if a low or minimum value was used as a criterion, then too many bearings would have a life much longer than the set value. With these considerations in mind, a 90 % value was chosen for common practice. A value of 95 % could have been taken as the statistical reliability, but the slightly looser reliability of 90 % was taken from a practical and economical viewpoint. A 90 % reliability however is not acceptable for aircraft parts, computers, or communication systems, and a 99 % or even 99.9 % reliability may be required in some of these cases.

The fatigue life distribution when a group of similar bearings are operated individually under similar conditions is shown in Fig. 4.27. The Weibull equation can be used to describe the fatigue life distribution

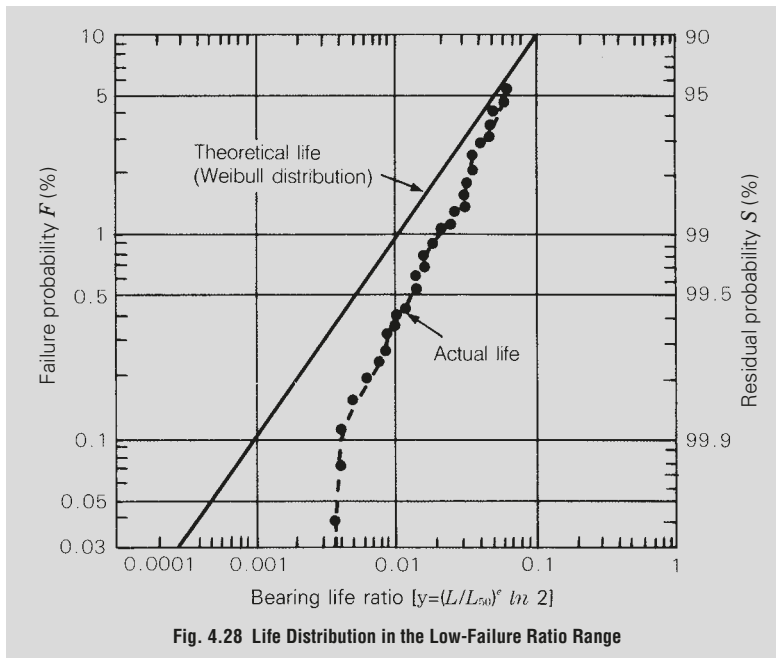
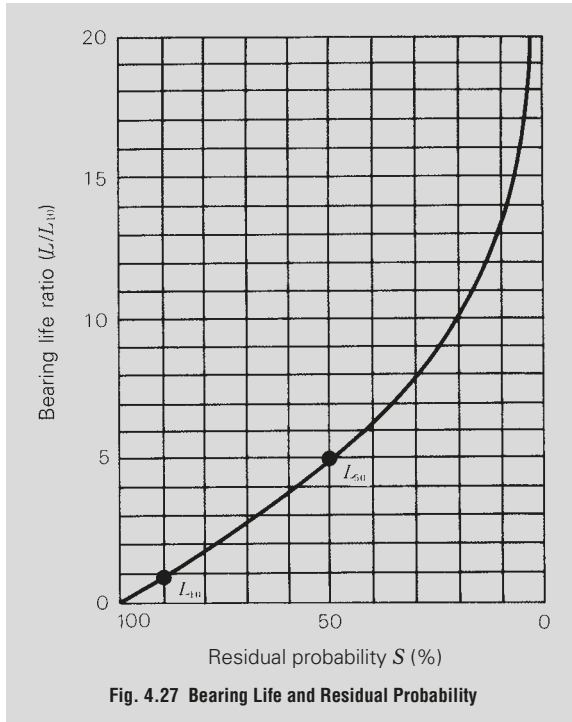
within a damage ratio of 10 to 60 % (residual probability of 90 to 40 %). At a damage ratio of 10 % or less (residual probability of 90 % or more) however, the rolling fatigue life becomes longer than the theoretical curve of the Weibull distribution, as shown in Fig. 4.28. This is a conclusion drawn from the life test of numerous, widely-varying bearings and an analysis of collected data.

When bearing life with a failure ratio of 10 % or less (for example, the 95 % life or 98 % life) is to be considered on the basis of the above concept, the reliability factor  $a_1$  shown in Table 4.12 is used to check the life. Assume here that the 98 % life  $L_2$  is to be calculated for a bearing whose rating fatigue life  $L_{10}$  was calculated at 10 000 hours. The life can be calculated as  $L_2 = 0.37 \times L_{10} = 3\,700$  hours. In this manner, the reliability of the bearing life can be matched to the equipment and difficulty of inspection and disassembly.

**Table 4.12 Reliability Factor**

Reliability, %	90	95	96	97	98	99
Life, $L$	$L_{10}$ rating life	$L_5$	$L_4$	$L_3$	$L_2$	$L_1$
Reliability Factor, $a_1$	1	0.64	0.55	0.47	0.37	0.25

Apart from rolling fatigue, factors such as lubrication, wear, sound, and accuracy govern the durability of a bearing. These factors must be taken into account, but the endurance limit of these factors varies depending on application and conditions.



## 4.8.2 Radial Clearance and Fatigue Life

As shown in the catalog and elsewhere, the fatigue life calculation equation of rolling bearings is as follows:

$$L = \left( \frac{C}{P} \right)^p \dots\dots\dots (4.57)$$

where  $L$  : Rating fatigue life ( $10^6$  rev)  
 $C$  : Basic dynamic load rating (N), {kgf}  
 $P$  : Dynamic equivalent load (N), {kgf}  
 $p$  : Index Ball bearing  $p=3$ ,

$$\text{Roller bearing } p = \frac{10}{3}$$

The rating fatigue life  $L$  for a radial bearing in this case requires the load distribution in the bearing corresponds to the state with the load factor  $\varepsilon = 0.5$  (Fig. 4.29).

The load distribution with  $\varepsilon=0.5$  is obtained when the bearing radial internal clearance is zero. In this sense, the normal fatigue life calculation is intended to obtain a value when the clearance is zero. When the effect of the radial clearance is taken into account, the bearing fatigue life can be calculated. Equations (4.58) and (4.59) can be established between the bearing radial clearance  $\Delta_r$  and a function  $f(\varepsilon)$  of load factor  $\varepsilon$ :

For deep groove ball bearings:

$$\left. \begin{aligned} f(\varepsilon) &= \frac{\Delta_r \cdot D_w^{1/3}}{0.00044 \left( \frac{F_r}{Z} \right)^{2/3}} \dots\dots\dots \text{(N)} \\ f(\varepsilon) &= \frac{\Delta_r \cdot D_w^{1/3}}{0.002 \left( \frac{F_r}{Z} \right)^{2/3}} \dots\dots\dots \text{{kgf}} \end{aligned} \right\} \dots\dots (4.58)$$

For cylindrical roller bearings:

$$\left. \begin{aligned} f(\varepsilon) &= \frac{\Delta_r \cdot L_{we}^{0.8}}{0.000077 \left( \frac{F_r}{Z \cdot i} \right)^{0.9}} \dots\dots\dots \text{(N)} \\ f(\varepsilon) &= \frac{\Delta_r \cdot L_{we}^{0.8}}{0.0006 \left( \frac{F_r}{Z \cdot i} \right)^{0.9}} \dots\dots\dots \text{{kgf}} \end{aligned} \right\} \dots\dots (4.59)$$

where  $\Delta_r$  : Radial clearance (mm)  
 $F_r$  : Radial load (N), {kgf}  
 $Z$  : Number of rolling elements  
 $i$  : No. of rows of rolling elements  
 $D_w$  : Ball diameter (mm)  
 $L_{we}$  : Effective roller length (mm)  
 $L_\varepsilon$  : Life with clearance of  $\Delta_r$   
 $L$  : Life with zero clearance, obtained from Equation (4.57)

The relationship between load factor  $\varepsilon$  and  $f(\varepsilon)$  and the life ratio  $L_\varepsilon/L$ , when radial internal clearance  $\Delta_r$  exists is shown in Table 4.13.

Fig. 4.30 shows the relationship between the radial clearance and bearing fatigue life in example 6208 and NU208 bearings.

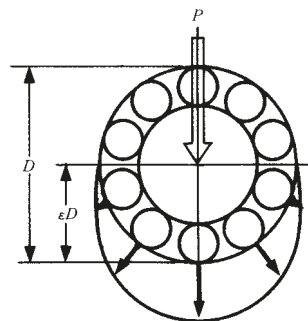


Fig. 4.29 Load Distribution With  $\varepsilon = 0.5$

Table 4.13  $\varepsilon$  and  $f(\varepsilon)$ ,  $L_\varepsilon/L$ 

$\varepsilon$	Deep Groove Ball Bearing		Cylindrical Roller Bearing	
	$f(\varepsilon)$	$\frac{L_\varepsilon}{L}$	$f(\varepsilon)$	$\frac{L_\varepsilon}{L}$
0.1	33.713	0.294	51.315	0.220
0.2	10.221	0.546	14.500	0.469
0.3	4.045	0.737	5.539	0.691
0.4	1.408	0.889	1.887	0.870
0.5	0	1.0	0	1.0
0.6	- 0.859	1.069	- 1.133	1.075
0.7	- 1.438	1.098	- 1.897	1.096
0.8	- 1.862	1.094	- 2.455	1.065
0.9	- 2.195	1.041	- 2.929	0.968
1.0	- 2.489	0.948	- 3.453	0.805
1.25	- 3.207	0.605	- 4.934	0.378
1.5	- 3.877	0.371	- 6.387	0.196
1.67	- 4.283	0.276	- 7.335	0.133
1.8	- 4.596	0.221	- 8.082	0.100
2.0	- 5.052	0.159	- 9.187	0.067
2.5	- 6.114	0.078	-11.904	0.029
3	- 7.092	0.043	-14.570	0.015
4	- 8.874	0.017	-19.721	0.005
5	-10.489	0.008	-24.903	0.002
10	-17.148	0.001	-48.395	0.0002

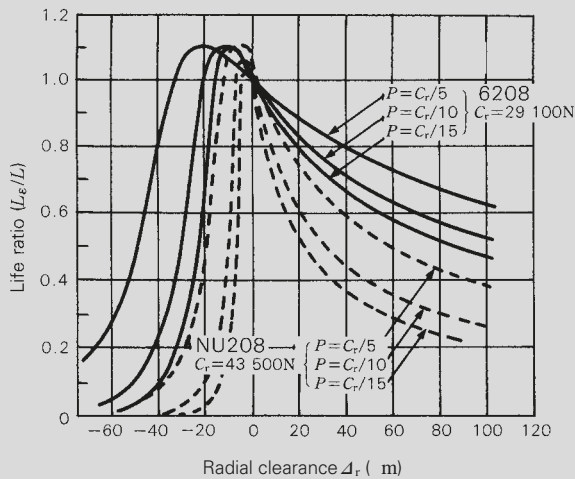


Fig. 4.30 Radial Clearance and Bearing Life Ratio

## 4.8.3 Misalignment of Inner/Outer Rings and Fatigue Life of Deep Groove Ball Bearings

A rolling bearing is manufactured with high accuracy, and careful attention to machining and assembly accuracies of the surrounding shafts and housing is critical for this accuracy is to be maintained. In practice however, the machining accuracy of parts around the bearing is limited, and bearings are subject to misalignment of inner/outer rings caused by the shaft deflection under external load.

The allowable misalignment is generally 0.0006 – 0.003 rad (2' to 10') but this varies depending on the size of the deep groove ball bearing, internal clearance during operation, and load.

This section introduces the relationship between the misalignment of inner/outer rings and fatigue life. Four Series 62 and 63 deep groove ball bearings of different sizes were selected as examples.

Assume the fatigue life without misalignment as  $L_{\theta=0}$  and the fatigue life with misalignment as  $L_{\theta}$ . The effect of the misalignment on the fatigue life may be found by calculating  $L_{\theta}/L_{\theta=0}$ . Results are shown in Figs. 4.31 to 4.34.

To represent ordinary running conditions in calculations, radial load  $F_r$  (N) {kgf} and axial load  $F_a$  (N) {kgf} were assumed to be approximately 10 %

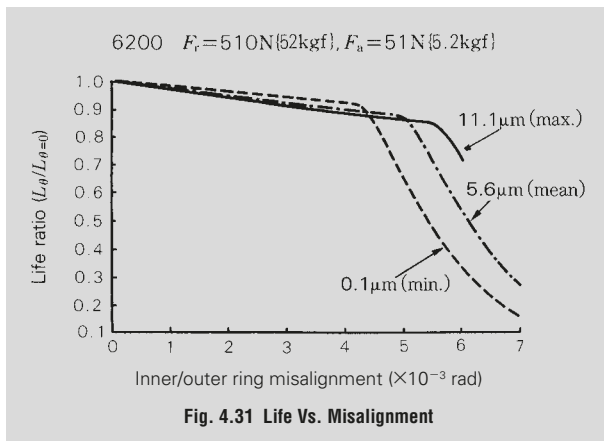
(normal load) and 1 % (light preload) of the dynamic load rating  $C_r$  (N) {kgf} respectively. Normal radial clearance was used and the shaft fit was set to around j5. Decrease of the internal clearance due to expansion of the inner ring was also taken into account.

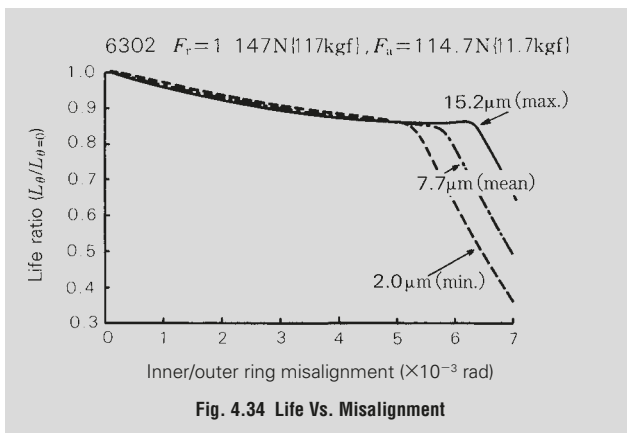
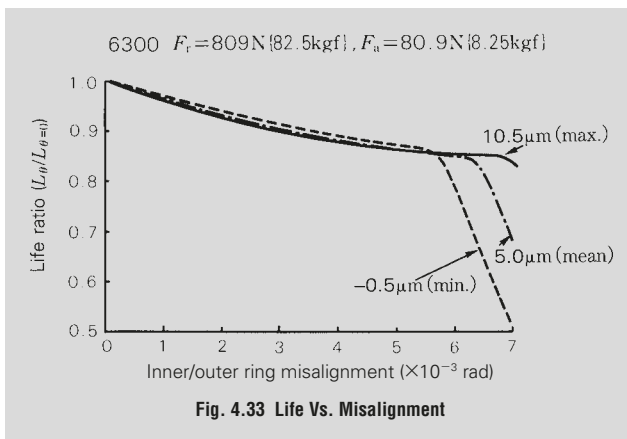
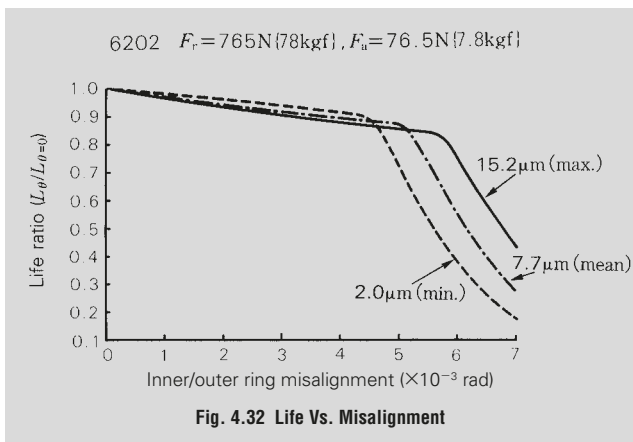
Moreover, assuming that the temperature difference between the inner and outer rings was 5 °C during operation, inner/outer ring misalignment,  $L_{\theta}/L_{\theta=0}$  was calculated for the maximum, minimum, and mean effective clearances.

As shown in Figs. 4.31 to 4.34, degradation of the fatigue life is limited to 5 to 10 % or less when the misalignment ranges from 0.0006 to 0.003 rad (2' to 10'), thus not presenting much of a problem.

When misalignment exceeds a certain limit however, the fatigue life degrades rapidly as shown in the figures; therefore, pay careful attention to this matter.

When the clearance is small, not much effect is observed as long as misalignment is also small, as shown in the figures; however, life decreases substantially when misalignment increases. As previously mentioned, aim to minimize mounting error as much as possible.





## 4.8.4 Misalignment of Inner/Outer Rings and Fatigue Life of Cylindrical Roller Bearings

When a shaft supported by rolling bearings is deflected or there is some inaccuracy in a shoulder, misalignment arises between the inner and outer rings of the bearings, thereby lowering their fatigue life. The degree of degradation depends on bearing type, interior design, radial internal clearance, and magnitude of load during operation.

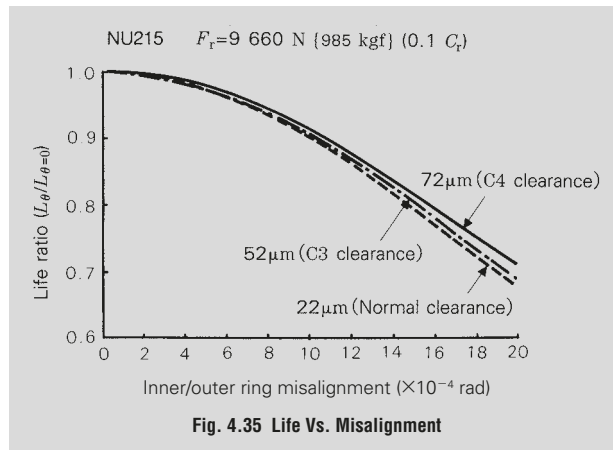
The relationship between the misalignment of inner/outer rings and fatigue life was determined with standard NU215 and NU315 cylindrical roller bearings, as shown in Figs. 4.35 to 4.38.

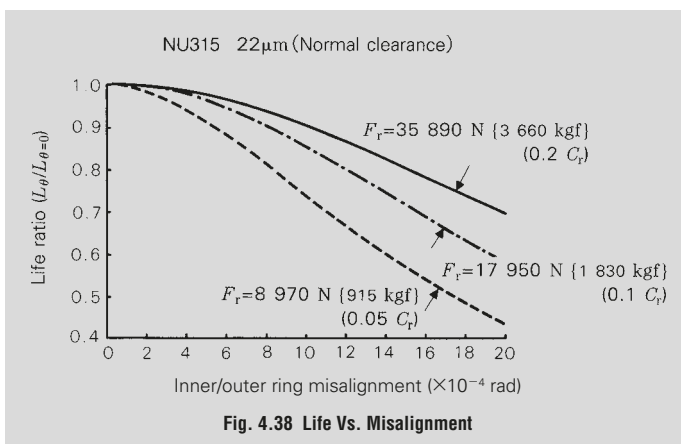
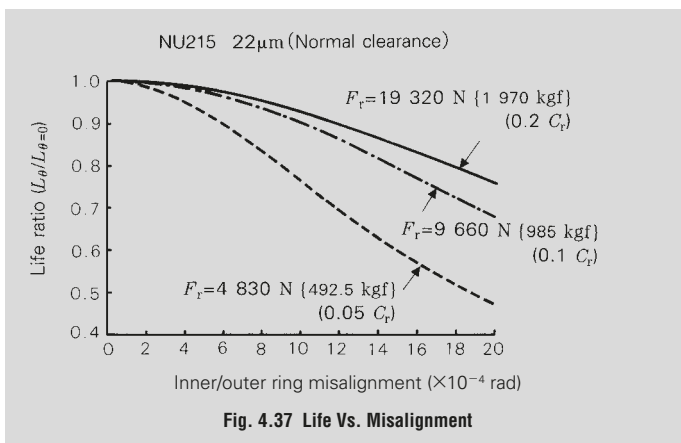
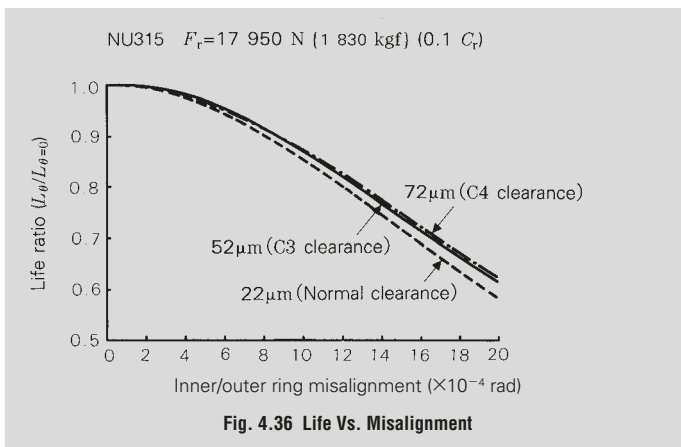
In these figures, the horizontal axis shows the misalignment of inner/outer rings (rad) while the vertical axis shows the fatigue life ratio  $L_{\theta}/L_{\theta=0}$ . The fatigue life without misalignment is  $L_{\theta=0}$  and the fatigue life with misalignment is  $L_{\theta}$ .

Figs. 4.35 and 4.36 show the life ratio for bearings under constant load (10 % of basic dynamic load rating  $C_r$  of a bearing) when the internal clearance is normal, C3, or C4. Figs. 4.37 and 4.38 show the life ratio for bearings with constant clearance (normal clearance) when the load is 5 %, 10 %, and 20 % of the basic dynamic load rating  $C_r$ .

Note that the median effective clearance in these examples was determined using m5/H7 fits and a temperature difference of 5°C between the inner and outer rings.

The fatigue life ratio for the clearance and load shows the same trend as in the case of other cylindrical roller bearings; however, the life ratio itself differs among bearing series and dimensions, with life degradation rapid in Series 22 and 23 bearings (wide type). Use of a specially designed bearing is advised when considerable misalignment is expected during application.





### 4.8.5 Oil Film Parameters and Rolling Fatigue Life

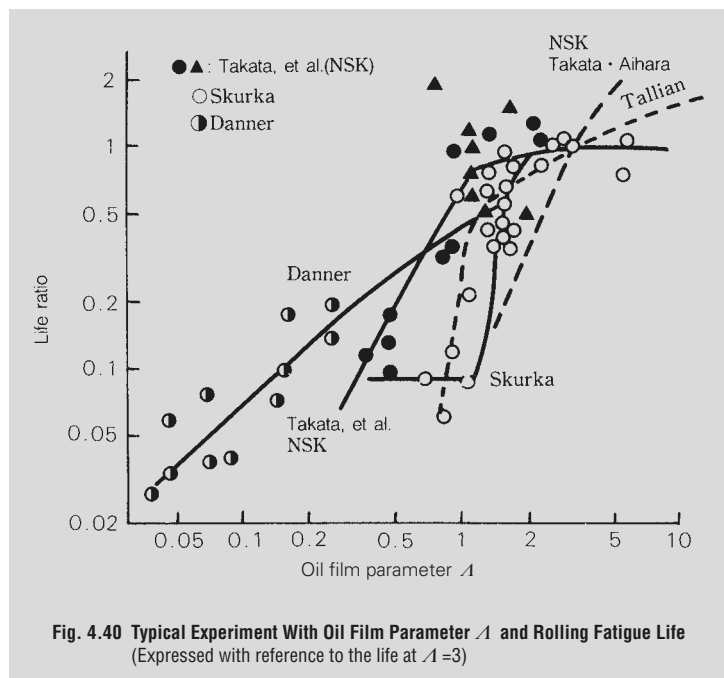
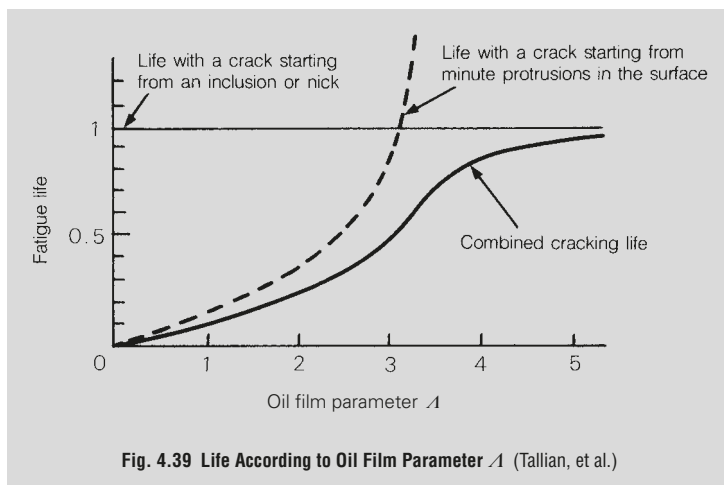
As evidenced by numerous experiments and experiences, the rolling fatigue life of rolling bearings is closely related to lubrication.

The rolling fatigue life is expressed by the maximum number of rotations that a bearing can endure until the raceway or rolling surface of a bearing develops fatigue in the material resulting in flaking of the surface due to cyclic stress. Such flaking begins with either microscopic non-uniform portions (such as nonmetallic inclusions or cavities) in the material or with microscopic defects in the material surface (such as extremely small cracks, surface damage, or dents caused by contact between extremely small projections in the raceway or rolling surface). The former flaking is called subsurface-originating flaking while the latter is surface-originating flaking.

The oil film parameter  $\lambda$ , which is the ratio between the resultant oil film thickness and surface roughness, expresses whether or not the lubrication at the rolling contact surface is satisfactory. The effect of the oil film grows with increasing  $\lambda$ . Namely, when  $\lambda$  is large (around 3 in general), surface-originating flaking due to contact between extremely small projections in the surface is less likely to occur. If the surface is free from defects (flaws, dents, etc.), the life is determined mainly by subsurface-originating flaking. On the other hand, a decrease in  $\lambda$  tends to cause surface-originating flaking, resulting in degradation of the bearing's life. This state is shown in Fig. 4.39.

NSK has performed life experiments with about 370 bearings within the range of  $\lambda = 0.3\text{--}3$  and with different lubricants and bearing materials (● and ▲ in Fig. 4.40). Fig. 4.40 shows a summary of the principal experiments reported until now. As is evident in the figures, life decreases rapidly at around  $\lambda \approx 1$  when compared with life values at around  $\lambda = 3\text{--}4$  where life changes at a slower rate. Life becomes about 1/10 or less at  $\lambda \leq 0.5$  due to severe surface-originating flaking.

Accordingly, to extend the fatigue life of rolling bearings, increase the oil film parameter (ideally to a value above 3) by improving lubrication conditions.



## 4.8.6 EHL Oil Film Parameter Calculation Diagram

Lubrication of rolling bearings can be expressed by the theory of elastohydrodynamic lubrication (EHL). Introduced below is a method to determine the oil film parameter (oil film to surface roughness ratio), the most critical component in EHL.

### (1) Oil Film Parameter

The raceway surfaces and rolling surfaces of a bearing are extremely smooth, but have fine irregularities when viewed through a microscope. As the EHL oil film thickness is in the same order as the surface roughness, lubrication conditions cannot be discussed without considering this surface roughness. For example, given a particular mean oil film thickness, there are two conditions that may occur depending on the surface roughness. One consists of complete separation of the two surfaces by means of the oil film (Fig. 4.41 (a)). The other consists of metal contact between surface projections (Fig. 4.41 (b)). The degradation of lubrication and surface damage is attributed to case (b). The symbol lambda ( $\lambda$ ) represents the ratio between the oil film thickness and roughness. It is widely employed as the oil film parameter in the study and application of EHL.

$$\lambda = h/\sigma \quad (4.60)$$

where  $h$  : EHL oil film thickness  
 $\sigma$  : Combined roughness ( $\sqrt{\sigma_1^2 + \sigma_2^2}$ )

$\sigma_1, \sigma_2$  : Root mean square (rms) roughness of each contact surface

The oil film parameter may be correlated to the formation of the oil film, and the degree of lubrication can be divided into three zones as shown in Fig. 4.42.

### (2) Oil Film Parameter Calculation Diagram

The **Dowson-Higginson** minimum oil film thickness equation shown below is used for figures:

$$H_{\min} = 2.65 \frac{G^{0.54} U^{0.7}}{W^{0.13}} \quad (4.61)$$

Use the oil film thickness that reflects the inner ring under maximum rolling element load (where thickness is minimum).

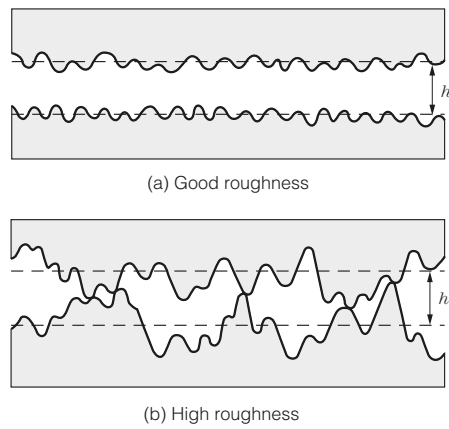
Equation (4.61) can be expressed by grouping variables as follows: ( $R$ ) for speed, ( $A$ ) for viscosity, ( $F$ ) for load, and ( $J$ ) for bearing technical specifications, with  $t$  as a constant:

$$\lambda = t \cdot R \cdot A \cdot F \cdot J \quad (4.62)$$

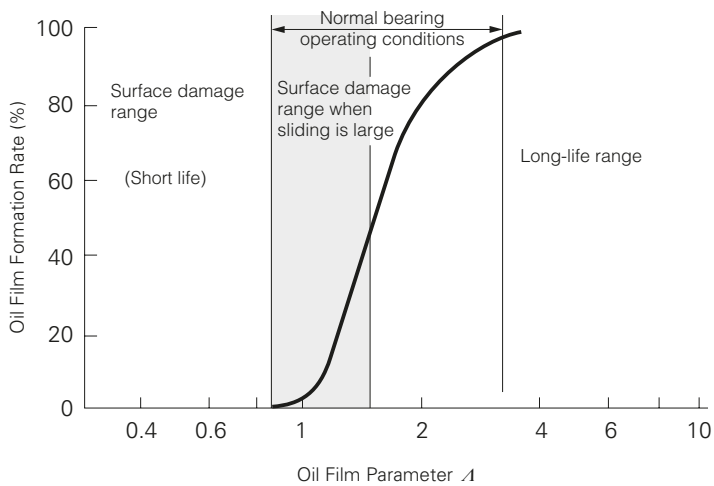
$R$  and  $A$  may be quantities not dependent on the bearing. When the load  $P$  is assumed to be between 98 N {10 kgf} and 98 kN {10 tf},  $F$  changes by 2.54 times as  $F \propto P^{-0.13}$ . Since the actual load is usually determined from bearing size however, such change may be limited to 20 to 30 %. As a result,  $F$  is handled together with term  $J$  [ $F = F(J)$ ]. Traditional Equation (4.62) can therefore be grouped as shown below:

$$\lambda = T \cdot R \cdot A \cdot D \quad (4.63)$$

where  $T$  : Factor determined by the bearing Type  
 $R$  : Factor related to Rotation speed  
 $A$  : Factor related to viscosity (viscosity grade  $\alpha$ : Alpha)  
 $D$  : Factor related to bearing Dimensions



**Fig. 4.41 Oil Film and Surface Roughness**



**Fig. 4.42 Effect of Oil Film on Bearing Performance**

The vitally important oil film parameter  $A$  is expressed by a simplified equation shown below. The fatigue life of rolling bearings becomes shorter when  $A$  is smaller. In the equation  $A = T \cdot R \cdot A \cdot D$  variables include  $A$  for oil viscosity  $\eta_0$  (mPa·s, {cp}),  $R$  for speed  $n$  (min<sup>-1</sup>), and  $D$  for bearing bore diameter  $d$  (mm). The calculation procedure is described below.

(i) Determine the value of  $T$  from the bearing type (Table 4.14).

(ii) Determine the  $R$  value for  $n$  (min<sup>-1</sup>) from Fig. 4.43.

(iii) Determine  $A$  from the absolute viscosity (mPa·s, {cp}) and kind of oil in Fig. 4.44.

Generally, the kinematic viscosity  $\nu_0$  (mm<sup>2</sup>/s, {cSt}) is used and conversion is made as follows:

$$\eta_0 = \rho \cdot \nu_0 \quad (4.64)$$

$\rho$  refers to oil density (g/cm<sup>3</sup>) and uses the approximate values shown below:

Mineral oil  $\rho = 0.85$

Silicon oil  $\rho = 1.0$

Diester oil  $\rho = 0.9$

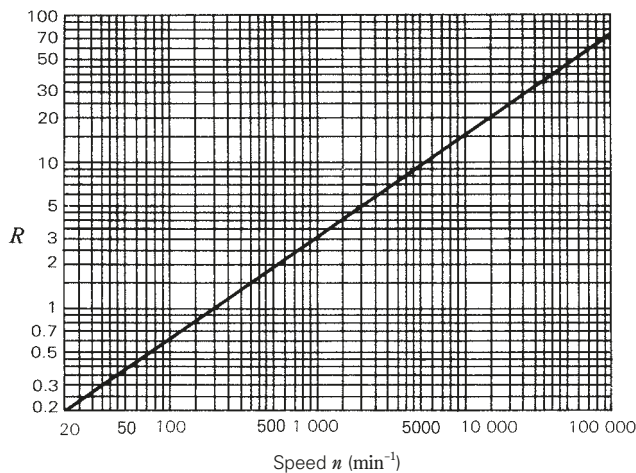
When the mineral oil could be naphthene or paraffin, use the paraffin curve shown in Fig. 4.44.

(iv) Determine the value of  $D$  from the Diameter Series and bore diameter  $d$  (mm) in Fig. 4.45.

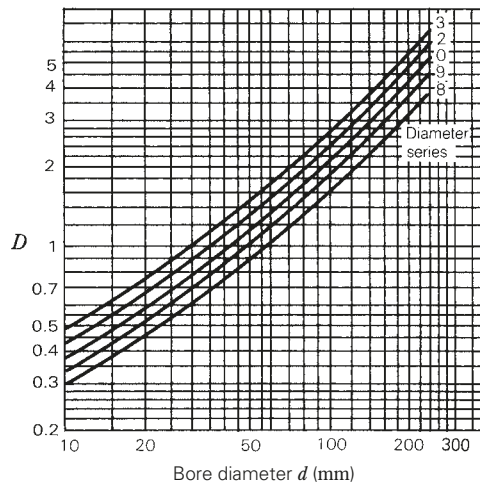
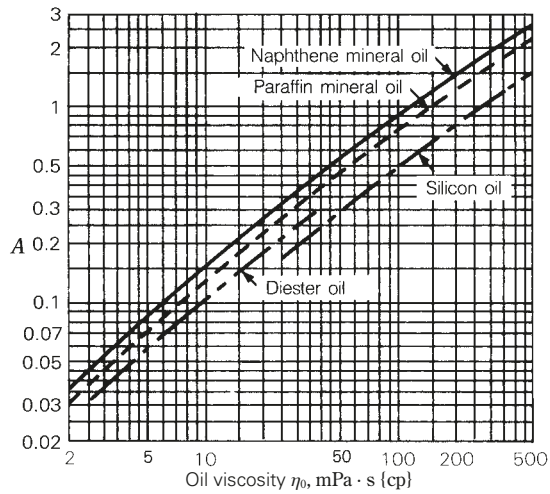
(v) The product of the above values is used as the oil film parameter.

**Table 4.14  $T$  Value**

Bearing Type	$T$ Value
Ball bearing	1.5
Cylindrical roller bearing	1.0
Tapered roller bearing	1.1
Spherical roller bearing	0.8



**Fig. 4.43 Speed  $R$**



Example EHL oil film parameter calculations are described below:

## Example 1

Determine the oil film parameter when deep groove ball bearing 6312 is operated with paraffin mineral oil ( $\eta_0 = 30 \text{ mPa} \cdot \text{s}$ , {cp}) at a speed of  $n = 1\,000 \text{ min}^{-1}$ .

## Solution

$d = 60 \text{ mm}$  and  $D = 130 \text{ mm}$  from the bearing catalog.  
 $T = 1.5$  from Table 4.18  
 $R = 3.0$  from Fig. 4.43  
 $A = 0.31$  from Fig. 4.44  
 $D = 1.76$  from Fig. 4.45  
 Accordingly,  $\Lambda = 2.5$

## Example 2

Determine the oil film parameter when cylindrical roller bearing NU240 is operated with paraffin mineral oil ( $\eta_0 = 10 \text{ mPa} \cdot \text{s}$ , {cp}) at a speed of  $n = 2\,500 \text{ min}^{-1}$ .

## Solution

$d = 200 \text{ mm}$  and  $D = 360 \text{ mm}$  from the bearing catalog.  
 $T = 1.0$  from Table 4.18  
 $R = 5.7$  from Fig. 4.43  
 $A = 0.13$  from Fig. 4.44  
 $D = 4.8$  from Fig. 4.45  
 Accordingly,  $\Lambda = 3.6$

## (3) Effects of Oil Shortage and Shearing Heat Generation

The oil film parameter obtained above is applicable when the contact inlet is fully flooded with oil and the temperature at the inlet is constant (isothermal). However, these conditions may not be satisfied depending on lubrication and operating conditions.

One such condition is called starvation, and in this case, the actual oil film parameter may become smaller than that determined by Equation (4.64). Starvation may occur if lubrication becomes limited. In this condition, the guideline for adjusting the oil film parameter is 50 to 70 % of the value obtained from Equation (4.64).

Another effect is the localized rise of oil temperature in the contact inlet due to heavy shearing during high-speed operation, resulting in a decrease of oil viscosity. In this case, the oil film parameter becomes smaller than the theoretical isothermal value. The effect of shearing heat generation was analyzed by Murch and Wilson, who established a decrease factor for the oil film parameter. An approximation using the viscosity and speed (pitch diameter of rolling element set  $D_{pw} \times$  rotating speed per minute  $n$ ) is shown in Fig. 4.46. By multiplying the oil film parameter determined in the previous section by this decrease factor  $Hi$ , an oil film parameter considering the shearing heat generation is obtained:

$$\Lambda = Hi \cdot T \cdot R \cdot A \cdot D \quad (4.65)$$

Note that the average of the bore and outside diameters of the bearings may be used as the pitch diameter  $D_{pw}$  ( $d_m$ ) of the set of rolling elements.

Conditions for the calculation of Example 1 include  $d_m n = 9.5 \times 10^4$  and  $\eta_0 = 30 \text{ mPa} \cdot \text{s}$ , {cp} and  $Hi$  nearly equivalent to 1, as evident from Fig. 4.46. Shearing heat generation therefore has almost no effect.

Conditions for Example 2 are  $d_m n = 7 \times 10^5$  and  $\eta_0 = 10 \text{ mPa} \cdot \text{s}$ , {cp} and  $Hi = 0.76$ , meaning that the oil film parameter is smaller by about 25%. Accordingly,  $\Lambda$  is actually 2.7, not 3.6.

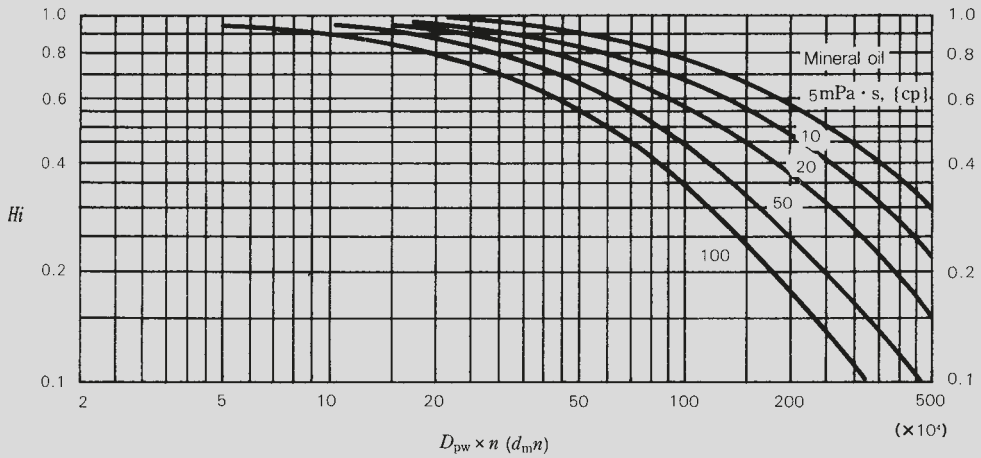


Fig. 4.46 Decrease of Oil Film Thickness  $H_i$  Due to Shearing Heat Generation

## 4.8.7 Load Calculation for Gears

### (1) Calculation of Loads on Spur, Helical, and Double-Helical Gears

Since they are both mechanical elements, there is an extremely close relationship between gears and rolling bearings. Gear units, which are widely used in machines, are almost always used with bearings. Rating life calculation and selection of bearings to be used in gear units are based on the load at the gear meshing point.

The load at the gear meshing point is calculated as follows:

#### Spur Gear:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots (N)$$

$$= \frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots \{kgf\}$$

$$S_1 = S_2 = P_1 \tan \alpha$$

The magnitudes of forces  $P_2$  and  $S_2$  applied to the driven gear are the same as  $P_1$  and  $S_1$  respectively, but the direction is opposite.

#### Helical Gear:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots (N)$$

$$= \frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots \{kgf\}$$

$$S_1 = S_2 = \frac{P_1 \tan \alpha_n}{\cos \beta}$$

$$T_1 = T_2 = P_1 \tan \beta$$

The magnitudes of the forces  $P_2$ ,  $S_2$ , and  $T_2$  applied to the driven gear are the same as  $P_1$ ,  $S_1$ , and  $T_1$  respectively, but the direction is opposite.

#### Double-Helical Gear:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots (N)$$

$$= \frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots \{kgf\}$$

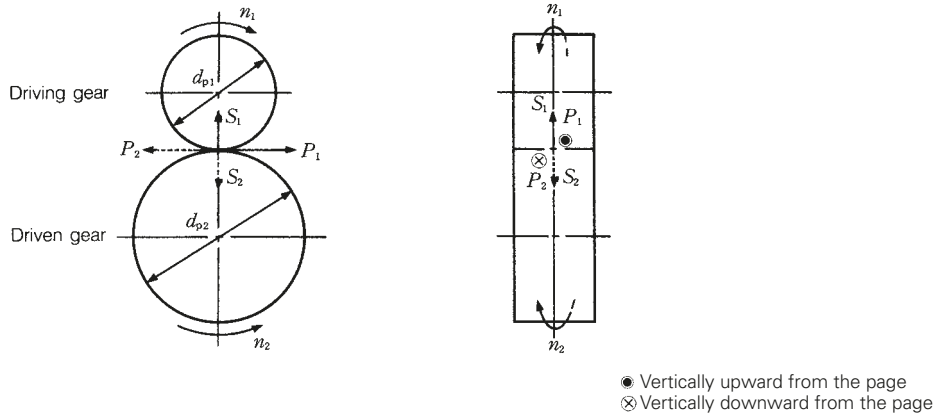
$$S_1 = S_2 = \frac{P_1 \tan \alpha_n}{\cos \beta}$$

where  $P$ : Tangential force (N), {kgf}  
 $S$ : Separating force (N), {kgf}  
 $T$ : Thrust (N), {kgf}  
 $H$ : Transmitted power (kW)  
 $n$ : Speed ( $\text{min}^{-1}$ )  
 $d_p$ : Pitch diameter (mm)  
 $\alpha$ : Gear pressure angle  
 $\alpha_n$ : Gear normal pressure angle  
 $\beta$ : Twist angle

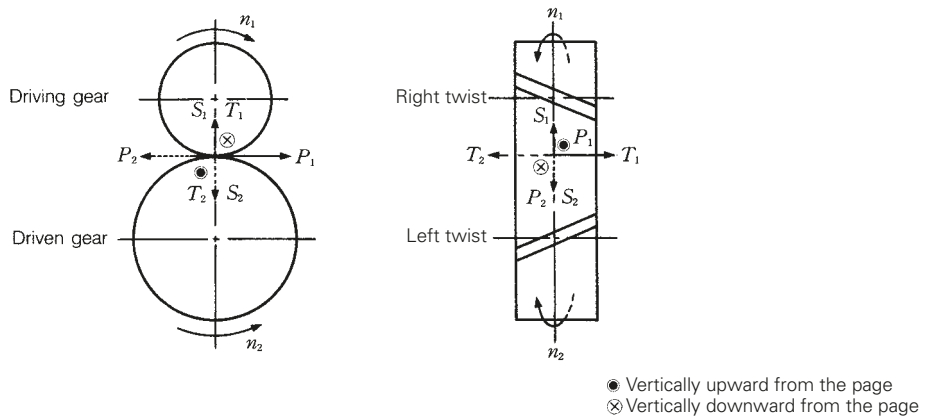
Subscript 1: Driving gear

Subscript 2: Driven gear

In the case of double-helical gears, thrust of the helical gears offsets each other and thus only tangential and separating forces act. For the directions of tangential, separating, and thrust forces, please refer to Figs. 4.47 and 4.48.



**Fig. 4.47 Spur Gear**



**Fig. 4.48 Helical Gear**

The thrust direction of the helical gear varies depending on the gear running direction, gear twist direction, and whether the gear is driving or driven. The directions are as follows:

The force on the bearing is determined as follows:

Tangential force:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots\dots (\text{N})$$

$$= \frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{d_{p2}}{2} \right)} \dots\dots \{ \text{kgf} \}$$

$$\text{Separating force: } S_1 = S_2 = P_1 \frac{\tan \alpha_n}{\cos \beta}$$

$$\text{Thrust: } T_1 = T_2 = P_1 \cdot \tan \beta$$

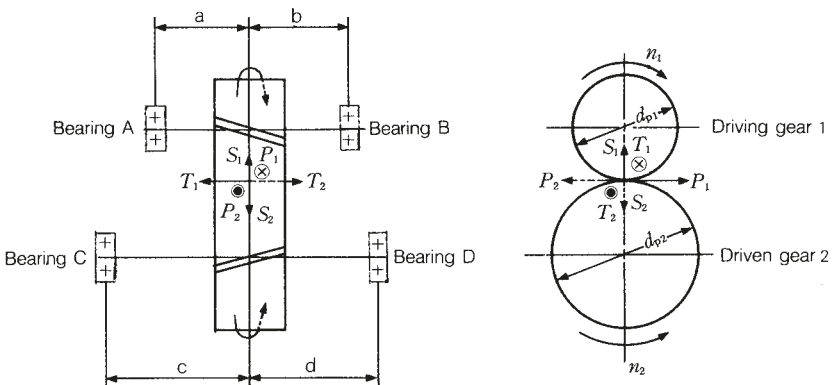
The same method can be applied to bearings C and D.

**Table 4.15**

Load Classification		Bearing A	Bearing B
Radial Load	From $P_1$	$P_A = \frac{b}{a+b} P_1 \quad \otimes$	$P_B = \frac{a}{a+b} P_1 \quad \otimes$
	From $S_1$	$S_A = \frac{b}{a+b} S_1 \quad \uparrow$	$S_B = \frac{a}{a+b} S_1 \quad \uparrow$
	From $T_1$	$U_A = \frac{d_{p1}/2}{a+b} T_1 \quad \uparrow$	$U_B = \frac{d_{p1}/2}{a+b} T_1 \quad \downarrow$
Combined Radial Load		$F_{RA} = \sqrt{P_A^2 + (S_A + U_A)^2}$	$F_{RB} = \sqrt{P_B^2 + (S_B - U_B)^2}$
Axial Load		$F_a = T_1 \quad \leftarrow$	

Load directions shown reference the left side of Fig. 4.49.

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- ⊗ Vertically downward from the page



**Fig. 4.49**

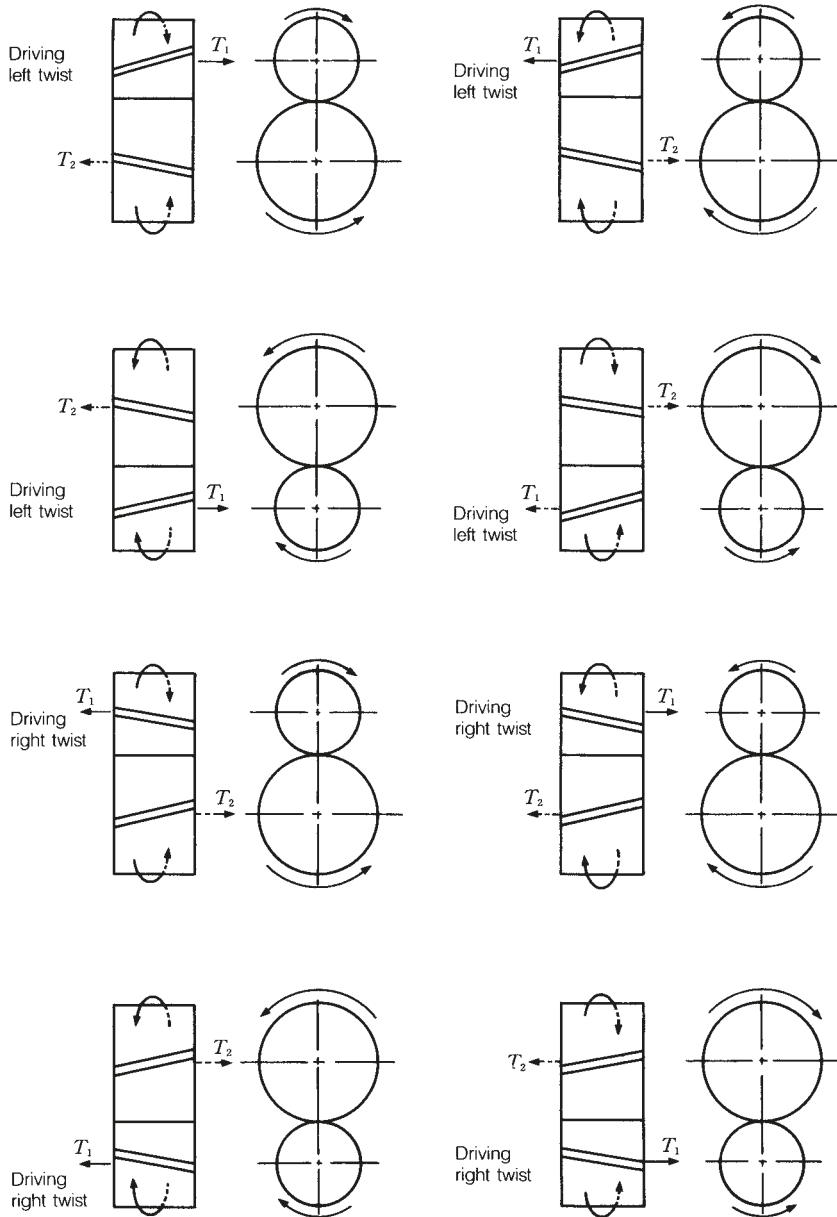


Fig. 4.50 Thrust Direction

## (2) Calculation of Load on Straight Bevel Gears

The load at the meshing point of straight bevel gears is calculated as follows:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots (\text{N})$$

$$= \frac{974\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots \{\text{kgf}\}$$

$$D_{m1} = d_{p1} - w \sin \delta_1$$

$$D_{m2} = d_{p2} - w \sin \delta_2$$

$$S_1 = P_1 \tan \alpha_n \cos \delta_1$$

$$S_2 = P_2 \tan \alpha_n \cos \delta_2$$

$$T_1 = P_1 \tan \alpha_n \cos \delta_1$$

$$T_2 = P_2 \tan \alpha_n \cos \delta_2$$

where  $D_m$  : Average pitch diameter (mm)

$d_p$  : Pitch diameter (mm)

$w$  : Gear width (pitch line length) (mm)

$\alpha_n$  : Gear normal pressure angle

$\delta$  : Pitch cone angle

Generally,  $\delta_1 + \delta_2 = 90^\circ$ . In this case,  $S_1$  and  $T_2$  (or  $S_2$  and  $T_1$ ) are the same in magnitude but opposite in direction.  $S/P$  and  $T/P$  for  $\delta$  are shown in Fig. 4.53. The load on the bearing can be calculated as shown below.

**Table 4.16**

⊙ Vertically upward from the page  
⊗ Vertically downward from the page

Load Classification		Bearing A	Bearing B	Bearing C	Bearing D
Radial Load	From $P$	$P_A = \frac{b}{a} P_1$ ⊙	$P_B = \frac{a+b}{a} P_1$ ⊗	$P_C = \frac{d}{c+d} P_2$ ⊙	$P_D = \frac{c}{c+d} P_2$ ⊙
	From $S$	$S_A = \frac{b}{a} S_1$ ↓	$S_B = \frac{a+b}{a} S_1$ ↑	$S_C = \frac{d}{c+d} S_2$ →	$S_D = \frac{c}{c+d} S_2$ →
	From $T$	$U_A = \frac{D_{m1}}{2a} T_1$ ↑	$U_B = \frac{D_{m1}}{2a} T_1$ ↓	$U_C = \frac{D_{m2}}{2(c+d)} T_2$ ←	$U_D = \frac{D_{m2}}{2(c+d)} T_2$ →
Combined Radial Load		$F_{rA} = \sqrt{P_A^2 + (S_A - U_A)^2}$	$F_{rB} = \sqrt{P_B^2 + (S_B - U_B)^2}$	$F_{rC} = \sqrt{P_C^2 + (S_C - U_C)^2}$	$F_{rD} = \sqrt{P_D^2 + (S_D + U_D)^2}$
Axial Load		$F_a = T_1$ ←		$F_a = T_2$ ↓	

Load directions shown reference Fig. 4.52.

Driving Gear  
(counterclockwise as  
viewed from the opposite  
side of the cone crest)

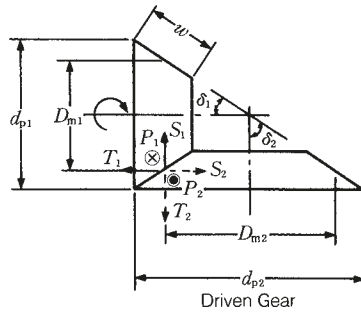


Fig. 4.51

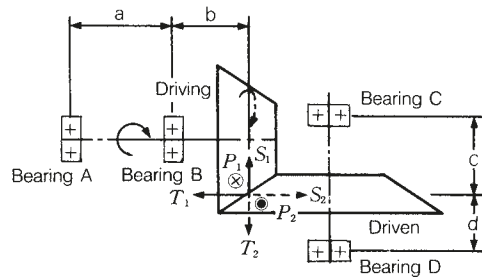


Fig. 4.52

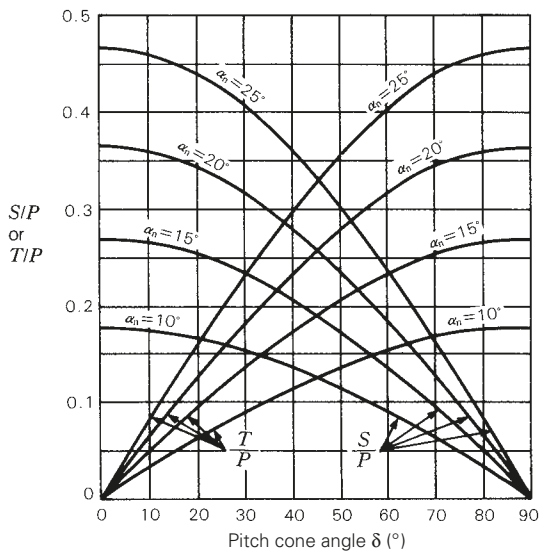


Fig. 4.53

### (3) Calculation of Load on Spiral Bevel Gears

In the case of spiral bevel gears, the magnitude and direction of loads at the meshing point vary depending on the running direction and gear twist direction. The running direction is either clockwise or counterclockwise as viewed from the side opposite of the gears (Fig. 4.54). The gear twist direction is classified as shown in Fig. 4.55. The force at the meshing point is calculated as follows:

$$P_1 = P_2 = \frac{9\,550\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{9\,550\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots \text{(N)}$$

$$= \frac{974\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{974\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots \text{{kgf}}$$

where  $\alpha_n$  : Gear normal pressure angle  
 $\beta$  : Twisting angle  
 $\delta$  : Pitch cone angle  
 $w$  : Gear width (mm)  
 $D_m$  : Average pitch diameter (mm)  
 $d_p$  : Pitch diameter (mm)

Note that the following applies:

$$D_{m1} = d_{p1} - w \sin \delta_1$$

$$D_{m2} = d_{p2} - w \sin \delta_2$$

The separating force S and thrust T depend on running direction and gear twist direction as follows:

(i) Clockwise with right twisting or counterclockwise with left twisting

Driving Gear  
 Separating Force

$$S_1 = \frac{P}{\cos \beta} (\tan \alpha_n \cos \delta_1 + \sin \beta \sin \delta_1)$$

Thrust

$$T_1 = \frac{P}{\cos \beta} (\tan \alpha_n \sin \delta_1 - \sin \beta \cos \delta_1)$$

Driven Gear  
 Separating Force

$$S_2 = \frac{P}{\cos \beta} (\tan \alpha_n \cos \delta_2 - \sin \beta \sin \delta_2)$$

Thrust

$$T_2 = \frac{P}{\cos \beta} (\tan \alpha_n \sin \delta_2 + \sin \beta \cos \delta_2)$$

(ii) Counterclockwise with right twist or clockwise with left twist

Driving Gear  
 Separating Force

$$S_1 = \frac{P}{\cos \beta} (\tan \alpha_n \cos \delta_1 - \sin \beta \sin \delta_1)$$

Thrust

$$T_1 = \frac{P}{\cos \beta} (\tan \alpha_n \sin \delta_1 + \sin \beta \cos \delta_1)$$

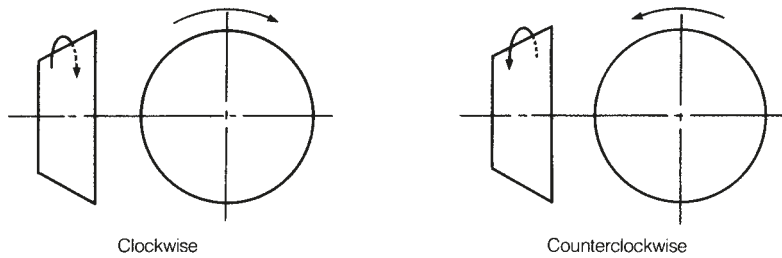
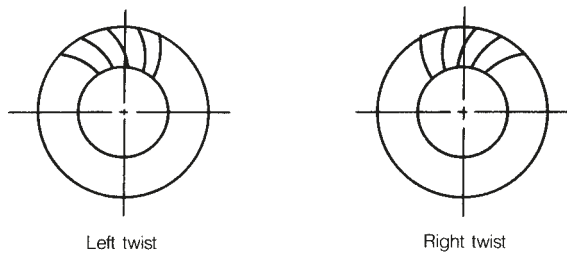
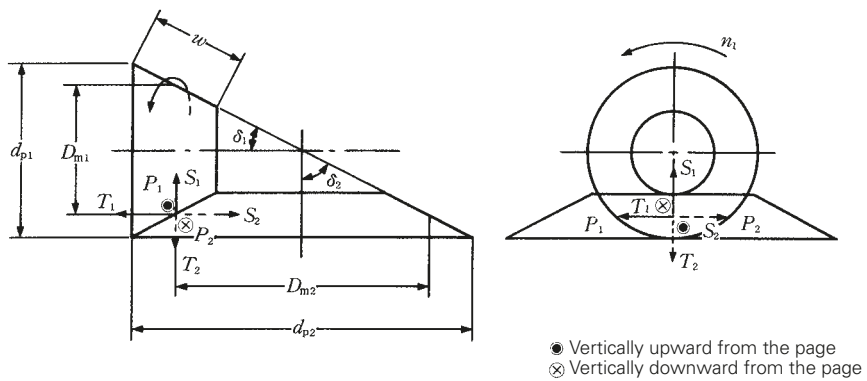
Driven Gear  
 Separating Force

$$S_2 = \frac{P}{\cos \beta} (\tan \alpha_n \cos \delta_2 + \sin \beta \sin \delta_2)$$

Thrust

$$T_2 = \frac{P}{\cos \beta} (\tan \alpha_n \sin \delta_2 - \sin \beta \cos \delta_2)$$

A positive (plus) calculation result indicates that the load is acting in a direction that separates the gears while a negative (minus) result indicates that the load is acting in a direction that brings the gears together. Generally,  $\delta_1 + \delta_2 = 90^\circ$ . In this case,  $T_1$  and  $S_2$  ( $S_1$  and  $T_2$ ) are the same in magnitude but opposite in direction. The load on the bearing can be calculated by the same method as described in Section 4.8.7 "(2) Calculation of Load on Straight Bevel Gears."


**Fig. 4.54 Gear Running Direction**

**Fig. 4.55 Gear Twist Direction**

**Fig. 4.56**

## (4) Calculation of Load on Hypoid Gears

The force acting at the meshing point of hypoid gears is calculated as follows:

$$P_1 = \frac{9\,550\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{\cos\beta_1}{\cos\beta_2} P_2 \dots\dots\dots (N)$$

$$= \frac{974\,000H}{n_1 \left( \frac{D_{m1}}{2} \right)} = \frac{\cos\beta_1}{\cos\beta_2} P_2 \dots\dots\dots \{kgf\}$$

$$P_2 = \frac{9\,550\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots (N)$$

$$= \frac{974\,000H}{n_2 \left( \frac{D_{m2}}{2} \right)} \dots\dots\dots \{kgf\}$$

$$D_{m1} = D_{m2} \frac{z_1}{z_2} \cdot \frac{\cos\beta_1}{\cos\beta_2}$$

$$D_{m2} = d_{p2} - w_2 \sin\delta_2$$

where  $\alpha_n$  : Gear normal pressure angle  
 $\beta$  : Twisting angle  
 $\delta$  : Pitch cone angle  
 $w$  : Gear width (mm)  
 $D_m$  : Average pitch diameter (mm)  
 $d_p$  : Pitch diameter (mm)  
 $z$  : Number of teeth

The separating force  $S$  and thrust  $T$  depend on running direction and gear twist direction as follows:

(i) Clockwise with right twisting or counterclockwise with left twisting

Driving Gear  
Separating Force

$$S_1 = \frac{P_1}{\cos\beta_1} (\tan\alpha_n \cos\delta_1 + \sin\beta_1 \sin\delta_1)$$

Thrust  
 $T_1 = \frac{P_1}{\cos\beta_1} (\tan\alpha_n \sin\delta_1 - \sin\beta_1 \cos\delta_1)$

Driven Gear  
Separating Force

$$S_2 = \frac{P_2}{\cos\beta_2} (\tan\alpha_n \cos\delta_2 - \sin\beta_2 \sin\delta_2)$$

Thrust  
 $T_2 = \frac{P_2}{\cos\beta_2} (\tan\alpha_n \sin\delta_2 + \sin\beta_2 \cos\delta_2)$

(ii) Counterclockwise with right twist or clockwise with left twist

Driving Gear  
Separating Force

$$S_1 = \frac{P_1}{\cos\beta_1} (\tan\alpha_n \cos\delta_1 - \sin\beta_1 \sin\delta_1)$$

Thrust  
 $T_1 = \frac{P_1}{\cos\beta_1} (\tan\alpha_n \sin\delta_1 + \sin\beta_1 \cos\delta_1)$

Driven Gear  
Separating Force

$$S_2 = \frac{P_2}{\cos\beta_2} (\tan\alpha_n \cos\delta_2 + \sin\beta_2 \sin\delta_2)$$

Thrust  
 $T_2 = \frac{P_2}{\cos\beta_2} (\tan\alpha_n \sin\delta_2 - \sin\beta_2 \cos\delta_2)$

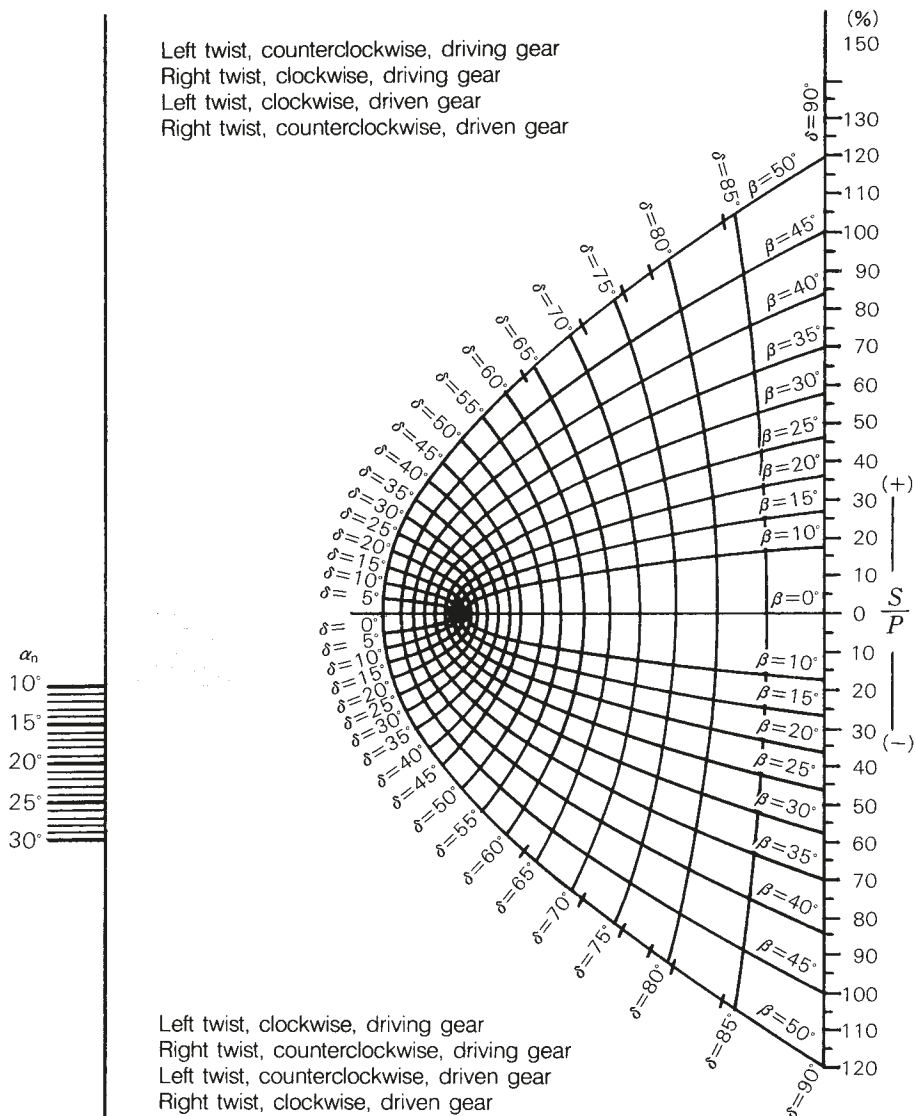
The positive (plus) calculation result indicates that the load is acting in a direction that separates the gears while a negative (minus) result indicates that the load is acting in a direction that brings the gears together. For more information on running direction and gear twist direction, refer to Section 4.8.7 “(3) *Calculation of Load on Spiral Bevel Gears.*” The load on the bearing can be calculated by the same method as described in Section 4.8.7 “(2) *Calculation of Load Acting on Straight Bevel Gears.*”

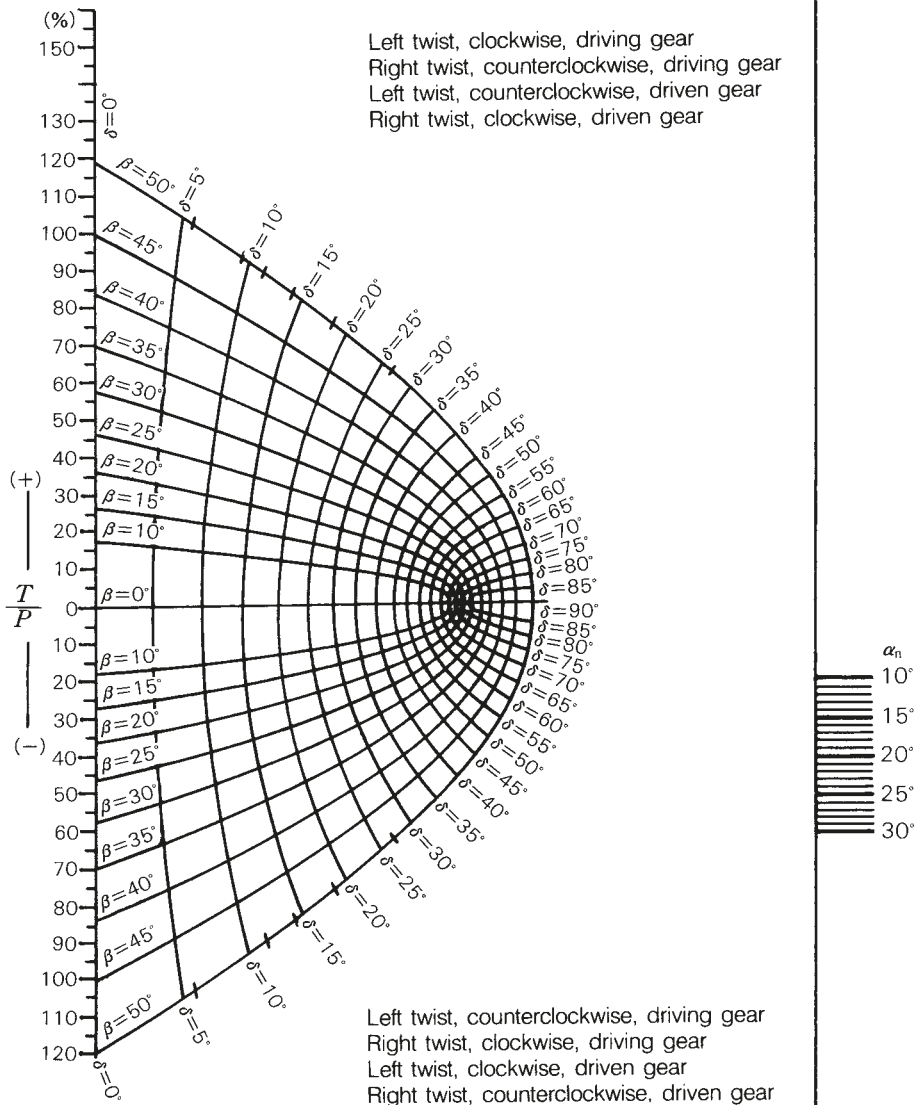
The following calculation diagrams are used to determine the approximate value and direction of separating force  $S$  and thrust  $T$ .

## How To Use

1. Mark the gear normal pressure angle  $\alpha_n$  on the vertical scale on the side of the appropriate diagram for  $S$  or  $T$ .

2. Determine the intersection between the pitch cone angle  $\delta$  and twist angle  $\beta$ . Match your gear configuration to the text on either side of the  $\beta = 0$  line, and use that side when determining the point of intersection.
3. Draw a line through the two points and the opposite vertical scale. The point where the line intersects the opposite vertical axis gives the ratio  $S/P$  or  $T/P$  (%) of the separating force  $S$  or thrust  $T$  to the tangential force  $P$ .





## (5) Calculation of Load on Worm Gears

A worm gear is a kind of spigot gear, which can produce a high reduction ratio with small volume. The load at the meshing point of worm gears is calculated as shown in Table 4.17. Variables used in Table 4.17 are as follows:

$i$ : Gear ratio  $\left( i = \frac{Z_2}{Z_w} \right)$

$\eta$ : Worm gear efficiency  $\left[ \eta = \frac{\tan \gamma}{\tan(\gamma + \psi)} \right]$

$\gamma$ : Advance angle  $\left( \gamma = \tan^{-1} \frac{d_{p2}}{id_{p1}} \right)$

$\psi$ : Frictional angle obtained from the following (as shown in Fig. 4.57):

$$V_R = \frac{\pi d_{p1} n_1}{\cos \gamma} \times \frac{10^{-3}}{60}$$

When  $V_R$  is 0.2 m/s or less,  $\psi = 8^\circ$ .

When  $V_R$  exceeds 6 m/s,  $\psi = 1^\circ 4'$ .

$\alpha_n$ : Gear normal pressure angle

$\alpha_a$ : Shaft plane pressure angle

$Z_w$ : No. of threads (No. of worm gear teeth)

$Z_2$ : No. of worm wheel teeth

Subscript 1: For driving worm gear

Subscript 2: For driven worm gear

In a worm gear, there are four combinations of interaction at the meshing point as shown below depending on the twist directions and rotating directions of the worm gear, as shown below.

The load on the bearing is obtained from the magnitude and direction of each component at the meshing point according to the method shown in Table 4.17.

**Table 4.17 Gear Loads**

Force	Worm	Worm Wheel
Tangential $P$	$\frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} \dots\dots\dots (N)$	$\frac{9\,550\,000H\eta}{n_1 \left( \frac{d_{p2}}{2} \right)} = \frac{P_1 \eta}{\tan \gamma} = \frac{P_1}{\tan(\gamma + \psi)} \dots\dots\dots (N)$
	$\frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} \dots\dots\dots \{kgf\}$	$\frac{974\,000H\eta}{n_1 \left( \frac{d_{p2}}{2} \right)} = \frac{P_1 \eta}{\tan \gamma} = \frac{P_1}{\tan(\gamma + \psi)} \dots\dots\dots \{kgf\}$
Thrust $T$	$\frac{9\,550\,000H\eta}{n_1 \left( \frac{d_{p2}}{2} \right)} = \frac{P_1 \eta}{\tan \gamma} = \frac{P_1}{\tan(\gamma + \psi)} \dots\dots\dots (N)$	$\frac{9\,550\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} \dots\dots\dots (N)$
	$\frac{974\,000H\eta}{n_1 \left( \frac{d_{p2}}{2} \right)} = \frac{P_1 \eta}{\tan \gamma} = \frac{P_1}{\tan(\gamma + \psi)} \dots\dots\dots \{kgf\}$	$\frac{974\,000H}{n_1 \left( \frac{d_{p1}}{2} \right)} \dots\dots\dots \{kgf\}$
Separating $S$	$\frac{P_1 \tan \alpha_n}{\sin(\gamma + \psi)} = \frac{P_1 \tan \alpha_a}{\tan(\gamma + \psi)} \dots\dots\dots (N), \{kgf\}$	$\frac{P_1 \tan \alpha_n}{\sin(\gamma + \psi)} = \frac{P_1 \tan \alpha_a}{\tan(\gamma + \psi)} \dots\dots\dots (N), \{kgf\}$

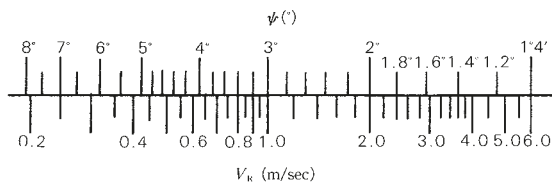


Fig. 4.57

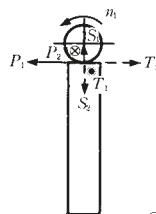
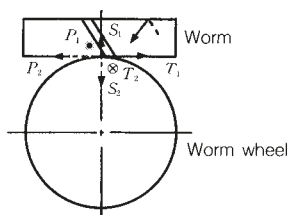


Fig. 4.58 Right Twist Worm Gear

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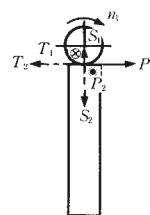
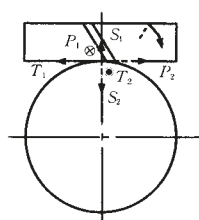


Fig. 4.59 Right Twist Worm Gear (Worm Rotation is Opposite Fig. 4.58)

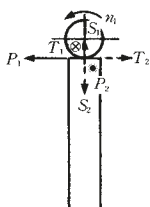
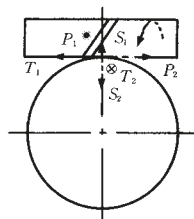


Fig. 4.60 Left Twist Worm Gear

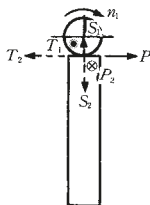
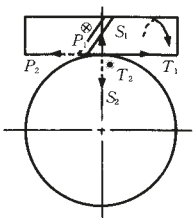
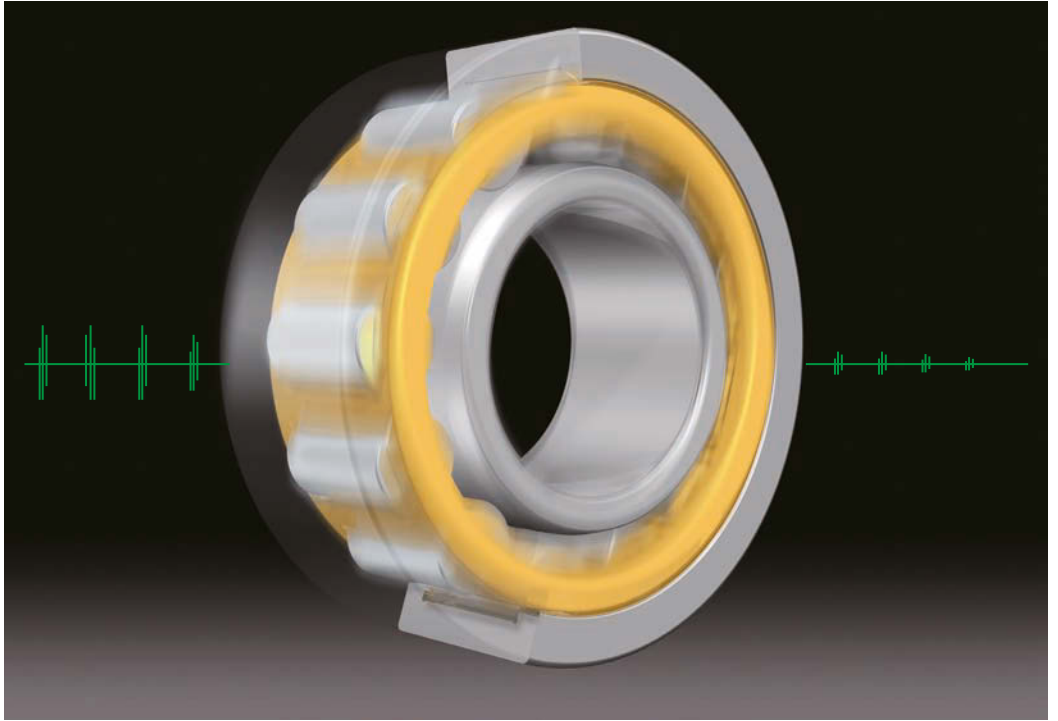


Fig. 4.61 Left Twist Worm Gear (Worm Rotation is Opposite Fig. 4.60)



## 5. SPEEDS

<b>5.1 Limiting Speed (Grease/Oil)</b> .....	A 098
<b>5.1.1 Correction of Limiting Speed (Grease/Oil)</b> .....	A 098
<b>5.1.2 Limiting Speed (Grease/Oil) for Rubber Contact Seals             in Ball Bearings</b> .....	A 099
<b>5.2 Thermal Reference Speed</b> .....	A 099
<b>5.3 Limiting Speed (Mechanical)</b> .....	A 099
<b>5.4 Technical Data</b> .....	A 100
<b>5.4.1 Rotation and Revolution Speed of             Rolling Elements</b> .....	A 100

## 5. SPEEDS

NSK uses four definitions of speed, as shown in Table 5.1.

**Table 5.1 Overview of Speeds**

Speed	Overview	Applicable Lubrication Methods
Limiting Speed (Grease)	Empirically obtained and comprehensive bearing limiting speed when using grease lubrication.	Grease lubrication
Limiting Speed (Oil)	Empirically obtained and comprehensive bearing limiting speed when using oil-bath lubrication.	Oil-bath lubrication
Thermal Reference Speed <sup>(1)</sup>	Rotational speed at which equilibrium is reached between the heat generated by the bearing and the heat flow emitted through the shaft and housing under reference conditions defined by ISO 15312. This is one among various criteria that shows suitability for high-speed operation.	Oil-bath lubrication subject to conditions outlined in ISO 15312
Limiting Speed (Mechanical) <sup>(1)</sup>	Mechanical and kinematic limiting speed achievable under ideal conditions for lubrication, heat dissipation, and temperature.	e.g. Properly designed and controlled forced-circulation oil lubrication

**Note** <sup>(1)</sup> Thermal reference speeds and limiting speed (mechanical) are only listed in the tables for single-row cylindrical roller bearings and spherical roller bearings.

### 5.1 Limiting Speed (Grease/Oil)

When bearings are in operation, the higher the speed, the higher the bearing temperature due to friction. The limiting speed is the empirically obtained value for the maximum speed at which bearings can be continuously operated without generating excessive heat or failing due to seizure. Consequently, the limiting speed of bearings varies depending on such factors as bearing type and size, cage shape and material, load, lubricating method, and heat dissipation of the bearing's surroundings.

The limiting speed (grease) and limiting speed (oil) in the bearing tables are applicable to bearings of standard design subjected to normal loads, i.e.  $C/P \geq 12$  and  $F_a/F_r \leq$  approximately 0.2. The limiting speed (oil) listed in the bearing tables is for conventional oil-bath lubrication.

Some types of lubricants are not suitable for high speed, even though they may be markedly superior in other respects. When speeds are more than 70 percent of the listed limiting speeds, be sure to select a grease or oil with good high speed characteristics.

#### Reference

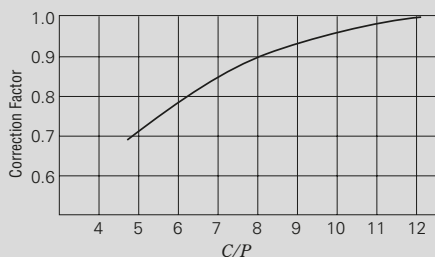
- Table 11.2 Grease Properties (Pages A236 and 237)
- Table 11.5 Example Selection of Lubricant for Bearing Operating Conditions (Page A239)
- Table 11.6 Brands and Properties of Lubricating Grease (Pages A240 and A241)

#### 5.1.1 Correction of Limiting Speed (Grease/Oil)

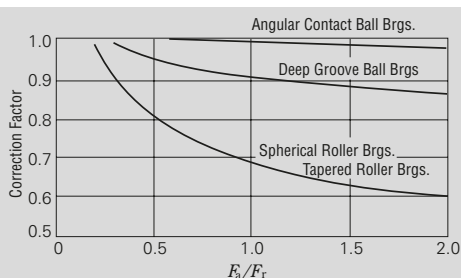
When bearing load  $P$  exceeds 8 % of the basic load rating  $C$ , or when the axial load  $F_a$  exceeds 20 % of the radial load  $F_r$ , the limiting speed (grease) and limiting speed (oil) must be corrected by multiplying the value found in the bearing tables by the correction factor shown in Figs. 5.1 and 5.2.

When the required speed exceeds the limiting speed (oil) of the desired bearing, then the accuracy grade, internal clearance, cage type and material, lubrication, etc. must be carefully studied in order to select a

bearing capable of the required speed. In such a case, forced-circulation oil lubrication, jet lubrication, oil-mist lubrication, or oil-air lubrication must be used. If all these conditions are considered, a corrected maximum permissible speed may be obtained by multiplying the limiting speed (oil) found in the bearing tables by the correction factor shown in table 5.2. Please consult with NSK regarding high-speed applications.



**Fig. 5.1 Limiting Speed Correction Factor Variation With Load Ratio**



**Fig. 5.2 Limiting Speed Correction Factor for Combined Radial and Axial Loads**

**Table 5.2 Limiting Speed Correction Factor for High-Speed Applications**

Bearing Types	Correction Factor
Needle Roller Brgs.(except broad width)	2
Tapered Roller Brgs.	2
Deep Groove Ball Brgs.	2.5
Angular Contact Ball Brgs.(except matched bearings)	1.5

### 5.1.2 Limiting Speed (Grease/Oil) for Rubber Contact Seals in Ball Bearings

The maximum permissible speed for rubber contact sealed bearings (DDU type) is determined mainly by the sliding surface speed of the inner circumference of the seal. Values for the limiting speed are listed in the bearing tables.

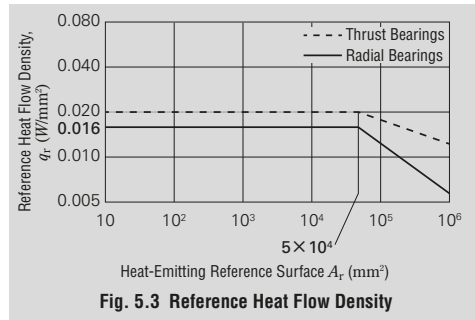
## 5.2 Thermal Reference Speed

The thermal reference speed is the rotational speed at which equilibrium is reached between the heat generated by the bearing and the heat flow emitted through the shaft and housing under reference conditions defined by ISO 15312. This is one among various criteria that shows suitability for operation at high speed.

The reference conditions below are defined by ISO 15312:

- Outer ring: fixed, inner ring: rotating
- Mean ambient temperature: 20 °C
- Mean bearing temperature on outer ring: 70 °C
- Load on radial bearings: 0.05 Cor
- Lubrication: oil bath
- Lubricant: ISO VG32 (radial bearings)
- Normal bearing internal clearance

The amount of heat dissipated through the housing and shaft can be obtained from Fig.5.3. In the figure,  $A_r$  (mm<sup>2</sup>) refers to the reference heat emission surface area. ISO defines  $A_r$  as the total area of the bearing's inner ring bore surface and outer ring outside surface (for radial bearings) and  $q_r$  (W/mm<sup>2</sup>) as the heat flow density. Heat dissipation is calculated by multiplying this surface area ( $A_r$ ) by the heat flow density ( $q_r$ ).



## 5.3 Limiting Speed (Mechanical)

Limiting speed (mechanical) refers to the mechanical and kinematic limiting speed of bearings achievable under ideal lubrication, heat dissipation and temperature conditions, such as with properly designed and controlled forced-circulation oil lubrication for high-speed conditions.

The limiting speed (mechanical) considers the sliding speed and contact forces between the various bearing elements, the centrifugal and gyratory forces, etc. The values in the tables are applicable to standard bearings subjected to normal loads ( $C/P$  = approximately 12).

In the bearing tables for single-row cylindrical roller bearings and spherical roller bearings, the thermal reference speeds, limiting speeds (mechanical) and limiting speeds (grease) are listed. In the bearing tables for other bearing types, limiting speeds (grease) and limiting speeds (oil) are listed.

## 5.4 Technical Data

### 5.4.1 Rotation and Revolution Speed of Rolling Elements

When the rolling element rotates without slippage between the bearing rings, the distance the rolling element rolls on the inner ring raceway is equal to that on the outer ring raceway. This allows for a relationship between inner and outer ring speeds  $n_i$  and  $n_e$  and rolling element rotations  $n_a$ .

The revolution speed of the rolling element can be determined as the arithmetic mean of the circumferential speed on the inner ring raceway and that on the outer ring raceway (generally with either a stationary inner or outer ring). The rotations and revolutions of the rolling elements can be related as expressed by Equations (5.1) through (5.4).

No. of rotations

$$n_a = \left( \frac{D_{pw}}{D_w} - \frac{D_w \cos^2 \alpha}{D_{pw}} \right) \frac{n_e - n_i}{2} \quad (\text{min}^{-1}) \quad (5.1)$$

Rotational circumferential speed

$$v_a = \frac{\pi D_w}{60 \times 10^3} \left( \frac{D_{pw}}{D_w} - \frac{D_w \cos^2 \alpha}{D_{pw}} \right) \frac{n_e - n_i}{2} \quad (\text{m/s}) \quad (5.2)$$

No. of revolutions (No. of cage rotations)

$$n_c = \left( 1 - \frac{D_w \cos \alpha}{D_{pw}} \right) \frac{n_i}{2} + \left( 1 + \frac{D_w \cos \alpha}{D_{pw}} \right) \frac{n_e}{2} \quad (\text{min}^{-1}) \quad (5.3)$$

Revolutional circumferential speed  
(cage speed at rolling element pitch diameter)

$$v_c = \frac{\pi D_{pw}}{60 \times 10^3} \left[ \left( 1 - \frac{D_w \cos \alpha}{D_{pw}} \right) \frac{n_i}{2} + \left( 1 + \frac{D_w \cos \alpha}{D_{pw}} \right) \frac{n_e}{2} \right] (\text{m/s}) \quad (5.4)$$

where  $D_{pw}$ : Pitch diameter of rolling elements (mm)

$D_w$ : Diameter of rolling element (mm)

$\alpha$ : Contact angle ( $^\circ$ )

$n_e$ : Outer ring speed ( $\text{min}^{-1}$ )

$n_i$ : Inner ring speed ( $\text{min}^{-1}$ )

Rotations and revolutions of the rolling elements are shown in Table 5.3 for inner ring rotating ( $n_e = 0$ ) and outer ring rotating ( $n_i = 0$ ) respectively at  $0^\circ \leq \alpha < 90^\circ$  and at  $\alpha = 90^\circ$ .

Table 5.4 shows the rotation speed  $n_a$  and revolution speed  $n_c$  of the rolling elements during inner ring rotation of ball bearings 6210 and 6310.

Contact Angle	Rotation/Revolution Speed
$0^\circ \leq \alpha < 90^\circ$	$n_a$ ( $\text{min}^{-1}$ )
	$v_a$ (m/s)
	$n_c$ ( $\text{min}^{-1}$ )
	$v_c$ (m/s)
$\alpha = 90^\circ$	$n_a$ ( $\text{min}^{-1}$ )
	$v_a$ (m/s)
	$n_c$ ( $\text{min}^{-1}$ )
	$v_c$ (m/s)

**Table 5.4 Rolling Element Rotation Speed  $n_a$  and Revolution Speed  $n_c$  for Ball Bearings 6210 and 6310**

Ball Bearing	$\gamma$	$n_a$	$n_c$
6210	0.181	$-2.67n_i$	$0.41n_i$
6310	0.232	$-2.04n_i$	$0.38n_i$

Remarks  $\gamma = \frac{D_w \cos \alpha}{D_{pw}}$

**Table 5.3 Rolling Element Rotation Speed  $n_a$ , Rotational Circumferential Speed  $v_a$ , Revolution Speed  $n_c$ , and Revolutinal Circumferential Speed  $v_c$** 

Inner Ring Rotation ( $n_c = 0$ )	Outer Ring Rotation ( $n_i = 0$ )
$-\left(\frac{1}{\gamma} - \gamma\right) \frac{n_i}{2} \cdot \cos \alpha$	$\left(\frac{1}{\gamma} - \gamma\right) \frac{n_c}{2} \cdot \cos \alpha$
$\frac{\pi D_w}{60 \times 10^3} n_a$	
$(1 - \gamma) \frac{n_i}{2}$	$(1 + \gamma) \frac{n_c}{2}$
$\frac{\pi D_{pw}}{60 \times 10^3} n_c$	
$-\frac{1}{\gamma} \cdot \frac{n_i}{2}$	$\frac{1}{\gamma} \cdot \frac{n_c}{2}$
$\frac{\pi D_w}{60 \times 10^3} n_a$	
$\frac{n_i}{2}$	$\frac{n_c}{2}$
$\frac{\pi D_{pw}}{60 \times 10^3} n_c$	

**Reference** 1.  $\pm$ : "+" indicates clockwise rotation while "-" indicates counterclockwise rotation.

2.  $\gamma = \frac{D_w \cos \alpha}{D_{pw}}$  ( $0^\circ \leq \alpha < 90^\circ$ ),  $\gamma = \frac{D_w}{D_{pw}}$  ( $\alpha = 90^\circ$ )



## **6. BOUNDARY DIMENSIONS AND BEARING DESIGNATIONS**

<b>6.1</b>	<b>Boundary Dimensions and Dimensions of Snap Ring Grooves .....</b>	<b>A 104</b>
<b>6.1.1</b>	<b>Boundary Dimensions .....</b>	<b>A 104</b>
<b>6.1.2</b>	<b>Dimensions of Snap Ring Grooves and Locating Snap Rings .....</b>	<b>A 104</b>
<b>6.2</b>	<b>Formulation of Bearing Designations .....</b>	<b>A 120</b>

## 6. BOUNDARY DIMENSIONS AND BEARING DESIGNATIONS

### 6.1 Boundary Dimensions and Dimensions of Snap Ring Grooves

#### 6.1.1 Boundary Dimensions

The boundary dimensions of rolling bearings, which are shown in Figs.6.1 through 6.5, refer to the dimensions that define their external geometry. They include bore diameter  $d$ , outside diameter  $D$ , width  $B$ , assembled bearing width(or height)  $T$ , chamfer dimension  $r$ , etc. All of these dimensions are important when mounting a bearing on a shaft and in a housing. These boundary dimensions have been internationally standardized (ISO15) and adopted by JIS B 1512 (*Boundary Dimensions of Rolling Bearings*).

The boundary dimensions and Dimension Series of radial bearings, tapered roller bearings, and thrust bearings are listed in Tables 6.1 to 6.3 (Pages A106 to A115).

These tables list boundary dimensions for each Diameter and Dimension Series by bore number. A very large number of series are possible; however, not all are currently commercially available. Representative bearing types and series designations are shown across the top of the bearing tables (refer to Table 6.5, Bearing Series Designations on Page A121 for more information).

The relative cross-sectional dimensions of radial bearings (excluding tapered roller bearings) and thrust bearings for various series are shown in Figs. 6.6 and 6.7 respectively.

#### 6.1.2 Dimensions of Snap Ring Grooves and Locating Snap Rings

The dimensions of snap ring grooves in the outer surfaces of bearings and the dimensions and accuracy of the locating snap rings themselves are specified by ISO 464. The dimensions of snap ring grooves and locating snap ring for bearings of Diameter Series 8, 9, 0, 2, 3, and 4 are shown in Table 6.4 (Pages A116 to A119).

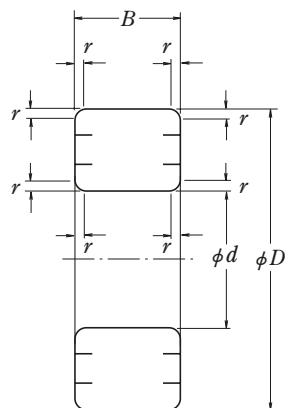


Fig. 6.1 Boundary Dimensions of Radial Ball and Roller Bearings

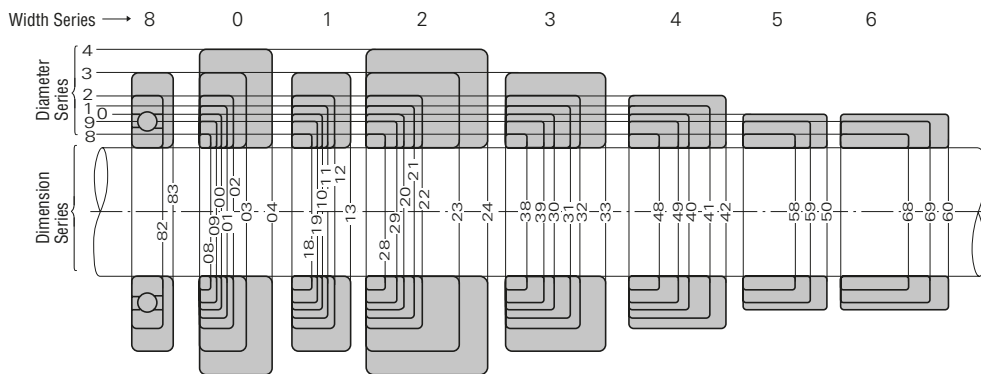


Fig. 6.6 Comparison of Cross Sections of Radial Bearings (Excluding Tapered Roller Bearings) for Various Dimensional Series

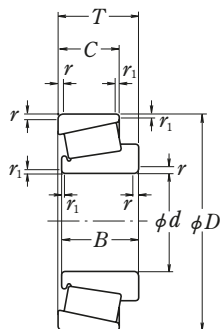


Fig. 6.2 Tapered Roller Bearings

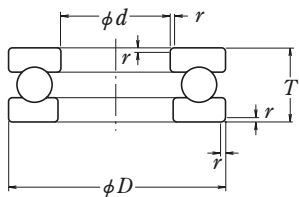


Fig. 6.3 Single-Direction Thrust Ball Bearings

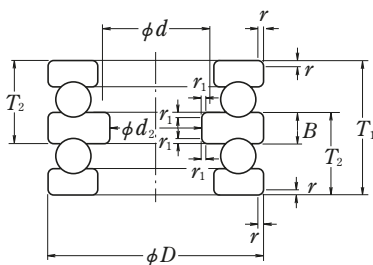


Fig. 6.4 Double-Direction Thrust Ball Bearings

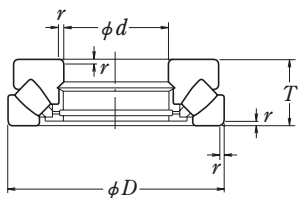


Fig. 6.5 Spherical Thrust Roller Bearings

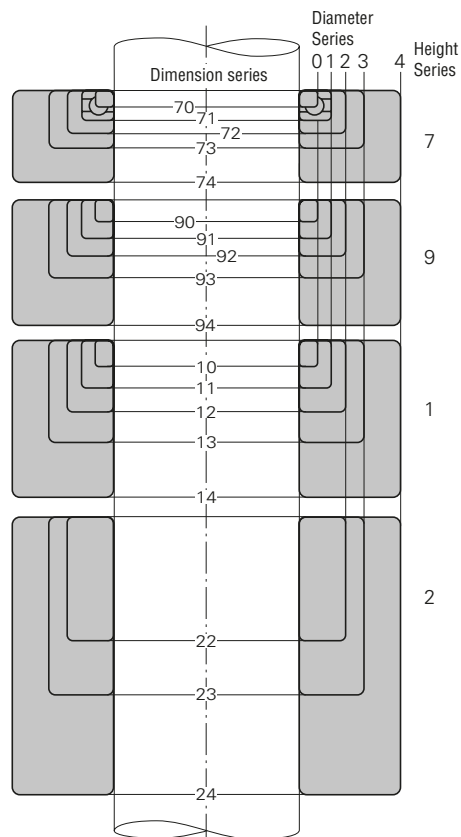


Fig. 6.7 Comparison of Cross Sections of Thrust Bearings (Excluding Diameter Series 5) for Various Dimension Series

Table 6. 1 Boundary Dimensions of Radial Bearings (Excluding Tapered Roller Bearings) — (1)

Bore Number		Diameter Series 7										Diameter Series 8										Diameter Series 9										Diameter Series 0									
		Dimension Series					Dimension Series					Dimension Series					Dimension Series					Dimension Series					Dimension Series					Dimension Series									
		<i>r</i> (min.)					<i>r</i> (min.)					<i>r</i> (min.)					<i>r</i> (min.)					<i>r</i> (min.)					<i>r</i> (min.)					<i>r</i> (min.)									
		<i>D</i>	17	27	37	17~37	<i>D</i>	08	18	28	38	48	58	68	08	18~68	<i>D</i>	09	19	29	39	49	59	69	09	19~39	49~69	<i>D</i>	00	10	20	30	40	50	60	00	10~60				
—	0.6	2	0.8	—	—	0.05	2.5	—	1	—	1.4	—	—	—	—	0.05	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
1	1.5	3	1	—	—	0.05	3	—	1.2	—	1.5	—	—	—	—	0.05	5	—	1.6	—	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
2	4	1.2	2	—	—	0.05	5	—	1.5	—	2.3	—	—	—	—	0.08	6	—	2.3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
3	6	2	2.5	3	0.8	7	2	—	2	—	2.6	—	—	—	—	0.08	7	—	2.5	3.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
4	4	7	2.5	3	0.8	9	—	—	3.5	4	—	—	—	—	—	0.1	11	—	4	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
5	8	2.5	3	—	—	0.15	11	—	3	4	5	—	—	—	—	0.15	13	—	4	6	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
6	10	2.5	3	—	—	0.1	13	—	3.5	5	6	—	—	—	—	0.15	15	—	5	7	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
7	11	2.5	3	—	—	0.15	14	—	3.5	5	6	8	—	—	—	0.15	17	—	5	7	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
8	12	2.5	—	—	—	0.2	16	—	4	5	6	8	—	—	—	0.2	19	—	6	9	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
9	14	3	—	—	—	0.1	17	—	4	5	6	8	—	—	—	0.2	20	—	6	9	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
00	10	15	3	—	—	0.1	19	—	5	6	7	9	—	—	—	0.3	22	—	6	8	10	13	16	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
01	12	18	4	—	—	0.2	21	—	5	6	7	9	—	—	—	0.3	24	—	6	8	10	13	16	22	30	—	—	—	—	—	—	—	—	—	—	—	—	—			
02	15	21	4	—	—	0.2	24	—	5	6	7	9	—	—	—	0.3	28	—	7	8	10	13	18	23	30	—	—	—	—	—	—	—	—	—	—	—	—	—			
03	17	23	4	—	—	0.2	26	—	5	6	7	9	—	—	—	0.3	30	—	7	8	10	13	18	23	30	—	—	—	—	—	—	—	—	—	—	—	—	—			
04	20	27	4	—	—	0.2	32	—	7	8	10	12	16	22	30	0.3	37	—	7	9	11	13	17	23	30	—	—	—	—	—	—	—	—	—	—	—	—	—			
05	22	—	—	—	—	0.3	34	—	7	10	—	16	22	30	0.3	39	—	7	9	11	13	17	23	30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		
06	25	32	4	—	—	0.2	37	4	7	8	10	12	16	22	30	0.3	42	7	9	11	13	17	23	30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		
07	35	—	—	—	—	—	40	4	7	—	10	—	16	22	30	0.3	45	7	9	11	13	17	23	30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		
08	38	37	4	—	—	0.2	42	4	7	8	10	12	16	22	30	0.3	47	7	9	11	13	17	23	30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		
09	45	—	—	—	—	—	44	4	7	—	10	—	16	22	30	0.3	52	7	10	13	15	20	27	36	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
10	50	—	—	—	—	—	52	4	7	8	10	12	16	22	30	0.3	55	7	10	13	15	20	27	36	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
11	55	—	—	—	—	—	58	4	7	8	10	13	18	23	30	0.3	62	8	12	14	16	22	30	40	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
12	60	—	—	—	—	—	72	7	9	11	13	17	23	30	0.3	80	8	12	14	16	22	30	40	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
13	65	—	—	—	—	—	85	7	10	12	14	18	24	32	0.3	85	9	13	16	19	25	34	45	0.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
14	70	—	—	—	—	—	90	8	10	13	15	20	27	36	0.3	90	9	13	16	19	25	34	45	0.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
15	75	—	—	—	—	—	100	9	10	13	15	20	27	36	0.3	100	10	16	19	23	30	40	54	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
16	80	—	—	—	—	—	110	8	10	13	15	20	27	36	0.3	105	10	16	19	23	30	40	54	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
17	85	—	—	—	—	—	110	9	13	16	19	25	34	45	0.3	120	11	18	22	26	35	46	63	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
18	90	—	—	—	—	—	115	9	13	16	19	25	34	45	0.3	125	11	18	22	26	35	46	63	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
19	95	—	—	—	—	—	120	9	13	16	19	25	34	45	0.3	130	11	18	22	26	35	46	63	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
20	100	—	—	—	—	—	125	9	13	16	19	25	34	45	0.3	140	13	20	24	30	40	54	71	0.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		

Units: mm

[illegible]

**Remarks** The chamfer dimensions listed in this table do not necessarily apply to the following:

- (a) Chamfers of grooves in outer rings with snap ring grooves  
(b) Chamfers on a side without ribs in thin-section cylindrical roller bearings  
(c) Chamfers on the front-facing side in angular contact ball bearings  
(d) Chamfers on inner rings in bearings with tapered bores



21	105	175	22	33	42	56	69	1.1	2	190	27	36	—	50	65.1	85	1.5	2.1	225	37	49	53	77	87.3	2.1	3	260	60	100	4
22	110	180	22	33	42	56	69	1.1	2	200	28	38	—	53	69.8	90	1.5	2.1	240	44	50	57	80	92.1	3	3	280	65	108	4
24	120	200	25	38	48	62	80	1.5	2	215	40	42	40	58	76	95	—	2.1	260	44	55	62	86	106	3	3	310	72	118	5
26	130	210	25	38	48	64	80	1.5	2	230	—	40	46	64	80	100	—	3	280	48	58	66	93	112	3	4	340	76	128	5
28	140	225	27	40	50	68	85	1.5	2.1	250	—	42	50	68	88	109	—	3	300	50	62	70	102	118	4	4	360	82	132	5
30	150	250	31	46	60	80	100	2	2.1	270	—	45	54	73	96	118	—	3	320	—	65	75	108	128	—	4	380	85	138	5
32	160	270	34	51	66	86	109	2	2.1	290	—	48	58	80	104	128	—	3	340	—	68	79	114	136	—	4	400	88	142	5
34	170	280	34	51	66	88	109	2.1	3	310	—	52	62	86	110	140	—	4	360	—	72	84	120	140	—	4	420	92	145	5
36	180	300	37	56	72	96	118	2.1	3	320	—	52	62	86	112	140	—	4	380	—	75	88	126	150	—	4	440	95	150	6
38	190	320	40	60	78	104	128	3	3	340	—	55	65	92	120	150	—	4	400	—	78	92	132	155	—	5	460	98	155	6
40	200	340	44	65	88	112	140	3	3	360	—	58	70	98	128	168	—	4	420	—	80	97	135	160	—	5	480	102	160	6
42	210	360	46	68	90	114	144	3	4	400	—	65	78	108	144	180	—	4	460	—	88	106	145	180	—	5	540	115	180	6
44	220	370	48	69	92	116	146	3	4	440	—	72	85	120	160	200	—	5	500	—	95	114	155	195	—	5	580	122	190	6
46	230	380	50	74	95	128	160	4	4	480	—	80	90	130	174	218	—	5	540	—	102	123	165	206	—	6	620	132	206	7.5
48	240	400	50	74	95	128	160	4	4	500	—	80	90	130	176	218	—	5	580	—	108	132	175	224	—	6	670	140	224	7.5
50	250	420	52	76	102	136	172	4	5	540	—	85	98	140	192	243	—	5	620	—	109	140	185	236	—	7.5	710	150	236	7.5
52	260	440	57	82	106	146	180	4	5	580	—	92	105	150	208	258	—	5	670	—	112	155	200	258	—	7.5	750	155	250	9.5
54	270	460	57	82	106	146	180	4	5	620	—	92	118	165	224	280	—	6	710	—	118	165	212	272	—	7.5	800	165	265	9.5
56	280	480	57	82	106	146	180	4	5	650	—	95	122	170	232	290	—	6	750	—	125	170	224	300	—	7.5	850	180	280	9.5
58	290	500	58	84	108	150	190	5	5	680	—	95	132	175	240	300	—	6	780	—	128	175	230	300	—	7.5	900	190	300	9.5
60	300	520	58	84	108	150	190	5	5	720	—	103	140	185	256	315	—	6	820	—	136	185	243	308	—	7.5	950	200	315	12
62	310	540	60	88	112	156	200	5	5	760	—	109	150	195	272	335	—	7.5	850	—	136	190	250	315	—	9.5	980	206	325	12
64	320	560	61	88	112	156	200	5	5	790	—	112	155	200	280	345	—	7.5	900	—	145	200	265	345	—	9.5	1030	212	335	12
66	330	580	61	88	112	156	200	5	5	830	—	118	165	212	296	365	—	7.5	950	—	155	212	280	365	—	9.5	1060	218	345	12
68	340	600	62	90	120	160	210	5	5	870	—	125	170	224	310	388	—	7.5	980	—	160	218	290	375	—	9.5	1120	220	365	15
70	350	620	63	90	120	160	210	5	5	920	—	136	185	243	336	412	—	7.5	1030	—	170	230	300	388	—	12	1150	236	375	15
72	360	640	63	90	120	160	210	5	5	960	—	145	200	258	355	450	—	9.5	1090	—	180	243	325	412	—	12	1220	250	400	15
74	370	660	63	90	120	160	210	5	5	1030	—	150	206	272	365	475	—	9.5	1150	—	190	258	335	438	—	12	1280	258	412	15
76	380	680	63	90	120	160	210	5	5	1090	—	155	212	280	388	488	—	9.5	1220	—	200	272	355	462	—	15	1360	272	438	15
78	390	700	63	90	120	160	210	5	5	1150	—	165	230	300	412	515	—	12	1280	—	206	280	375	488	—	15	1420	280	450	15
80	400	720	63	90	120	160	210	5	5	1220	—	175	243	315	438	545	—	12	1360	—	218	300	400	515	—	15	1500	290	475	15
82	410	740	63	90	120	160	210	5	5	1280	—	180	250	325	450	560	—	12	1420	—	224	308	412	530	—	15	—	—	—	—
84	420	760	63	90	120	160	210	5	5	1360	—	195	265	345	475	615	—	15	1500	—	236	325	438	560	—	15	—	—	—	—
86	430	780	63	90	120	160	210	5	5	1380	—	195	265	345	475	615	—	15	1500	—	236	325	438	560	—	15	—	—	—	—
88	440	800	63	90	120	160	210	5	5	1420	—	200	272	355	488	615	—	15	1600	—	258	355	462	600	—	15	—	—	—	—
90	450	820	63	90	120	160	210	5	5	1500	—	206	280	375	515	670	—	15	1700	—	272	375	488	630	—	19	—	—	—	—
92	460	840	63	90	120	160	210	5	5	1580	—	218	300	388	515	670	—	15	1780	—	280	388	500	650	—	19	—	—	—	—
94	470	860	63	90	120	160	210	5	5	1660	—	230	315	412	530	710	—	15	1850	—	290	400	515	670	—	19	—	—	—	—
96	480	880	63	90	120	160	210	5	5	1750	—	243	330	425	560	750	—	15	1950	—	300	412	545	710	—	—	—	—	—	—
98	490	900	63	90	120	160	210	5	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
100	1000	1580	175	243	315	438	545	12	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1020	1060	1660	190	265	345	475	600	12	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1080	1120	1750	—	280	365	475	630	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1100	1180	1850	—	280	365	475	630	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1120	1240	1950	—	308	400	530	710	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1140	1300	2060	—	325	425	560	750	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1160	1360	2180	—	345	450	580	775	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1180	1420	2300	—	365	462	600	800	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Remarks The chamfer dimensions listed in this table do not necessarily apply to the following:

- (a) Chamfers of grooves in outer rings with snap ring grooves  
 (b) Chamfers on a side without ribs in thin-section cylindrical roller bearings  
 (c) Chamfers on the front-facing side in angular contact ball bearings  
 (d) Chamfers on inner rings in bearings with tapered bores

**Table 6. 2 Boundary Dimensions of**

Tapered Roller Bearings		329										320 X				330				331									
Bore Number	<i>d</i>	Diameter Series 9										Diameter Series 0										Diameter Series 1							
		<i>D</i>	Dimension Series 29						Chamfer Dimension		<i>D</i>	Dimension Series			Dimension Series			Chamfer Dimension		<i>D</i>	Dimension Series			Chamfer Dimension					
			I			II			I.R.	O.R.		20			30			I.R.	O.R.		31			I.R.	O.R.				
			<i>B</i>	<i>C</i>	<i>T</i>	<i>B</i>	<i>C</i>	<i>T</i>	<i>r</i> (min.)	<i>B</i>		<i>C</i>	<i>T</i>	<i>B</i>	<i>C</i>	<i>T</i>	<i>r</i> (min.)	<i>B</i>	<i>C</i>		<i>T</i>	<i>r</i> (min.)							
00	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
01	12	—	—	—	—	—	—	—	—	—	28	11	—	—	11	13	—	—	—	—	—	—	—	—	—	—	—	—	—
02	15	—	—	—	—	—	—	—	—	—	32	12	—	—	12	14	—	—	13	0.3	0.3	—	—	—	—	—	—	—	—
03	17	—	—	—	—	—	—	—	—	—	35	13	—	—	13	15	—	—	15	0.3	0.3	—	—	—	—	—	—	—	—
04	20	37	11	—	11.6	12	9	12	0.3	0.3	42	15	12	15	17	—	—	17	0.6	0.6	—	—	—	—	—	—	—	—	—
/22	22	40	—	—	—	12	9	12	0.3	0.3	44	15	11.5	15	—	—	—	—	0.6	0.6	—	—	—	—	—	—	—	—	—
05	25	42	11	—	11.6	12	9	12	0.3	0.3	47	15	11.5	15	17	14	17	0.6	0.6	—	—	—	—	—	—	—	—	—	—
/28	28	45	—	—	—	12	9	12	0.3	0.3	52	16	12	16	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
06	30	47	11	—	11.6	12	9	12	0.3	0.3	55	17	13	17	20	16	20	1	1	—	—	—	—	—	—	—	—	—	—
/32	32	52	—	—	—	15	10	14	0.6	0.6	58	17	13	17	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
07	35	55	13	—	14	14	11.5	14	0.6	0.6	62	18	14	18	21	17	21	1	1	—	—	—	—	—	—	—	—	—	—
08	40	62	14	—	15	15	12	15	0.6	0.6	68	19	14.5	19	22	18	22	1	1	75	26	20.5	26	1.5	1.5	—	—	—	—
09	45	68	14	—	15	15	12	15	0.6	0.6	75	20	15.5	20	24	19	24	1	1	80	26	20.5	26	1.5	1.5	—	—	—	—
10	50	72	14	—	15	15	12	15	0.6	0.6	80	20	15.5	20	24	19	24	1	1	85	26	20	26	1.5	1.5	—	—	—	—
11	55	80	16	—	17	17	14	17	1	1	90	23	17.5	23	27	21	27	1.5	1.5	95	30	23	30	1.5	1.5	—	—	—	—
12	60	85	16	—	17	17	14	17	1	1	95	23	17.5	23	27	21	27	1.5	1.5	100	30	23	30	1.5	1.5	—	—	—	—
13	65	90	16	—	17	17	14	17	1	1	100	23	17.5	23	27	21	27	1.5	1.5	110	34	26.5	34	1.5	1.5	—	—	—	—
14	70	100	19	—	20	20	16	20	1	1	110	25	19	25	31	25.5	31	1.5	1.5	120	37	29	37	2	1.5	—	—	—	—
15	75	105	19	—	20	20	16	20	1	1	115	25	19	25	31	25.5	31	1.5	1.5	125	37	29	37	2	1.5	—	—	—	—
16	80	110	19	—	20	20	16	20	1	1	125	29	22	29	36	29.5	36	1.5	1.5	130	37	29	37	2	1.5	—	—	—	—
17	85	120	22	—	23	23	18	23	1.5	1.5	130	29	22	29	36	29.5	36	1.5	1.5	140	41	32	41	2.5	2	—	—	—	—
18	90	125	22	—	23	23	18	23	1.5	1.5	140	32	24	32	39	32.5	39	2	1.5	150	45	35	45	2.5	2	—	—	—	—
19	95	130	22	—	23	23	18	23	1.5	1.5	145	32	24	32	39	32.5	39	2	1.5	160	49	38	49	2.5	2	—	—	—	—
20	100	140	24	—	25	25	20	25	1.5	1.5	150	32	24	32	39	32.5	39	2	1.5	165	52	40	52	2.5	2	—	—	—	—
21	105	145	24	—	25	25	20	25	1.5	1.5	160	35	26	35	43	34	43	2.5	2	175	56	44	56	2.5	2	—	—	—	—
22	110	150	24	—	25	25	20	25	1.5	1.5	170	38	29	38	47	37	47	2.5	2	180	56	43	56	2.5	2	—	—	—	—
24	120	165	27	—	29	29	23	29	1.5	1.5	180	38	29	38	48	38	48	2.5	2	200	62	48	62	2.5	2	—	—	—	—
26	130	180	30	—	32	32	25	32	2	1.5	200	45	34	45	55	43	55	2.5	2	—	—	—	—	—	—	—	—	—	—
28	140	190	30	—	32	32	25	32	2	1.5	210	45	34	45	56	44	56	2.5	2	—	—	—	—	—	—	—	—	—	—
30	150	210	36	—	38	38	30	38	2.5	2	225	48	36	48	59	46	59	3	2.5	—	—	—	—	—	—	—	—	—	—
32	160	220	36	—	38	38	30	38	2.5	2	240	51	38	51	—	—	—	3	2.5	—	—	—	—	—	—	—	—	—	—
34	170	230	36	—	38	38	30	38	2.5	2	260	57	43	57	—	—	—	3	2.5	—	—	—	—	—	—	—	—	—	—
36	180	250	42	—	45	45	34	45	2.5	2	280	64	48	64	—	—	—	3	2.5	—	—	—	—	—	—	—	—	—	—
38	190	260	42	—	45	45	34	45	2.5	2	290	64	48	64	—	—	—	3	2.5	—	—	—	—	—	—	—	—	—	—
40	200	280	48	—	51	51	39	51	3	2.5	310	70	53	70	—	—	—	3	2.5	—	—	—	—	—	—	—	—	—	—
44	220	300	48	—	51	51	39	51	3	2.5	340	76	57	76	—	—	—	4	3	—	—	—	—	—	—	—	—	—	—
48	240	320	48	—	51	51	39	51	3	2.5	360	76	57	76	—	—	—	4	3	—	—	—	—	—	—	—	—	—	—
52	260	360	—	—	—	63.5	48	63.5	3	2.5	400	87	65	87	—	—	—	5	4	—	—	—	—	—	—	—	—	—	—
56	280	380	—	—	—	63.5	48	63.5	3	2.5	420	87	65	87	—	—	—	5	4	—	—	—	—	—	—	—	—	—	—
60	300	420	—	—	—	76	57	76	4	3	460	100	74	100	—	—	—	5	4	—	—	—	—	—	—	—	—	—	—
64	320	440	—	—	—	76	57	76	4	3	480	100	74	100	—	—	—	5	4	—	—	—	—	—	—	—	—	—	—
68	340	460	—	—	—	76	57	76	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
72	360	480	—	—	—	76	57	76	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

- Remarks**
1. Other Series not conforming to this table are also specified by ISO.
  2. In Diameter Series 9, Classification I refers to specifications of the old standard, while Classification II refers to those specified by ISO. Dimension Series without classifications conform to dimensions (D, B, C, T) specified by ISO.
  3. The chamfer dimensions listed are the minimum permissible dimensions specified by ISO. They do not apply to chamfers on the front face.

## Tapered Roller Bearings

Units: mm

302				322				332				303 or 303D				313				323				Tapered Roller Bearings			
Diameter Series 2												Diameter Series 3												d	Bore Number		
D	Dimension Series 02			Dimension Series 22			Dimension Series 32			Chamfer Dimension I.R. O.R.		D	Dimension Series 03				Dimension Series 13			Dimension Series 23			Chamfer Dimension I.R. O.R.				
	B	C	T	B	C	T	B	C	T	r (min.)	B		C	C (1)	T	B	C	T	B	C	T	r (min.)					
30	9	—	9.7	14	—	14.7	—	—	—	0.6	0.6	35	11	—	—	11.9	—	—	—	17	—	17.9	0.6	0.6	10	00	
32	10	9	10.75	14	—	14.75	—	—	—	0.6	0.6	37	12	—	—	12.9	—	—	—	17	—	17.9	1	1	12	01	
35	11	10	11.75	14	—	14.75	—	—	—	0.6	0.6	42	13	11	—	14.25	—	—	—	17	14	18.25	1	1	15	02	
40	12	11	13.25	16	14	17.25	—	—	—	1	1	47	14	12	—	15.25	—	—	—	19	16	20.25	1	1	17	03	
47	14	12	15.25	18	15	19.25	—	—	—	1	1	52	15	13	—	16.25	—	—	—	21	18	22.25	1.5	1.5	20	04	
50	14	12	15.25	18	15	19.25	—	—	—	1	1	56	16	14	—	17.25	—	—	—	21	18	22.25	1.5	1.5	22	/22	
52	15	13	16.25	18	15	19.25	22	18	22	1	1	62	17	15	13	18.25	—	—	—	24	20	25.25	1.5	1.5	25	05	
58	16	14	17.25	19	16	20.25	24	19	24	1	1	68	18	15	14	19.75	—	—	—	24	20	25.75	1.5	1.5	28	/28	
62	16	14	17.25	20	17	21.25	25	19.5	25	1	1	72	19	16	14	20.75	—	—	—	27	23	28.75	1.5	1.5	30	06	
65	17	15	18.25	21	18	22.25	26	20.5	26	1	1	75	20	17	15	21.75	—	—	—	28	24	29.75	1.5	1.5	32	/32	
72	17	15	18.25	23	19	24.25	28	22	28	1.5	1.5	80	21	18	15	22.75	—	—	—	31	25	32.75	2	1.5	35	07	
80	18	16	19.75	23	19	24.75	32	25	32	1.5	1.5	90	23	20	17	25.25	—	—	—	33	27	35.25	2	1.5	40	08	
85	19	16	20.75	23	19	24.75	32	25	32	1.5	1.5	100	25	22	18	27.25	—	—	—	36	30	38.25	2	1.5	45	09	
90	20	17	21.75	23	19	24.75	32	24.5	32	1.5	1.5	110	27	23	19	29.25	—	—	—	40	33	42.25	2.5	2	50	10	
100	21	18	22.75	25	21	26.75	35	27	35	2	1.5	120	29	25	21	31.5	—	—	—	43	35	45.5	2.5	2	55	11	
110	22	19	23.75	28	24	29.75	38	29	38	2	1.5	130	31	26	22	33.5	—	—	—	46	37	48.5	3	2.5	60	12	
120	23	20	24.75	31	27	32.75	41	32	41	2	1.5	140	33	28	23	36	—	—	—	48	39	51	3	2.5	65	13	
125	24	21	26.25	31	27	33.25	41	32	41	2	1.5	150	35	30	25	38	—	—	—	51	42	54	3	2.5	70	14	
130	25	22	27.25	31	27	33.25	41	31	41	2	1.5	160	37	31	26	40	—	—	—	55	45	58	3	2.5	75	15	
140	26	22	28.25	33	28	35.25	46	35	46	2.5	2	170	39	33	27	42.5	—	—	—	58	48	61.5	3	2.5	80	16	
150	28	24	30.5	36	30	38.5	49	37	49	2.5	2	180	41	34	28	44.5	—	—	—	60	49	63.5	4	3	85	17	
160	30	26	32.5	40	34	42.5	55	42	55	2.5	2	190	43	36	30	46.5	—	—	—	64	53	67.5	4	3	90	18	
170	32	27	34.5	43	37	45.5	58	44	58	3	2.5	200	45	38	32	49.5	—	—	—	67	55	71.5	4	3	95	19	
180	34	29	37	46	39	49	63	48	63	3	2.5	215	47	39	—	51.5	51	35	56.5	73	60	77.5	4	3	100	20	
190	36	30	39	50	43	53	68	52	68	3	2.5	225	49	41	—	53.5	53	36	58	77	63	81.5	4	3	105	21	
200	38	32	41	53	46	56	—	—	—	3	2.5	240	50	42	—	54.5	57	38	63	80	65	84.5	4	3	110	22	
215	40	34	43.5	58	50	61.5	—	—	—	3	2.5	260	55	46	—	59.5	62	42	68	86	69	90.5	4	3	120	24	
230	40	34	43.75	64	54	67.75	—	—	—	4	3	280	58	49	—	63.75	66	44	72	93	78	98.75	5	4	130	26	
250	42	36	45.75	68	58	71.75	—	—	—	4	3	300	62	53	—	67.75	70	47	77	102	85	107.75	5	4	140	28	
270	45	38	49	73	60	77	—	—	—	4	3	320	65	55	—	72	75	50	82	108	90	114	5	4	150	30	
290	48	40	52	80	67	84	—	—	—	4	3	340	68	58	—	75	79	—	87	114	95	121	5	4	160	32	
310	52	43	57	86	71	91	—	—	—	5	4	360	72	62	—	80	84	—	92	120	100	127	5	4	170	34	
320	52	43	57	86	71	91	—	—	—	5	4	380	75	64	—	83	88	—	97	126	106	134	5	4	180	36	
340	55	46	60	92	75	97	—	—	—	5	4	400	78	65	—	86	92	—	101	132	109	140	6	5	190	38	
360	58	48	64	98	82	104	—	—	—	5	4	420	80	67	—	89	97	—	107	138	115	146	6	5	200	40	
400	65	54	72	108	90	114	—	—	—	5	4	460	88	73	—	97	106	—	117	145	122	154	6	5	220	44	
440	72	60	79	120	100	127	—	—	—	5	4	500	95	80	—	105	114	—	125	155	132	165	6	5	240	48	
480	80	67	89	130	106	137	—	—	—	6	5	540	102	85	—	113	123	—	135	165	136	176	6	6	260	52	
500	80	67	89	130	106	137	—	—	—	6	5	580	108	90	—	119	132	—	145	175	145	187	6	6	280	56	
540	85	71	96	140	115	149	—	—	—	6	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	300	60
580	92	75	104	150	125	159	—	—	—	6	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	320	64
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	340	68
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	360	72

**Table 6. 3 Boundary Dimensions of**

Thrust Ball Brgs.										511					512	522					
Spherical Thrust Roller Brgs.														292							
Bore Number	<i>d</i>	Diameter Series 0					Diameter Series 1					Diameter Series 2									
		<i>D</i>	Dimension Series			<i>r</i> (min.)	<i>D</i>	Dimension Series			<i>r</i> (min.)	<i>D</i>	Dimension Series						<i>r</i> (min.)	<i>r</i> <sub>1</sub> (min.)	
			70	90	10			71	91	11			72	92	12	22	22				
																	<i>T</i>				Central Washer
						<i>T</i>				<i>T</i>		<i>d</i> <sub>2</sub>		<i>B</i>							
4	4	12	4	—	6	0.3	—	—	—	—	16	6	—	8	—	—	—	0.3	—		
6	6	16	5	—	7	0.3	—	—	—	—	20	6	—	9	—	—	—	0.3	—		
8	8	18	5	—	7	0.3	—	—	—	—	22	6	—	9	—	—	—	0.3	—		
00	10	20	5	—	7	0.3	24	6	—	9	0.3	26	7	—	11	—	—	—	0.6	—	
01	12	22	5	—	7	0.3	26	6	—	9	0.3	28	7	—	11	—	—	—	0.6	—	
02	15	26	5	—	7	0.3	28	6	—	9	0.3	32	8	—	12	22	10	5	0.6	0.3	
03	17	28	5	—	7	0.3	30	6	—	9	0.3	35	8	—	12	—	—	—	0.6	—	
04	20	32	6	—	8	0.3	35	7	—	10	0.3	40	9	—	14	26	15	6	0.6	0.3	
05	25	37	6	—	8	0.3	42	8	—	11	0.6	47	10	—	15	28	20	7	0.6	0.3	
06	30	42	6	—	8	0.3	47	8	—	11	0.6	52	10	—	16	29	25	7	0.6	0.3	
07	35	47	6	—	8	0.3	52	8	—	12	0.6	62	12	—	18	34	30	8	1	0.3	
08	40	52	6	—	9	0.3	60	9	—	13	0.6	68	13	—	19	36	30	9	1	0.6	
09	45	60	7	—	10	0.3	65	9	—	14	0.6	73	13	—	20	37	35	9	1	0.6	
10	50	65	7	—	10	0.3	70	9	—	14	0.6	78	13	—	22	39	40	9	1	0.6	
11	55	70	7	—	10	0.3	78	10	—	16	0.6	90	16	21	25	45	45	10	1	0.6	
12	60	75	7	—	10	0.3	85	11	—	17	1	95	16	21	26	46	50	10	1	0.6	
13	65	80	7	—	10	0.3	90	11	—	18	1	100	16	21	27	47	55	10	1	0.6	
14	70	85	7	—	10	0.3	95	11	—	18	1	105	16	21	27	47	55	10	1	1	
15	75	90	7	—	10	0.3	100	11	—	19	1	110	16	21	27	47	60	10	1	1	
16	80	95	7	—	10	0.3	105	11	—	19	1	115	16	21	28	48	65	10	1	1	
17	85	100	7	—	10	0.3	110	11	—	19	1	125	18	24	31	55	70	12	1	1	
18	90	105	7	—	10	0.3	120	14	—	22	1	135	20	27	35	62	75	14	1.1	1	
20	100	120	9	—	14	0.6	135	16	21	25	1	150	23	30	38	67	85	15	1.1	1	
22	110	130	9	—	14	0.6	145	16	21	25	1	160	23	30	38	67	95	15	1.1	1	
24	120	140	9	—	14	0.6	155	16	21	25	1	170	23	30	39	68	100	15	1.1	1.1	
26	130	150	9	—	14	0.6	170	18	24	30	1	190	27	36	45	80	110	18	1.5	1.1	
28	140	160	9	—	14	0.6	180	18	24	31	1	200	27	36	46	81	120	18	1.5	1.1	
30	150	170	9	—	14	0.6	190	18	24	31	1	215	29	39	50	89	130	20	1.5	1.1	
32	160	180	9	—	14	0.6	200	18	24	31	1	225	29	39	51	90	140	20	1.5	1.1	
34	170	190	9	—	14	0.6	215	20	27	34	1.1	240	32	42	55	97	150	21	1.5	1.1	
36	180	200	9	—	14	0.6	225	20	27	34	1.1	250	32	42	56	98	150	21	1.5	2	
38	190	215	11	—	17	1	240	23	30	37	1.1	270	36	48	62	109	160	24	2	2	
40	200	225	11	—	17	1	250	23	30	37	1.1	280	36	48	62	109	170	24	2	2	
44	220	250	14	—	22	1	270	23	30	37	1.1	300	36	48	63	110	190	24	2	2	
48	240	270	14	—	22	1	300	27	36	45	1.5	340	45	60	78	—	—	—	2.1	—	
52	260	290	14	—	22	1	320	27	36	45	1.5	360	45	60	79	—	—	—	2.1	—	
56	280	310	14	—	22	1	350	32	42	53	1.5	380	45	60	80	—	—	—	2.1	—	
60	300	340	18	24	30	1	380	36	48	62	2	420	54	73	95	—	—	—	3	—	
64	320	360	18	24	30	1	400	36	48	63	2	440	54	73	95	—	—	—	3	—	

**Remarks**

1. Dimension Series 22, 23, and 24 are double-direction bearings.
2. The maximum permissible outside diameter of shaft and central washers and minimum permissible bore diameter of housing washers are omitted here (refer to the bearing tables for thrust bearings).

## Thrust Bearings (Flat Seats) — (1)

Units: mm

			513	523						514	524							Thrust Ball Brgs.				
		293							294									Spherical Thrust Roller Brgs.				
Diameter Series 3								Diameter Series 4								Diameter Series 5			Bore Number			
D	Dimension Series					<i>r</i> (min.)	<i>r</i> <sub>1</sub> (min.)	D	Dimension Series					<i>r</i> (min.)	<i>r</i> <sub>1</sub> (min.)	D	Dimension Series	<i>r</i> (min.)				
	73	93	13	23	23				74	94	14	24	24							95		
	T				Central Washer				T				Central Washer							T		
					<i>d</i> <sub>2</sub>								B								<i>d</i> <sub>2</sub>	B
20 24 26	7 8 8	— — —	11 12 12	— — —	— — —	0.6 0.6 0.6	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	4 6 8	4 6 8				
30 32 37	9 9 10	— — —	14 14 15	— — —	— — —	0.6 0.6 0.6	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	10 12 15	00 01 02				
40 47 52	10 12 12	— — —	16 18 18	— — 34	— — 20	— 1 8	0.6 1 0.3	— — 60	— — 16	— — 21	— — 24	— — 45	— — 15	— — 11	— — 1	— — 0.6	52 60 73	21 24 29	1 1.1 1.1			
60 68 78	14 15 17	— — 22	21 24 26	38 44 49	25 30 30	9 10 12	1 0.3 1	0.3 0.3 0.6	70 80 90	18 20 23	24 27 30	28 32 36	52 59 65	20 25 30	12 14 15	1 1.1 1.1	0.6 0.6 0.6	85 100 110	34 39 42	1.1 1.5 1.5		
85 95 105	18 20 23	24 27 30	28 31 35	52 58 64	35 40 45	12 14 15	1 1.1 1.1	0.6 0.6 0.6	100 110 120	25 27 29	34 36 39	39 43 48	72 78 87	35 40 45	17 18 20	1.1 1.5 1.5	0.6 0.6 0.6	120 135 150	45 51 58	2 2 2.1		
110 115 125	23 23 25	30 30 34	35 36 40	64 65 72	50 55 55	15 15 16	1.1 1.1 1.1	0.6 0.6 1	130 140 150	32 34 36	42 45 48	51 56 60	93 101 107	50 50 55	21 23 24	1.5 2 2	0.6 1 1	160 170 180	60 63 67	2.1 2.1 3		
135 140 150	27 27 29	36 36 39	44 44 49	79 79 87	60 65 70	18 18 19	1.5 1.5 1.5	1 1 1	160 170 180	38 41 42	51 54 58	65 68 72	115 120 128	60 65 65	26 27 29	2 2.1 2.1	1 1 1.1	190 200 215	69 73 78	3 3 4		
155 170 190	29 32 36	39 42 48	50 55 63	88 97 110	75 85 95	19 21 24	1.5 1.5 2	1 1.5 2	190 210 230	45 50 54	60 67 73	77 85 95	135 150 166	70 80 90	30 33 37	2.1 3 3	1.1 1.1 1.1	225 250 270	82 90 95	4 4 5		
210 225 240	41 42 45	54 58 60	70 75 80	123 130 140	100 110 120	27 30 31	2.1 2.1 2.1	1.1 1.1 1.1	250 270 280	58 63 63	78 85 85	102 110 112	177 192 196	95 100 110	40 42 44	4 4 4	1.5 2 2	300 320 340	109 115 122	5 5 5		
250 270 280	45 50 50	60 67 67	80 87 87	140 153 153	130 140 150	31 33 33	2.1 3 3	1.1 1.1 1.1	300 320 340	67 73 78	90 95 103	120 130 135	209 226 236	120 130 135	46 50 50	4 5 5	2 2 2.1	360 380 400	125 132 140	6 6 6		
300 320 340	54 58 63	73 78 85	95 105 110	165 183 192	150 160 170	37 40 42	3 4 4	2 2 2	360 380 400	82 85 90	109 115 122	140 150 155	245 — —	140 — —	52 — —	5 5 5	3 — —	420 440 460	145 150 155	6 6 7.5		
360 380 420	63 63 73	85 85 95	112 112 130	— — —	— — —	4 4 5	— — —	— — —	420 440 480	90 90 100	122 122 132	160 160 175	— — —	— — —	— 6 6	— 6 6	— — —	500 540 580	170 180 190	7.5 7.5 9.5		
440 480 500	73 82 82	95 109 109	130 140 140	— — —	— — —	5 5 5	— — —	— — —	520 540 580	109 109 118	145 145 155	190 190 205	— — —	— — —	— 6 7.5	— — —	— — —	620 670 710	206 224 236	9.5 9.5 9.5		
																			280 300 320	56 60 64		

**Table 6.3 Boundary Dimensions of**

Thrust Ball Brgs.										511						512	522				
Spherical Thrust Roller Brgs.															292						
Bore Number	<i>d</i>	Diameter Series 0					Diameter Series 1					Diameter Series 2									
		<i>D</i>	Dimension Series			<i>r</i> (min.)	<i>D</i>	Dimension Series			<i>r</i> (min.)	<i>D</i>	Dimension Series							<i>r</i> (min.)	<i>r</i> <sub>1</sub> (min.)
			70	90	10			71	91	11			72	92	12	22	22				
<i>T</i>					<i>T</i>					<i>T</i>							Central Washer				
																	<i>d</i> <sub>2</sub>	<i>B</i>			
68	340	380	18	24	30	1	420	36	48	64	2	460	54	73	96	—	—	—	3	—	
72	360	400	18	24	30	1	440	36	48	65	2	500	63	85	110	—	—	—	4	—	
76	380	420	18	24	30	1	460	36	48	65	2	520	63	85	112	—	—	—	4	—	
80	400	440	18	24	30	1	480	36	48	65	2	540	63	85	112	—	—	—	4	—	
84	420	460	18	24	30	1	500	36	48	65	2	580	73	95	130	—	—	—	5	—	
88	440	480	18	24	30	1	540	45	60	80	2.1	600	73	95	130	—	—	—	5	—	
92	460	500	18	24	30	1	560	45	60	80	2.1	620	73	95	130	—	—	—	5	—	
96	480	520	18	24	30	1	580	45	60	80	2.1	650	78	103	135	—	—	—	5	—	
/500	500	540	18	24	30	1	600	45	60	80	2.1	670	78	103	135	—	—	—	5	—	
/530	530	580	23	30	38	1.1	640	50	67	85	3	710	82	109	140	—	—	—	5	—	
/560	560	610	23	30	38	1.1	670	50	67	85	3	750	85	115	150	—	—	—	5	—	
/600	600	650	23	30	38	1.1	710	50	67	85	3	800	90	122	160	—	—	—	5	—	
/630	630	680	23	30	38	1.1	750	54	73	95	3	850	100	132	175	—	—	—	6	—	
/670	670	730	27	36	45	1.5	800	58	78	105	4	900	103	140	180	—	—	—	6	—	
/710	710	780	32	42	53	1.5	850	63	85	112	4	950	109	145	190	—	—	—	6	—	
/750	750	820	32	42	53	1.5	900	67	90	120	4	1000	112	150	195	—	—	—	6	—	
/800	800	870	32	42	53	1.5	950	67	90	120	4	1060	118	155	205	—	—	—	7.5	—	
/850	850	920	32	42	53	1.5	1000	67	90	120	4	1120	122	160	212	—	—	—	7.5	—	
/900	900	980	36	48	63	2	1060	73	95	130	5	1180	125	170	220	—	—	—	7.5	—	
/950	950	1030	36	48	63	2	1120	78	103	135	5	1250	136	180	236	—	—	—	7.5	—	
/1000	1000	1090	41	54	70	2.1	1180	82	109	140	5	1320	145	190	250	—	—	—	9.5	—	
/1060	1060	1150	41	54	70	2.1	1250	85	115	150	5	1400	155	206	265	—	—	—	9.5	—	
/1120	1120	1220	45	60	80	2.1	1320	90	122	160	5	1460	—	206	—	—	—	—	9.5	—	
/1180	1180	1280	45	60	80	2.1	1400	100	132	175	6	1520	—	206	—	—	—	—	9.5	—	
/1250	1250	1360	50	67	85	3	1460	—	—	175	6	1610	—	216	—	—	—	—	9.5	—	
/1320	1320	1440	—	—	95	3	1540	—	—	175	6	1700	—	228	—	—	—	—	9.5	—	
/1400	1400	1520	—	—	95	3	1630	—	—	180	6	1790	—	234	—	—	—	—	12	—	
/1500	1500	1630	—	—	105	4	1750	—	—	195	6	1920	—	252	—	—	—	—	12	—	
/1600	1600	1730	—	—	105	4	1850	—	—	195	6	2040	—	264	—	—	—	—	15	—	
/1700	1700	1840	—	—	112	4	1970	—	—	212	7.5	2160	—	276	—	—	—	—	15	—	
/1800	1800	1950	—	—	120	4	2080	—	—	220	7.5	2280	—	288	—	—	—	—	15	—	
/1900	1900	2060	—	—	130	5	2180	—	—	220	7.5	—	—	—	—	—	—	—	—	—	
/2000	2000	2160	—	—	130	5	2300	—	—	236	7.5	—	—	—	—	—	—	—	—	—	
/2120	2120	2300	—	—	140	5	2430	—	—	243	7.5	—	—	—	—	—	—	—	—	—	
/2240	2240	2430	—	—	150	5	2570	—	—	258	9.5	—	—	—	—	—	—	—	—	—	
/2360	2360	2550	—	—	150	5	2700	—	—	265	9.5	—	—	—	—	—	—	—	—	—	
/2500	2500	2700	—	—	160	5	2850	—	—	272	9.5	—	—	—	—	—	—	—	—	—	

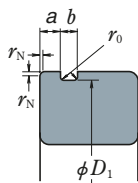
- Remarks**
1. Dimension Series 22, 23, and 24 are double-direction bearings.
  2. The maximum permissible outside diameter of shaft and central washers and minimum permissible bore diameter of housing washers are omitted here (refer to the bearings tables for thrust bearings).

**Thrust Bearings (Flat Seats) — (2)**

Units: mm

			513	523						514	524							Thrust Ball Brgs.				
		293								294								Spherical Thrust Roller Brgs.				
Diameter Series 3									Diameter Series 4									Diameter Series 5			Bore Number	
D	Dimension Series						r (min.)	r <sub>1</sub> (min.)	D	Dimension Series					r (min.)	r <sub>1</sub> (min.)	D	Dimension Series	d			
	73	93	13	23	23	74				94	14	24	24	95								
	T				Central Washer					T				Central Washer				T		r (min.)		
					d <sub>2</sub>	B								d <sub>2</sub>				B				
540	90	122	160	—	—	—	5	—	620	125	170	220	—	—	—	7.5	—	750	243	12	340	68
560	90	122	160	—	—	—	5	—	640	125	170	220	—	—	—	7.5	—	780	250	12	360	72
600	100	132	175	—	—	—	6	—	670	132	175	224	—	—	—	7.5	—	820	265	12	380	76
620	100	132	175	—	—	—	6	—	710	140	185	243	—	—	—	7.5	—	850	272	12	400	80
650	103	140	180	—	—	—	6	—	730	140	185	243	—	—	—	7.5	—	900	290	15	420	84
680	109	145	190	—	—	—	6	—	780	155	206	265	—	—	—	9.5	—	950	308	15	440	88
710	112	150	195	—	—	—	6	—	800	155	206	265	—	—	—	9.5	—	980	315	15	460	92
730	112	150	195	—	—	—	6	—	850	165	224	290	—	—	—	9.5	—	1000	315	15	480	96
750	112	150	195	—	—	—	6	—	870	165	224	290	—	—	—	9.5	—	1060	335	15	500	/500
800	122	160	212	—	—	—	7.5	—	920	175	236	308	—	—	—	9.5	—	1090	335	15	530	/530
850	132	175	224	—	—	—	7.5	—	980	190	250	335	—	—	—	12	—	1150	355	15	560	/560
900	136	180	236	—	—	—	7.5	—	1030	195	258	335	—	—	—	12	—	1220	375	15	600	/600
950	145	190	250	—	—	—	9.5	—	1090	206	280	365	—	—	—	12	—	1280	388	15	630	/630
1000	150	200	258	—	—	—	9.5	—	1150	218	290	375	—	—	—	15	—	1320	388	15	670	/670
1060	160	212	272	—	—	—	9.5	—	1220	230	308	400	—	—	—	15	—	1400	412	15	710	/710
1120	165	224	290	—	—	—	9.5	—	1280	236	315	412	—	—	—	15	—	—	—	—	750	/750
1180	170	230	300	—	—	—	9.5	—	1360	250	335	438	—	—	—	15	—	—	—	—	800	/800
1250	180	243	315	—	—	—	12	—	1440	—	354	—	—	—	—	15	—	—	—	—	850	/850
1320	190	250	335	—	—	—	12	—	1520	—	372	—	—	—	—	15	—	—	—	—	900	/900
1400	200	272	355	—	—	—	12	—	1600	—	390	—	—	—	—	15	—	—	—	—	950	/950
1460	—	276	—	—	—	—	12	—	1670	—	402	—	—	—	—	15	—	—	—	—	1000	/1000
1540	—	288	—	—	—	—	15	—	1770	—	426	—	—	—	—	15	—	—	—	—	1060	/1060
1630	—	306	—	—	—	—	15	—	1860	—	444	—	—	—	—	15	—	—	—	—	1120	/1120
1710	—	318	—	—	—	—	15	—	1950	—	462	—	—	—	—	19	—	—	—	—	1180	/1180
1800	—	330	—	—	—	—	19	—	2050	—	480	—	—	—	—	19	—	—	—	—	1250	/1250
1900	—	348	—	—	—	—	19	—	2160	—	505	—	—	—	—	19	—	—	—	—	1320	/1320
2000	—	360	—	—	—	—	19	—	2280	—	530	—	—	—	—	19	—	—	—	—	1400	/1400
2140	—	384	—	—	—	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	1500	/1500
2270	—	402	—	—	—	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	1600	/1600
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1700	/1700
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1800	/1800
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1900	/1900
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2000	/2000
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2120	/2120
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2240	/2240
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2360	/2360
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2500	/2500

**Table 6. 4 Dimensions of Snap Ring Grooves and Locating Snap Rings — (1)**  
Bearings of Dimension Series 18 and 19



Applicable Bearings			Snap Ring Groove								
<i>d</i>		<i>D</i>	Snap Ring Groove Diameter <i>D</i> <sub>1</sub>		Snap Ring Groove Position <i>a</i>				Snap Ring Groove Width <i>b</i>		Radius of Bottom Corners <i>r</i> <sub>0</sub>
					Bearing Dimension Series						
Dimension Series			max. min.		18		19				
18	19				max.	min.	max.	min.	max.	min.	
—	10	<b>22</b>	20.8	20.5	—	—	1.05	0.9	1.05	0.8	0.2
—	12	<b>24</b>	22.8	22.5	—	—	1.05	0.9	1.05	0.8	0.2
—	15	<b>28</b>	26.7	26.4	—	—	1.3	1.15	1.2	0.95	0.25
—	17	<b>30</b>	28.7	28.4	—	—	1.3	1.15	1.2	0.95	0.25
20	—	<b>32</b>	30.7	30.4	1.3	1.15	—	—	1.2	0.95	0.25
22	—	<b>34</b>	32.7	32.4	1.3	1.15	—	—	1.2	0.95	0.25
25	20	<b>37</b>	35.7	35.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
—	22	<b>39</b>	37.7	37.4	—	—	1.7	1.55	1.2	0.95	0.25
28	—	<b>40</b>	38.7	38.4	1.3	1.15	—	—	1.2	0.95	0.25
30	25	<b>42</b>	40.7	40.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
32	—	<b>44</b>	42.7	42.4	1.3	1.15	—	—	1.2	0.95	0.25
—	28	<b>45</b>	43.7	43.4	—	—	1.7	1.55	1.2	0.95	0.25
35	30	<b>47</b>	45.7	45.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
40	32	<b>52</b>	50.7	50.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
—	35	<b>55</b>	53.7	53.4	—	—	1.7	1.55	1.2	0.95	0.25
45	—	<b>58</b>	56.7	56.4	1.3	1.15	—	—	1.2	0.95	0.25
—	40	<b>62</b>	60.7	60.3	—	—	1.7	1.55	1.2	0.95	0.25
50	—	<b>65</b>	63.7	63.3	1.3	1.15	—	—	1.2	0.95	0.25
—	45	<b>68</b>	66.7	66.3	—	—	1.7	1.55	1.2	0.95	0.25
55	50	<b>72</b>	70.7	70.3	1.7	1.55	1.7	1.55	1.2	0.95	0.25
60	—	<b>78</b>	76.2	75.8	1.7	1.55	—	—	1.6	1.3	0.4
—	55	<b>80</b>	77.9	77.5	—	—	2.1	1.9	1.6	1.3	0.4
65	60	<b>85</b>	82.9	82.5	1.7	1.55	2.1	1.9	1.6	1.3	0.4
70	65	<b>90</b>	87.9	87.5	1.7	1.55	2.1	1.9	1.6	1.3	0.4
75	—	<b>95</b>	92.9	92.5	1.7	1.55	—	—	1.6	1.3	0.4
80	70	<b>100</b>	97.9	97.5	1.7	1.55	2.5	2.3	1.6	1.3	0.4
—	75	<b>105</b>	102.6	102.1	—	—	2.5	2.3	1.6	1.3	0.4
85	80	<b>110</b>	107.6	107.1	2.1	1.9	2.5	2.3	1.6	1.3	0.4
90	—	<b>115</b>	112.6	112.1	2.1	1.9	—	—	1.6	1.3	0.4
95	85	<b>120</b>	117.6	117.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
100	90	<b>125</b>	122.6	122.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
105	95	<b>130</b>	127.6	127.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
110	100	<b>140</b>	137.6	137.1	2.5	2.3	3.3	3.1	2.2	1.9	0.6
—	105	<b>145</b>	142.6	142.1	—	—	3.3	3.1	2.2	1.9	0.6
120	110	<b>150</b>	147.6	147.1	2.5	2.3	3.3	3.1	2.2	1.9	0.6
130	120	<b>165</b>	161.8	161.3	3.3	3.1	3.7	3.5	2.2	1.9	0.6
140	—	<b>175</b>	171.8	171.3	3.3	3.1	—	—	2.2	1.9	0.6
—	130	<b>180</b>	176.8	176.3	—	—	3.7	3.5	2.2	1.9	0.6
150	140	<b>190</b>	186.8	186.3	3.3	3.1	3.7	3.5	2.2	1.9	0.6
160	—	<b>200</b>	196.8	196.3	3.3	3.1	—	—	2.2	1.9	0.6

**Remarks** The minimum permissible chamfer dimensions *r*<sub>N</sub> on the snap-ring-groove side of the outer rings are as follows:

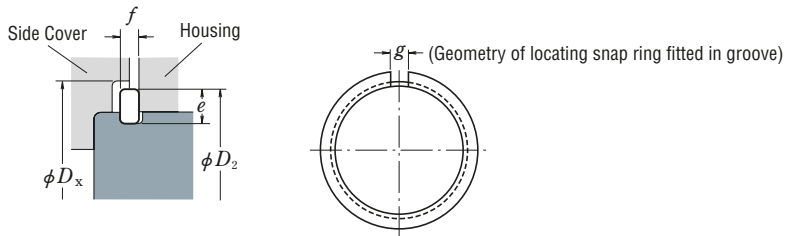
Dimension series 18 : For outside diameters of 78 mm or less, use a 0.3 mm chamfer.

For all others exceeding 78 mm, use 0.5 mm chamfer.

Dimension series 19 : For outside diameters of 24 mm or less, use a 0.2 mm chamfer.

For 47mm or less, use a 0.3 mm chamfer.

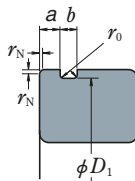
For those exceeding 47 mm, use a 0.5 mm chamfer (However, for an outside diameter of 68 mm, use a 0.3 mm chamfer, though note this is not compliant with ISO 15).



Units: mm

Locating Snap Ring Number	Locating Snap Ring				Geometry of Snap Ring Fitted in Groove (Reference)		Side Cover
	Cross Sectional Height		Thickness		Slit Width $g$	Snap Ring Outside Diameter $D_2$	Stepped Bore Diameter (Reference)
	max.	min.	max.	min.			$D_x$
NR 1022	2.0	1.85	0.7	0.6	2	24.8	25.5
NR 1024	2.0	1.85	0.7	0.6	2	26.8	27.5
NR 1028	2.05	1.9	0.85	0.75	3	30.8	31.5
NR 1030	2.05	1.9	0.85	0.75	3	32.8	33.5
NR 1032	2.05	1.9	0.85	0.75	3	34.8	35.5
NR 1034	2.05	1.9	0.85	0.75	3	36.8	37.5
NR 1037	2.05	1.9	0.85	0.75	3	39.8	40.5
NR 1039	2.05	1.9	0.85	0.75	3	41.8	42.5
NR 1040	2.05	1.9	0.85	0.75	3	42.8	43.5
NR 1042	2.05	1.9	0.85	0.75	3	44.8	45.5
NR 1044	2.05	1.9	0.85	0.75	4	46.8	47.5
NR 1045	2.05	1.9	0.85	0.75	4	47.8	48.5
NR 1047	2.05	1.9	0.85	0.75	4	49.8	50.5
NR 1052	2.05	1.9	0.85	0.75	4	54.8	55.5
NR 1055	2.05	1.9	0.85	0.75	4	57.8	58.5
NR 1058	2.05	1.9	0.85	0.75	4	60.8	61.5
NR 1062	2.05	1.9	0.85	0.75	4	64.8	65.5
NR 1065	2.05	1.9	0.85	0.75	4	67.8	68.5
NR 1068	2.05	1.9	0.85	0.75	5	70.8	72
NR 1072	2.05	1.9	0.85	0.75	5	74.8	76
NR 1078	3.25	3.1	1.12	1.02	5	82.7	84
NR 1080	3.25	3.1	1.12	1.02	5	84.4	86
NR 1085	3.25	3.1	1.12	1.02	5	89.4	91
NR 1090	3.25	3.1	1.12	1.02	5	94.4	96
NR 1095	3.25	3.1	1.12	1.02	5	99.4	101
NR 1100	3.25	3.1	1.12	1.02	5	104.4	106
NR 1105	4.04	3.89	1.12	1.02	5	110.7	112
NR 1110	4.04	3.89	1.12	1.02	5	115.7	117
NR 1115	4.04	3.89	1.12	1.02	5	120.7	122
NR 1120	4.04	3.89	1.12	1.02	7	125.7	127
NR 1125	4.04	3.89	1.12	1.02	7	130.7	132
NR 1130	4.04	3.89	1.12	1.02	7	135.7	137
NR 1140	4.04	3.89	1.7	1.6	7	145.7	147
NR 1145	4.04	3.89	1.7	1.6	7	150.7	152
NR 1150	4.04	3.89	1.7	1.6	7	155.7	157
NR 1165	4.85	4.7	1.7	1.6	7	171.5	173
NR 1175	4.85	4.7	1.7	1.6	10	181.5	183
NR 1180	4.85	4.7	1.7	1.6	10	186.5	188
NR 1190	4.85	4.7	1.7	1.6	10	196.5	198
NR 1200	4.85	4.7	1.7	1.6	10	206.5	208

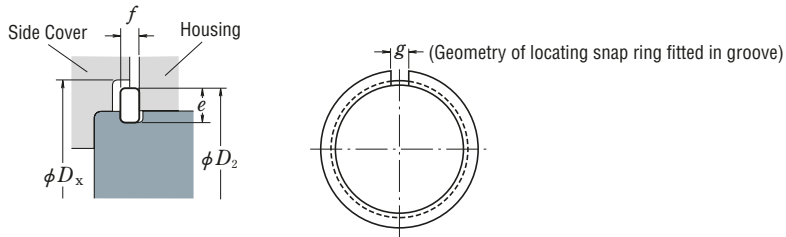
**Table 6. 4 Dimensions of Snap Ring Grooves and Locating Snap Rings — (2)**  
Bearings of Diameter Series 0, 2, 3, and 4



Applicable Bearings				Snap Ring Groove									
<i>d</i>				<i>D</i>	Snap Ring Groove Diameter <i>D</i> <sub>1</sub>		Snap Ring Groove Position <i>a</i>				Snap Ring Groove Width <i>b</i>		Radius of Bottom Corners <i>r</i> <sub>0</sub>
							Bearing Diameter Series						
Diameter Series					max. min.		0		2, 3, 4		max. min.		
0	2	3	4				max.	min.	max.	min.			
10	—	—	—	<b>26</b>	24.5	24.25	1.35	1.19	—	—	1.17	0.87	0.2
12	—	—	—	<b>28</b>	26.5	26.25	1.35	1.19	—	—	1.17	0.87	0.2
—	10	9	8	<b>30</b>	28.17	27.91	—	—	2.06	1.9	1.65	1.35	0.4
15	12	—	9	<b>32</b>	30.15	29.9	2.06	1.9	2.06	1.9	1.65	1.35	0.4
17	15	10	—	<b>35</b>	33.17	32.92	2.06	1.9	2.06	1.9	1.65	1.35	0.4
—	—	12	10	<b>37</b>	34.77	34.52	—	—	2.06	1.9	1.65	1.35	0.4
—	17	—	—	<b>40</b>	38.1	37.85	—	—	2.06	1.9	1.65	1.35	0.4
20	—	15	12	<b>42</b>	39.75	39.5	2.06	1.9	2.06	1.9	1.65	1.35	0.4
22	—	—	—	<b>44</b>	41.75	41.5	2.06	1.9	—	—	1.65	1.35	0.4
25	20	17	—	<b>47</b>	44.6	44.35	2.06	1.9	2.46	2.31	1.65	1.35	0.4
—	22	—	—	<b>50</b>	47.6	47.35	—	—	2.46	2.31	1.65	1.35	0.4
28	25	20	15	<b>52</b>	49.73	49.48	2.06	1.9	2.46	2.31	1.65	1.35	0.4
30	—	—	—	<b>55</b>	52.6	52.35	2.08	1.88	—	—	1.65	1.35	0.4
—	—	22	—	<b>56</b>	53.6	53.35	—	—	2.46	2.31	1.65	1.35	0.4
32	28	—	—	<b>58</b>	55.6	55.35	2.08	1.88	2.46	2.31	1.65	1.35	0.4
35	30	25	17	<b>62</b>	59.61	59.11	2.08	1.88	3.28	3.07	2.2	1.9	0.6
—	32	—	—	<b>65</b>	62.6	62.1	—	—	3.28	3.07	2.2	1.9	0.6
40	—	28	—	<b>68</b>	64.82	64.31	2.49	2.29	3.28	3.07	2.2	1.9	0.6
—	35	30	20	<b>72</b>	68.81	68.3	—	—	3.28	3.07	2.2	1.9	0.6
45	—	32	—	<b>75</b>	71.83	71.32	2.49	2.29	3.28	3.07	2.2	1.9	0.6
50	40	35	25	<b>80</b>	76.81	76.3	2.49	2.29	3.28	3.07	2.2	1.9	0.6
—	45	—	—	<b>85</b>	81.81	81.31	—	—	3.28	3.07	2.2	1.9	0.6
55	50	40	30	<b>90</b>	86.79	86.28	2.87	2.67	3.28	3.07	3	2.7	0.6
60	—	—	—	<b>95</b>	91.82	91.31	2.87	2.67	—	—	3	2.7	0.6
65	55	45	35	<b>100</b>	96.8	96.29	2.87	2.67	3.28	3.07	3	2.7	0.6
70	60	50	40	<b>110</b>	106.81	106.3	2.87	2.67	3.28	3.07	3	2.7	0.6
75	—	—	—	<b>115</b>	111.81	111.3	2.87	2.67	—	—	3	2.7	0.6
—	65	55	45	<b>120</b>	115.21	114.71	—	—	4.06	3.86	3.4	3.1	0.6
80	70	—	—	<b>125</b>	120.22	119.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6
85	75	60	50	<b>130</b>	125.22	124.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6
90	80	65	55	<b>140</b>	135.23	134.72	3.71	3.45	4.9	4.65	3.4	3.1	0.6
95	—	—	—	<b>145</b>	140.23	139.73	3.71	3.45	—	—	3.4	3.1	0.6
100	85	70	60	<b>150</b>	145.24	144.73	3.71	3.45	4.9	4.65	3.4	3.1	0.6
105	90	75	65	<b>160</b>	155.22	154.71	3.71	3.45	4.9	4.65	3.4	3.1	0.6
110	95	80	—	<b>170</b>	163.65	163.14	3.71	3.45	5.69	5.44	3.8	3.5	0.6
120	100	85	70	<b>180</b>	173.66	173.15	3.71	3.45	5.69	5.44	3.8	3.5	0.6
—	105	90	75	<b>190</b>	183.64	183.13	—	—	5.69	5.44	3.8	3.5	0.6
130	110	95	80	<b>200</b>	193.65	193.14	5.69	5.44	5.69	5.44	3.8	3.5	0.6

**Note** (1) The locating snap rings and snap ring grooves of these bearings are not specified by ISO.

- Remarks**
1. The dimensions of these snap ring grooves are not applicable to bearings of Dimension Series 00, 82, and 83.
  2. The minimum permissible chamfer dimension  $r_N$  on the snap-ring side of outer rings is 0.5 mm. However, for Diameter Series 0 bearings with outside diameters of 35 mm or below, it is 0.3 mm.



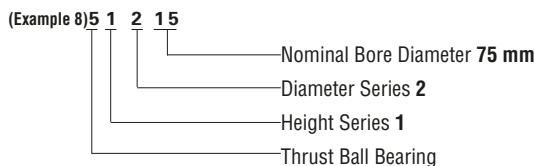
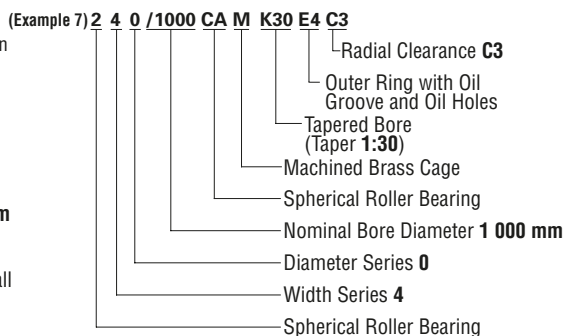
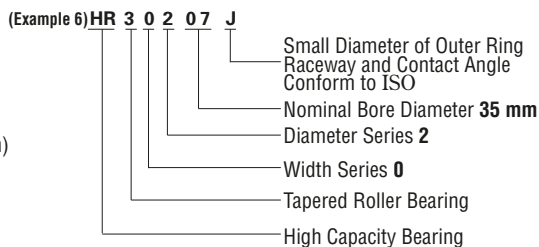
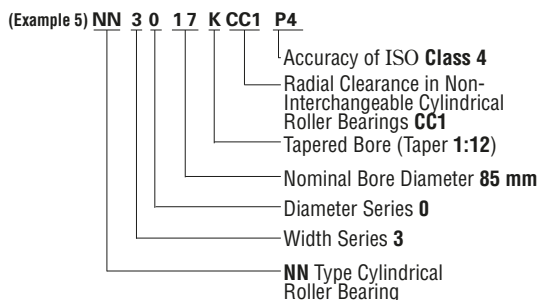
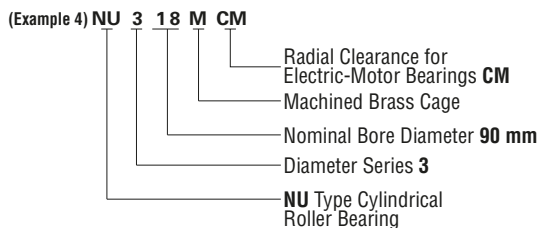
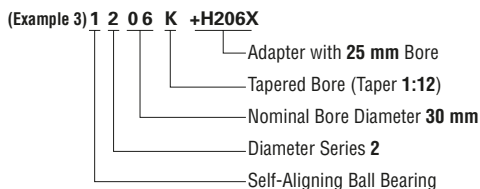
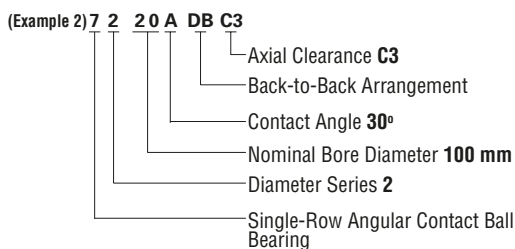
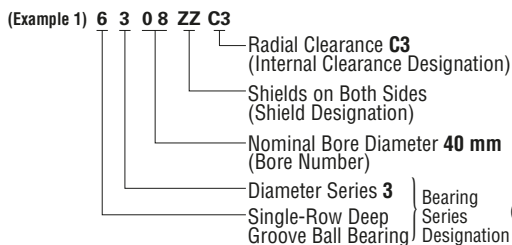
Units: mm

Locating Snap Ring Number	Cross Sectional Height		Thickness		Geometry of Snap Ring Fitted in Groove (Reference)		Side Cover
	$e$		$f$		Slit Width $g$	Snap Ring Outside Diameter $D_2$	Stepped Bore Diameter (Reference) $D_x$
	max.	min.	max.	min.	approx.	max.	min.
NR 26 <sup>(1)</sup>	2.06	1.91	0.84	0.74	3	28.7	29.4
NR 28 <sup>(1)</sup>	2.06	1.91	0.84	0.74	3	30.7	31.4
NR 30	3.25	3.1	1.12	1.02	3	34.7	35.5
NR 32	3.25	3.1	1.12	1.02	3	36.7	37.5
NR 35	3.25	3.1	1.12	1.02	3	39.7	40.5
NR 37	3.25	3.1	1.12	1.02	3	41.3	42
NR 40	3.25	3.1	1.12	1.02	3	44.6	45.5
NR 42	3.25	3.1	1.12	1.02	3	46.3	47
NR 44	3.25	3.1	1.12	1.02	3	48.3	49
NR 47	4.04	3.89	1.12	1.02	4	52.7	53.5
NR 50	4.04	3.89	1.12	1.02	4	55.7	56.5
NR 52	4.04	3.89	1.12	1.02	4	57.9	58.5
NR 55	4.04	3.89	1.12	1.02	4	60.7	61.5
NR 56	4.04	3.89	1.12	1.02	4	61.7	62.5
NR 58	4.04	3.89	1.12	1.02	4	63.7	64.5
NR 62	4.04	3.89	1.7	1.6	4	67.7	68.5
NR 65	4.04	3.89	1.7	1.6	4	70.7	71.5
NR 68	4.85	4.7	1.7	1.6	5	74.6	76
NR 72	4.85	4.7	1.7	1.6	5	78.6	80
NR 75	4.85	4.7	1.7	1.6	5	81.6	83
NR 80	4.85	4.7	1.7	1.6	5	86.6	88
NR 85	4.85	4.7	1.7	1.6	5	91.6	93
NR 90	4.85	4.7	2.46	2.36	5	96.5	98
NR 95	4.85	4.7	2.46	2.36	5	101.6	103
NR 100	4.85	4.7	2.46	2.36	5	106.5	108
NR 110	4.85	4.7	2.46	2.36	5	116.6	118
NR 115	4.85	4.7	2.46	2.36	5	121.6	123
NR 120	7.21	7.06	2.82	2.72	7	129.7	131.5
NR 125	7.21	7.06	2.82	2.72	7	134.7	136.5
NR 130	7.21	7.06	2.82	2.72	7	139.7	141.5
NR 140	7.21	7.06	2.82	2.72	7	149.7	152
NR 145	7.21	7.06	2.82	2.72	7	154.7	157
NR 150	7.21	7.06	2.82	2.72	7	159.7	162
NR 160	7.21	7.06	2.82	2.72	7	169.7	172
NR 170	9.6	9.45	3.1	3	10	182.9	185
NR 180	9.6	9.45	3.1	3	10	192.9	195
NR 190	9.6	9.45	3.1	3	10	202.9	205
NR 200	9.6	9.45	3.1	3	10	212.9	215

## 6.2 Formulation of Bearing Designations

Bearing designations (or "bearing numbers") are alphanumeric combinations that indicate the bearing type, boundary dimensions, dimensional and running accuracies, internal clearance, and other related specifications. The boundary dimensions of commonly used bearings mostly conform to the organizational concept of ISO, and the bearing numbers of these standard bearings are specified by JIS B 1513 (*Rolling bearings- Designation*). Due to a need for more detailed classification, NSK uses auxiliary designations other than those specified by JIS.

Bearing designations consist of a basic designation and supplementary designations. The basic designation indicates the bearing series (type) and the width and diameter series as shown in Table 6.5. Basic designations, supplementary designations, and the meanings of common numbers and designations are listed in Table 6.6 (Pages A122 and A123). Contact angle and other supplementary designations are shown in successive columns from left to right in Table 6.6. For reference, some example designations are shown here:



**Table 6. 5 Bearing Series Designations**

Bearing Type	Bearing Series	Type	Dimensions	
			Width	Diameter
Single-Row Deep Groove Ball Bearings	<b>68</b>	6	(1)	8
	<b>69</b>	6	(1)	9
	<b>60</b>	6	(1)	0
	<b>62</b>	6	(0)	2
	<b>63</b>	6	(0)	3
Single-Row Angular Contact Ball Bearings	<b>79</b>	7	(1)	9
	<b>70</b>	7	(1)	0
	<b>72</b>	7	(0)	2
	<b>73</b>	7	(0)	3
Self-Aligning Ball Bearings	<b>12</b>	1	(0)	2
	<b>13</b>	1	(0)	3
	<b>22</b>	(1)	2	2
	<b>23</b>	(1)	2	3
Single-Row Cylindrical Roller Bearings	<b>NU10</b>	NU	1	0
	<b>NU2</b>	NU	(0)	2
	<b>NU22</b>	NU	2	2
	<b>NU3</b>	NU	(0)	3
	<b>NU23</b>	NU	2	3
	<b>NU4</b>	NU	(0)	4
	<b>NJ2</b>	NJ	(0)	2
	<b>NJ22</b>	NJ	2	2
	<b>NJ3</b>	NJ	(0)	3
	<b>NJ23</b>	NJ	2	3
	<b>NJ4</b>	NJ	(0)	4
	<b>NUP2</b>	NUP	(0)	2
	<b>NUP22</b>	NUP	2	2
	<b>NUP3</b>	NUP	(0)	3
	<b>NUP23</b>	NUP	2	3
	<b>NUP4</b>	NUP	(0)	4
	<b>N10</b>	N	1	0
	<b>N2</b>	N	(0)	2
	<b>N3</b>	N	(0)	3
	<b>N4</b>	N	(0)	4
	<b>NF2</b>	NF	(0)	2
	<b>NF3</b>	NF	(0)	3
	<b>NF4</b>	NF	(0)	4
Double-Row Cylindrical Roller Bearings	<b>NNU49</b>	NNU	4	9
	<b>NN30</b>	NN	3	0
Needle Roller Bearings	<b>NA48</b>	NA	4	8
	<b>NA49</b>	NA	4	9
	<b>NA59</b>	NA	5	9
	<b>NA69</b>	NA	6	9
Tapered Roller Bearings	<b>329</b>	3	2	9
	<b>320</b>	3	2	0
	<b>330</b>	3	3	0
	<b>331</b>	3	3	1
	<b>302</b>	3	0	2
	<b>322</b>	3	2	2
	<b>332</b>	3	3	2
	<b>303</b>	3	0	3
	<b>323</b>	3	2	3
Spherical Roller Bearings	<b>230</b>	2	3	0
	<b>231</b>	2	3	1
	<b>222</b>	2	2	2
	<b>232</b>	2	3	2
	<b>213 <sup>(1)</sup></b>	2	0	3
	<b>223</b>	2	2	3
Thrust Ball Bearings with Flat Seats	<b>511</b>	5	1	1
	<b>512</b>	5	1	2
	<b>513</b>	5	1	3
	<b>514</b>	5	1	4
	<b>522</b>	5	2	2
	<b>523</b>	5	2	3
	<b>524</b>	5	2	4
Spherical Thrust Roller Bearings	<b>292</b>	2	9	2
	<b>293</b>	2	9	3
	<b>294</b>	2	9	4

**Note** <sup>(1)</sup> Bearing Series 213 should logically be 203, but customarily it is numbered 213.  
**Remark** Numbers in parentheses ( ) in the width column are usually omitted from the bearing number.

**Table 6. 6 Formulation of**

Basic Designations														
Bearing Series <sup>(1)</sup>		Bore Number		Contact Angle		Internal Design		Material		Cage		External Features		
												Seals, Shields		
Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning	
68	Single-Row Deep Groove Ball Bearings	1	Bore Diam. 1 mm		Angular Contact Ball Bearings	A	Internal Design Differs From Standard	g	Case-Hardened Steel Used in Rings, Rolling Elements	M	Machined-Brass Cage	Z	} Shield on One Side Only	
69		2	2									ZS		
60		3	3	A	Standard Contact Angle of 30°	J	Smaller Diameter of Outer Ring Raceway, Contact Angle, and Outer Ring Width of Tapered Roller Bearings (Conforms to ISO 355)							
:		.....	.....											
70	Single-Row Angular Contact Ball Bearings	9	9	A5	Standard Contact Angle of 25°			h	Stainless Steel Used in Rings, Rolling Elements	W	Pressed-Steel Cage	ZZ	} Shields on Both Sides	
72		.....	.....									ZZS		
73		00	10											
:		01	12											
12	Self-Aligning Ball Bearings	02	15	B	Standard Contact Angle of 40°									
13		03	17											
22										T	Synthetic Resin Cage	DU	Rubber Contact Seal on One Side Only	
:														
NU10	Cylindrical Roller Bearings	/22	22	C	Standard Contact Angle of 15°		(For High Capacity Bearings)							
NJ 2														
N 3		/28	28									DDU	Rubber Contact Seals on Both Sides	
NN 30		/32	32							V	Without Cage			
:						C	} Spherical Roller Bearings							
NA48	Needle Roller Bearings	04 <sup>(3)</sup>	20		Tapered Roller Bearings	CA							V	Rubber Non-Contact Seal on One Side Only
NA49		05	25			CD								
NA69		06	30	Omitted	Contact Angle Less Than 17°	EA								
:														
320	Tapered Roller Bearings	88	440	C	Approx. 20° Contact Angle	E	Cylindrical Roller Bearings					VV	Rubber Non-Contact Seals on Both Sides	
322		92	460											
323		96	480											
:		/500	500	D	Approx. 28° Contact Angle	E	Spherical Thrust Roller Bearings							
511	Thrust Ball Bearing With Flat Seats	/530	530			EA	Angular Contact Ball Bearings							
512		/560	560											
513		.....	.....											
:		.....	.....											
292	Thrust Spherical Roller Bearings	/2 360	2 360											
293		/2 500	2 500											
294														
:														
HR <sup>(4)</sup> High Capacity Tapered Roller Bearings and Others														
Designations and Numbers Conform to JIS <sup>(5)</sup>						NSK Designations						NSK Designations		
Marked on Bearings										Not Marked on Bearings				

**Notes** <sup>(1)</sup> Bearing Series designations conform to Table 6.5.

<sup>(2)</sup> For basic designations of tapered roller bearings in ISO's new series, refer to Page C182.

<sup>(3)</sup> The bore size (mm) is five times the bore number for Bore Numbers 04 through 96 (except double-direction thrust ball bearings).

<sup>(4)</sup> HR is an NSK Bearing Series designation.

## Bearing Designations

Auxiliary Designations																
External Features		Arrangement		Internal Clearance / Preload		Tolerance Class		Special Specification		Spacer / Sleeve		Grease				
Design of Rings																
Code	Meaning	Code	Meaning	Code	Meaning (radial clearance)	Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning			
K	Tapered Bore of Inner Ring (Taper 1:12)	DB	Back-to-Back Arrangement	C1	For All Radial Brigs. Clearance Less Than C2 Clearance Less Than CN CN Clearance Clearance Greater Than CN Clearance Greater Than C3 Clearance Greater Than C4	Omitted	ISO Normal	Bearings Treated with Dimensional Stabilization	+K	Bearings With Outer Ring Spacers	AS2	SHELL ALVANIA GREASE S2				
K30	Tapered Bore of Inner Ring (Taper 1:30)	DF	Face-to-Face Arrangement	C2		P6	ISO Class 6						+L	Bearings With Inner Ring Spacers	ENS	ENS GREASE
				C3		P6X	ISO Class 6X									
				C4		P5	ISO Class 5									
				C5	P4	ISO Class 4										
E	Notch or Lubricating Groove in Ring	DT	Tandem Arrangement	For Non-Interchangeable Cylindrical Roller Brigs. Clearance Less Than CC2 Clearance Less Than CC Normal Clearance Clearance Greater Than CC Clearance Greater Than CC3 Clearance Greater Than CC4	CC1	ABMA(?) Tapered Roller Bearing	X26	Working Temperature Lower Than 150 °C	+KL	Bearings With Both Inner and Outer Ring Spacers	PS2	MULTEMP PS No. 2				
E4	Lubricating Groove in Outside Surface and Holes in Outer Ring				CC2								X28	Working Temperature Lower Than 200 °C		
					CC										X29	Working Temperature Lower Than 250 °C
					CC3											
				CC4	Spherical Roller Bearings											
CC5	S11			Dimensional Stabilizing Treatment Working Temperature Lower Than 200 °C												
N						Snap Ring Groove in Outer Ring	For Extra-Small and Miniature Ball Brigs. Clearance Less Than MC2 Clearance Less Than MC3 Normal Clearance Clearance Greater Than MC3 Clearance Greater Than MC4 Clearance Greater Than MC5	Omitted	Class 4							
								MC1	PN2	Class 2						
					MC2											
	MC3															
MC4																
NR	Snap Ring Groove With Snap Ring in Outer Ring			MC5	PN3	Class 3										
		MC6														
		CM	PN0	Class 0												
		CT														
CM	PN00	Class 00														
(Preload of Angular Contact) Ball Bearing																
			EL	Extra Light Preload												
			L		Light Preload											
	M	Medium Preload														
H	Heavy Preload															
Partially Match JIS(5)			Match JIS(5)			Match JIS(5)		NSK Designations, Partially Match JIS(5)								
In General, Marked on Bearings										Not Marked on Bearings						

- Notes**
- <sup>(5)</sup> JIS : Japanese Industrial Standards.
  - <sup>(6)</sup> BAS : The Japan Bearing Industrial Association Standard.
  - <sup>(7)</sup> ABMA : The American Bearing Manufacturers Association.



## **7. BEARING TOLERANCES**

**7.1 Bearing Tolerance Standards** ..... A 126

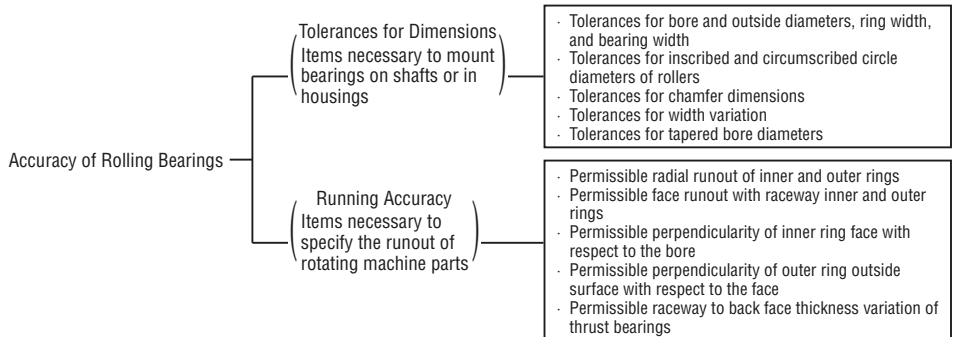
**7.2 Selection of Tolerance Classes** ..... A 151

## 7. BEARING TOLERANCES

### 7.1 Bearing Tolerance Standards

The tolerances for the boundary dimensions and running accuracy of rolling bearings are specified by ISO 492, 199, and 582. Tolerances are specified for the following items:

Class 2 is the highest bearing tolerance class in ISO but additional classes exist, including Class 6X (for tapered roller bearings), Class 6, Class 5, and Class 4. The applicable tolerance classes for each bearing type and the correspondence of these classes are shown in Table 7.1.



**Table 7. 1 Bearing Types and Tolerance Classes**

Deep Groove Ball Bearing					ISO 492	Normal	—	Class 6	Class 5	Class 4	Class 2	
Angular Contact Ball Bearings						Normal	—	Class 6	Class 5	Class 4	Class 2	
Self-Aligning Ball Bearings						Normal	—	Class 6 Equivalent	Class 5 Equivalent	—	—	
Cylindrical Roller Bearings						Normal	—	Class 6	Class 5	Class 4	Class 2	
Needle Roller Bearings						Normal	—	Class 6	Class 5	Class 4	—	
Spherical Roller Bearings						Normal	—	Class 6	Class 5	—	—	
Tapered Roller Bearings	Metric Design				ISO 492	Normal	Class 6X	Class 6	Class 5	Class 4	—	
	Inch Design				ANSI/ AFBMA Std.19.2	Class 4	—	Class 2	Class 3	Class 0	Class 00	
	J Series				ANSI/ AFBMA Std.19.1	Class K	Class N	—	Class C	Class B	—	
Magnet Ball Bearings					BAS1061	Normal	—	Class 6	Class 5	—	—	
Thrust Ball Bearings					ISO 199	Normal	—	Class 6	Class 5	Class 4	—	
Thrust Roller Bearings						Normal	—	—	—	—	—	
Thrust Spherical Roller Bearings						Normal	—	—	—	—	—	
Equivalent Standards (Reference)	JIS				JIS B 1514, 1536	Class 0	—	Class 6	Class 5	Class 4	Class 2	
		Tapered Roller Bearings	Metric Design		JIS B 1514	Class 0	Class 6X	(Class 6)	Class 5	Class 4	—	
	DIN					DIN620	P0	—	P6	P5	P4	P2
	ANSI/ AFBMA	Ball Bearings				ANSI/ AFBMA Std.20	ABEC1	—	ABEC3	ABEC5	ABEC7	ABEC9
		Roller Bearings					RBEC1	—	RBEC3	RBEC5	—	—
		Instrument Ball Bearings				ANSI/ AFBMA Std.12.2	—	—	—	Class 5P	Class 7P	Class 9P
		Tapered Roller Bearings	Metric Design		ANSI/ AFBMA Std.19.1	Class K	Class N	—	Class C	Class B	Class A	
	BAS	Tapered Roller Bearings	Metric Design	Multi/ Four-Row	BAS1002	Class 0	—	—	—	—	—	

**(Reference)** Rough definitions of items related to running accuracy and their measuring methods are shown in Fig. 7.1. These are further described in detail in ISO 5593 (*Rolling Bearings-Vocabulary*), JIS B 1515, (*Rolling Bearings-Tolerances*) and elsewhere.

Supplementary Table

Running Accuracy	Inner Ring	Outer Ring	Dial Gauge
$K_{ia}$	Rotating	Stationary	A
$K_{ea}$	Stationary	Rotating	A
$S_{ia}$	Rotating	Stationary	B <sub>1</sub>
$S_{ea}$	Stationary	Rotating	B <sub>2</sub>
$S_d$	Rotating	Stationary	C
$S_D$	—	Rotating	D
$S_i, S_e$	Only the shaft, housing, or central washer is to be rotated.		E

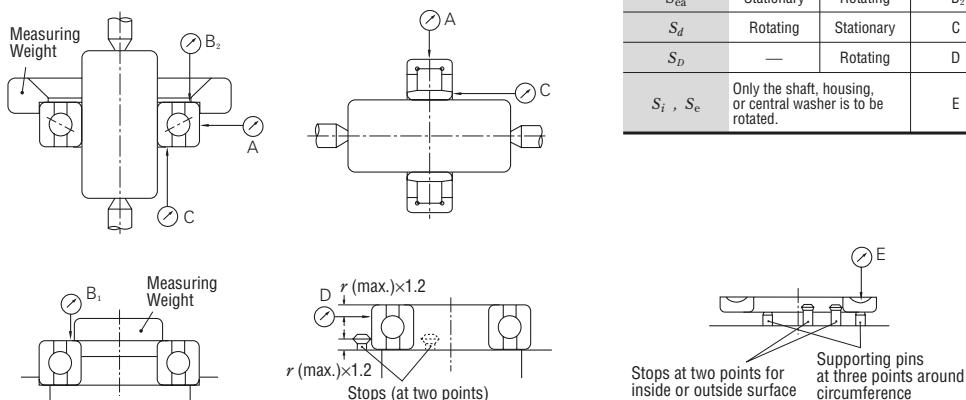
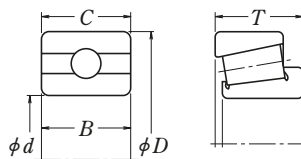


Fig. 7.1 Measuring Methods for Running Accuracy (Summarized)

### Symbols for Boundary Dimensions and Running Accuracy

$d$	Nominal bore diameter
$\Delta_{ds}$	Deviation of a single bore diameter
$\Delta_{dmp}$	Single plane mean bore diameter deviation
$V_{dp}$	Bore diameter variation in a single radial plane
$V_{dmp}$	Mean bore diameter variation
$V_{dsp}$	Variation of bore diameter in a single plane
$B$	Inner ring width, nominal
$\Delta_{Bs}$	Deviation of a single inner ring width
$V_{Bs}$	Inner ring width variation
$K_{ia}$	Radial runout of assembled brg. inner ring
$S_d$	Perpendicularity of inner ring face with respect to the bore
$S_{ia}$	Axial runout of inner ring of assembled bearing
$S_i, S_e$	Parallelism of inner ring raceway with respect to the face
$T$	Nominal (assembled) bearing width
$\Delta_{Ts}$	Deviation of the actual brg. width
$\Delta_{TIs}$	Deviation of the actual effective width of inner subunit
$\Delta_{T2s}$	Deviation of the actual effective width of outer ring

$D$	Nominal outside diameter
$\Delta_{Ds}$	Deviation of a single outside diameter
$\Delta_{Dmp}$	Single plane mean outside diameter deviation
$V_{Dp}$	Outside diameter variation in a single radial plane
$V_{Dmp}$	Mean outside diameter variation
$V_{Dsp}$	Variation of outside diameter in a single plane
$C$	Nominal outer ring width
$\Delta_{Cs}$	Deviation of a single outer ring width
$V_{Cs}$	Outer ring width variation
$K_{ea}$	Radial runout of assembled brg. outer ring
$S_D$	Perpendicularity of outer ring outside surface with respect to the face
$S_{ea}$	Axial runout of outer ring of assembled bearing



**Table 7. 2 Tolerances for Radial Bearings**

**Table 7. 2. 1 Tolerances for Inner Rings and**

Nominal Bore Diameter <i>d</i> (mm)		$\Delta_{amp}^{(2)}$										$\Delta_{ds}^{(2)}$			
		Normal Class		Class 6		Class 5		Class 4		Class 2		Class 4		Class 2	
												Diameter Series		Diameter Series	
												0, 1, 2, 3, 4		0, 1, 2, 3, 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low
0.6 <sup>(1)</sup>	2.5	0	-8	0	-7	0	-5	0	-4	0	-2.5	0	-4	0	-2.5
2.5	10	0	-8	0	-7	0	-5	0	-4	0	-2.5	0	-4	0	-2.5
10	18	0	-8	0	-7	0	-5	0	-4	0	-2.5	0	-4	0	-2.5
18	30	0	-10	0	-8	0	-6	0	-5	0	-2.5	0	-5	0	-2.5
30	50	0	-12	0	-10	0	-8	0	-6	0	-2.5	0	-6	0	-2.5
50	80	0	-15	0	-12	0	-9	0	-7	0	-4	0	-7	0	-4
80	120	0	-20	0	-15	0	-10	0	-8	0	-5	0	-8	0	-5
120	150	0	-25	0	-18	0	-13	0	-10	0	-7	0	-10	0	-7
150	180	0	-25	0	-18	0	-13	0	-10	0	-7	0	-10	0	-7
180	250	0	-30	0	-22	0	-15	0	-12	0	-8	0	-12	0	-8
250	315	0	-35	0	-25	0	-18	—	—	—	—	—	—	—	—
315	400	0	-40	0	-30	0	-23	—	—	—	—	—	—	—	—
400	500	0	-45	0	-35	—	—	—	—	—	—	—	—	—	—
500	630	0	-50	0	-40	—	—	—	—	—	—	—	—	—	—
630	800	0	-75	—	—	—	—	—	—	—	—	—	—	—	—
800	1 000	0	-100	—	—	—	—	—	—	—	—	—	—	—	—
1 000	1 250	0	-125	—	—	—	—	—	—	—	—	—	—	—	—
1 250	1 600	0	-160	—	—	—	—	—	—	—	—	—	—	—	—
1 600	2 000	0	-200	—	—	—	—	—	—	—	—	—	—	—	—

$\Delta_{Bs}$ (or $\Delta_{Cs}$ ) <sup>(3)</sup>												$V_{Bs}$ (or $V_{Cs}$ )				
Single Bearing						Combined Bearings						Inner Ring (or Outer Ring) <sup>(4)</sup>		Inner Ring		
Normal Class	Class 6	Class 5	Class 4	Class 2	Class Normal <sup>(4)</sup> <sup>(5)</sup>	Class 6 <sup>(4)</sup> <sup>(5)</sup>	Class 5 <sup>(4)</sup> <sup>(5)</sup>	Class 4 <sup>(4)</sup> <sup>(5)</sup>	Class 2 <sup>(4)</sup> <sup>(5)</sup>	Normal Class	Class 6	Class 5	Class 4	Class 2		
high low	high low	high low	high low	high low	high low	high low	high low	high low	high low	Max.	Max.	Max.	Max.	Max.		
0 - 40	0 - 40	0 - 40	0 - 40	0 - 40	— —	— —	0 -250	0 -250	0 -250	12	12	5	2.5	1.5		
0 - 120	0 -120	0 - 40	0 - 40	0 - 40	0 -250	0 -250	0 -250	0 -250	0 -250	15	15	5	2.5	1.5		
0 - 120	0 -120	0 - 80	0 - 80	0 - 80	0 -250	0 -250	0 -250	0 -250	0 -250	20	20	5	2.5	1.5		
0 - 120	0 -120	0 -120	0 -120	0 -120	0 -250	0 -250	0 -250	0 -250	0 -250	20	20	5	2.5	1.5		
0 - 120	0 -120	0 -120	0 -120	0 -120	0 -250	0 -250	0 -250	0 -250	0 -250	20	20	5	3	1.5		
0 - 150	0 -150	0 -150	0 -150	0 -150	0 -380	0 -380	0 -250	0 -250	0 -250	25	25	6	4	1.5		
0 - 200	0 -200	0 -200	0 -200	0 -200	0 -380	0 -380	0 -380	0 -380	0 -380	25	25	7	4	2.5		
0 - 250	0 -250	0 -250	0 -250	0 -250	0 -500	0 -500	0 -380	0 -380	0 -380	30	30	8	5	2.5		
0 - 250	0 -250	0 -250	0 -250	0 -250	0 -500	0 -500	0 -380	0 -380	0 -380	30	30	8	5	4		
0 - 300	0 -300	0 -300	0 -300	0 -300	0 -500	0 -500	0 -500	0 -500	0 -500	30	30	10	6	5		
0 - 350	0 -350	0 -350	— —	— —	0 -500	0 -500	0 -500	— —	— —	35	35	13	—	—		
0 - 400	0 -400	0 -400	— —	— —	0 -630	0 -630	0 -630	— —	— —	40	40	15	—	—		
0 - 450	0 -450	— —	— —	— —	— —	— —	— —	— —	— —	50	45	—	—	—		
0 - 500	0 -500	— —	— —	— —	— —	— —	— —	— —	— —	60	50	—	—	—		
0 - 750	— —	— —	— —	— —	— —	— —	— —	— —	— —	70	—	—	—	—		
0 -1 000	— —	— —	— —	— —	— —	— —	— —	— —	— —	80	—	—	—	—		
0 -1 250	— —	— —	— —	— —	— —	— —	— —	— —	— —	100	—	—	—	—		
0 -1 600	— —	— —	— —	— —	— —	— —	— —	— —	— —	120	—	—	—	—		
0 -2 000	— —	— —	— —	— —	— —	— —	— —	— —	— —	140	—	—	—	—		

**Notes** <sup>(1)</sup> 0.6mm is included in this group.

<sup>(2)</sup> Applicable to bearings with cylindrical bores.

<sup>(3)</sup> Outer ring width tolerances or deviation depend on the values for the inner ring of the same bearing. Tolerances for the width variation of outer rings in Class 5, 4, and 2 are shown in Table 7.2.2.

<sup>(4)</sup> Applicable to individual rings manufactured for combined bearings.

<sup>(5)</sup> Also applicable to inner ring tapered bores with  $d \geq 50$  mm.

<sup>(6)</sup> Applicable to ball bearings such as deep groove ball bearings and angular contact ball bearings.

## (Excluding Tapered Roller Bearings)

## Widths of Outer Rings

$V_{dnp}^{(2)}$											$V_{dnp}^{(2)}$					
Normal Class			Class 6			Class 5		Class 4		Class 2	Normal Class	Class 6	Class 5	Class 4	Class 2	
Diameter Series			Diameter Series			Diameter Series		Diameter Series		Diameter Series						
9	0, 1	2, 3, 4	9	0, 1	2, 3, 4	9	1, 2, 3, 4	9	1, 2, 3, 4	0, 1, 2, 3, 4						
Max.			Max.			Max.		Max.		Max.	Max.	Max.	Max.	Max.	Max.	
10	8	6	9	7	5	5	4	4	3	2.5	6	5	3	2	1.5	
10	8	6	9	7	5	5	4	4	3	2.5	6	5	3	2	1.5	
10	8	6	9	7	5	5	4	4	3	2.5	6	5	3	2	1.5	
13	10	8	10	8	6	6	5	5	4	2.5	8	6	3	2.5	1.5	
15	12	9	13	10	8	8	6	6	5	2.5	9	8	4	3	1.5	
19	19	11	15	15	9	9	7	7	5	4	11	9	5	3.5	2	
25	25	15	19	19	11	10	8	8	6	5	15	11	5	4	2.5	
31	31	19	23	23	14	13	10	10	8	7	19	14	7	5	3.5	
31	31	19	23	23	14	13	10	10	8	7	19	14	7	5	3.5	
38	38	23	28	28	17	15	12	12	9	8	23	17	8	6	4	
44	44	26	31	31	19	18	14	—	—	—	26	19	9	—	—	
50	50	30	38	38	23	23	18	—	—	—	30	23	12	—	—	
56	56	34	44	44	26	—	—	—	—	—	34	26	—	—	—	
63	63	38	50	50	30	—	—	—	—	—	38	30	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Units :  $\mu\text{m}$ 

$K_{ia}$					$S_d$			$S_{ia}^{(6)}$			Nominal Bore Diameter $d$ (mm)	
Normal Class	Class 6	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2		
Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	over	incl.
10	5	4	2.5	1.5	7	3	1.5	7	3	1.5	0.6	2.5
10	6	4	2.5	1.5	7	3	1.5	7	3	1.5	2.5	10
10	7	4	2.5	1.5	7	3	1.5	7	3	1.5	10	18
13	8	4	3	2.5	8	4	1.5	8	4	2.5	18	30
15	10	5	4	2.5	8	4	1.5	8	4	2.5	30	50
20	10	5	4	2.5	8	5	1.5	8	5	2.5	50	80
25	13	6	5	2.5	9	5	2.5	9	5	2.5	80	120
30	18	8	6	2.5	10	6	2.5	10	7	2.5	120	150
30	18	8	6	5	10	6	4	10	7	5	150	180
40	20	10	8	5	11	7	5	13	8	5	180	250
50	25	13	—	—	13	—	—	15	—	—	250	315
60	30	15	—	—	15	—	—	20	—	—	315	400
65	35	—	—	—	—	—	—	—	—	—	400	500
70	40	—	—	—	—	—	—	—	—	—	500	630
80	—	—	—	—	—	—	—	—	—	—	630	800
90	—	—	—	—	—	—	—	—	—	—	800	1 000
100	—	—	—	—	—	—	—	—	—	—	1 000	1 250
120	—	—	—	—	—	—	—	—	—	—	1 250	1 600
140	—	—	—	—	—	—	—	—	—	—	1 600	2 000

- Remarks**
- The cylindrical bore diameter "no-go side" tolerance limit (high) specified in this table does not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).
  - AISI/ABMA Std 20-1996: ABEC1·RBEC1, ABEC3·RBEC3, ABEC5·RBEC5, ABEC7·RBEC7, and ABEC9·RBEC9 are equivalent to Classes Normal, 6, 5, 4, and 2 respectively.

**Table 7. 2 Tolerances for Radial Bearings**

**Table 7. 2. 2 Tolerances**

Nominal Outside Diameter <i>D</i> (mm)		$\Delta_{Dmp}$										$\Delta_{Ds}$			
		Normal Class		Class 6		Class 5		Class 4		Class 2		Class 4		Class 2	
												Diameter Series			
												0, 1, 2, 3, 4			
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low
<b>2.5<sup>(1)</sup></b>	<b>6</b>	0	– 8	0	– 7	0	– 5	0	– 4	0	– 2.5	0	– 4	0	– 2.5
<b>6</b>	<b>18</b>	0	– 8	0	– 7	0	– 5	0	– 4	0	– 2.5	0	– 4	0	– 2.5
<b>18</b>	<b>30</b>	0	– 9	0	– 8	0	– 6	0	– 5	0	– 4	0	– 5	0	– 4
<b>30</b>	<b>50</b>	0	– 11	0	– 9	0	– 7	0	– 6	0	– 4	0	– 6	0	– 4
<b>50</b>	<b>80</b>	0	– 13	0	– 11	0	– 9	0	– 7	0	– 4	0	– 7	0	– 4
<b>80</b>	<b>120</b>	0	– 15	0	– 13	0	– 10	0	– 8	0	– 5	0	– 8	0	– 5
<b>120</b>	<b>150</b>	0	– 18	0	– 15	0	– 11	0	– 9	0	– 5	0	– 9	0	– 5
<b>150</b>	<b>180</b>	0	– 25	0	– 18	0	– 13	0	– 10	0	– 7	0	– 10	0	– 7
<b>180</b>	<b>250</b>	0	– 30	0	– 20	0	– 13	0	– 11	0	– 8	0	– 11	0	– 8
<b>250</b>	<b>315</b>	0	– 35	0	– 25	0	– 18	0	– 13	0	– 8	0	– 13	0	– 8
<b>315</b>	<b>400</b>	0	– 40	0	– 28	0	– 20	0	– 15	0	– 10	0	– 15	0	– 10
<b>400</b>	<b>500</b>	0	– 45	0	– 33	0	– 23	—	—	—	—	—	—	—	—
<b>500</b>	<b>630</b>	0	– 50	0	– 38	0	– 28	—	—	—	—	—	—	—	—
<b>630</b>	<b>800</b>	0	– 75	0	– 45	0	– 35	—	—	—	—	—	—	—	—
<b>800</b>	<b>1 000</b>	0	– 100	0	– 60	—	—	—	—	—	—	—	—	—	—
<b>1 000</b>	<b>1 250</b>	0	– 125	—	—	—	—	—	—	—	—	—	—	—	—
<b>1 250</b>	<b>1 600</b>	0	– 160	—	—	—	—	—	—	—	—	—	—	—	—
<b>1 600</b>	<b>2 000</b>	0	– 200	—	—	—	—	—	—	—	—	—	—	—	—
<b>2 000</b>	<b>2 500</b>	0	– 250	—	—	—	—	—	—	—	—	—	—	—	—

**Notes** <sup>(1)</sup> 2.5 mm is included in this group.

<sup>(2)</sup> Applicable only when a locating snap ring is not used.

<sup>(3)</sup> Applicable to ball bearings, such as deep groove ball bearings and angular contact ball bearings.

<sup>(4)</sup> Not applicable to bearings with flanges.

<sup>(5)</sup> The tolerances for outer ring width variation in Normal Class and Class 6 bearings are shown in Table 7.2.1.

**Remarks** 1. The outside diameter "no-go side" tolerances (low) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension *r* (max.).  
2. AISI/ABMA Std 20-1996: ABEC1·RBEC1, ABEC3·RBEC3, ABEC5·RBEC5, ABEC7·RBEC7, and ABEC9·RBEC9 are equivalent to Classes Normal, 6, 5, 4, and 2 respectively.

## (Excluding Tapered Roller Bearings)

## for Outer Rings

$V_{Dnp}^{(2)}$													$V_{Dnp}^{(2)}$					
Normal Class				Class 6				Class 5		Class 4		Class 2		Normal Class	Class 6	Class 5	Class 4	Class 2
Open Bearings		Sealed/ Shielded Bearings	Open Bearings	Sealed/ Shielded Bearings	Open Bearings		Open Bearings		Open Bearings									
Diameter Series				Diameter Series		Diameter Series		Diameter Series		Diameter Series								
9	0, 1	2, 3, 4	2, 3, 4	9	0, 1	2, 3, 4	0,1,2,3,4	9	1, 2, 3, 4	9	1, 2, 3, 4	0, 1, 2, 3, 4						
Max.				Max.					Max.		Max.		Max.	Max.	Max.	Max.	Max.	
10	8	6	10	9	7	5	9	5	4	4	3	2.5	6	5	3	2	1.5	
10	8	6	10	9	7	5	9	5	4	4	3	2.5	6	5	3	2	1.5	
12	9	7	12	10	8	6	10	6	5	5	4	4	7	6	3	2.5	2	
14	11	8	16	11	9	7	13	7	5	6	5	4	8	7	4	3	2	
16	13	10	20	14	11	8	16	9	7	7	5	4	10	8	5	3.5	2	
19	19	11	26	16	16	10	20	10	8	8	6	5	11	10	5	4	2.5	
23	23	14	30	19	19	11	25	11	8	9	7	5	14	11	6	5	2.5	
31	31	19	38	23	23	14	30	13	10	10	8	7	19	14	7	5	3.5	
38	38	23	—	25	25	15	—	15	11	11	8	8	23	15	8	6	4	
44	44	26	—	31	31	19	—	18	14	13	10	8	26	19	9	7	4	
50	50	30	—	35	35	21	—	20	15	15	11	10	30	21	10	8	5	
56	56	34	—	41	41	25	—	23	17	—	—	—	34	25	12	—	—	
63	63	38	—	48	48	29	—	28	21	—	—	—	38	29	14	—	—	
94	94	55	—	56	56	34	—	35	26	—	—	—	55	34	18	—	—	
125	125	75	—	75	75	45	—	—	—	—	—	—	75	45	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Units : mm

$K_{ra}$					$S_D^{(4)}$			$S_{ra}^{(3)(4)}$			$V_{cs}^{(5)}$			Nominal Outside Diameter $D$ (mm)	
Normal Class	Class 6	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2		
Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	over	incl.
15	8	5	3	1.5	8	4	1.5	8	5	1.5	5	2.5	1.5	2.5	6
15	8	5	3	1.5	8	4	1.5	8	5	1.5	5	2.5	1.5	6	18
15	9	6	4	2.5	8	4	1.5	8	5	2.5	5	2.5	1.5	18	30
20	10	7	5	2.5	8	4	1.5	8	5	2.5	5	2.5	1.5	30	50
25	13	8	5	4	8	4	1.5	10	5	4	6	3	1.5	50	80
35	18	10	6	5	9	5	2.5	11	6	5	8	4	2.5	80	120
40	20	11	7	5	10	5	2.5	13	7	5	8	5	2.5	120	150
45	23	13	8	5	10	5	2.5	14	8	5	8	5	2.5	150	180
50	25	15	10	7	11	7	4	15	10	7	10	7	4	180	250
60	30	18	11	7	13	8	5	18	10	7	11	7	5	250	315
70	35	20	13	8	13	10	7	20	13	8	13	8	7	315	400
80	40	23	—	—	15	—	—	23	—	—	15	—	—	400	500
100	50	25	—	—	18	—	—	25	—	—	18	—	—	500	630
120	60	30	—	—	20	—	—	30	—	—	20	—	—	630	800
140	75	—	—	—	—	—	—	—	—	—	—	—	—	800	1 000
160	—	—	—	—	—	—	—	—	—	—	—	—	—	1 000	1 250
190	—	—	—	—	—	—	—	—	—	—	—	—	—	1 250	1 600
220	—	—	—	—	—	—	—	—	—	—	—	—	—	1 600	2 000
250	—	—	—	—	—	—	—	—	—	—	—	—	—	2 000	2 500

**Table 7. 3 Tolerances for Metric Series Tapered Roller Bearings**  
**Table 7. 3. 1 Tolerances for Inner Ring Bore Diameter and Running Accuracy**

Nominal Bore Diameter <i>d</i> (mm)		$\Delta_{dmp}$								$\Delta_{ds}$		$V_{dsp}$				$V_{dmp}$			
		Normal Class Class 6X		(Class 6)		Class 5		Class 4		Class 4		Normal Class Class 6X		(Class 6)		Class 5		Class 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
10 <sup>(1)</sup>	18	0	-12	0	-7	0	-7	0	-5	0	-5	12	7	5	4	9	5	5	4
18	30	0	-12	0	-8	0	-8	0	-6	0	-6	12	8	6	5	9	6	5	4
30	50	0	-12	0	-10	0	-10	0	-8	0	-8	12	10	8	6	9	8	5	5
50	80	0	-15	0	-12	0	-12	0	-9	0	-9	15	12	9	7	11	9	6	5
80	120	0	-20	0	-15	0	-15	0	-10	0	-10	20	15	11	8	15	11	8	5
120	180	0	-25	0	-18	0	-18	0	-13	0	-13	25	18	14	10	19	14	9	7
180	250	0	-30	0	-22	0	-22	0	-15	0	-15	30	22	17	11	23	16	11	8
250	315	0	-35	—	—	0	-25	0	-18	0	-18	35	—	19	12	26	—	13	9
315	400	0	-40	—	—	0	-30	—	—	—	—	40	—	23	—	30	—	15	—
400	500	0	-45	—	—	0	-35	—	—	—	—	45	—	28	—	34	—	17	—
500	630	0	-60	—	—	0	-40	—	—	—	—	60	—	35	—	40	—	20	—
630	800	0	-75	—	—	0	-50	—	—	—	—	75	—	45	—	45	—	25	—
800	1 000	0	-100	—	—	0	-60	—	—	—	—	100	—	60	—	55	—	30	—
1 000	1 250	0	-125	—	—	0	-75	—	—	—	—	125	—	75	—	65	—	37	—
1 250	1 600	0	-160	—	—	0	-90	—	—	—	—	160	—	90	—	80	—	45	—
1 600	2 000	0	-200	—	—	—	—	—	—	—	—	200	—	—	—	100	—	—	—

**Notes** <sup>(1)</sup> 10 mm is included in this group.

- Remarks**
- The bore diameter "no-go side" tolerances (high) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).
  - Some of these tolerances conform to NSK standards.

**Table 7. 3. 2 Tolerances for Outer Ring Outside Diameter and Running Accuracy**

Nominal Outside Diameter <i>D</i> (mm)		$\Delta_{Dmp}$								$\Delta_{Ds}$		$V_{Dsp}$				$V_{Dmp}$			
		Normal Class Class 6X		(Class 6)		Class 5		Class 4		Class 4		Normal Class Class 6X		(Class 6)		Class 5		Class 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
18 <sup>(1)</sup>	30	0	-12	0	-8	0	-8	0	-6	0	-6	12	8	6	5	9	6	5	4
30	50	0	-14	0	-9	0	-9	0	-7	0	-7	14	9	7	5	11	7	5	5
50	80	0	-16	0	-11	0	-11	0	-9	0	-9	16	11	8	7	12	8	6	5
80	120	0	-18	0	-13	0	-13	0	-10	0	-10	18	13	10	8	14	10	7	5
120	150	0	-20	0	-15	0	-15	0	-11	0	-11	20	15	11	8	15	11	8	6
150	180	0	-25	0	-18	0	-18	0	-13	0	-13	25	18	14	10	19	14	9	7
180	250	0	-30	0	-20	0	-20	0	-15	0	-15	30	20	15	11	23	15	10	8
250	315	0	-35	0	-25	0	-25	0	-18	0	-18	35	25	19	14	26	19	13	9
315	400	0	-40	0	-28	0	-28	0	-20	0	-20	40	28	22	15	30	21	14	10
400	500	0	-45	—	—	0	-33	—	—	—	—	45	—	26	—	34	—	17	—
500	630	0	-50	—	—	0	-38	—	—	—	—	60	—	30	—	38	—	20	—
630	800	0	-75	—	—	0	-45	—	—	—	—	80	—	38	—	55	—	25	—
800	1000	0	-100	—	—	0	-60	—	—	—	—	100	—	50	—	75	—	30	—
1 000	1 250	0	-125	—	—	0	-80	—	—	—	—	130	—	65	—	90	—	38	—
1 250	1 600	0	-160	—	—	0	-100	—	—	—	—	170	—	90	—	100	—	50	—
1 600	2 000	0	-200	—	—	0	-125	—	—	—	—	210	—	120	—	110	—	65	—
2 000	2 500	0	-250	—	—	—	—	—	—	—	—	265	—	—	—	120	—	—	—

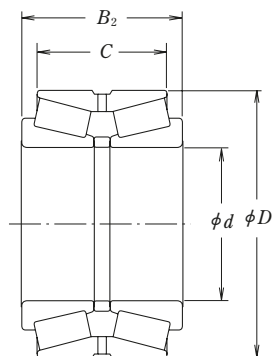
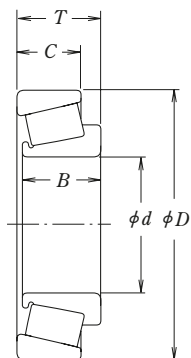
**Notes** <sup>(1)</sup> 18 mm is included in this group.

<sup>(2)</sup> Not applicable to bearings with flanges.

- Remarks**
- The outside diameter "no-go side" tolerances (low) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).
  - Some of these tolerances conform to NSK standards.

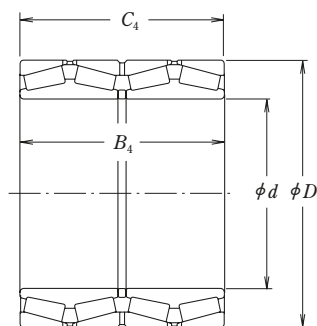
Units : m

$K_{ia}$				$S_d$		$S_{ia}$
Normal Class Class 6X	(Class 6)	Class 5	Class 4	Class 5	Class 4	Class 4
Max.	Max.	Max.	Max.	Max.	Max.	Max.
15	7	5	3	7	3	3
18	8	5	3	8	4	4
20	10	6	4	8	4	4
25	10	7	4	8	5	4
30	13	8	5	9	5	5
35	18	11	6	10	6	7
50	20	13	8	11	7	8
60	—	13	9	13	8	9
70	—	15	—	15	—	—
80	—	20	—	17	—	—
90	—	25	—	20	—	—
100	—	30	—	25	—	—
115	—	37	—	30	—	—
130	—	45	—	40	—	—
150	—	55	—	50	—	—
170	—	—	—	—	—	—



Units : m

$K_{en}$				$S_D(^{\circ})$		$S_{en}(^{\circ})$
Normal Class Class 6X	(Class 6)	Class 5	Class 4	Class 5	Class 4	Class 4
Max.	Max.	Max.	Max.	Max.	Max.	Max.
18	9	6	4	8	4	5
20	10	7	5	8	4	5
25	13	8	5	8	4	5
35	18	10	6	9	5	6
40	20	11	7	10	5	7
45	23	13	8	10	5	8
50	25	15	10	11	7	10
60	30	18	11	13	8	10
70	35	20	13	13	10	13
80	—	24	—	17	—	—
100	—	30	—	20	—	—
120	—	36	—	25	—	—
140	—	43	—	30	—	—
160	—	52	—	38	—	—
180	—	62	—	50	—	—
200	—	73	—	65	—	—
220	—	—	—	—	—	—



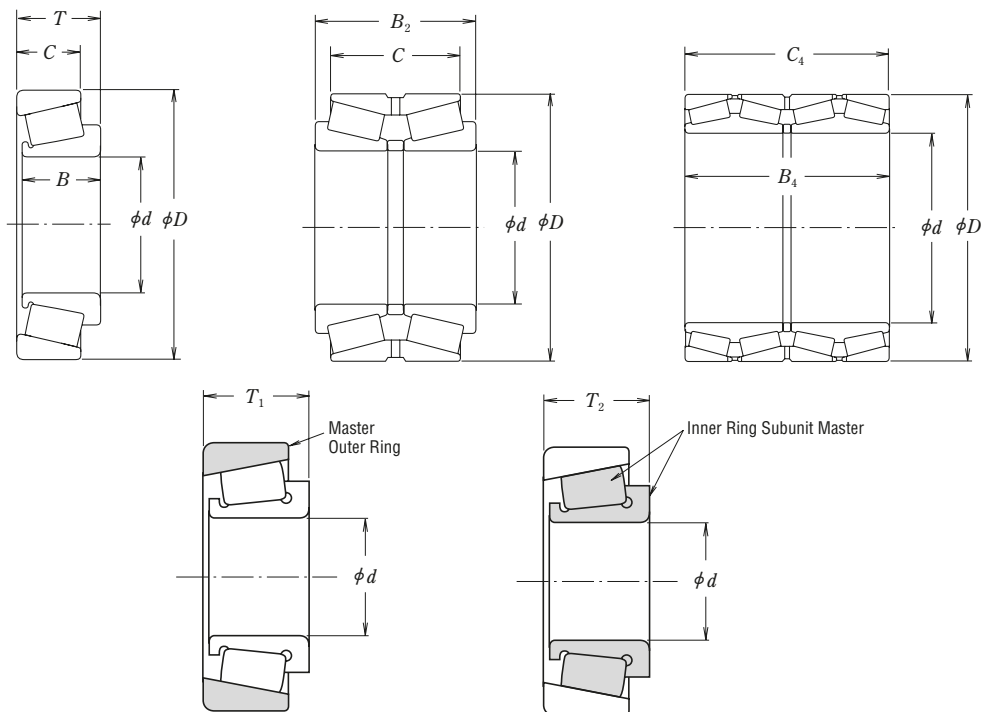
**Table 7. 3 Tolerances for Metric Series**  
**Table 7. 3. 3 Tolerances for Width, Overall Bearing Width,**

Nominal Bore Diameter $d$ (mm)		$\Delta_{Bs}$										$\Delta_{Cs}$									
		Normal Class		(Class 6)		Class 6X		Class 5		Class 4		Normal Class		(Class 6)		Class 6X		Class 5		Class 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low
<b>10<sup>(1)</sup></b>	<b>18</b>	0	-120	0	-120	0	-50	0	-200	0	-200	0	-120	0	-120	0	-100	0	-200	0	-200
<b>18</b>	<b>30</b>	0	-120	0	-120	0	-50	0	-200	0	-200	0	-120	0	-120	0	-100	0	-200	0	-200
<b>30</b>	<b>50</b>	0	-120	0	-120	0	-50	0	-240	0	-240	0	-120	0	-120	0	-100	0	-240	0	-240
<b>50</b>	<b>80</b>	0	-150	0	-150	0	-50	0	-300	0	-300	0	-150	0	-150	0	-100	0	-300	0	-300
<b>80</b>	<b>120</b>	0	-200	0	-200	0	-50	0	-400	0	-400	0	-200	0	-200	0	-100	0	-400	0	-400
<b>120</b>	<b>180</b>	0	-250	0	-250	0	-50	0	-500	0	-500	0	-250	0	-250	0	-100	0	-500	0	-500
<b>180</b>	<b>250</b>	0	-300	0	-300	0	-50	0	-600	0	-600	0	-300	0	-300	0	-100	0	-600	0	-600
<b>250</b>	<b>315</b>	0	-350	—	—	0	-50	0	-700	0	-700	0	-350	—	—	0	-100	0	-700	0	-700
<b>315</b>	<b>400</b>	0	-400	—	—	0	-50	0	-800	—	—	0	-400	—	—	0	-100	0	-800	—	—
<b>400</b>	<b>500</b>	0	-450	—	—	0	-50	0	-900	—	—	0	-450	—	—	0	-100	—	-900	—	—
<b>500</b>	<b>630</b>	0	-500	—	—	—	—	0	-1 100	—	—	0	-500	—	—	—	—	—	-1 100	—	—
<b>630</b>	<b>800</b>	0	-750	—	—	—	—	0	-1 600	—	—	0	-750	—	—	—	—	—	-1 600	—	—
<b>800</b>	<b>1 000</b>	0	-1 000	—	—	—	—	0	-2 000	—	—	0	-1 000	—	—	—	—	—	-2 000	—	—
<b>1 000</b>	<b>1 250</b>	0	-1 250	—	—	—	—	0	-2 000	—	—	0	-1 250	—	—	—	—	—	-2 000	—	—
<b>1 250</b>	<b>1 600</b>	0	-1 600	—	—	—	—	0	-2 000	—	—	0	-1 600	—	—	—	—	—	-2 000	—	—
<b>1 600</b>	<b>2 000</b>	0	-2 000	—	—	—	—	—	—	—	—	0	-2 000	—	—	—	—	—	—	—	—

**Notes** <sup>(1)</sup> 10 mm is included in this group.

**Remarks** The nominal effective width of the inner subunit  $T_1$  is defined as the overall bearing width of the inner subunit combined with a master outer ring.

The nominal effective width of the outer ring  $T_2$  is defined as the overall bearing width of the outer ring combined with a master inner subunit.





**Table 7. 4 Tolerances for Inch Series Tapered Roller Bearings**

(Refer to Page A126 Table 7.1 for more information on "CLASS \*\* " ANSI/ABMA tolerances.)

**Table 7. 4. 1 Tolerances for Inner Ring Bore Diameter**

Units : m

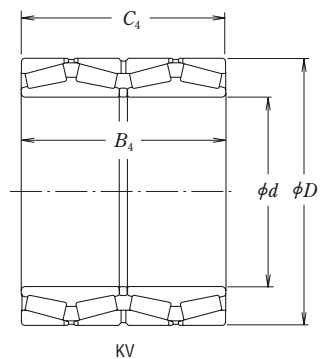
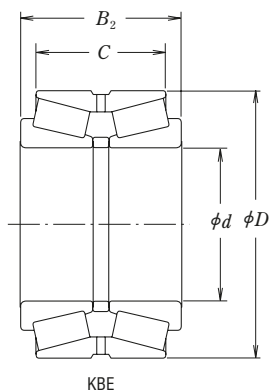
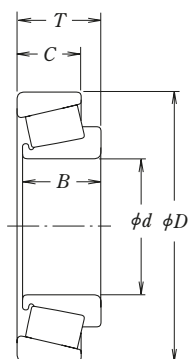
Nominal Bore Diameter $d$				$\Delta_{ds}$					
over		incl.		CLASS 4, 2		CLASS 3, 0		CLASS 00	
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low
—	—	<b>76.200</b>	3.0000	+ 13	0	+13	0	+8	0
<b>76.200</b>	3.0000	<b>266.700</b>	10.5000	+ 25	0	+13	0	+8	0
<b>266.700</b>	10.5000	<b>304.800</b>	12.0000	+ 25	0	+13	0	—	—
<b>304.800</b>	12.0000	<b>609.600</b>	24.0000	+ 51	0	+25	0	—	—
<b>609.600</b>	24.0000	<b>914.400</b>	36.0000	+ 76	0	+38	0	—	—
<b>914.400</b>	36.0000	<b>1 219.200</b>	48.0000	+102	0	+51	0	—	—
<b>1 219.200</b>	48.0000	—	—	+127	0	+76	0	—	—

**Table 7. 4. 2 Tolerances for Outer Ring Outside Diameter**

Nominal Outside Diameter $D$				$\Delta_{Ds}$					
over		incl.		CLASS 4, 2		CLASS 3, 0		CLASS 00	
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low
—	—	<b>266.700</b>	10.5000	+ 25	0	+13	0	+8	0
<b>266.700</b>	10.5000	<b>304.800</b>	12.0000	+ 25	0	+13	0	+8	0
<b>304.800</b>	12.0000	<b>609.600</b>	24.0000	+ 51	0	+25	0	—	—
<b>609.600</b>	24.0000	<b>914.400</b>	36.0000	+ 76	0	+38	0	—	—
<b>914.400</b>	36.0000	<b>1 219.200</b>	48.0000	+102	0	+51	0	—	—
<b>1 219.200</b>	48.0000	—	—	+127	0	+76	0	—	—

**Table 7. 4. 3 Tolerances for**

Nominal Bore Diameter <i>d</i>				<i>Δ</i> <i>T</i> <sub>s</sub>									
over		incl.		CLASS 4		CLASS 2		CLASS 3				CLASS 0, 00	
								<i>D</i> ≤ 508.000 (mm)		<i>D</i> > 508.000 (mm)			
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low	high	low	high	low
— <b>101.600</b>	— 4.0000	<b>101.600</b> <b>304.800</b>	4.0000 12.0000	+203 +356	0 −254	+203 +203	0 0	+203 +203	−203 −203	+203 +203	−203 −203	+203 +203	−203 −203
<b>304.800</b> <b>609.600</b>	12.0000 24.0000	<b>609.600</b> —	24.0000 —	+381 +381	−381 −381	+381 —	−381 —	+203 +381	−203 −381	+381 +381	−381 −381	— —	— —



## and Radial Runout of Inner and Outer Rings

Units : m

$K_{ia}, K_{ea}$				
CLASS 4	CLASS 2	CLASS 3	CLASS 0	CLASS 00
max.	max.	max.	max.	max.
51	38	8	4	2
51	38	8	4	2
51	38	18	—	—
76	51	51	—	—
76	—	76	—	—
76	—	76	—	—

## Overall Width and Combined Width

Units : m

Double-Row Bearings (KBE Type)										Four-Row Bearings (KV Type)	
$\Delta_{B\ 2s}$										$\Delta_{B\ 4s},\ \Delta_{C\ 4s}$	
CLASS 4		CLASS 2		CLASS 3				CLASS 0,00		CLASS 4, 3	
				$D\leq 508.000\ (mm)$		$D> 508.000\ (mm)$					
high	low	high	low	high	low	high	low	high	low	high	low
+406 +711	0 -508	+406 +406	0 -203	+406 +406	-406 -406	+406 +406	-406 -406	+406 +406	-406 -406	+1 524 +1 524	-1 524 -1 524
+762 +762	-762 -762	+762 —	-762 —	+406 +762	-406 -762	+762 +762	-762 -762	— —	— —	+1 524 +1 524	-1 524 -1 524

**Table 7. 5 Tolerances**

**Table 7. 5. 1 Tolerances for Inner Rings**

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$						$V_{dp}$			$V_{dmp}$			$\Delta_{Bs}$ (or $\Delta_{Cs}$ ) <sup>(1)</sup>			
		Normal		Class 6		Class 5		Normal	Class 6	Class 5	Normal	Class 6	Class 5	Normal Class 6		Class 5	
over	incl.	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.	high	low	high	low
<b>2.5</b>	<b>10</b>	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 40
<b>10</b>	<b>18</b>	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 80
<b>18</b>	<b>30</b>	0	−10	0	−8	0	−6	8	6	5	8	6	3	0	−120	0	−120

**Note** <sup>(1)</sup> The actual width deviation and width variation of an outer ring is determined according to the inner ring of the same bearing.

**Remark** The bore diameter "no-go side" tolerances (high) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).

**Table 7. 5. 2 Tolerances**

Nominal Outside Diameter $D$ (mm)		$\Delta_{Dmp}$												$V_{Dp}$		
		Bearing Series E						Bearing Series EN								
		Normal		Class 6		Class 5		Normal		Class 6		Class 5		Normal	Class 6	Class 5
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	max.	max.	max.
<b>6</b>	<b>18</b>	+ 8	0	+7	0	+5	0	0	− 8	0	−7	0	−5	6	5	4
<b>18</b>	<b>30</b>	+ 9	0	+8	0	+6	0	0	− 9	0	−8	0	−6	7	6	5
<b>30</b>	<b>50</b>	+11	0	+9	0	+7	0	0	−11	0	−9	0	−7	8	7	5

**Remark** The outside diameter "no-go side" tolerances (low) do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).

### for Magneto Bearings and Width of Outer Rings

Units : m

$V_{Bs}$ (or $V_{Cs}$ ) (°)		$\Delta T_s$		$K_{ia}$			$S_d$	$S_{ia}$
Normal Class 6	Class 5	Normal Class 6 Class 5		Normal	Class 6	Class 5	Class 5	Class 5
max.	max.	high	low	max.	max.	max.	max.	max.
15	5	+120	-120	10	6	4	7	7
20	5	+120	-120	10	7	4	7	7
20	5	+120	-120	13	8	4	8	8

### for Outer Rings

Units : m

$V_{Dmp}$			$K_{ea}$			$S_{ea}$	$S_D$
Normal	Class 6	Class 5	Normal	Class 6	Class 5	Class 5	Class 5
max.	max.	max.	max.	max.	max.	max.	max.
6	5	3	15	8	5	8	8
7	6	3	15	9	6	8	8
8	7	4	20	10	7	8	8

Table 7. 6 Tolerances for Thrust Ball Bearings

Table 7. 6. 1 Tolerances for Shaft Washer Bore Diameter and Running Accuracy

Units : m

Nominal Bore Diameter $d$ or $d_2$ (mm)		$\Delta d_{mp}$ or $\Delta d_{2mp}$				$V_{dsp}$ or $V_{d2sp}$		$S_i$ or $S_e$ <sup>(1)</sup>			
		Normal Class 6 Class 5		Class 4		Normal Class 6 Class 5	Class 4	Normal	Class 6	Class 5	Class 4
over	incl.	high	low	high	low	max.	max.	max.	max.	max.	max.
—	18	0	— 8	0	— 7	6	5	10	5	3	2
18	30	0	— 10	0	— 8	8	6	10	5	3	2
30	50	0	— 12	0	— 10	9	8	10	6	3	2
50	80	0	— 15	0	— 12	11	9	10	7	4	3
80	120	0	— 20	0	— 15	15	11	15	8	4	3
120	180	0	— 25	0	— 18	19	14	15	9	5	4
180	250	0	— 30	0	— 22	23	17	20	10	5	4
250	315	0	— 35	0	— 25	26	19	25	13	7	5
315	400	0	— 40	0	— 30	30	23	30	15	7	5
400	500	0	— 45	0	— 35	34	26	30	18	9	6
500	630	0	— 50	0	— 40	38	30	35	21	11	7
630	800	0	— 75	0	— 50	—	—	40	25	13	8
800	1 000	0	— 100	—	—	—	—	45	30	15	—
1 000	1 250	0	— 125	—	—	—	—	50	35	18	—

Note <sup>(1)</sup> For double-direction bearings, the thickness variation does not depend on the bore diameter  $d_2$ , but rather on  $d$  for single-direction bearings with the same  $D$  in the same Diameter Series.  
The thickness variation of housing washers  $S_e$  applies only to flat-seat thrust bearings.

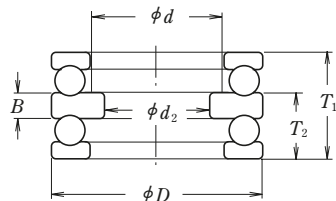
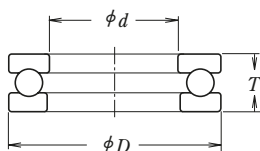


Table 7. 6. 2 Tolerances for Outside Diameter of Housing Washers and Aligning Seat Washers

Nominal Outside Diameter of Bearing or Aligning Seat Washer $D$ or $D_3$ (mm)		$\Delta_{Dmp}$						$V_{Dsp}$		Aligning Seat Washer Outside Diameter Deviation $\Delta_{D3s}$	
		Flat Seat Type				Aligning Seat Washer Type					
		Normal Class 6 Class 5		Class 4		Normal Class 6		Normal Class 6 Class 5	Class 4	Normal Class 6	
		high	low	high	low	high	low	max.	max.	high	low
over	incl.										
10	18	0	-11	0	-7	0	-17	8	5	0	-25
18	30	0	-13	0	-8	0	-20	10	6	0	-30
30	50	0	-16	0	-9	0	-24	12	7	0	-35
50	80	0	-19	0	-11	0	-29	14	8	0	-45
80	120	0	-22	0	-13	0	-33	17	10	0	-60
120	180	0	-25	0	-15	0	-38	19	11	0	-75
180	250	0	-30	0	-20	0	-45	23	15	0	-90
250	315	0	-35	0	-25	0	-53	26	19	0	-105
315	400	0	-40	0	-28	0	-60	30	21	0	-120
400	500	0	-45	0	-33	0	-68	34	25	0	-135
500	630	0	-50	0	-38	0	-75	38	29	0	-180
630	800	0	-75	0	-45	0	-113	55	34	0	-225
800	1 000	0	-100	—	—	—	—	75	—	—	—
1 000	1 250	0	-125	—	—	—	—	—	—	—	—
1 250	1 600	0	-160	—	—	—	—	—	—	—	—

Units : m

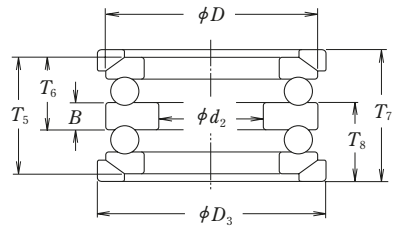
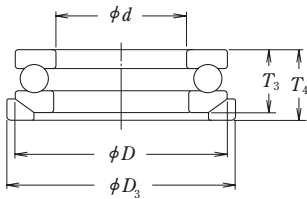


Table 7. 6. 3 Tolerances for Thrust Ball Bearing Height and Central Washer Height

Units : m

Nominal Bore Diameter $d^{(1)}$ (mm)		Flat Seat Type				Aligning Seat Washer Type				With Aligning Seat Washer				Height Deviation of Central Washer $\Delta_{Bs}$	
		$\Delta_{Ts}$ or $\Delta_{T_{2s}}$		$\Delta_{T_{1s}}$		$\Delta_{T_{3s}}$ or $\Delta_{T_{6s}}$		$\Delta_{T_{3s}}$		$\Delta_{T_{4s}}$ or $\Delta_{T_{8s}}$		$\Delta_{T_{7s}}$			
		Normal, Class 6 Class 5, Class 4		Normal, Class 6 Class 5, Class 4		Normal Class 6		Normal Class 6		Normal Class 6		Normal Class 6		Normal, Class 6 Class 5, Class 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low
—	30	0	− 75	+ 50	−150	0	− 75	+ 50	−150	+ 50	− 75	+150	−150	0	− 50
30	50	0	−100	+ 75	−200	0	−100	+ 75	−200	+ 50	−100	+175	−200	0	− 75
50	80	0	−125	+100	−250	0	−125	+100	−250	+ 75	−125	+250	−250	0	−100
80	120	0	−150	+125	−300	0	−150	+125	−300	+ 75	−150	+275	−300	0	−125
120	180	0	−175	+150	−350	0	−175	+150	−350	+100	−175	+350	−350	0	−150
180	250	0	−200	+175	−400	0	−200	+175	−400	+100	−200	+375	−400	0	−175
250	315	0	−225	+200	−450	0	−225	+200	−450	+125	−225	+450	−450	0	−200
315	400	0	−300	+250	−600	0	−300	+250	−600	+150	−275	+550	−550	0	−250

**Note** <sup>(1)</sup> For double-direction bearings, classification depends on  $d$  for single-direction bearings with the same  $D$  in the same Diameter Series.

**Remark**  $\Delta_{Ts}$  in the table is the deviation in the respective heights  $T$  in the figures below.

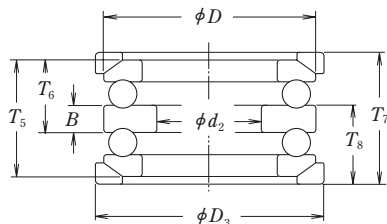
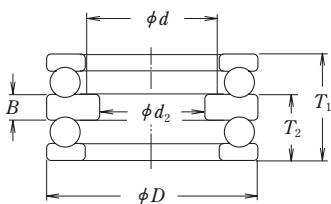
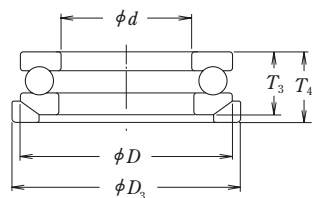
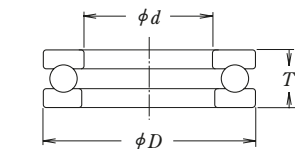


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

Table 7. 7. 1 Tolerances for Bore Diameters of Shaft Washers and Height (Metric, Normal Class)

Units : m

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$		$\Delta_{Ts}$	
over	incl	high	low	high	low
<b>80</b>	<b>120</b>	0	-20	0	-150
<b>120</b>	<b>180</b>	0	-25	0	-175
<b>180</b>	<b>250</b>	0	-30	0	-200
<b>250</b>	<b>315</b>	0	-35	0	-225
<b>315</b>	<b>400</b>	0	-40	0	-300
<b>400</b>	<b>500</b>	0	-45	0	-350
<b>500</b>	<b>630</b>	0	-50	0	-450
<b>630</b>	<b>800</b>	0	-75	0	-550
<b>800</b>	<b>1 000</b>	0	-100	0	-700
<b>1 000</b>	<b>1 250</b>	0	-125	0	-900
<b>1 250</b>	<b>1 600</b>	0	-160	0	-1 200

Table 7. 7. 2  
Tolerances for Housing Washer  
Outside Diameters (Metric,  
Normal Class)

Units : m

Nominal Outside Diameter $D$ (mm)		$\Delta_{Dmp}$	
over	incl	high	low
<b>180</b>	<b>250</b>	0	-30
<b>250</b>	<b>315</b>	0	-35
<b>315</b>	<b>400</b>	0	-40
<b>400</b>	<b>500</b>	0	-45
<b>500</b>	<b>630</b>	0	-50
<b>630</b>	<b>800</b>	0	-75
<b>800</b>	<b>1 000</b>	0	-100
<b>1 000</b>	<b>1 250</b>	0	-125
<b>1 250</b>	<b>1 600</b>	0	-160
<b>1 600</b>	<b>2 000</b>	0	-200

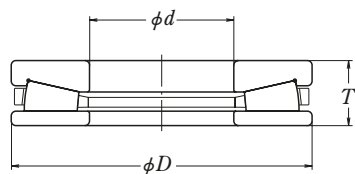
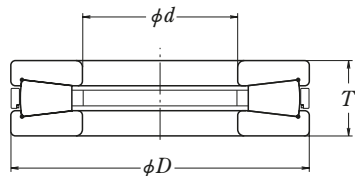


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

Table 7. 7. 3 Tolerances for Bore Diameters of Shaft Washers and Height (Inch, Class 4)

Units : m

Nominal Bore Diameter $d$				$\Delta_{dmp}$		$\Delta_{Ts}$	
over		incl					
(mm)	(inch)	(mm)	(inch)	high	low	high	low
—	—	<b>304.800</b>	12.0000	+25	0	+381	−381
<b>304.800</b>	12.0000	<b>609.600</b>	24.0000	+51	0	+381	−381
<b>609.600</b>	24.0000	<b>914.400</b>	36.0000	+76	0	+381	−381
<b>914.400</b>	36.0000	<b>1 219.200</b>	48.0000	+102	0	+381	−381

Table 7. 7. 4 Tolerances for Housing Washer Outside Diameters (Inch, Class 4)

Units : m

Nominal Outside Diameter $D$				$\Delta_{Dmp}$	
over		incl			
(mm)	(inch)	(mm)	(inch)	high	low
—	—	<b>304.800</b>	12.0000	+25	0
<b>304.800</b>	12.0000	<b>609.600</b>	24.0000	+51	0
<b>609.600</b>	24.0000	<b>914.400</b>	36.0000	+76	0
<b>914.400</b>	36.0000	<b>1 219.200</b>	48.0000	+102	0
<b>1 219.200</b>	48.0000	—	—	+127	0

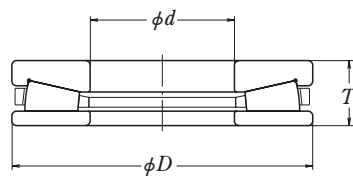
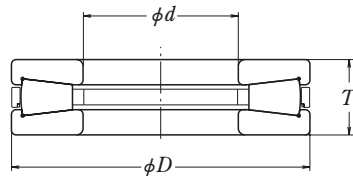


Table 7. 8 Tolerances for Thrust Spherical Roller Bearings

Table 7. 8. 1 Tolerances for Bore Diameters of Shaft Rings and Height (Normal Class)

Units :    m

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$		$V_{dsp}$	Reference		
					$S_d$	$\Delta_{Ts}$	
over	incl.	high	low	max.	max.	high	low
50	80	0	−15	11	25	+150	−150
80	120	0	−20	15	25	+200	−200
120	180	0	−25	19	30	+250	−250
180	250	0	−30	23	30	+300	−300
250	315	0	−35	26	35	+350	−350
315	400	0	−40	30	40	+400	−400
400	500	0	−45	34	45	+450	−450

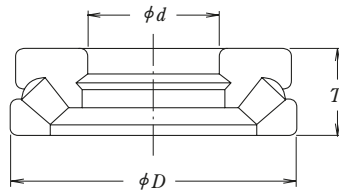
**Remark** The bore diameter "no-go side" tolerances (high) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).

Table 7. 8. 2 Tolerances for Housing Ring Diameter (Normal Class)

Units :    m

Nominal Outside Diameter $D$ (mm)		$\Delta_{Dmp}$	
over	incl.	high	low
120	180	0	− 25
180	250	0	− 30
250	315	0	− 35
315	400	0	− 40
400	500	0	− 45
500	630	0	− 50
630	800	0	− 75
800	1 000	0	−100

**Remark** The outside diameter "no-go side" tolerances (low) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension  $r$  (max.).



**Table 7. 9 Tolerances of**  
**CLASS 5P, CLASS 7P, and CLASS 9P**

**(1) Tolerances for Inner Rings**

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$				$\Delta_{ds}$				$V_{dp}$		$V_{dmp}$		$\Delta_{Bs}$	
		CLASS 5P CLASS 7P		CLASS 9P		CLASS 5P CLASS 7P		CLASS 9P		CLASS 5P CLASS 7P	CLASS 9P	CLASS 5P CLASS 7P	CLASS 9P	Single Brgs CLASS 5P CLASS 7P CLASS 9P	
		high	low	high	low	high	low	high	low	max.	max.	max.	max.	high	low
—	<b>10</b>	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4
<b>10</b>	<b>18</b>	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4
<b>18</b>	<b>30</b>	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4

**Note** <sup>(1)</sup> Applicable to bearings for which the axial clearance (preload) is to be adjusted by combining two selected bearings.  
**Remark** Please consult with NSK regarding CLASS 3P and the tolerances of Metric Series instrument ball bearings.

**(2) Tolerances for**

Nominal Outside Diameter $D$ (mm)		$\Delta_{Dmp}$				$\Delta_{Ds}$				$V_{Dp}$		$V_{Dmp}$			
		CLASS 5P CLASS 7P		CLASS 9P		CLASS 5P CLASS 7P		CLASS 9P		CLASS 5P CLASS 7P	CLASS 9P	CLASS 5P CLASS 7P		CLASS 9P	
		high	low	high	low	Open	Shielded Sealed	Open		Open	Shielded Sealed	Open	Open	Shielded Sealed	Open
—	<b>18</b>	0	−5.1	0	−2.5	0	−5.1	+1	−6.1	0	−2.5	2.5	5.1	1.3	2.5
<b>18</b>	<b>30</b>	0	−5.1	0	−3.8	0	−5.1	+1	−6.1	0	−3.8	2.5	5.1	2	2.5
<b>30</b>	<b>50</b>	0	−5.1	0	−3.8	0	−5.1	+1	−6.1	0	−3.8	2.5	5.1	2	2.5

**Notes** <sup>(1)</sup> Applicable to flange width variation for flanged bearings.  
<sup>(2)</sup> Applicable to the flange back face.

**Instrument Ball Bearings (Inch Series)**
**(ANSI/ABMA Equivalent)**
**and Width of Outer Rings**

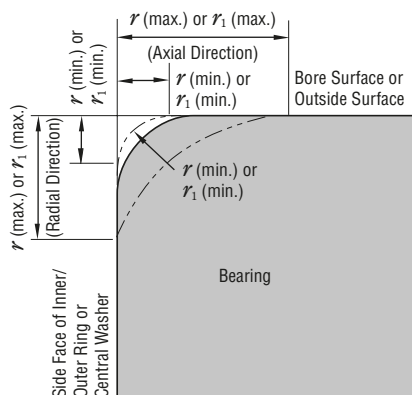
Units : m

(or $\Delta_{Cs}$ )		$V_{Bs}$			$K_{ia}$			$S_{ia}$			$S_d$		
Combined Brgs (°)		CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P
high	low	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
0	−400	5.1	2.5	1.3	3.8	2.5	1.3	7.6	2.5	1.3	7.6	2.5	1.3
0	−400	5.1	2.5	1.3	3.8	2.5	1.3	7.6	2.5	1.3	7.6	2.5	1.3
0	−400	5.1	2.5	1.3	3.8	3.8	2.5	7.6	3.8	1.3	7.6	3.8	1.3

**Outer Rings**

Units : m

$V_{Cs}$ (°)			$S_D$			$K_{ea}$			$S_{ea}$			Deviation of Flange Outside Diameter $\Delta_{D1S}$		Deviation of Flange Width $\Delta_{C1S}$		Flange Backface Runout with Raceway (°) $S_{ea1}$
CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P	CLASS 5P	CLASS 7P	CLASS 9P					
max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	high	low	high	low	max.
5.1	2.5	1.3	7.6	3.8	1.3	5.1	3.8	1.3	7.6	5.1	1.3	0	−25.4	0	−50.8	7.6
5.1	2.5	1.3	7.6	3.8	1.3	5.1	3.8	2.5	7.6	5.1	2.5	0	−25.4	0	−50.8	7.6
5.1	2.5	1.3	7.6	3.8	1.3	5.1	5.1	2.5	7.6	5.1	2.5	0	−25.4	0	−50.8	7.6



$r$  : Chamfer dimension of inner/outer ring  
 $r_1$  : Chamfer dimension of inner/outer ring (front side)  
 or of central washer of thrust ball bearings

**Remark** The precise shape of chamfer surfaces has not been specified but its profile in the axial plane must not intersect an arc of radius  $r$  (min.) or  $r_1$  (min.) that touches the side face of an inner ring or central washer and bore surface or the side face of an outer ring and outside surface.

**Table 7. 10 Chamfer Dimension Limits (for Metric Series Bearings)**

**Table 7. 10. 1 Chamfer Dimension Limits for Radial Bearings (Excluding Tapered Roller Bearings)**

Units : mm

Permissible Chamfer Dimension for Inner/Outer Rings $r$ (min.) or $r_1$ (min.)	Nominal Bore Diameter $d$		Permissible Chamfer Dimension for Inner/Outer Rings $r$ (max.) or $r_1$ (max.)		Reference Corner Radius of Shaft or Housing $r_a$ max.
	over	incl.	Radial Direction	Axial Direction <sup>(1)</sup>	
<b>0.05</b>	—	—	0.1	0.2	0.05
<b>0.08</b>	—	—	0.16	0.3	0.08
<b>0.1</b>	—	—	0.2	0.4	0.1
<b>0.15</b>	—	—	0.3	0.6	0.15
<b>0.2</b>	—	—	0.5	0.8	0.2
<b>0.3</b>	—	40	0.6	1	0.3
	40	—	0.8	1	
<b>0.6</b>	—	40	1	2	0.6
	40	—	1.3	2	
<b>1</b>	—	50	1.5	3	1
	50	—	1.9	3	
<b>1.1</b>	—	120	2	3.5	1
	120	—	2.5	4	
<b>1.5</b>	—	120	2.3	4	1.5
	120	—	3	5	
<b>2</b>	—	80	3	4.5	
	80	220	3.5	5	2
	220	—	3.8	6	
<b>2.1</b>	—	280	4	6.5	2
	280	—	4.5	7	
<b>2.5</b>	—	100	3.8	6	
	100	280	4.5	6	2
	280	—	5	7	
<b>3</b>	—	280	5	8	2.5
	280	—	5.5	8	
<b>4</b>	—	—	6.5	9	3
<b>5</b>	—	—	8	10	4
<b>6</b>	—	—	10	13	5
<b>7.5</b>	—	—	12.5	17	6
<b>9.5</b>	—	—	15	19	8
<b>12</b>	—	—	18	24	10
<b>15</b>	—	—	21	30	12
<b>19</b>	—	—	25	38	15

**Note** <sup>(1)</sup> For bearings with nominal widths less than 2 mm, the value of  $r$  (max.) in the axial direction is the same as that in the radial direction.

**Table 7. 10. 2 Chamfer Dimension Limits for  
Tapered Roller Bearings**

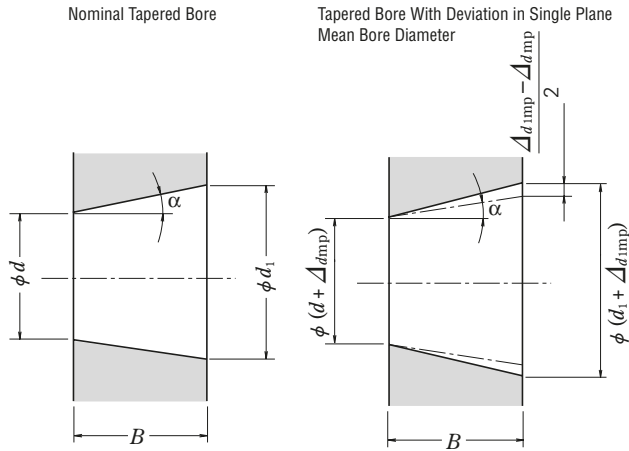
Units : mm					
Permissible Chamfer Dimension for Inner/ Outer Rings $r$ (min.)	Nominal Bore or Nominal Outside Diameter <sup>(1)</sup> $d$ or $D$		Permissible Chamfer Dimension for Inner/ Outer Rings $r$ (max.)		Reference
					Corner Radius of Shaft or Housing $r_a$
	over	incl.	Radial Direction	Axial Direction	max.
<b>0.15</b>	—	—	0.3	0.6	0.15
<b>0.3</b>	—	40	0.7	1.4	0.3
	40	—	0.9	1.6	
<b>0.6</b>	—	40	1.1	1.7	0.6
	40	—	1.3	2	
<b>1</b>	—	50	1.6	2.5	1
	50	—	1.9	3	
<b>1.5</b>	—	120	2.3	3	1.5
	120	250	2.8	3.5	
	250	—	3.5	4	
<b>2</b>	—	120	2.8	4	2
	120	250	3.5	4.5	
	250	—	4	5	
<b>2.5</b>	—	120	3.5	5	2
	120	250	4	5.5	
	250	—	4.5	6	
<b>3</b>	—	120	4	5.5	2.5
	120	250	4.5	6.5	
	250	400	5	7	
	400	—	5.5	7.5	
<b>4</b>	—	120	5	7	3
	120	250	5.5	7.5	
	250	400	6	8	
	400	—	6.5	8.5	
<b>5</b>	—	180	6.5	8	4
	180	—	7.5	9	
<b>6</b>	—	180	7.5	10	5
	180	—	9	11	

**Note** <sup>(1)</sup> Inner rings are classified by  $d$  and outer rings by  $D$ .

**Table 7. 10. 3 Chamfer Dimension Limits for Thrust Bearings**

Units : mm		
Permissible Chamfer Dimension for Shaft (or Central)/Housing Washers $r$ (min.) or $r_1$ (min.)	Permissible Chamfer Dimension for Shaft (or Central)/Housing Washers $r$ (max.) or $r_1$ (max.)	Reference
		Corner Radius of Shaft or Housing $r_a$
	Radial and Axial Direction	max.
<b>0.05</b> <b>0.08</b> <b>0.1</b>	0.1	0.05
	0.16	0.08
	0.2	0.1
<b>0.15</b> <b>0.2</b> <b>0.3</b>	0.3	0.15
	0.5	0.2
	0.8	0.3
<b>0.6</b> <b>1</b> <b>1.1</b>	1.5	0.6
	2.2	1
	2.7	1
<b>1.5</b> <b>2</b> <b>2.1</b>	3.5	1.5
	4	2
	4.5	2
<b>3</b> <b>4</b> <b>5</b>	5.5	2.5
	6.5	3
	8	4
<b>6</b> <b>7.5</b> <b>9.5</b>	10	5
	12.5	6
	15	8
<b>12</b> <b>15</b> <b>19</b>	18	10
	21	12
	25	15

**Table 7.11 Tolerances for Tapered Bores (Normal Class)**



- $d$  : Nominal bore diameter  
 $d_1$  : Theoretical diameter of larger end of tapered bore  
 Taper 1:12  $d_1 = d + 1/12 B$       Taper 1:30  $d_1 = d + 1/30 B$   
 $\Delta_{dmp}$  : Single plane mean bore diameter deviation in theoretical diameter of smaller end of bore  
 $\Delta_{d1mp}$  : Single plane mean bore diameter deviation in theoretical diameter of larger end of bore  
 $V_{dp}$  : Bore diameter variation in a single radial plane  
 $B$  : Nominal inner ring width  
 $\alpha$  : Half of taper angle of tapered bore  
 Taper 1:12  $\alpha = 2^\circ 23' 9.4'' = 2.38594^\circ = 0.041643 \text{ rad}$   
 Taper 1:30  $\alpha = 57' 17.4'' = 0.95484^\circ = 0.016665 \text{ rad}$

**Taper 1 : 12**

Units :  $\mu\text{m}$

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$		$\Delta_{d1mp} - \Delta_{dmp}$		$V_{dp}^{(1)} (^{\circ})$
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	—
800	1 000	+140	0	+90	0	—
1 000	1 250	+165	0	+105	0	—
1 250	1 600	+195	0	+125	0	—

- Notes** <sup>(1)</sup> Applicable to all radial planes of tapered bores.  
<sup>(2)</sup> Not applicable to Diameter Series 7 and 8.

Taper 1 : 30

Units : m

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$		$\Delta_{d1mp} - \Delta_{dmp}$		$V_{dp}^{(1)} \text{ } ^{(2)}$
over	incl.	high	low	high	low	max.
<b>80</b>	<b>120</b>	+20	0	+35	0	22
<b>120</b>	<b>180</b>	+25	0	+40	0	40
<b>180</b>	<b>250</b>	+30	0	+46	0	46
<b>250</b>	<b>315</b>	+35	0	+52	0	52
<b>315</b>	<b>400</b>	+40	0	+57	0	57
<b>400</b>	<b>500</b>	+45	0	+63	0	63
<b>500</b>	<b>630</b>	+50	0	+70	0	70

**Notes** <sup>(1)</sup> Applicable to all radial planes of tapered bores.

<sup>(2)</sup> Not applicable to diameter series 7 and 8.

**Remark** For a value exceeding 630 mm, please contact NSK.

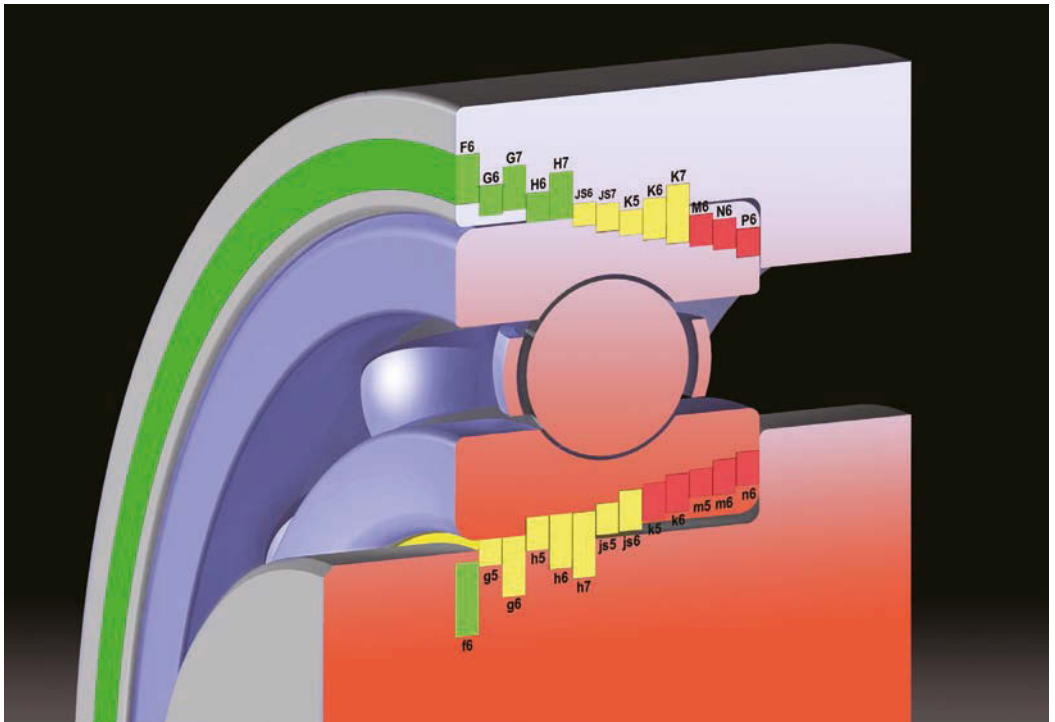
## 7.2 Selection of Tolerance Classes

For general applications, Normal Class tolerances are adequate in nearly all cases for satisfactory performance. However, bearings with Class 5, 4, or higher tolerances are more suitable for the following applications in Table 7.12.

Example reference applications and appropriate tolerance classes are listed for various bearing requirements and operating conditions.

Table 7.12 Typical Tolerance Classes for Specific Applications (Reference)

Bearing Requirements, Operating Conditions	Example Applications	Tolerance Classes
High Running Accuracy	VTR Drum Spindles	P5
	Magnetic Disk Spindles for Computers }	P5, P4, P2
	Machine-Tool Main Spindles	P5, P4, P2
	Rotary Printing Presses	P5
	Rotary Tables of Vertical Presses, etc. }	P5, P4
	Roll Necks of Cold Rolling Mill Backup Rolls }	Higher than P4
	Slewing Bearings for Parabolic Antennas }	Higher than P4
Extra High Speed	Dental Drills	CLASS 7P, CLASS 5P
	Gyroscopes	CLASS 7P, P4
	High Frequency Spindles	CLASS 7P, P4
	Superchargers	P5, P4
	Centrifugal Separators	P5, P4
	Main Shafts of Jet Engines	Higher than P4
Low Torque and Low Torque Variation	Gyroscope Gimbals	CLASS 7P, P4
	Servomechanisms	CLASS 7P, CLASS 5P
	Potentiometric Controllers	CLASS 7P



## 8. FITS AND INTERNAL CLEARANCES

<b>8.1 Fits</b>	A 154
<b>8.1.1 Importance of Proper Fits</b>	A 154
<b>8.1.2 Selection of Fit</b>	A 154
(1) Load Conditions and Fit	A 154
(2) Magnitude of Load and Interference	A 154
(3) Interference Variation Caused by Temperature Differences Between Bearing and Shaft or Housing	A 156
(4) Effective Interference and Finish of Shaft and Housing	A 156
(5) Fitting Stress and Ring Expansion and Contraction	A 156
(6) Surface Pressure and Maximum Stress on Fitting Surface	A 158
(7) Mounting and Withdrawal Loads	A 160
<b>8.1.3 Recommended Fits</b>	A 162
<b>8.2 Bearing Internal Clearances</b>	A 168
<b>8.2.1 Internal Clearances and Their Standards</b>	A 168
<b>8.2.2 Selection of Bearing Internal Clearances</b>	A 174
(1) Decrease in Radial Clearance Caused by Fitting and Residual Clearance	A 174
(2) Decrease in Radial Internal Clearance Caused by Temperature Differences Between Inner and Outer Rings and Effective Clearance	A 175
<b>8.3 Technical Data</b>	A 176
<b>8.3.1 Temperature Rise and Dimensional Change</b>	A 176
<b>8.3.2 Interference Deviation Due to Temperature Rise         (Aluminum Housing, Plastic Housing)</b>	A 178
<b>8.3.3 Calculating Residual Internal Clearance After Mounting</b>	A 180
<b>8.3.4 Effect of Interference Fits on Bearing Raceways (Fit of Inner Ring)</b>	A 182
<b>8.3.5 Effect of Interference Fits on Bearing Raceways (Fit of Outer Ring)</b>	A 184
<b>8.3.6 Measuring the Internal Clearance of Combined         Tapered Roller Bearings (Offset Measuring Method)</b>	A 186
<b>8.3.7 Internal Clearance Adjustment Method         When Mounting a Tapered Roller Bearing</b>	A 188

## 8. FITS AND INTERNAL CLEARANCES

### 8.1 Fits

#### 8.1.1 Importance of Proper Fits

In cases where a rolling bearing has its inner ring fitted to the shaft with only slight interference, harmful circumferential slippage may occur between the inner ring and shaft. This slipping of the inner ring, which is called “creep”, results in a circumferential displacement of the ring relative to the shaft if the interference fit is not sufficiently tight. When creep occurs, the fitted surfaces become abraded, causing wear and considerable damage to the shaft. Abnormal heating and vibration may also occur due to abrasive metallic particles entering the interior of the bearing. It is important to prevent creep by having sufficient interference to firmly secure the ring that rotates to either the shaft or housing. Creep cannot always be eliminated using only axial tightening through the bearing ring faces. Generally, it is not necessary, to provide interference for rings subjected only to stationary loads. Fits are sometimes made without any interference for either the inner or outer ring to accommodate certain operating conditions, or to facilitate mounting and dismounting. In these cases, lubrication of other applicable methods should be considered to prevent damage to the fitting surfaces due to creep.

#### 8.1.2 Selection of Fit

##### (1) Load Conditions and Fit

The proper fit can be selected from Table 8.1 based on the load and operating conditions.

##### (2) Magnitude of Load and Interference

The interference of the inner ring is slightly reduced by bearing load; therefore, the loss of interference should be estimated using the following equations:

$$\left. \begin{aligned} \Delta d_F &= 0.08 \sqrt{\frac{d}{B}} F_r \times 10^{-3} \dots\dots (N) \\ \Delta d_F &= 0.25 \sqrt{\frac{d}{B}} F_r \times 10^{-3} \dots\dots \{ \text{kgf} \} \end{aligned} \right\} \dots (8.1)$$

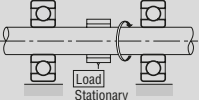
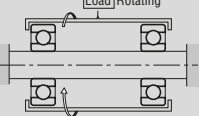
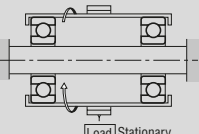
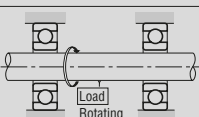
where  $\Delta d_F$  : Interference decrease of inner ring (mm)

$d$  : Bearing bore diameter (mm)

$B$  : Nominal inner ring width (mm)

$F_r$  : Radial load applied on bearing (N), {kgf}

Table 8.1 Loading Conditions and Fits

Load Application	Bearing Operation		Load Conditions	Fitting	
	Inner Ring	Outer Ring		Inner Ring	Outer Ring
	Rotating	Stationary	Rotating Inner Ring Load Stationary Outer Ring Load	Tight Fit	Loose Fit
	Stationary	Rotating			
	Stationary	Rotating	Rotating Outer Ring Load Stationary Inner Ring Load	Loose Fit	Tight Fit
	Rotating	Stationary			
Indeterminate load direction due to variation of direction or unbalanced load	Rotating or Stationary	Rotating or Stationary	Direction of Load Indeterminate	Tight Fit	Tight Fit

Therefore, the effective interference  $\Delta d$  should be larger than the interference given by Equation (8.1). However, interference often becomes insufficient with heavy loads where the radial load exceeds 20% of the basic static load rating  $C_{0r}$ , under normal operating conditions. In these cases, interference should be estimated using Equation (8.2):

$$\left. \begin{aligned} \Delta d &\geq 0.02 \frac{F_r}{B} \times 10^{-3} \dots\dots\dots (\text{N}) \\ \Delta d &\geq 0.2 \frac{F_r}{B} \times 10^{-3} \dots\dots\dots \{\text{kgf}\} \end{aligned} \right\} \dots\dots\dots (8.2)$$

where  $\Delta d$  : Effective interference (mm)  
 $F_r$  : Radial load applied on bearing  
 (N), {kgf}  
 $B$  : Nominal inner ring width (mm)

Creep experiments conducted by NSK with NU219 bearings showed a linear relation between radial load (load at creep occurrence limit) and required effective

interference. It was confirmed that this line agrees well with the straight line of Equation (8.2).

When subjected to loads heavier than 0.25  $C_{0r}$ , the interference given by Equation (8.1) for NU219 bearings becomes insufficient and creep occurs.

Generally speaking, the necessary interference for loads heavier than 0.25  $C_{0r}$  should be calculated using Equation (8.2). When doing this, verify that the fit does not cause excessive circumferential stress.

#### Calculation example

For NU219,  $B = 32$  (mm) and assume

$F_r = 98\,100$  N {10 000 kgf}

$C_{0r} = 183\,000$  N {18 600 kgf}

$$\frac{F_r}{C_{0r}} = \frac{98\,100}{183\,000} = 0.536 > 0.2$$

Therefore, the required effective interference is calculated using Equation (8.2).

$$\Delta d = 0.02 \times \frac{98\,100}{32} \times 10^{-3} = 0.061 \text{ (mm)}$$

This result agrees well with Fig. 8.1.

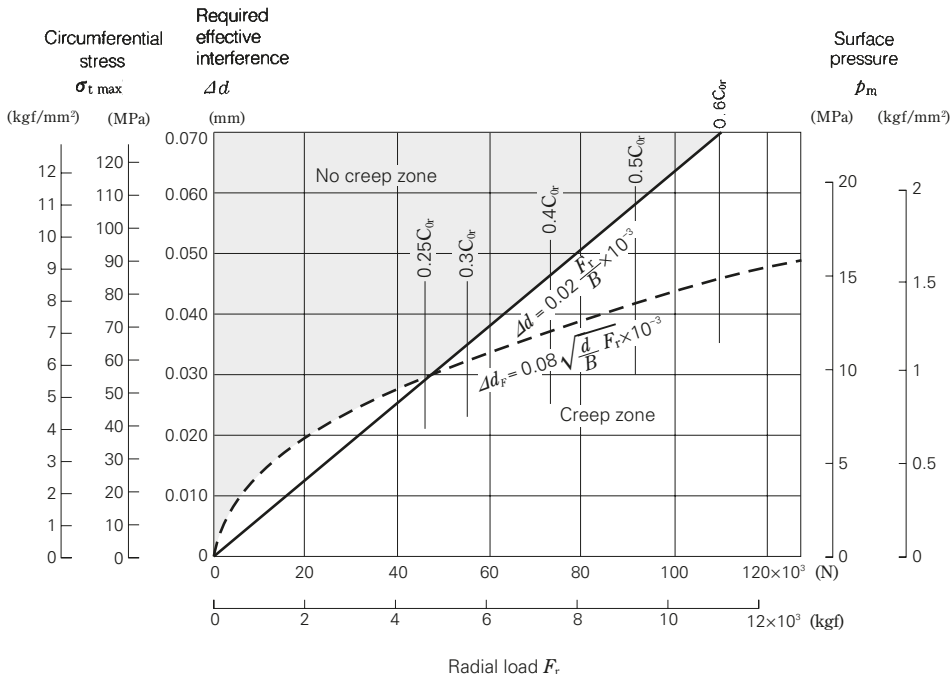


Fig. 8.1 Load and Required Effective Interference for Fit

## **(3) Interference Variation Caused by Temperature Differences Between Bearing and Shaft or Housing**

The effective interference decreases due to the increasing bearing temperature during operation. If the temperature difference between the bearing and housing is  $\Delta T$  ( $^{\circ}\text{C}$ ), then the temperature difference between the fitted surfaces of the shaft and inner ring is estimated to be about  $(0.1-0.15) \Delta T$  when the shaft is cooled. The decrease in the interference of the inner ring due to this temperature difference  $\Delta d_T$  may be calculated using Equation (8.3):

$$\Delta d_T = (0.10 \text{ to } 0.15) \times \Delta T \alpha \cdot d \div 0.0015 \Delta T \cdot d \times 10^{-3} \dots\dots\dots (8.3)$$

where  $\Delta d_T$ : Decrease in interference of inner ring due to temperature difference (mm)  
 $\Delta T$ : Temperature difference between bearing interior and surrounding parts ( $^{\circ}\text{C}$ )  
 $\alpha$ : Coefficient of linear expansion of bearing steel  $\doteq 12.5 \times 10^{-6}$  ( $1/^{\circ}\text{C}$ )  
 $d$ : Bearing nominal bore diameter (mm)

In addition, depending on the temperature difference between the outer ring and housing, or difference in their coefficients of linear expansion, interference may increase.

## **(4) Effective Interference and Finish of Shaft and Housing**

Since the roughness of fitted surfaces is reduced during fitting, the effective interference becomes less than the apparent interference. The amount of this interference decrease varies depending on the roughness of the surfaces and may be estimated using the following equations:

$$\text{For ground shafts} \quad \Delta d = \frac{d}{d+2} \Delta d_a \dots\dots\dots (8.4)$$

$$\text{For machined shafts} \quad \Delta d = \frac{d}{d+3} \Delta d_a \dots\dots\dots (8.5)$$

where  $\Delta d$ : Effective interference (mm)  
 $\Delta d_a$ : Apparent interference (mm)  
 $d$ : Bearing nominal bore diameter (mm)

According to Equations (8.4) and (8.5), the effective interference of bearings with a bore diameter of 30 to 150 mm is about 95% of the apparent interference.

## **(5) Fitting Stress and Ring Expansion and Contraction**

When bearings are mounted with interference on a shaft or in a housing, the rings either expand or contract and stress is produced. Excessive interference may damage the bearings; therefore, as a general rule, the maximum interference should be kept under approximately 7/10 000 the shaft diameter.

The pressure between fitted surfaces, expansion or contraction of the rings, and circumferential stress may be calculated using the equations in Table 8.2.

Table 8.2 Fit Conditions

	Inner Ring and Shaft	Outer Ring and Housing
Surface Pressure $p_m$ (MPa) {kgf/mm <sup>2</sup> }	Hollow shaft $p_m = \frac{\Delta d}{d} \frac{1}{\left[ \frac{m_s - 1}{m_s E_s} - \frac{m_i - 1}{m_i E_i} \right] + 2 \left[ \frac{k_0^2}{E_s (1 - k_0^2)} + \frac{1}{E_i (1 - k^2)} \right]}$ Solid shaft $p_m = \frac{\Delta d}{d} \frac{1}{\left[ \frac{m_s - 1}{m_s E_s} - \frac{m_i - 1}{m_i E_i} \right] + \frac{2}{E_i (1 - k^2)}}$	Housing outside diameter $p_m = \frac{\Delta D}{D} \frac{1}{\left[ \frac{m_e - 1}{m_e E_e} - \frac{m_h - 1}{m_h E_h} \right] + 2 \left[ \frac{h^2}{E_e (1 - h^2)} + \frac{1}{E_h (1 - h^2)} \right]}$
Expansion of Inner Ring Raceway $\Delta D_i$ (mm) Contraction of Outer Ring Raceway $\Delta D_e$ (mm)	$\Delta D_i = 2d \frac{p_m}{E_i} \frac{k}{1 - k^2}$ $= \Delta d \cdot k \frac{1 - k_0^2}{1 - k^2 k_0^2} \text{ (hollow shaft)}$ $= \Delta d \cdot k \text{ (solid shaft)}$	$\Delta D_e = 2D \frac{p_m}{E_e} \frac{h}{1 - h^2}$ $= \Delta D \cdot h \frac{1 - h_0^2}{1 - h^2 h_0^2}$
Maximum Stress $\sigma_{t \max}$ (MPa) {kgf/mm <sup>2</sup> }	Maximum circumferential stress at inner ring bore fitting surface. $\sigma_{t \max} = p_m \frac{1 + k^2}{1 - k^2}$	Maximum circumferential stress at outer ring outer surface. $\sigma_{t \max} = p_m \frac{2}{1 - h^2}$
Symbols	$d$ : Shaft diameter, inner ring bore $d_0$ : Hollow shaft bore $D_i$ : Inner ring raceway diameter $k = d/D_i$ , $k_0 = d_0/d$ $E_i$ : Inner ring Young's modulus, 208 000 MPa {21 200 kgf/mm <sup>2</sup> } $E_s$ : Shaft Young's modulus $m_i$ : Inner ring Poisson's number, 3.33 $m_s$ : Shaft Poisson's number	$D$ : Housing bore diameter, outer ring outside diameter $D_0$ : Housing outside diameter $D_e$ : Outer ring raceway diameter $h = D_e/D$ , $h_0 = D_0/D$ $E_e$ : Outer ring Young's modulus, 208 000 MPa {21 200 kgf/mm <sup>2</sup> } $E_h$ : Housing Young's modulus $m_e$ : Outer ring Poisson's number, 3.33 $m_h$ : Housing Poisson's number

## (6) Surface Pressure and Maximum Stress on Fitting Surfaces

In order for rolling bearings to achieve their full life expectancy, their fitting must be appropriate. Usually an interference fit is chosen for a rotating inner ring, and a loose fit is used for a fixed outer ring. To select the fit, the magnitude of the load, the temperature differences among the bearing and shaft and housing, material characteristics of the shaft and housing, level of finish, material thickness, and bearing mounting/dismounting method must all be considered.

If the interference is insufficient for the operating conditions, ring loosening, creep, fretting, heat generation, or other problems may occur. If the interference is excessive, the ring may crack due to circumferential stress. The magnitude of the interference is usually satisfactory if it follows recommendations for the size of the shaft or housing listed in the bearing catalog. To determine surface pressure and stress on the fitting surfaces, calculations can be made assuming a thick-walled cylinder with uniform internal and external pressures; necessary equations for this are summarized in Table 8.2. For convenience in fitting bearing inner rings on solid steel shafts, which are the most common type of shaft, the surface pressure and maximum stress are shown in Figs. 8.3 and 8.4.

Fig. 8.3 shows the surface pressure  $p_m$  and maximum stress  $\sigma_{t \max}$  for given combinations of bearing bores for mean interference at various tolerance grades. Fig. 8.4 shows the maximum surface pressure  $p_m$  and maximum stress  $\sigma_{t \max}$  when maximum interference occurs.

Fig. 8.4 is convenient for checking if  $\sigma_{t \max}$  exceeds acceptable limits. The tensile strength of hardened bearing steel is about 1 570 to 1 960 MPa {160 to 200 kgf/mm<sup>2</sup>}. However, for safety, plan for a maximum fitting stress of 127 MPa {13 kgf/mm<sup>2</sup>}. For reference, the distributions of circumferential stress  $\sigma_t$  and radial stress  $\sigma_r$  in an inner ring are shown in Fig. 8.2.

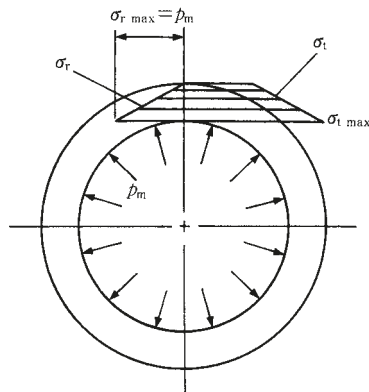


Fig. 8.2 Distribution of Circumferential Stress  $\sigma_t$  and Radial Stress  $\sigma_r$

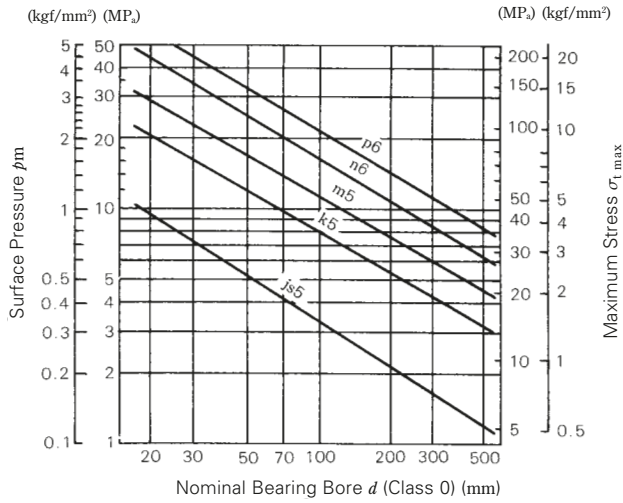


Fig. 8.3 Surface Pressure  $p_m$  and Maximum Stress  $\sigma_{t \max}$  for Mean Interference in Various Tolerance Grades

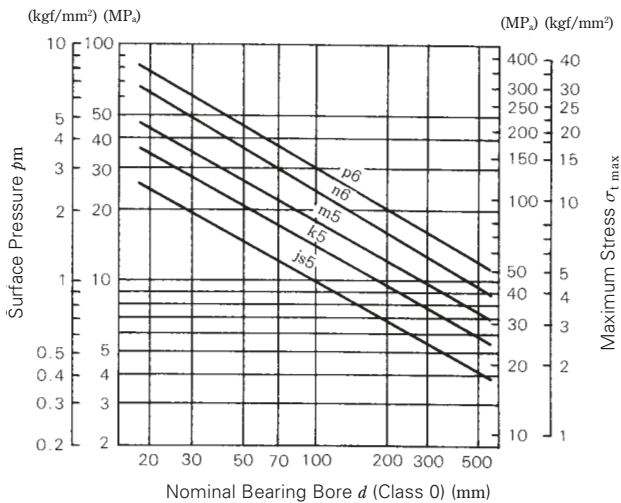


Fig. 8.4 Surface Pressure  $p_m$  and Maximum Stress  $\sigma_{t \max}$  for Maximum Interference in Various Tolerance Grades

## (7) Press-Fit Force and Withdrawal Force

The force needed to mount bearings on shafts or in a housing hole with interference can be obtained using the thick-walled cylinder theory.

The press-fit force (or withdrawal force) depends upon the contact area, surface pressure, and coefficient of friction between the fitting surfaces.

The press-fit force (or withdrawal force)  $K$  needed to mount inner rings on shafts is given by Equation (8.6).

$$K = \mu p_m \pi d B \text{ (N), {kgf}} \dots\dots\dots (8.6)$$

where  $\mu$ : Coefficient of friction between fitting surfaces

$\mu=0.12$  (for press-fitting)

$\mu=0.18$  (for withdrawal)

$p_m$ : Surface pressure (MPa), {kgf/mm<sup>2</sup>}  
For example, inner ring surface pressure can be obtained using Table 8.2.

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

$d$ : Shaft diameter (mm)

$B$ : Bearing width (mm)

$\Delta d$ : Effective interference (mm)

$E$ : Young's modulus of steel (MPa), {kgf/mm<sup>2</sup>}  
 $E=208\,000$  MPa {21 200 kgf/mm<sup>2</sup>}

$k$ : Inner ring thickness ratio

$k=d/D_i$

$D_i$ : Inner ring raceway diameter (mm)

$k_0$ : Hollow shaft thickness ratio

$k_0=d_0/d$

$d_0$ : Bore diameter of hollow shaft (mm)

For solid shafts,  $d_0=0$ , consequently  $k_0=0$ . The value of  $k$  varies depending on bearing type and size, but it usually ranges between  $k=0.7$  and  $0.9$ . Assuming that  $k=0.8$  and the shaft is solid, Equation (8.6) becomes the following:

$$\left. \begin{aligned} K &= 118\,000 \mu \Delta d B \text{ (N)} \\ &= 12\,000 \mu \Delta d B \text{ {kgf}} \end{aligned} \right\} \dots\dots\dots (8.7)$$

Equation (8.7) is shown graphically in Fig. 8.5. The press-fit and withdrawal forces for outer rings and housings have also been calculated and the results are shown in Fig. 8.6.

The actual press-fit and withdrawal forces can become much higher than the calculated values if the bearing ring and shaft (or housing) are slightly misaligned or load is applied unevenly to the circumference of the bearing ring. Consequently, the values obtained from Figs. 8.5 and 8.6 should be considered only as guides when designing withdrawal tools. Tool strength should be five to six times higher than that indicated by the figures.

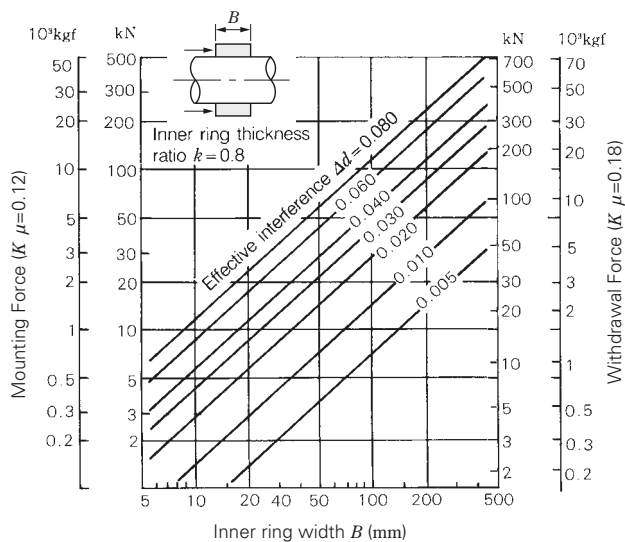


Fig. 8.5 Press-Fit and Withdrawal Forces for Inner Rings

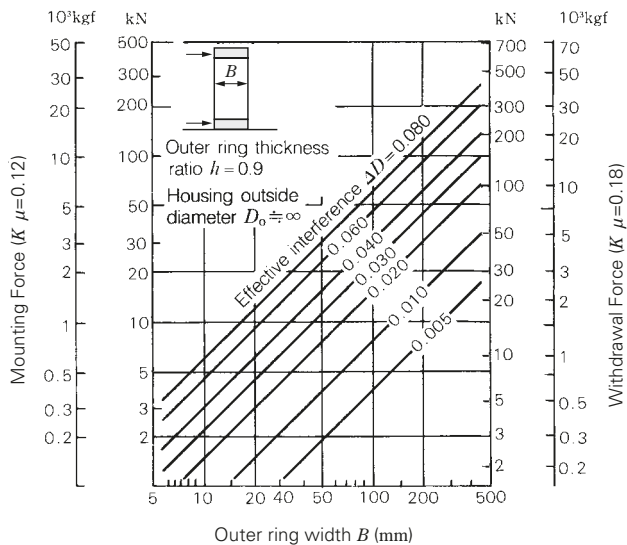


Fig. 8.6 Press-Fit and Withdrawal Forces for Outer Rings

### 8.1.3 Recommended Fits

As described previously, many factors, such as the characteristics and magnitude of bearing load, temperature differences, and means of bearing mounting and dismounting, must be considered when selecting the proper fit.

If the housing is thin or the bearing is mounted on a hollow shaft, a tighter than usual fit is necessary. A split housing often deforms the bearing into an oval shape; therefore, a split housing should be avoided when a tight fit with the outer ring is required.

The fits of both the inner and outer rings should be tight in applications where the shaft is subjected to considerable vibration.

The recommended fits for some common applications are shown in Tables 8.3 to 8.8. Please consult NSK regarding unusual operating conditions. For the tolerances and surface finish of shafts and housings, please refer to Section 13.1 (Page A270).



**Table 8.3 Fits of Radial Bearings (Normal Class, Class 6X, and Class 6) With Shafts**

Load Conditions		Examples	Shaft Diameter (mm)			Tolerance of Shaft	Remarks
			Ball Brgs	Cylindrical Roller Brgs, Tapered Roller Brgs	Spherical Roller Brgs		
Radial Bearings With Cylindrical Bores							
Rotating Outer Ring Load	Easy axial displacement of inner ring on shaft is necessary.	Wheels on Stationary Axles	All Shaft Diameters			g6	Use g5 and h5 where accuracy is required. f6 can be used in large bearings to allow easy axial movement.
	Easy axial displacement of inner ring on shaft is unnecessary	Tension Pulleys Rope Sheaves				h6	
Rotating Inner Ring Load or Indeterminate Direction of Load	Light Loads or Variable Loads (<0.06C <sub>r</sub> <sup>(1)</sup> )	Electrical Home Appliances Pumps, Blowers, Transport Vehicles, Precision Machinery, Machine Tools	<18	—	—	js5	Use Class 5 and high-precision bearings where accuracy is required. Use h5 for high-precision ball bearings with bore diameters of 18 mm or less.
			18 to 100	<40	—	js6(j6)	
			100 to 200	40 to 140	—	k6	
			—	140 to 200	—	m6	
	Normal Loads (0.06 to 0.13C <sub>r</sub> <sup>(1)</sup> )	General Bearing Applications, Medium and Large Motors <sup>(2)</sup> , Turbines, Pumps, Engine Main Bearings, Gears, Woodworking Machines	<18	—	—	js5 or js6 (j5 or j6)	k6 and m6 can be used for single-row tapered roller bearings and single-row angular contact ball bearings instead of k5 and m5.
			18 to 100	<40	<40	k5 or k6	
			100 to 140	40 to 100	40 to 65	m5 or m6	
			140 to 200	100 to 140	65 to 100	m6	
			200 to 280	140 to 200	100 to 140	n6	
			—	200 to 400	140 to 280	p6	
			—	—	280 to 500	r6	
			—	—	over 500	r7	
	Heavy Loads or Shock Loads (>0.13C <sub>r</sub> <sup>(1)</sup> )	Railway Axleboxes, Industrial Vehicles, Traction Motors, Construction Equipment, Crushers	—	50 to 140	50 to 100	n6	A bearing internal clearance greater than CN is necessary.
			—	140 to 200	100 to 140	p6	
			—	over 200	140 to 200	r6	
			—	—	200 to 500	r7	
Axial Loads Only		All Types of Bearing Applications	All Shaft Diameters			js6 (j6)	—
Radial Bearings With Tapered Bores and Sleeves							
All Types of Loading		General Bearing Applications, Railway Axleboxes	All Shaft Diameters			h9/IT5 <sup>(2)</sup>	The deviation of the shaft from its true geometric form, e. g. roundness and cylindricity should be within the tolerances of IT5 and IT7.
		Transmission Shafts, Woodworking Spindles				h10/IT7 <sup>(2)</sup>	

**Notes** <sup>(1)</sup>  $C_r$  represents the basic load rating of the bearing.

<sup>(2)</sup> Refer to Appendix Table 11 on Page E016 for the values of IT standard tolerance grades.

<sup>(3)</sup> Refer to Tables 8.14.1 and 8.14.2 for the recommended fits of shafts used in electric motors for deep groove ball bearings with bore diameters ranging from 10 mm to 160 mm and for cylindrical roller bearings with bore diameters ranging from 24 mm to 200 mm.

**Remark** This table applies only to solid steel shafts.

**Table 8.4 Fits of Thrust Bearings With Shafts**

Load Conditions		Examples	Shaft Diameter (mm)		Tolerance of Shaft	Remarks
Central Axial Load Only		Main Shafts of Lathes	All Shaft Diameters		h6 or js6 (j6)	—
Combined Radial and Axial Loads (Spherical Thrust Roller Bearings)	Stationary Inner Ring Load	Cone Crushers	All Shaft Diameters		js6 (j6)	
	Rotating Inner Ring Load or Indeterminate Direction of Load	Paper Pulp Refiners, Plastic Extruders	$<200$		k6	
			200 to 400		m6	
			over 400		n6	

**Table 8.5 Fits of Radial Bearings (Normal Class, Class 6X, and Class 6) With Housings**

Load Conditions			Examples	Tolerances for Housing Bores	Axial Displacement of Outer Ring	Remarks
Solid Housings	Rotating Outer Ring Load	Heavy Loads on Bearing in Thin-Walled Housing or Heavy Shock Loads	Automotive Wheel Hubs (Roller Bearings) Crane Travelling Wheels	P7	Impossible	—
		Normal or Heavy Loads	Automotive Wheel Hubs (Ball Bearings) Vibrating Screens	N7		
		Light or Variable Loads	Conveyor Rollers Rope Sheaves Tension Pulleys	M7		
	Indeterminate Direction of Load	Heavy Shock Loads	Traction Motors	K7	Generally Impossible	If axial displacement of the outer ring is not required.
		Normal or Heavy Loads	Pumps Crankshaft Main Bearings			
Solid or Split Housings	Indeterminate Direction of Load	Normal or Light Loads	Medium and Large Motors <sup>(1)</sup>	JS7 (J7)	Possible	Axial displacement of outer ring is necessary.
		Any Kind of Load	General Bearing Applications, Railway Axleboxes	H7	Easily possible	—
	Rotating Inner Ring Load	Normal or Light Loads	Plummer Blocks	H8		
		High Temperature Rise of Inner Ring Through Shaft	Paper Dryers	G7		
		Accurate Running Required Under Normal or Light Loads	Grinding Spindle Rear Ball Bearings High Speed Centrifugal Compressor Free Bearings	JS6 (J6)	Possible	For heavy loads, an interference fit tighter than K may be used. When high accuracy is required, very strict tolerances should be used for fitting.
Solid Housing	Indeterminate Direction of Load	Grinding Spindle Front Ball Bearings High Speed Centrifugal Compressor Fixed Bearings		K6	Generally Impossible	
		Accurate Running and High Rigidity Required Under Variable Loads	Cylindrical Roller Bearings for Machine Tool Main Spindle	M6 or N6	Impossible	
	Rotating Inner Ring Load	Minimal noise is required.	Electrical Home Appliances	H6	Easily Possible	—

**Note** <sup>(1)</sup> Refer to Tables 8.14.1 and 8.14.2 for the recommended fits of housing bores of deep groove ball bearings and cylindrical roller bearings for electric motors.

**Remarks**

1. This table is applicable to cast-iron and steel housings. For housings made of light alloys, the interference should be tighter than listed in this table.
2. Refer to the introductory section of the bearing tables for special fits, such as those for drawn cup needle roller bearings.

**Table 8.6 Fits of Thrust Bearings With Housings**

Load Conditions		Bearing Types	Tolerances for Housing Bores	Remarks
Axial Loads Only		Thrust Ball Bearings	Clearance over 0.25mm	For General Applications
			H8	When precision is required
		Spherical Thrust Roller Bearings Steep Angle Tapered Roller Bearings	Outer ring has radial clearance.	When radial loads are sustained by other bearings
Combined Radial and Axial Loads	Stationary Outer Ring Loads	Spherical Thrust Roller Bearings	H7 or JS7 (J7)	—
	Rotating Outer Ring Loads or Indeterminate Direction of Load		K7	Normal Loads
			M7	Relatively Heavy Radial Loads

**Table 8.7 Fits of Inch Series Tapered Roller Bearings With Shafts**
**(1) Bearings of Precision Classes 4 and 2**

Units :  $\mu\text{m}$ 

Operating Conditions		Nominal Bore Diameters $d$				Bore Diameter Tolerances $\Delta_{ds}$		Shaft Diameter Tolerances		Remarks
		over		incl.		high	low	high	low	
		(mm)	1/25.4	(mm)	1/25.4					
Rotating Inner Ring Loads	Normal Loads	—		76.200	3.0000	+13	0	+ 38	+ 25	For bearings with $d \leq 152.4$ mm, clearance is usually larger than CN.  In general, bearings with a clearance larger than CN are used. ※ indicates that the average interference is about $0.0005 d$ .
			3.0000	304.800	12.0000	+25	0	+ 64	+ 38	
			12.0000	609.600	24.0000	+51	0	+127	+ 76	
		24.0000	914.400	36.0000	+76	0	+190	+114		
	Heavy Loads Shock Loads High Speeds	—		76.200	3.0000	+13	0	+ 64	+ 38	
			3.0000	304.800	12.0000	+25	0	※	※	
		12.0000	609.600	24.0000	+51	0	※	※		
		24.0000	914.400	36.0000	+76	0	+381	+305		
Rotating Outer Ring Loads	Normal Loads Without Shocks	—		76.200	3.0000	+13	0	+ 13	0	The inner ring cannot be displaced axially. When heavy or shock loads exist, the figures above (rotating inner ring loads, heavy or shock loads) apply.
			3.0000	304.800	12.0000	+25	0	+ 25	0	
			12.0000	609.600	24.0000	+51	0	+ 51	0	
			24.0000	914.400	36.0000	+76	0	+ 76	0	
		—		76.200	3.0000	+13	0	0	- 13	The inner ring can be displaced axially.
			3.0000	304.800	12.0000	+25	0	0	- 25	
			12.0000	609.600	24.0000	+51	0	0	- 51	
			24.0000	914.400	36.0000	+76	0	0	- 76	

**(2) Bearings of Precision Classes 3 and 0 <sup>(1)</sup>**

Units :  $\mu\text{m}$ 

Operating Conditions		Nominal Bore Diameters $d$				Bore Diameter Tolerances $\Delta_{ds}$		Shaft Diameter Tolerances		Remarks
		over		incl.		high	low	high	low	
		(mm)	1/25.4	(mm)	1/25.4					
Rotating Inner Ring Loads	Precision Machine-Tool Main Spindles	—		76.200	3.0000	+13	0	+ 30	+18	—
		76.200	3.0000	304.800	12.0000	+13	0	+ 30	+18	
		304.800	12.0000	609.600	24.0000	+25	0	+ 64	+38	
		609.600	24.0000	914.400	36.0000	+38	0	+102	+64	
	Heavy Loads Shock Loads High Speeds	—		76.200	3.0000	+13	0	—	A minimum interference of about 0.00025 $d$ is used.	
		76.200	3.0000	304.800	12.0000	+13	0	—		
		304.800	12.0000	609.600	24.0000	+25	0	—		
		609.600	24.0000	914.400	36.0000	+38	0	—		
Rotating Outer Ring Loads	Precision Machine-Tool Main Spindles	—		76.200	3.0000	+13	0	+ 30	+18	—
		76.200	3.0000	304.800	12.0000	+13	0	+ 30	+18	
		304.800	12.0000	609.600	24.0000	+25	0	+ 64	+38	
		609.600	24.0000	914.400	36.0000	+38	0	+102	+64	

**Note** <sup>(1)</sup> For bearings with  $d$  greater than 304.8 mm, Class 0 does not exist.

Table 8.8 Fits of Inch Series Tapered Roller Bearings With Housings

## (1) Bearings of Precision Classes 4 and 2

Units :  $\mu\text{m}$ 

Operating Conditions		Nominal Outside Diameters $D$				Outside Diameter Tolerances $\Delta D_s$		Housing Bore Diameter Tolerances		Remarks
		over		incl.						
		(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	
Rotating Inner Ring Loads	Used either on free-end or fixed-end	—	—	76.200	3.0000	+25	0	+ 76	+ 51	The outer ring can be easily displaced axially.
		76.200	3.0000	127.000	5.0000	+25	0	+ 76	+ 51	
		127.000	5.0000	304.800	12.0000	+25	0	+ 76	+ 51	
		304.800	12.0000	609.600	24.0000	+51	0	+152	+102	
	The outer ring position can be adjusted axially.	609.600	24.0000	914.400	36.0000	+76	0	+229	+152	
		—	—	76.200	3.0000	+25	0	+ 25	0	The outer ring can be displaced axially.
		76.200	3.0000	127.000	5.0000	+25	0	+ 25	0	
		127.000	5.0000	304.800	12.0000	+25	0	+ 51	0	
	304.800	12.0000	609.600	24.0000	+51	0	+ 76	+ 25		
	The outer ring position cannot be adjusted axially.	609.600	24.0000	914.400	36.0000	+76	0	+127	+ 51	
		—	—	76.200	3.0000	+25	0	− 13	− 38	Generally, the outer ring is fixed axially.
		76.200	3.0000	127.000	5.0000	+25	0	− 25	− 51	
127.000		5.0000	304.800	12.0000	+25	0	− 25	− 51		
304.800	12.0000	609.600	24.0000	+51	0	− 25	− 76			
Rotating Outer Ring Loads	Normal Loads The outer ring position cannot be adjusted axially.	609.600	24.0000	914.400	36.0000	+76	0	− 25	−102	
		—	—	76.200	3.0000	+25	0	− 13	− 38	The outer ring is fixed axially.
		76.200	3.0000	127.000	5.0000	+25	0	− 25	− 51	
		127.000	5.0000	304.800	12.0000	+25	0	− 25	− 51	
	304.800	12.0000	609.600	24.0000	+51	0	− 25	− 76		
	609.600	24.0000	914.400	36.0000	+76	0	− 25	−102		

(2) Bearings of Precision Classes 3 and 0 <sup>(1)</sup>Units :  $\mu\text{m}$ 

Operating Conditions		Nominal Outside Diameters $D$				Outside Diameter Tolerances $\Delta D_s$		Housing Bore Diameter Tolerances		Remarks
		over		incl.						
		(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	
Rotating Inner Ring Loads	Used on free-end	—		152.400	6.0000	+13	0	+38	+25	The outer ring can be easily displaced axially.
		152.400	6.0000	304.800	12.0000	+13	0	+38	+25	
		304.800	12.0000	609.600	24.0000	+25	0	+64	+38	
		609.600	24.0000	914.400	36.0000	+38	0	+89	+51	
	Used on fixed-end	—		152.400	6.0000	+13	0	+25	+13	The outer ring can be displaced axially.
		152.400	6.0000	304.800	12.0000	+13	0	+25	+13	
		304.800	12.0000	609.600	24.0000	+25	0	+51	+25	
		609.600	24.0000	914.400	36.0000	+38	0	+76	+38	
	The outer ring position can be adjusted axially.	—		152.400	6.0000	+13	0	+13	0	Generally, the outer ring is fixed axially.
		152.400	6.0000	304.800	12.0000	+13	0	+25	0	
		304.800	12.0000	609.600	24.0000	+25	0	+25	0	
		609.600	24.0000	914.400	36.0000	+38	0	+38	0	
The outer ring position cannot be adjusted axially.	—		152.400	6.0000	+13	0	0	−13	The outer ring is fixed axially.	
	152.400	6.0000	304.800	12.0000	+13	0	0	−25		
	304.800	12.0000	609.600	24.0000	+25	0	0	−25		
	609.600	24.0000	914.400	36.0000	+38	0	0	−38		
Rotating Outer Ring Loads	Normal Loads The outer ring position cannot be adjusted axially.	—		76.200	3.0000	+13	0	−13	−25	The outer ring is fixed axially.
		76.200	3.0000	152.400	6.0000	+13	0	−13	−25	
		152.400	6.0000	304.800	12.0000	+13	0	−13	−38	
		304.800	12.0000	609.600	24.0000	+25	0	−13	−38	
		609.600	24.0000	914.400	36.0000	+38	0	−13	−51	

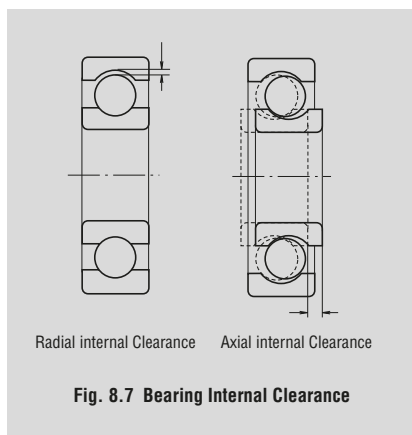
Note <sup>(1)</sup> For bearings with  $D$  greater than 304.8 mm, Class 0 does not exist.

## 8.2 Bearing Internal Clearances

### 8.2.1 Internal Clearances and Their Standards

The internal clearance of rolling bearings in operation greatly influences bearing performance including fatigue life, vibration, noise, heat generation, etc. Consequently, the selection of proper internal clearance is one of the most important tasks when choosing a bearing after the type and size have been determined.

This bearing internal clearance refers to the combined clearances between the inner/outer rings and rolling elements. The radial and axial internal clearances are defined as the total amount that one ring can be displaced relative to the other in the radial and axial directions respectively (Fig. 8.7).



To obtain accurate measurements, the clearance is generally measured by applying a specified measuring load on the bearing. This “measured clearance” is always slightly larger than the theoretical internal clearance (“geometrical clearance” for radial bearings) by the amount of elastic deformation caused by the measuring load.

Therefore, the theoretical internal clearance may be obtained by correcting the measured clearance by the amount of elastic deformation. However, in the case of roller bearings, this elastic deformation is negligibly small.

Usually the clearance before mounting is specified by the theoretical internal clearance.

In Table 8.9, reference table and page numbers are listed by bearing types.

**Table 8.9 Index for Radial Internal Clearances by Bearing Type**

Bearing Type		Table Number	Page Number
Deep Groove Ball Bearings		8.10	A169
Extra Small and Miniature Ball Bearings		8.11	A169
Magneto Bearings		8.12	A169
Self-Aligning Ball Bearings		8.13	A170
Deep Groove Ball Bearings	For Motors	8.14.1	A170
Cylindrical Roller Bearings		8.14.2	A170
Cylindrical Roller Bearings	With Cylindrical Bores	8.15	A171
	With Cylindrical Bores (Matched)		
	With Tapered Bores (Matched)		
Spherical Roller Bearings	With Cylindrical Bores	8.16	A172
	With Tapered Bores		
Double-Row and Combined Tapered Roller Bearings		8.17	A173
Combined Angular Contact Ball Bearings <sup>(1)</sup>		8.18	A174
Four-Point-Contact Ball Bearings <sup>(1)</sup>		8.19	A174

**Note** <sup>(1)</sup> Values given are axial internal clearances.

**Table 8.10 Radial Internal Clearances in Deep Groove Ball Bearings**

Units : mm

Nominal Bore Diameter <i>d</i> (mm)		Clearance									
		C2		CN		C3		C4		C5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
<b>10 only</b>		0	7	2	13	8	23	14	29	20	37
<b>10</b>	<b>18</b>	0	9	3	18	11	25	18	33	25	45
<b>18</b>	<b>24</b>	0	10	5	20	13	28	20	36	28	48
<b>24</b>	<b>30</b>	1	11	5	20	13	28	23	41	30	53
<b>30</b>	<b>40</b>	1	11	6	20	15	33	28	46	40	64
<b>40</b>	<b>50</b>	1	11	6	23	18	36	30	51	45	73
<b>50</b>	<b>65</b>	1	15	8	28	23	43	38	61	55	90
<b>65</b>	<b>80</b>	1	15	10	30	25	51	46	71	65	105
<b>80</b>	<b>100</b>	1	18	12	36	30	58	53	84	75	120
<b>100</b>	<b>120</b>	2	20	15	41	36	66	61	97	90	140
<b>120</b>	<b>140</b>	2	23	18	48	41	81	71	114	105	160
<b>140</b>	<b>160</b>	2	23	18	53	46	91	81	130	120	180
<b>160</b>	<b>180</b>	2	25	20	61	53	102	91	147	135	200
<b>180</b>	<b>200</b>	2	30	25	71	63	117	107	163	150	230
<b>200</b>	<b>225</b>	2	35	25	85	75	140	125	195	175	265
<b>225</b>	<b>250</b>	2	40	30	95	85	160	145	225	205	300
<b>250</b>	<b>280</b>	2	45	35	105	90	170	155	245	225	340
<b>280</b>	<b>315</b>	2	55	40	115	100	190	175	270	245	370
<b>315</b>	<b>355</b>	3	60	45	125	110	210	195	300	275	410
<b>355</b>	<b>400</b>	3	70	55	145	130	240	225	340	315	460
<b>400</b>	<b>450</b>	3	80	60	170	150	270	250	380	350	510
<b>450</b>	<b>500</b>	3	90	70	190	170	300	280	420	390	570
<b>500</b>	<b>560</b>	10	100	80	210	190	330	310	470	440	630
<b>560</b>	<b>630</b>	10	110	90	230	210	360	340	520	490	690
<b>630</b>	<b>710</b>	20	130	110	260	240	400	380	570	540	760
<b>710</b>	<b>800</b>	20	140	120	290	270	450	430	630	600	840

**Remarks** To obtain the measured values, use the clearance correction values in the table below.

For the C2 clearance class, the smaller value should be used for bearings with minimum clearance and the larger value for bearings near the maximum clearance range.

Units : mm

Nominal Bore Dia. <i>d</i> (mm)		Measuring Load (N) {kgf}	Radial Clearance Correction Amount				
over	incl.		C2	CN	C3	C4	C5
<b>10 (incl)</b>	<b>18</b>	24.5 {2.5}	3 to 4	4	4	4	4
<b>18</b>	<b>50</b>	49 {5}	4 to 5	5	6	6	6
<b>50</b>	<b>280</b>	147 {15}	6 to 8	8	9	9	9

**Remark** For values exceeding 280 mm, please contact NSK.

**Table 8.11 Radial Internal Clearances in Extra Small and Miniature Ball Bearings**

Units : mm

Clearance Symbol	MC1	MC2	MC3	MC4	MC5	MC6
Clearance	min. max.	min. max.	min. max.	min. max.	min. max.	min. max.
	0 5	3 8	5 10	8 13	13 20	20 28

**Remarks** 1. The standard clearance is MC3.  
2. To obtain the measured value, add correction amount from the table below.

Units : mm

Clearance Symbol	MC1	MC2	MC3	MC4	MC5	MC6
Clearance Correction Value	1	1	1	1	2	2

The measuring loads are as follows:

For miniature ball bearings\*

2.5N {0.25kgf}

For extra small ball bearings\*

4.4N {0.45kgf}

\*For classification details, refer to Table 1 on Page C054.

**Table 8.12 Radial Internal Clearances in Magneto Bearings**

Units : mm

Nominal Bore Diameter <i>d</i> (mm)		Bearing Series	Clearance	
over	incl.		min.	max.
<b>2.5</b>	<b>30</b>	EN	10	50
		E	30	60

**Table 8.13 Radial Internal Clearances in Self-Aligning Ball Bearings**

Units :  $\mu\text{m}$

Nominal Bore Dia. $d$ (mm)		Clearance in Bearings With Cylindrical Bores										Clearance in Bearings With Tapered Bores									
		C2		CN		C3		C4		C5		C2		CN		C3		C4		C5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
<b>2.5</b>	<b>6</b>	1	8	5	15	10	20	15	25	21	33	—	—	—	—	—	—	—	—	—	—
<b>6</b>	<b>10</b>	2	9	6	17	12	25	19	33	27	42	—	—	—	—	—	—	—	—	—	—
<b>10</b>	<b>14</b>	2	10	6	19	13	26	21	35	30	48	—	—	—	—	—	—	—	—	—	—
<b>14</b>	<b>18</b>	3	12	8	21	15	28	23	37	32	50	—	—	—	—	—	—	—	—	—	—
<b>18</b>	<b>24</b>	4	14	10	23	17	30	25	39	34	52	7	17	13	26	20	33	28	42	37	55
<b>24</b>	<b>30</b>	5	16	11	24	19	35	29	46	40	58	9	20	15	28	23	39	33	50	44	62
<b>30</b>	<b>40</b>	6	18	13	29	23	40	34	53	46	66	12	24	19	35	29	46	40	59	52	72
<b>40</b>	<b>50</b>	6	19	14	31	25	44	37	57	50	71	14	27	22	39	33	52	45	65	58	79
<b>50</b>	<b>65</b>	7	21	16	36	30	50	45	69	62	88	18	32	27	47	41	61	56	80	73	99
<b>65</b>	<b>80</b>	8	24	18	40	35	60	54	83	76	108	23	39	35	57	50	75	69	98	91	123
<b>80</b>	<b>100</b>	9	27	22	48	42	70	64	96	89	124	29	47	42	68	62	90	84	116	109	144
<b>100</b>	<b>120</b>	10	31	25	56	50	83	75	114	105	145	35	56	50	81	75	108	100	139	130	170
<b>120</b>	<b>140</b>	10	38	30	68	60	100	90	135	125	175	40	68	60	98	90	130	120	165	155	205
<b>140</b>	<b>160</b>	15	44	35	80	70	120	110	161	150	210	45	74	65	110	100	150	140	191	180	240

**Table 8.14 Radial Internal Clearances in Bearings for Electric Motors**

**Table 8.14. 1 Deep Groove Ball Bearings for Electric Motors**

Units :  $\mu\text{m}$

Nominal Bore Dia. <i>d</i> (mm)		Clearance		Remarks	
		CM		Recommended fit	
over	incl.	min.	max.	Shaft	Housing Bore
<b>10 (incl)</b>	<b>18</b>	4	11	js5 (j5)	H6, H7 <sup>(1)</sup> or JS6, JS7 (J6, J7) <sup>(2)</sup>
	<b>18</b>	<b>30</b>	5	12	
	<b>30</b>	<b>50</b>	9	17	
	<b>50</b>	<b>80</b>	12	22	
	<b>80</b>	<b>100</b>	18	30	
	<b>100</b>	<b>120</b>	18	30	
	<b>120</b>	<b>160</b>	24	38	m5

**Notes** <sup>(1)</sup> Applicable to outer rings that require movement in the axial direction.

<sup>(2)</sup> Applicable to outer rings that do not require movement in the axial direction.

**Remark** The radial internal clearance increase caused by the measuring load is equal to the correction amount for CN clearance listed in the remarks under Table 8.10.

**Table 8.14.2 Cylindrical Roller Bearings for Electric Motors**

Units :  $\mu\text{m}$

Nominal Bore Dia. <i>d</i> (mm)		Clearance				Remarks	
		Interchangeable CT		Non-Interchangeable CM		Recommended Fit	
over	incl.	min.	max.	min.	max.	Shaft	Housing Bore
<b>24</b>	<b>40</b>	15	35	15	30	k5	JS6, JS7 (J6, J7) <sup>(1)</sup> or K6, K7 <sup>(2)</sup>
<b>40</b>	<b>50</b>	20	40	20	35	m5	
<b>50</b>	<b>65</b>	25	45	25	40		
<b>65</b>	<b>80</b>	30	50	30	45		
<b>80</b>	<b>100</b>	35	60	35	55		
<b>100</b>	<b>120</b>	35	65	35	60		
<b>120</b>	<b>140</b>	40	70	40	65	n6	
<b>140</b>	<b>160</b>	50	85	50	80		
<b>160</b>	<b>180</b>	60	95	60	90		
<b>180</b>	<b>200</b>	65	105	65	100		

**Notes** <sup>(1)</sup> Applicable to outer rings that require movement in the axial direction.

<sup>(2)</sup> Applicable to outer rings that do not require movement in the axial direction.

**Table 8.15 Radial Internal Clearances in Cylindrical Roller Bearings and Solid Needle Roller Bearings**

Units :  $\mu\text{m}$ 

Nominal Bore Dia. <i>d</i> (mm)		Clearances in Bearings With Cylindrical Bores										Clearances in Noninterchangeable Bearings With Cylindrical Bores											
		C2		CN		C3		C4		C5		CC1		CC2		CC (1)		CC3		CC4		CC5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
—	10	0	25	20	45	35	60	50	75	—	—	—	—	—	—	—	—	—	—	—	—	—	
10	24	0	25	20	45	35	60	50	75	65	90	5	15	10	20	20	30	35	45	45	55	65	
24	30	0	25	20	45	35	60	50	75	70	95	5	15	10	25	25	35	40	50	50	60	70	
30	40	5	30	25	50	45	70	60	85	80	105	5	15	12	25	25	40	45	55	55	70	80	
40	50	5	35	30	60	50	80	70	100	95	125	5	18	15	30	30	45	50	65	65	80	95	
50	65	10	40	40	70	60	90	80	110	110	140	5	20	15	35	35	50	55	75	75	90	110	
65	80	10	45	40	75	65	100	90	125	130	165	10	25	20	40	40	60	70	90	90	110	130	
80	100	15	50	50	85	75	110	105	140	155	190	10	30	25	45	45	70	80	105	105	125	155	
100	120	15	55	50	90	85	125	125	165	180	220	10	30	25	50	50	80	95	120	120	145	180	
120	140	15	60	60	105	100	145	145	190	200	245	10	35	30	60	60	90	105	135	135	160	200	
140	160	20	70	70	120	115	165	165	215	225	275	10	35	35	65	65	100	115	150	150	180	225	
160	180	25	75	75	125	120	170	170	220	250	300	10	40	35	75	75	110	125	165	165	200	250	
180	200	35	90	90	145	140	195	195	250	275	330	15	45	40	80	80	120	140	180	180	220	275	
200	225	45	105	105	165	160	220	220	280	305	365	15	50	45	90	90	135	155	200	200	240	305	
225	250	45	110	110	175	170	235	235	300	330	395	15	50	50	100	100	150	170	215	215	265	330	
250	280	55	125	125	195	190	260	260	330	370	440	20	55	55	110	110	165	185	240	240	295	370	
280	315	55	130	130	205	200	275	275	350	410	485	20	60	60	120	120	180	205	265	265	325	410	
315	355	65	145	145	225	225	305	305	385	455	535	20	65	65	135	135	200	225	295	295	360	455	
355	400	100	190	190	280	280	370	370	460	510	600	25	75	75	150	150	225	255	330	330	405	510	
400	450	110	210	210	310	310	410	410	510	565	665	25	85	85	170	170	255	285	370	370	455	565	
450	500	110	220	220	330	330	440	440	550	625	735	25	95	95	190	190	285	315	410	410	505	625	

**Note** (1) CC denotes normal clearance for noninterchangeable cylindrical roller bearings and solid needle roller bearings.

Units :  $\mu\text{m}$ 

Nominal Bore Dia. <i>d</i> (mm)		Clearances in Noninterchangeable Bearings with Tapered Bores															
		CC9 (1)		CC0		CC1		CC2		CC (2)		CC3		CC4		CC5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
10	24	5	10	—	—	10	20	20	30	35	45	45	55	55	65	75	85
24	30	5	10	8	15	10	25	25	35	40	50	50	60	60	70	80	95
30	40	5	12	8	15	12	25	25	40	45	55	55	70	70	80	95	110
40	50	5	15	10	20	15	30	30	45	50	65	65	80	80	95	110	125
50	65	5	15	10	20	15	35	35	50	55	75	75	90	90	110	130	150
65	80	10	20	15	30	20	40	40	60	70	90	90	110	110	130	150	170
80	100	10	25	20	35	25	45	45	70	80	105	105	125	125	150	180	205
100	120	10	25	20	35	25	50	50	80	95	120	120	145	145	170	205	230
120	140	15	30	25	40	30	60	60	90	105	135	135	160	160	190	230	260
140	160	15	35	30	50	35	65	65	100	115	150	150	180	180	215	260	295
160	180	15	35	30	50	35	75	75	110	125	165	165	200	200	240	285	320
180	200	20	40	30	50	40	80	80	120	140	180	180	220	220	260	315	355
200	225	20	45	35	60	45	90	90	135	155	200	200	240	240	285	350	395
225	250	25	50	40	65	50	100	100	150	170	215	215	265	265	315	380	430
250	280	25	55	40	70	55	110	110	165	185	240	240	295	295	350	420	475
280	315	30	60	—	—	60	120	120	180	205	265	265	325	325	385	470	530
315	355	30	65	—	—	65	135	135	200	225	295	295	360	360	430	520	585
355	400	35	75	—	—	75	150	150	225	255	330	330	405	405	480	585	660
400	450	40	85	—	—	85	170	170	255	285	370	370	455	455	540	650	735
450	500	45	95	—	—	95	190	190	285	315	410	410	505	505	600	720	815

**Notes** (1) Clearance CC9 is applicable to cylindrical roller bearings with tapered bores in ISO Tolerance Classes 5 and 4.  
(2) CC denotes normal clearance for noninterchangeable cylindrical roller bearings and solid needle roller bearings.

**Table 8.16 Radial Internal Clearances in Spherical Roller Bearings**

 Units :  $\mu\text{m}$ 

Nominal Bore Dia. $d$ (mm)		Clearance in Bearings With Cylindrical Bores										Clearance in Bearings With Tapered Bores									
		C2		CN		C3		C4		C5		C2		CN		C3		C4		C5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
<b>24</b>	<b>30</b>	15	25	25	40	40	55	55	75	75	95	20	30	30	40	40	55	55	75	75	95
<b>30</b>	<b>40</b>	15	30	30	45	45	60	60	80	80	100	25	35	35	50	50	65	65	85	85	105
<b>40</b>	<b>50</b>	20	35	35	55	55	75	75	100	100	125	30	45	45	60	60	80	80	100	100	130
<b>50</b>	<b>65</b>	20	40	40	65	65	90	90	120	120	150	40	55	55	75	75	95	95	120	120	160
<b>65</b>	<b>80</b>	30	50	50	80	80	110	110	145	145	180	50	70	70	95	95	120	120	150	150	200
<b>80</b>	<b>100</b>	35	60	60	100	100	135	135	180	180	225	55	80	80	110	110	140	140	180	180	230
<b>100</b>	<b>120</b>	40	75	75	120	120	160	160	210	210	260	65	100	100	135	135	170	170	220	220	280
<b>120</b>	<b>140</b>	50	95	95	145	145	190	190	240	240	300	80	120	120	160	160	200	200	260	260	330
<b>140</b>	<b>160</b>	60	110	110	170	170	220	220	280	280	350	90	130	130	180	180	230	230	300	300	380
<b>160</b>	<b>180</b>	65	120	120	180	180	240	240	310	310	390	100	140	140	200	200	260	260	340	340	430
<b>180</b>	<b>200</b>	70	130	130	200	200	260	260	340	340	430	110	160	160	220	220	290	290	370	370	470
<b>200</b>	<b>225</b>	80	140	140	220	220	290	290	380	380	470	120	180	180	250	250	320	320	410	410	520
<b>225</b>	<b>250</b>	90	150	150	240	240	320	320	420	420	520	140	200	200	270	270	350	350	450	450	570
<b>250</b>	<b>280</b>	100	170	170	260	260	350	350	460	460	570	150	220	220	300	300	390	390	490	490	620
<b>280</b>	<b>315</b>	110	190	190	280	280	370	370	500	500	630	170	240	240	330	330	430	430	540	540	680
<b>315</b>	<b>355</b>	120	200	200	310	310	410	410	550	550	690	190	270	270	360	360	470	470	590	590	740
<b>355</b>	<b>400</b>	130	220	220	340	340	450	450	600	600	750	210	300	300	400	400	520	520	650	650	820
<b>400</b>	<b>450</b>	140	240	240	370	370	500	500	660	660	820	230	330	330	440	440	570	570	720	720	910
<b>450</b>	<b>500</b>	140	260	260	410	410	550	550	720	720	900	260	370	370	490	490	630	630	790	790	1 000
<b>500</b>	<b>560</b>	150	280	280	440	440	600	600	780	780	1 000	290	410	410	540	540	680	680	870	870	1 100
<b>560</b>	<b>630</b>	170	310	310	480	480	650	650	850	850	1 100	320	460	460	600	600	760	760	980	980	1 230
<b>630</b>	<b>710</b>	190	350	350	530	530	700	700	920	920	1 190	350	510	510	670	670	850	850	1 090	1 090	1 360
<b>710</b>	<b>800</b>	210	390	390	580	580	770	770	1 010	1 010	1 300	390	570	570	750	750	960	960	1 220	1 220	1 500
<b>800</b>	<b>900</b>	230	430	430	650	650	860	860	1 120	1 120	1 440	440	640	640	840	840	1 070	1 070	1 370	1 370	1 690
<b>900</b>	<b>1 000</b>	260	480	480	710	710	930	930	1 220	1 220	1 570	490	710	710	930	930	1 190	1 190	1 520	1 520	1 860
<b>1 000</b>	<b>1 120</b>	290	530	530	780	780	1 020	1 020	1 330	—	—	530	770	770	1 030	1 030	1 300	1 300	1 670	—	—
<b>1 120</b>	<b>1 250</b>	320	580	580	860	860	1 120	1 120	1 460	—	—	570	830	830	1 120	1 120	1 420	1 420	1 830	—	—
<b>1 250</b>	<b>1 400</b>	350	640	640	950	950	1 240	1 240	1 620	—	—	620	910	910	1 230	1 230	1 560	1 560	2 000	—	—

Table 8.17 Radial Internal Clearances in Double-Row and Combined Tapered Roller Bearings

Units :  $\mu\text{m}$ 

Cylindrical Bore Tapered Bore Nominal Bore Dia. $d$ (mm)		Clearance											
		C1		C2		CN		C3		C4		C5	
		—		C1		C2		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
—	18	0	10	10	20	20	30	35	45	50	60	65	75
18	24	0	10	10	20	20	30	35	45	50	60	65	75
24	30	0	10	10	20	20	30	40	50	50	60	70	80
30	40	0	12	12	25	25	40	45	60	60	75	80	95
40	50	0	15	15	30	30	45	50	65	65	80	95	110
50	65	0	15	15	35	35	55	60	80	80	100	110	130
65	80	0	20	20	40	40	60	70	90	90	110	130	150
80	100	0	25	25	50	50	75	80	105	105	130	155	180
100	120	5	30	30	55	55	80	90	115	120	145	180	210
120	140	5	35	35	65	65	95	100	130	135	165	200	230
140	160	10	40	40	70	70	100	110	140	150	180	220	260
160	180	10	45	45	80	80	115	125	160	165	200	250	290
180	200	10	50	50	90	90	130	140	180	180	220	280	320
200	225	20	60	60	100	100	140	150	190	200	240	300	340
225	250	20	65	65	110	110	155	165	210	220	270	330	380
250	280	20	70	70	120	120	170	180	230	240	290	370	420
280	315	30	80	80	130	130	180	190	240	260	310	410	460
315	355	30	80	80	130	140	190	210	260	290	350	450	510
355	400	40	90	90	140	150	200	220	280	330	390	510	570
400	450	45	95	95	145	170	220	250	310	370	430	560	620
450	500	50	100	100	150	190	240	280	340	410	470	620	680
500	560	60	110	110	160	210	260	310	380	450	520	700	770
560	630	70	120	120	170	230	290	350	420	500	570	780	850
630	710	80	130	130	180	260	310	390	470	560	640	870	950
710	800	90	140	150	200	290	340	430	510	630	710	980	1 060
800	900	100	150	160	210	320	370	480	570	700	790	1 100	1 200
900	1 000	120	170	180	230	360	410	540	630	780	870	1 200	1 300
1 000	1 120	130	190	200	260	400	460	600	700	—	—	—	—
1 120	1 250	150	210	220	280	450	510	670	770	—	—	—	—
1 250	1 400	170	240	250	320	500	570	750	870	—	—	—	—

**Remark** Axial internal clearance  $\Delta_a = \Delta_r \cot \alpha \div \frac{1.5}{e} \Delta_r$

where  $\Delta_r$  : Radial internal clearance

$\alpha$  : Contact angle

$e$  : Constant (listed in bearing tables)

**Table 8.18 Axial Internal Clearances in Combined Angular Contact Ball Bearings (Measured Clearance)**

 Units :  $\mu\text{m}$ 

Nominal Bore Diameter. $d$ (mm)		Axial Internal Clearance									
		Contact Angle 30°						Contact Angle 40°			
		CN		C3		C4		CN		C3	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
—	<b>10</b>	9	29	29	49	49	69	6	26	26	46
<b>10</b>	<b>18</b>	10	30	30	50	50	70	7	27	27	47
<b>18</b>	<b>24</b>	19	39	39	59	59	79	13	33	33	53
<b>24</b>	<b>30</b>	20	40	40	60	60	80	14	34	34	54
<b>30</b>	<b>40</b>	26	46	46	66	66	86	19	39	39	59
<b>40</b>	<b>50</b>	29	49	49	69	69	89	21	41	41	61
<b>50</b>	<b>65</b>	35	60	60	85	85	110	25	50	50	75
<b>65</b>	<b>80</b>	38	63	63	88	88	115	27	52	52	77
<b>80</b>	<b>100</b>	49	74	74	99	99	125	35	60	60	85
<b>100</b>	<b>120</b>	72	97	97	120	120	145	52	77	77	100
<b>120</b>	<b>140</b>	85	115	115	145	145	175	63	93	93	125
<b>140</b>	<b>160</b>	90	120	120	150	150	180	66	96	96	125
<b>160</b>	<b>180</b>	95	125	125	155	155	185	68	98	98	130
<b>180</b>	<b>200</b>	110	140	140	170	170	200	80	110	110	140

**Remark** This table is applicable to bearings with Normal and Class 6 tolerances. Please consult NSK regarding the internal axial clearances of bearings with Class 5 tolerance or better and contact angles of 15° and 25°.

**Table 8.19 Axial Internal Clearance in Four-Point-Contact Ball Bearings (Measured Clearances)**

 Units :  $\mu\text{m}$ 

Nominal Bore Dia. $d$ (mm)		Axial Internal Clearance					
		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.
<b>10</b>	<b>18</b>	45	85	75	125	115	165
<b>18</b>	<b>40</b>	56	106	96	146	136	186
<b>40</b>	<b>60</b>	76	126	116	166	156	206
<b>60</b>	<b>80</b>	86	136	126	176	166	226
<b>80</b>	<b>100</b>	96	156	136	196	186	246
<b>100</b>	<b>140</b>	116	176	156	216	206	266
<b>140</b>	<b>180</b>	136	196	176	246	226	296
<b>180</b>	<b>220</b>	156	226	206	276	256	326
<b>220</b>	<b>260</b>	175	245	225	305	285	365
<b>260</b>	<b>300</b>	195	275	255	335	315	395
<b>300</b>	<b>350</b>	215	305	275	365	345	425
<b>350</b>	<b>400</b>	245	335	315	405	385	475
<b>400</b>	<b>500</b>	285	385	355	455	435	525

### 8.2.2 Selection of Bearing Internal Clearances

CN Clearance is adequate for standard operating conditions. Clearance becomes progressively smaller from C2 to C1 and larger from C3 to C5.

Standard operating conditions are defined as those where the inner ring speed is less than approximately 50 % of the limiting speed listed in the bearing tables, the load is less than normal ( $P \div 0.1C_r$ ), and the bearing has a tight fit on the shaft.

To reduce bearing noise, the radial internal clearance range is narrower than the normal class and the values are somewhat smaller for deep groove ball bearings and cylindrical roller bearings for electric motors (refer to Table 8.14.1 and 8.14.2).

Internal clearance varies with the fit and temperature differences in operation. The changes in radial internal clearance in a roller bearing are shown in Fig. 8.8.

#### (1) Decrease in Radial Clearance Caused by Fitting and Residual Clearance

When the inner ring or the outer ring has a tight fit on a shaft or in a housing, a decrease in the radial internal clearance is caused by the expansion or contraction of the bearing rings. The decrease varies according to the bearing type, bearing size, and design of the shaft and housing. The amount of this decrease is approximately 70 to 90% of the interference (refer to Section 8.1.2, Selection of Fit, (5) *Fitting Stress and Ring Expansion and Contraction*, Pages A156 and A157). The internal clearance after subtracting this decrease from the theoretical internal clearance  $\Delta_0$  is called the residual clearance  $\Delta_r$ .

## (2) Decrease in Radial Internal Clearance Caused by Temperature Differences Between Inner and Outer Rings and Effective Clearance

The frictional heat generated during operation is conducted away from the bearing through the shaft and housing. Since housings generally conduct heat better than shafts, the temperature of the inner ring and the rolling elements is usually higher than that of the outer ring by 5 to 10 °C. If the shaft is heated or the housing is cooled, the difference in temperature between the inner and outer rings increases. The radial clearance decreases due to the thermal expansion caused by the temperature difference between the inner and outer rings. The amount of this decrease can be calculated using the following equations:

$$\delta_t \doteq \alpha \Delta_t D_e \dots \dots \dots (8.8)$$

where  $\delta_t$  : Decrease in radial clearance due to temperature difference between inner and outer rings (mm)

$\alpha$  : Coefficient of linear expansion of bearing steel  $\doteq 12.5 \times 10^{-6}$  (1/°C)

$\Delta_t$  : Temperature difference between inner and outer rings (°C)

$D_e$  : Outer ring raceway diameter (mm)

For ball bearings

$$D_e \doteq \frac{1}{5} (4D + d) \dots \dots \dots (8.9)$$

For roller bearings

$$D_e \doteq \frac{1}{4} (3D + d) \dots \dots \dots (8.10)$$

The clearance after subtracting  $\delta_t$  from the residual clearance  $\Delta_f$  is called the effective clearance  $\Delta$ . Theoretically, the longest life of a bearing can be achieved when the effective clearance is slightly negative. However, it is difficult to achieve such an ideal condition, and an excessive negative clearance will greatly shorten the bearing life. Therefore, a clearance of zero or a slightly positive amount, instead of a negative one, should be selected. When single-row angular contact ball bearings or tapered roller bearings are used facing each other, there should be a small effective clearance, unless a preload is required. When two cylindrical roller bearings with a rib on one side are used facing each other, adequate axial clearance is necessary to allow for shaft elongation during operation.

The radial clearances used in some specific applications are given in Table 8.20. Please consult NSK regarding special operating conditions.

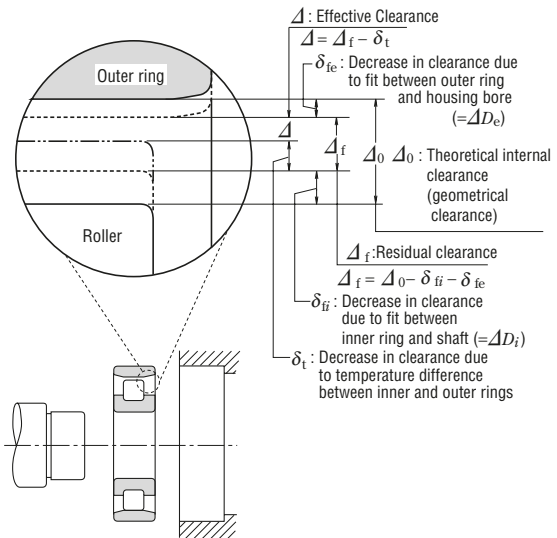


Fig. 8.8 Changes in Radial Internal Clearance of Bearings

Table 8.20 Example Clearances for Specific Applications

Operating Conditions	Examples	Internal Clearance
When shaft deflection is large	Semi-floating rear wheels of automobiles	C5 or equivalent
When steam passes through hollow shafts or roller shafts are heated	Dryers in paper making machines Table rollers for rolling mills	C3, C4 C3
When impact loads and vibration are severe or when both the inner and outer rings are tight-fitted	Traction motors for railways Vibrating screens Fluid couplings Final reduction gears for tractors	C4 C3, C4 C4 C4
When both the inner and outer rings are loose-fitted	Rolling mill roll necks	C2 or equivalent
When noise and vibration restrictions are severe	Small motors with special specifications	C1, C2, CM
When clearance is adjusted after mounting to prevent shaft deflection, etc.	Main shafts of lathes	CC9, CC1

## **8.3 Technical Data**

### **8.3.1 Temperature Rise and Dimensional Change**

Rolling bearings are extremely precise mechanical elements; any change in dimensional accuracy due to temperature cannot be ignored. Accordingly, as a rule, measurement of a bearing must be performed at 20 °C and the dimensions set forth in the standards must be expressed by values at 20 °C.

Dimensional changes due to temperature change not only affect dimensional accuracy, but also cause changes in the internal clearance of a bearing during operation. Dimensional change may cause interference between the inner ring and shaft or between the outer ring and housing bore. It is possible to achieve shrink fitting with large interference by utilizing dimensional changes induced by temperature differences. The dimensional change  $\Delta l$  due to temperature rise can be expressed as Equation (8.11) below:

$$\Delta l = \Delta T \alpha l \quad (8.11)$$

where,  $\Delta l$ : Dimensional change (mm)

$\Delta T$ : Temperature rise (°C)

$\alpha$ : Coefficient of linear expansion for bearing steel

$\alpha = 12.5 \times 10^{-6} \text{ (1/°C)}$

$l$ : Original dimension (mm)

Equation (8.11) may be illustrated as shown in Fig. 8.9. In the following cases, Fig. 8.9 can be utilized to easily obtain an approximate numerical values for dimensional change when there is, need to:

- (1) Correct dimensional measurements according to the ambient air temperature
- (2) Find the change in bearing internal clearance due to a temperature difference between the inner and outer rings during operation
- (3) Find the relationship between interference and heating temperature during shrink fitting
- (4) Find the change in interference when a temperature difference exists on the fit surface

### **Example**

If an inner ring with a 110 mm bore is to be shrink-fitted to an n6 tolerance shaft, how much should it be heated?

The maximum interference between an inner ring with a 110 mm bore and an n6 shaft is 0.065 mm. To enable insertion of the inner ring with ease on the shaft, there must be a clearance of 0.03 to 0.04 mm. Accordingly, the inner ring must expand by 0.095 to 0.105 mm.

By using Fig 8.9, the intersection of the vertical axis when  $\Delta l = 0.105$  and the horizontal axis when  $l = 110$  can be determined.  $\Delta T$  is located in the temperature range between 70 °C and 80 °C ( $\Delta T \approx 77^\circ\text{C}$ ). Therefore, it's sufficient to set the inner ring heating temperature to the room temperature +80 °C.

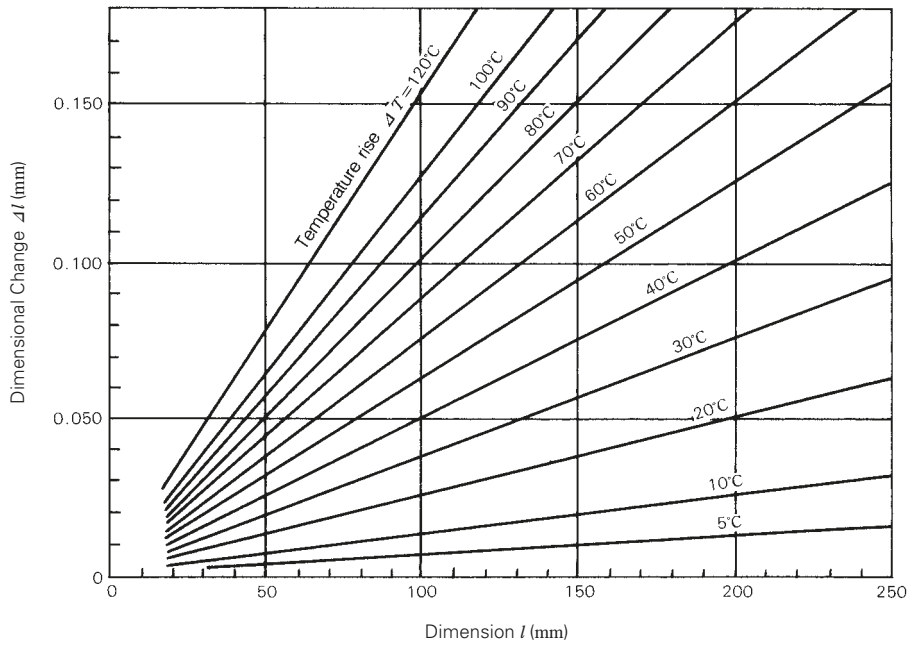


Fig. 8.9 Temperature Rise and Dimensional Change of Bearing Steel

## **8.3.2 Interference Deviation Due to Temperature Rise (Aluminum Housing, Plastic Housing)**

Bearing housing materials such as aluminum, light alloys, or plastics (polyacetal resin, etc.) are often used to reduce weight and cost or improve the performance of equipment.

When non-ferrous materials are used in housings, any temperature rise occurring during operation affects the interference or clearance of the outer ring due to the difference in the coefficients of linear expansion. This change is significant for plastics which have high coefficients of linear expansion.

The deviation of clearance or interference of a fitting surface  $\Delta D_T$  of a bearing's outer ring due to temperature rise is expressed by the following equation:

$$\Delta D_T = (\alpha_1 \cdot \Delta T_1 - \alpha_2 \cdot \Delta T_2) D \quad \text{.....(8.12)}$$

where  $\Delta D_T$ : Change of clearance or interference at fitting surface due to temperature rise

$\alpha_1$ : Coefficient of linear expansion of housing ( $1/^\circ\text{C}$ )

$\Delta T_1$ : Housing temperature rise near fitting surface ( $^\circ\text{C}$ )

$\alpha_2$ : Coefficient of linear expansion of bearing outer ring

Bearing steel ....  $\alpha_2 = 12.5 \times 10^{-6}$  ( $1/^\circ\text{C}$ )

$\Delta T_2$ : Outer ring temperature rise near fitting surface ( $^\circ\text{C}$ )

$D$ : Nominal outside diameter (mm)

In general, housing temperature rise and outer ring temperature rise are somewhat different, but if we assume they are approximately equal near the fitting surfaces ( $\Delta T_1 \doteq \Delta T_2 = \Delta T$ ), Equation (8.12) becomes Equation (8.13):

$$\Delta D_T = (\alpha_1 - \alpha_2) \Delta T \cdot D \quad \text{.....(8.13)}$$

where  $\Delta T$ : Temperature rise of outer ring and housing near fitting surfaces ( $^\circ\text{C}$ )

Equation (8.13) for aluminum housings ( $\alpha_1 = 23.7 \times 10^{-6}$ ), can be shown graphically as Fig. 8.10.

Polyacetal resin is the plastic most-often used for bearing housings. The coefficients of linear expansion of plastics may vary or show directional characteristics. For molded products made with polyacetal resin, the coefficient of linear expansion is approximately  $9 \times 10^{-5}$ . Equation (8.13) for polyacetal-resin housings can be expressed as Fig. 8.11.

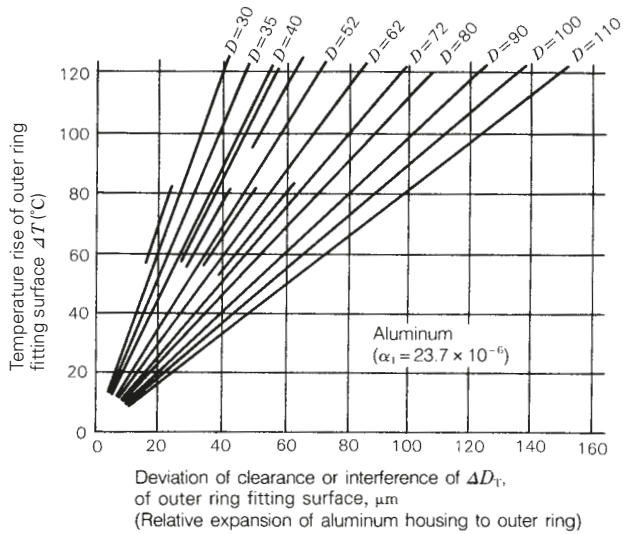


Fig. 8.10 Aluminum Housing

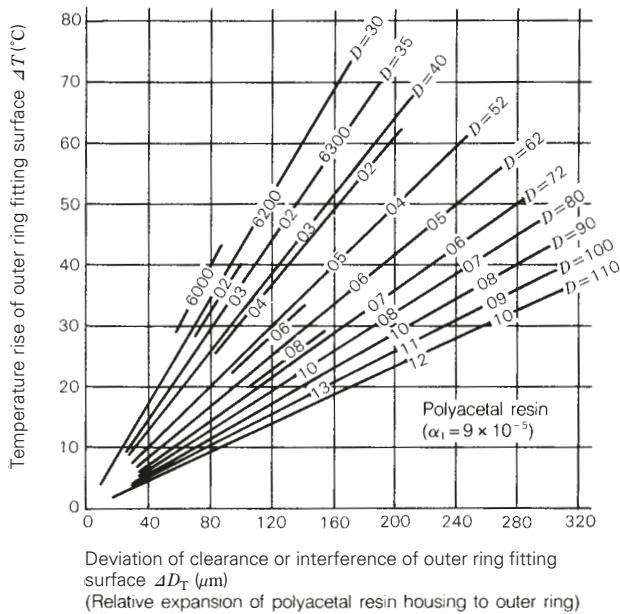


Fig. 8.11 Polyacetal-Resin Housing

## 8.3.3 Calculating Residual Internal Clearance After Mounting

The various types of internal bearing clearance were discussed in Section 8.2.2. This section will explain the step by step procedures for calculating residual internal clearance.

When the inner ring of a bearing is press-fit onto a shaft or when the outer ring is press fit into a housing, it stands to reason that radial internal clearance will decrease due to the resulting expansion or contraction of the bearing raceways. Generally, most bearing applications have a rotating shaft which requires a tight fit between the inner ring and shaft and a loose fit between the outer ring and housing; therefore, generally only the effect of the interference on the inner ring needs to be taken into account.

Below we have selected a 6310 single row deep groove ball bearing for our representative calculations. The shaft is set as k5 and the housing set as H7. An interference fit is applied only to the inner ring.

Shaft diameter, bore size, and radial clearance are standard bearing measurements. Assuming that 99.7% of the parts are within tolerance, the mean value of residual clearance  $m_{df}$  and standard deviation of the internal clearance after mounting (residual clearance)  $\sigma_{df}$  can be calculated. Measurements are given in millimeters (mm).

$$\sigma_s = \frac{R_s/2}{3} = 0.0018$$

$$\sigma_i = \frac{R_i/2}{3} = 0.0020$$

$$\sigma_{d0} = \frac{R_{d0}/2}{3} = 0.0028$$

$$\sigma_f^2 = \sigma_s^2 + \sigma_i^2$$

$$m_{df} = m_{d0} - \lambda_i (m_s - m_i) = 0.0035$$

$$\sigma_{df} = \sqrt{\sigma_{d0}^2 + \lambda_i^2 \sigma_f^2} = 0.0035$$

- where,  $\sigma_s$ : Standard deviation of shaft diameter  
 $\sigma_i$ : Standard deviation of bore diameter  
 $\sigma_f$ : Standard deviation of interference  
 $\sigma_{d0}$ : Standard deviation of radial clearance (before mounting)  
 $\sigma_{df}$ : Standard deviation of residual clearance (after mounting)  
 $m_s$ : Mean value of shaft diameter ( $\phi 50 + 0.008$ )  
 $m_i$ : Mean value of bore diameter ( $\phi 50 - 0.006$ )  
 $m_{d0}$ : Mean value of radial clearance (before mounting) (0.014)  
 $m_{df}$ : Mean value of residual clearance (after mounting)  
 $R_s$ : Shaft tolerance (0.011)  
 $R_i$ : Bearing bore tolerance (0.012)  
 $R_{d0}$ : Range in radial clearance (before mounting) (0.017)  
 $\lambda_i$ : Rate of raceway expansion from apparent interference (0.75 from Fig. 8.12)

The average amount of raceway expansion and contraction from apparent interference is calculated from  $\lambda_i (m_m - m_i)$ .

To determine, within a 99.7% probability, the variation in internal clearance after mounting  $R_{df}$ , use the following equation:

$$R_{df} = m_{df} \pm 3\sigma_{df} = +0.014 \text{ to } -0.007$$

In other words, the mean value of residual clearance ( $m_{df}$ ) is +0.0035, and the range is from -0.007 to +0.014 for bearing 6310.

Units : mm

Shaft diameter	$\phi 50$ +0.013 +0.002
Bearing bore diameter, (d)	$\phi 50$ 0 -0.012
Radial internal clearance ( $\Delta_0$ )	0.006 to 0.023 <sup>(1)</sup>

**Note** <sup>(1)</sup> Standard internal clearance, unmounted

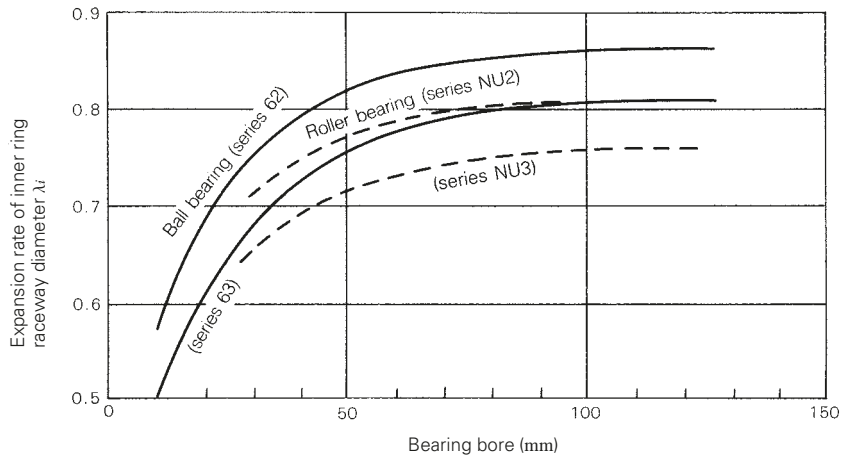


Fig. 8.12  $\lambda_i$  : Rate of Inner Ring Raceway Expansion From Apparent Interference

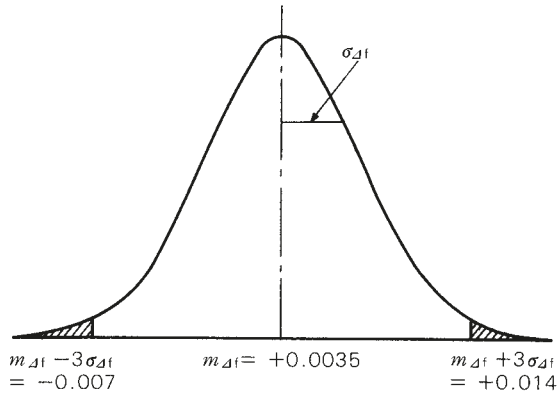


Fig. 8.13 Distribution of Residual Internal Clearance

## 8.3.4 Effect of Interference Fits on Bearing Raceways (Fit of Inner Ring)

One important factor related to radial clearance is the reduction in radial clearance resulting from the mounting fit. When an inner ring is mounted on a shaft with an interference fit and the outer ring is secured in a housing with an interference fit, the inner ring will expand and the outer ring will contract.

The means of calculating the amount of ring expansion or contraction were previously noted in Section 8.1.2 (5); however, the equation for establishing the amount of inner raceway expansion  $\Delta D_i$  is given in Equation (8.14) below:

$$\Delta D_i = \Delta d \cdot k \cdot \frac{1 - k_0^2}{1 - k^2 \cdot k_0^2} \dots \dots \dots (8.14)$$

where,  $\Delta d$ : Effective interference (mm)  
 $k$ : Ratio of bore to inner raceway diameter;  
 $k = d/D_i$   
 $k_0$ : Ratio of inside to outside diameter of hollow shaft;  $k_0 = d_0/D_i$   
 $d$ : Bore or shaft diameter (mm)  
 $D_i$ : Inner raceway diameter (mm)  
 $d_0$ : Inside diameter of hollow shaft (mm)

Equation (8.14) is represented in a clearer graphical form in Fig. 8.14.

The vertical axis of Fig. 8.14 represents inner raceway diameter expansion in relation to the amount of interference. The horizontal axis represents  $k_0$ : the ratio of the inside diameter of a hollow shaft to the outside diameter.

Generally, the decrease in radial clearance is calculated to be approximately 80% of the interference for solid shaft mountings only. For hollow shaft mountings the decrease in radial clearance varies with the ratio of inside shaft diameter to outside shaft diameter. Since the general 80% rule is based on average bearing bore size to inner raceway diameter ratios, the change will vary with different bearing types, sizes, and series. Typical plots for single-row deep groove ball bearings and for cylindrical roller bearings are shown in Figs. 8.15 and 8.16. Values in Fig. 8.14 apply only for steel shafts.

As an example, let us determine the decrease in the radial clearance of a 6220 ball bearing mounted on a hollow shaft (diameter  $d=100$  mm, inside diameter  $d_0=65$  mm) with a fit class of m5.

The ratio between bore diameter and raceway diameter  $k$  is 0.87 as shown in Fig. 8.15. The ratio of the shaft inside diameter to the shaft outside diameter  $k_0$ , is  $k_0 = d_0/d = 0.65$ . Thus, reading from Fig. 8.14, the rate of raceway expansion is 73%.

Given that an interference of m5 has a mean value of  $30 \mu\text{m}$ , the amount of raceway expansion, or, the

amount of decrease in the radial clearance from the fit is  $0.73 \times 30 = 22 \mu\text{m}$ .

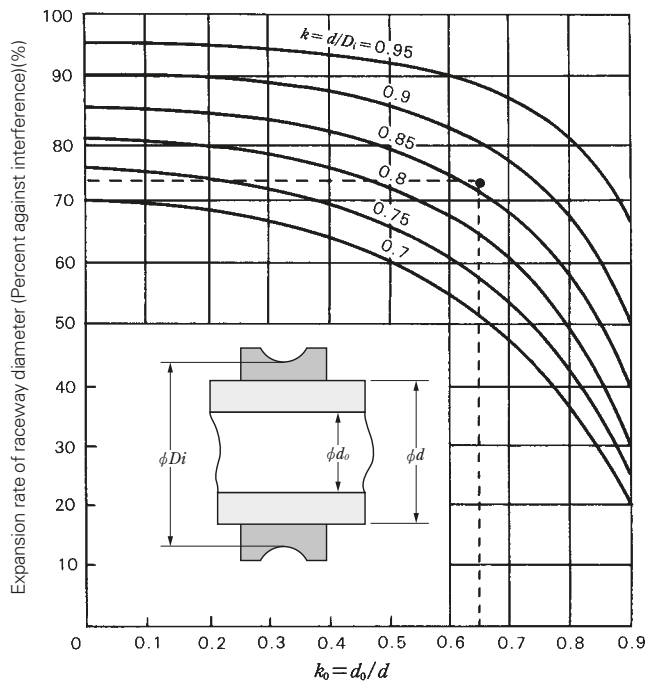


Fig. 8.14 Raceway Expansion in Relation to Bearing Fit  
(Inner Ring Fit on Steel Shaft)

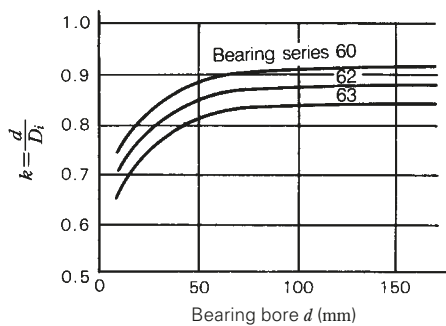


Fig. 8.15 Ratio of Bore Size to Raceway Diameter  
for Single-Row Deep Groove Ball Bearings

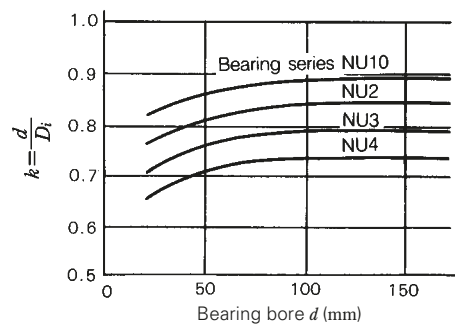


Fig. 8.16 Ratio of Bore Size to Raceway Diameter  
for Cylindrical Roller Bearings

## 8.3.5 Effect of Interference Fits on Bearing Raceways (Fit of Outer Ring)

When a bearing load is applied on a rotating inner ring (outer ring carrying a static load), an interference fit is adopted for the inner ring and the outer ring is mounted either with a transition fit or a clearance fit. However, when load is applied on a rotating outer ring (inner ring carrying a static load) or when there is an indeterminate load and the outer ring must be mounted with an interference fit, a decrease in radial internal clearance caused by the fit begins to contribute in the same way as when the inner ring is mounted with an interference fit.

Because the amount of interference that can be applied to the outer ring is limited by stress, the constraints of most bearing applications make it difficult to apply a large amount of interference to the outer ring. In addition, instances where there is an indeterminate load are quite rare compared to those where a rotating inner ring carries the load; therefore, there are few occasions where it is necessary to be cautious about the decrease in radial clearance caused by outer ring interference.

The decrease in outer raceway diameter  $\Delta D_e$  is calculated using Equation (8.15) below:

$$\Delta D_e = \Delta D \cdot h \cdot \frac{1 - h_0^2}{1 - h^2 h_0^2} \dots\dots\dots (8.15)$$

where  $\Delta D$ : Effective interference (mm)

$h$ : Ratio between raceway dia. and outside dia. of outer ring,  $h = D_e/D$

$h_0$ : Housing thickness ratio,  $h_0 = D/D_0$

$D$ : Bearing outside diameter (housing bore diameter) (mm)

$D_e$ : Raceway diameter of outer ring (mm)

$D_0$ : Outside diameter of housing (mm)

Fig. 8.17 represents the above equation graphically. The vertical axis shows the outer ring raceway contraction as a percentage of interference, and the horizontal axis shows the housing thickness ratio  $h_0$ . The data are plotted for constant values of outer ring thickness ratios from 0.7 through 1.0 in increments of 0.05. The value of thickness ratio  $h$  will differ with bearing type, size, and diameter series. Representative values for single-row deep groove ball bearings and cylindrical roller bearings are given in Figs. 8.18 and 8.19 respectively.

Loads applied on rotating outer rings occur in such applications as automotive front axles, tension pulleys, conveyor systems, and other pulley systems. As an example, let us estimate the decrease in radial clearance for a 6207 ball bearing mounted in a steel housing with an N7 fit. The outside diameter of the housing is assumed as  $D_0 = 95$ , and the bearing outside diameter  $D = 72$ . From Fig. 8.18, the outer ring thickness ratio,  $h$ , is 0.9. Because  $h_0 = D/D_0 = 0.76$ , the raceway contraction is 71 %, as indicated in Fig. 8.17. Taking the mean value for N7 interference as 18  $\mu\text{m}$ , the contraction of the outer raceway, or decrease in radial clearance is  $0.71 \times 18 \approx 13 \mu\text{m}$ .

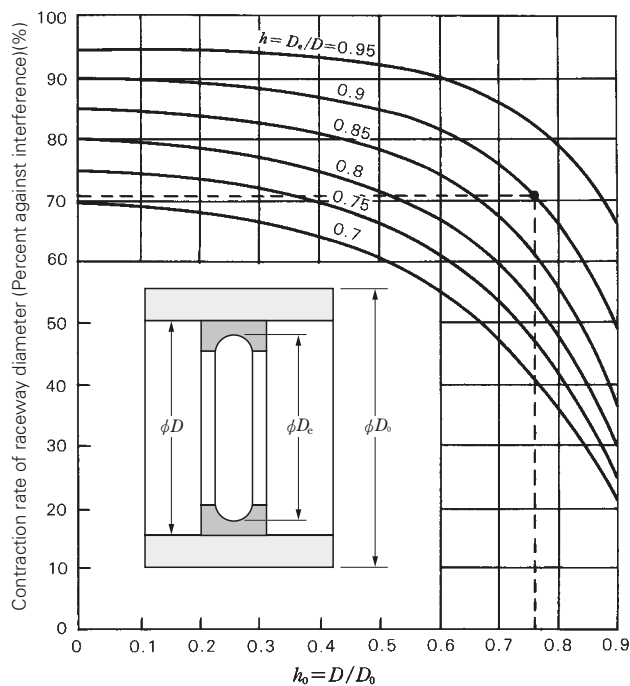


Fig. 8.17 Raceway Contraction in Relation to Bearing Fit  
(Outer Ring Fit in Steel Housing)

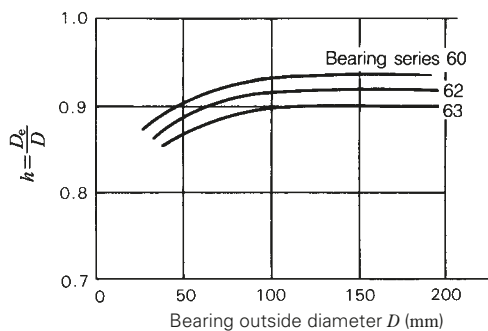


Fig. 8.18 Ratio of Outside Diameter to Raceway  
Diameter for Single-Row Deep Groove  
Ball Bearings

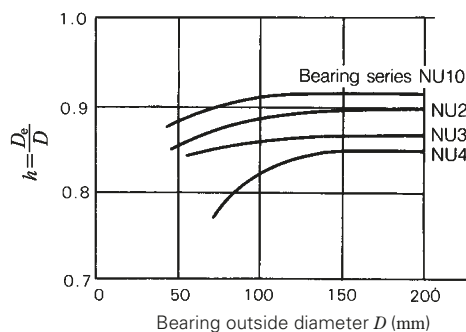


Fig. 8.19 Ratio of Outside Diameter to  
Raceway Diameter for Cylindrical  
Roller Bearings

## **8.3.6 Measuring Internal Clearance of Combined Tapered Roller Bearings (Offset Measuring Method)**

Combined tapered roller bearings are available in two types: a back-to-back arrangement (DB type) and a face-to-face arrangement (DF type) (see Figs. 8.20 and Fig. 8.21). These arrangements have certain advantages and can be assembled as a set or combined with other bearings as a fixed- or free-side bearing.

The cages of DB tapered roller bearing arrangements protrude from the back side of the outer ring; therefore, the outer ring spacer (K spacer in Fig. 8.20) is mounted to prevent mutual contact of cages. An inner ring spacer (L spacer in Fig. 8.20), with the appropriate width is provided for the inner ring to secure the clearance. For the DF type, a K spacer is used, as shown in Fig. 8.21.

In general, to use such a bearing arrangement requires an appropriate clearance that accounts for heat generated during operation or an applied preload that increases the rigidity of the bearings. The spacer width should be adjusted so as to provide an appropriate clearance or preload (minus clearance) after mounting. The clearance measurement method for a DB arrangement is as follows:

- (1) As shown in Fig. 8.22, put bearing A on the surface plate and after stabilizing the rollers by rotating the outer ring (over 10 turns), measure the offset  $f_A = T_A - B_A$  (consult Figs. 8.22 through 8.24 for these symbols).
- (2) Next, as shown in Fig. 8.23, use the same procedure to measure bearing B for its offset  $f_B = T_B - B_B$ .
- (3) Last, measure the width of the K and L spacers as shown in Fig. 8.24.

From the results of the above measurements, the axial clearance  $\Delta_a$  of the arrangement can be obtained by Equation (8.16):

$$\Delta_a = (L - K) - (f_A + f_B) \quad \text{.....(8.16)}$$

As an example, let's confirm the clearance of tapered roller bearing arrangement HR32232JDB + KLR10AC3 to specifications. First, refer to Table 8.17 and note that the C3 clearance range is  $\Delta_r = 110$  to  $140 \mu\text{m}$ .

To compare this specification with the offset measurement results, convert it into axial clearance  $\Delta_a$  by using Equation (8.17):

$$\Delta_a = \Delta_r \cot \alpha \doteq \Delta_r \frac{1.5}{e} \quad \text{.....(8.17)}$$

where  $e$ : Constant determined for each bearing No. (listed in the bearing tables of this catalog)

By referring to Page C205, we find  $e = 0.44$  and the following:

$$\begin{aligned} \Delta_a &= (110 \text{ to } 140) \times \frac{1.5}{e} \\ &\doteq 380 \text{ to } 480 \mu\text{m} \end{aligned}$$

We can confirm that the bearing clearance is C3 by verifying that the axial clearance  $\Delta_a$  of Equation (8.16) (obtained by the bearing offset measurement) is within the above-mentioned range.

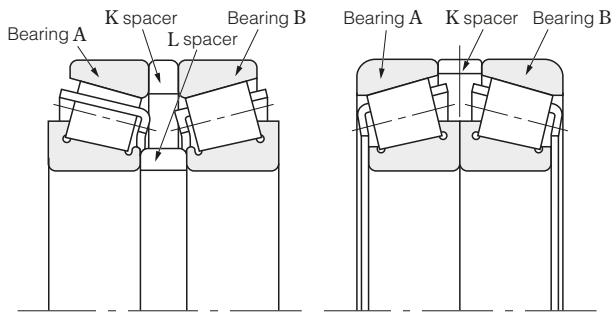


Fig. 8.20 DB Arrangement

Fig. 8.21 DF Arrangement

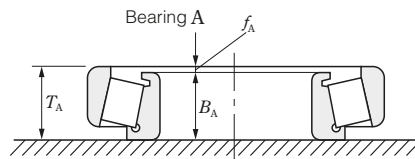


Fig. 8.22

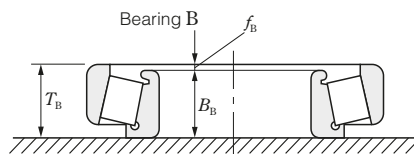


Fig. 8.23

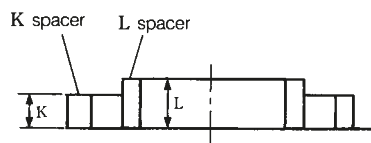


Fig. 8.24

## **8.3.7 Internal Clearance Adjustment When Mounting a Tapered Roller Bearing**

Two single-row tapered roller bearings are usually arranged in a configuration opposite each other with clearance adjusted in the axial direction. There are two types of opposite placement methods: back-to-back (DB arrangement) and face-to-face (DF arrangement). Clearance adjustment for a back-to-back arrangement is performed by tightening the inner ring by a shaft nut or a shaft end bolt. In Fig. 8.25, an example using a shaft-end bolt is shown. In this case, the fit on the tightened side of the inner ring with the shaft must be loose to allow displacement of the inner ring in the axial direction.

For a face-to-face arrangement (Fig. 8.26), a shim is inserted between the cover, which retains the outer ring in the axial direction, and the housing in order to allow adjustment to the specified axial clearance. In this case, use a loose fit between the tightened side of the outer ring and the housing in order to allow appropriate displacement of the outer ring in the axial direction. This is not necessary when the surrounding structure is designed to install the outer ring into a retaining cover (Fig. 8.27), allowing for both easy mounting and dismounting.

Theoretically, fatigue life is longest when bearing clearance is slightly negative during operation; however if the negative clearance is excessive, fatigue life becomes very short and heat generation quickly increases. Thus, we generally recommend that the clearance be slightly positive (slightly above zero) during operation. The bearing clearance after mounting should be decided while considering the reduction in clearance caused by the temperature difference between inner and outer rings during operation and thermal expansion of the shaft and housing in the axial direction.

In practice, clearances C1 or C2 are frequently adopted, as detailed in Table 8.17 on Page A173. In addition, the relationship between radial clearance  $\Delta_r$  and axial clearance  $\Delta_a$  is as follows:

$$\Delta_a = \Delta_r \cot \alpha \approx \Delta_r \frac{1.5}{e}$$

where  $\alpha$ : Contact angle

$e$ : Constant determined for each bearing No. (listed in the bearing tables of this catalog)

Tapered roller bearings, which are used for head spindles of machine tools, automotive final reduction gears, etc., are set to a negative clearance for the purpose of obtaining bearing rigidity. This method is called a preload. There are two different types of preloading: constant-pressure preload and the more commonly used position preload.

There are two methods of position preload: one uses an already adjusted arrangement of bearings, while the other achieves the specified preload by tightening an adjustment nut or using an adjustment shim.

Constant pressure preload applies the appropriate preload to the bearing by means of a spring, hydraulic pressure, etc.

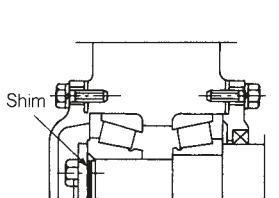
Fig. 8.28 shows an automotive final reduction gear.

For pinion gears, preload is adjusted by use of an inner ring spacer and shim. For large gears on the other hand, preload is controlled by the tightening torque of the outer ring retaining screw.

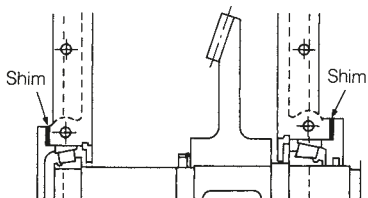
Fig. 8.29 shows the rear wheel of a truck. In this application, preload is applied by tightening the inner ring in the axial direction with a shaft nut. The preload is controlled by measuring the starting friction moment of the bearing.

Fig. 8.30 shows an example lathe head spindle where preload is controlled by tightening the shaft nut.

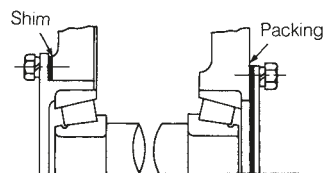
Fig. 8.31 shows an example of constant-pressure preload by spring displacement. In this case, the relationship between the spring's preload and displacement is used to establish the constant-pressure preload.



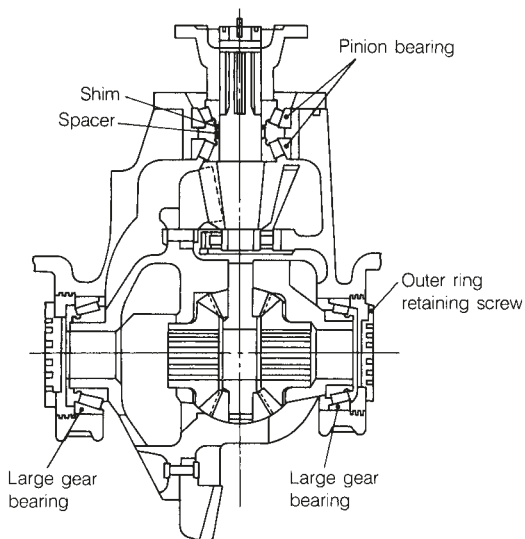
**Fig. 8.25 DB Arrangement  
With Clearance  
Adjusted by Inner  
Rings.**



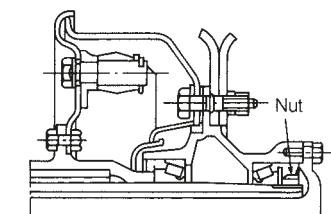
**Fig. 8.26 DF Arrangement  
With Clearance  
Adjusted by Outer  
Rings.**



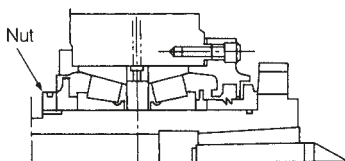
**Fig. 8.27 Clearance Adjusted  
by Shim Thickness of  
Outer Ring Cover**



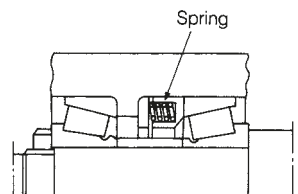
**Fig. 8.28 Automotive Final Reduction Gear**



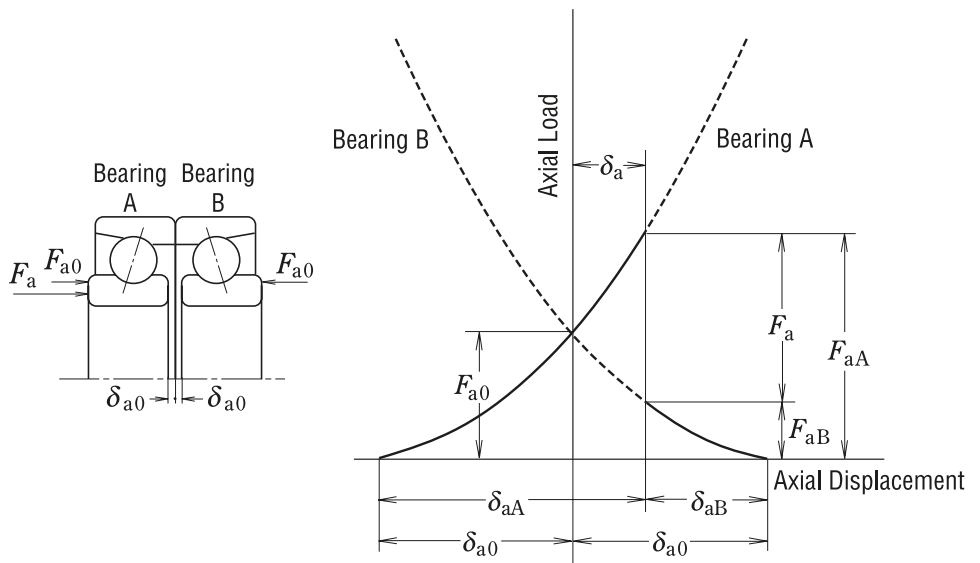
**Fig. 8.29 Rear Wheel of Truck**



**Fig. 8.30 Head Spindle of Lathe**



**Fig. 8.31 Constant-Pressure Preload  
Applied by Spring**



## 9. PRELOAD

<b>9.1 Purpose of Preload</b> .....	A 192
<b>9.2 Preloading Methods</b> .....	A 192
<b>9.2.1 Position Preload</b> .....	A 192
<b>9.2.2 Constant-Pressure Preload</b> .....	A 192
<b>9.3 Preload and Rigidity</b> .....	A 192
<b>9.3.1 Position Preload and Rigidity</b> .....	A 192
<b>9.3.2 Constant-Pressure Preload and Rigidity</b> .....	A 193
<b>9.4 Selection of Preloading Method and Amount of Preload</b> .....	A 193
<b>9.4.1 Comparison of Preloading Methods</b> .....	A 193
<b>9.5 Amount of Preload</b> .....	A 194
<b>9.5.1 Average Preload for Paired Mounting Angular Contact Ball Bearings</b> .....	A 194
<b>9.5.2 Preload of Thrust Ball Bearings</b> .....	A 198
<b>9.5.3 Preload of Spherical Thrust Roller Bearings</b> .....	A 198
<b>9.6 Technical Data</b> .....	A 200
<b>9.6.1 Load and Displacement of Position-Preloaded Bearings</b> .....	A 200
<b>9.6.2 Axial Displacement of Deep Groove Ball Bearings</b> ...	A 208
<b>9.6.3 Axial Displacement of Tapered Roller Bearings</b> .....	A 212

## 9. PRELOAD

Rolling bearings usually retain some internal clearance while in operation. In some cases however, a negative clearance is desirable to keep them internally stressed. This is called “preloading”. A preload is usually applied to bearings whose clearance can be adjusted during mounting, such as angular contact ball bearings or tapered roller bearings. Usually, two bearings are mounted face-to-face or back-to-back to form a paired mounting with a preload.

### 9.1 Purpose of Preload

The main purposes and some typical applications of preloaded bearings are as follows:

- (1) To maintain the bearings in an exact position both radially and axially and to maintain the running accuracy of the shaft.  
Applications: Main shafts of machine tools, precision instruments, etc.
- (2) To increase bearing rigidity  
Applications: Main shafts of machine tools, pinion shafts of final drive gears of automobiles, etc.
- (3) To minimize noise due to axial vibration and resonance  
Applications: Small electric motors, etc.
- (4) To prevent sliding between the rolling elements and raceways due to gyroscopic moments  
Applications: High speed or high acceleration applications of angular contact ball bearings and thrust ball bearings
- (5) To maintain the rolling elements in their proper position with the bearing rings  
Applications: Thrust ball bearings and spherical thrust roller bearings mounted on a horizontal shaft

### 9.2 Preloading Methods

#### 9.2.1 Position Preload

A position preload is achieved by fixing two axially opposed bearings in such a way that a preload is imposed on them. Their position, once fixed, remains unchanged while in operation.

In practice, the following three methods are generally used to obtain a position preload:

- (1) Installing a paired mounting with previously adjusted stand-out dimensions (see Page A007, Fig. 1.1) and axial clearance.
- (2) Using spacers or shims that have been specifically sized to obtain the required spacing and preload. (refer to Fig. 9.1)
- (3) Utilizing bolts or nuts to allow adjustment of the axial preload. In this case, the starting torque should be measured to verify the proper preload.

#### 9.2.2 Constant-Pressure Preload

A constant-pressure preload is achieved by using a coil or leaf spring to impose a constant preload. Even if the relative position of the bearings changes during operation, the spring ensures that the magnitude of the preload remains relatively constant (refer to Fig. 9.2).

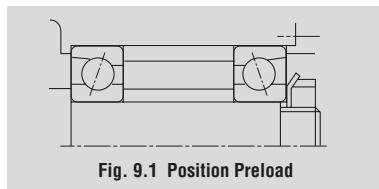


Fig. 9.1 Position Preload

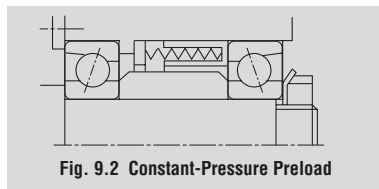


Fig. 9.2 Constant-Pressure Preload

### 9.3 Preload and Rigidity

#### 9.3.1 Position Preload and Rigidity

The inner rings of Bearing A and B in the paired mounting shown in Fig. 9.3 are each displaced by  $\delta_{a0}$ . When they are fixed axially, this total displacement  $2\delta_{a0}$  is eliminated. Under this condition, preload  $F_{a0}$  is imposed on each bearing. A preload diagram showing bearing rigidity, or the relation between load and displacement with given axial load  $F_a$  imposed on a paired mounting, is shown in Fig. 9.4.

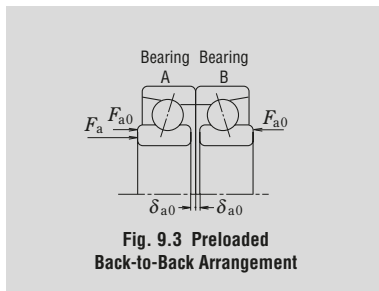


Fig. 9.3 Preloaded Back-to-Back Arrangement

### 9.3.2 Constant-Pressure Preload and Rigidity

A preload diagram for paired mountings under constant-pressure preload is shown in Fig. 9.5. The deflection curve of the spring is nearly parallel to the horizontal axis because the rigidity of the spring is lower than that of the bearing. As a result, rigidity under a constant-pressure preload is approximately equal to that of a single bearing with a preload  $F_{a0}$  applied to it. Fig. 9.6 presents a comparison of rigidity between a bearing with a position preload and one with a constant-pressure preload.

## 9.4 Selection of Preloading Method and Amount of Preload

### 9.4.1 Comparison of Preloading Methods

A comparison of the rigidity of both preloading methods is shown in Fig. 9.6. The position preload and constant-pressure preload may be compared as follows:

- (1) When both of the preloads are equal, the position preload provides greater bearing rigidity. In other words, bearings with a position preload experience less deflection due to external loads.
- (2) Under position preload, the amount of preload varies depending on such factors as differences in axial expansion due to temperature differences between the shaft and housing, differences in radial expansion due to temperature differences between the inner and outer rings, deflection due to load, etc.

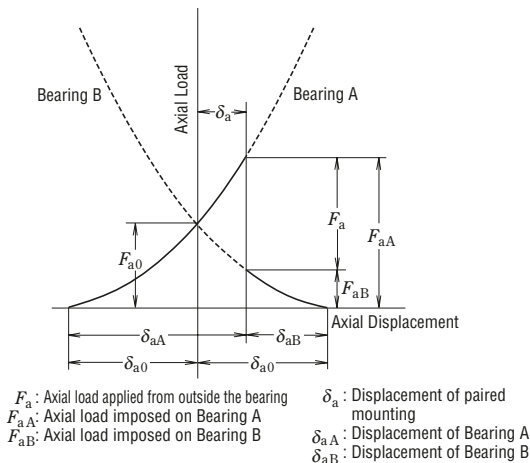


Fig. 9.4 Axial Displacement With Position Preload

Under constant-pressure preload, it is possible to minimize change in the amount of preload because the variation of the spring load with shaft expansion and contraction is negligible. Thus, position preloads are generally preferred for increasing rigidity and constant-pressure preloads are more suitable for high-speed applications, prevention of axial vibration, use with thrust bearings on horizontal shafts, etc.

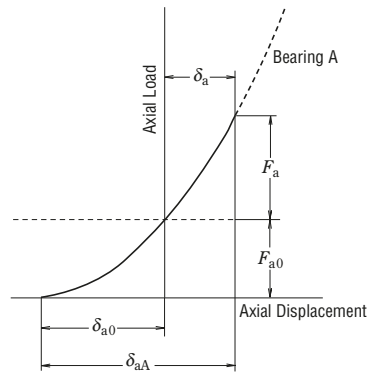


Fig. 9.5 Axial Displacement With Constant-Pressure Preload

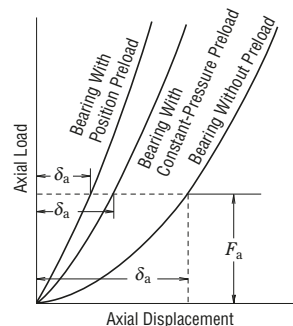


Fig. 9.6 Comparison of Rigidities and Preloading Methods

## 9.5 Amount of Preload

If the preload is larger than necessary, abnormal heat generation, increased frictional torque, reduced fatigue life, or other negative effects may occur. The amount of the preload should be carefully determined considering the operating conditions and the purpose of the preload.

### 9.5.1 Average Preload for Duplex Angular Contact Ball Bearings

Angular contact ball bearings are widely used in spindles for grinding, milling, high-speed turning, and similar applications. NSK divides preloads into four graduated classifications—Extra light, Light, Medium, and Heavy—to allow the customer to freely choose the appropriate preload for the specific application. These four preload classes are expressed by codes EL, L, M, and H respectively when applied to DB and DF bearing sets.

The average preload and measured axial clearance for paired mounting angular contact ball bearing sets with contact angles of 15° and 30° (widely used on machine tool spindles) are given in Tables 9.3 to 9.5. The measuring load when measuring axial clearance is shown in Table 9.1.

The recommended axial clearance to achieve proper preload was determined for machine-tool spindles and other applications requiring ISO Class 5 and above high-precision bearing sets. The standard values given in Table 9.2 are used for the shaft/inner ring and housing/outer ring fits. Housing fits should be selected from the lower part of the standard clearance range for bearings in fixed-end applications and the higher part of the standard clearance range in free-end applications.

As a general rule, grinding machine spindles or machining center spindles require extra light to light preloads, whereas lathe spindles, which need rigidity, require medium preloads.

If the bearing set is mounted with a tight fit, preloads are greater than those shown in Tables 9.3 to 9.5. Since excessive preload causes bearing temperature rise and increases the risk of seizure among other negative effects, pay careful attention to fitting.

When speeds result in a value of  $D_{pw} \cdot n$  ( $d_m n$  value) higher than 500 000, the preload should be very carefully studied and selected. In such a case, please consult with NSK before bearing selection.

Table 9.1 Measuring Load for Axial Clearance

Nominal Outside Diameter $D$ (mm)		Measuring Load
over	incl	(N)
10*	50	24.5
50	120	49
120	200	98
200	—	196

\*10 mm is included in this range.

Table 9.2 Target Fitting

Units :  $\mu\text{m}$

Bore or Outside Diameter $d$ or $D$ (mm)		Shaft and Inner Ring	Housing and Outer Ring
over	incl	Target Interference	Target Clearance
—	18	0 to 2	—
18	30	0 to 2.5	2 to 6
30	50	0 to 2.5	2 to 6
50	80	0 to 3	3 to 8
80	120	0 to 4	3 to 9
120	150	—	4 to 12
150	180	—	4 to 12
180	250	—	5 to 15

Table 9.3 Average Preload and Axial Clearance for Series 79C Bearings

Bearing Designation	Extra Light EL		Light L		Medium M		Heavy H	
	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance
	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )
7900C	7	5	16	2	29	-1	58	-6
7901C	8.6	4	16	2	41	-3	77	-8
7902C	12	3	25	0	47	-4	104	-11
7903C	11	3	25	0	56	-5	119	-12
7904C	20	1	42	-3	80	-8	152	-15
7905C	19	1	37	-2	99	-9	203	-17
7906C	25	0	46	-3	95	-8	204	-16
7907C	33	2	67	-2	149	-9	297	-18
7908C	41	1	78	-3	196	-12	384	-22
7909C	49	0	104	-5	192	-11	391	-21
7910C	49	0	95	-4	240	-13	499	-24
7911C	60	-1	111	-5	296	-15	593	-26
7912C	60	-1	113	-5	305	-15	581	-25
7913C	74	-2	151	-7	348	-16	690	-27
7914C	101	-4	205	-10	503	-22	1 004	-36
7915C	103	-4	190	-9	489	-21	997	-35
7916C	104	-4	195	-9	503	-21	986	-34
7917C	138	-6	307	-14	629	-25	1 281	-41
7918C	153	-3	289	-9	740	-23	1 488	-39
7919C	154	-3	294	-9	800	-24	1 588	-40
7920C	191	-5	387	-13	905	-28	1 790	-46

**Remark** The axial clearance column contains measured values.

**Table 9.4 Average Preload and Axial Clearance for Series 70C Bearings**

Bearing Designation	Extra Light EL		Light L		Medium M		Heavy H	
	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance
	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )
7000C	13	3	25	0	49	-5	96	-12
7001C	13	3	25	0	57	-6	120	-14
7002C	12	3	29	-1	66	-7	147	-16
7003C	15	2	30	-1	69	-7	156	-16
7004C	25	0	49	-4	119	-12	244	-22
7005C	30	-1	58	-5	148	-14	292	-24
7006C	41	1	75	-3	195	-13	386	-24
7007C	58	-1	121	-7	251	-16	493	-28
7008C	58	-1	114	-6	291	-17	594	-30
7009C	80	-3	144	-8	338	-19	695	-33
7010C	70	-2	152	-8	388	-20	791	-34
7011C	95	-4	200	-11	479	-24	971	-40
7012C	96	-4	189	-10	526	-25	1 092	-42
7013C	130	-6	260	-13	537	-24	1 062	-39
7014C	148	-7	285	-14	732	-30	1 460	-48
7015C	151	-7	294	-14	796	-31	1 573	-49
7016C	202	-6	382	-14	921	-31	1 880	-52
7017C	205	-6	393	-14	995	-32	1 956	-52
7018C	247	-8	502	-18	1 187	-37	2 373	-60
7019C	275	-9	549	-19	1 188	-36	2 348	-58
7020C	282	-9	534	-18	1 278	-37	2 572	-60

**Remark** The axial clearance column contains measured values.

Table 9.5 Average Preload and Axial Clearance for Series 72C Bearings

Bearing Designation	Extra Light EL		Light L		Medium M		Heavy H	
	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance	Preload	Axial Clearance
	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )	(N)	( $\mu\text{m}$ )
7200C	13	3	29	-1	68	-8	150	-18
7201C	20	1	39	-3	99	-12	197	-22
7202C	20	1	40	-3	97	-11	199	-21
7203C	25	0	46	-4	146	-16	296	-28
7204C	35	-2	68	-7	196	-20	384	-33
7205C	42	1	82	-4	193	-14	402	-27
7206C	57	-1	114	-7	292	-20	591	-35
7207C	75	-3	151	-10	385	-25	794	-43
7208C	98	-5	202	-13	501	-29	985	-47
7209C	123	-7	254	-16	534	-30	1 067	-49
7210C	127	-7	248	-15	590	-31	1 171	-50
7211C	142	-8	289	-17	788	-38	1 554	-60
7212C	190	-11	397	-22	928	-42	1 878	-67
7213C	219	-12	448	-23	1 069	-44	2 175	-70
7214C	243	-9	484	-20	1 164	-42	2 368	-69
7215C	270	-10	530	-21	1 224	-42	2 445	-68
7216C	305	-12	595	-24	1 367	-47	2 752	-76
7217C	355	-14	697	-27	1 658	-53	3 358	-85
7218C	384	-15	771	-29	1 865	-57	3 713	-90
7219C	448	-18	876	-33	2 081	-63	4 153	-99
7220C	503	-20	984	-36	2 337	-68	4 700	-107

**Remark** The axial clearance column contains measured values.

### 9.5.2 Preload of Thrust Ball Bearings

When the balls in thrust ball bearings rotate at relatively high speeds, sliding due to gyroscopic moments on the balls may occur. The larger of the two values obtained from Equations (9.1) and (9.2) below should be adopted as the minimum axial load in order to prevent such sliding:

$$F_{a \min} = \frac{C_{0a}}{100} \left( \frac{n}{N_{\max}} \right)^2 \dots\dots\dots (9.1)$$

$$F_{a \min} = \frac{C_{0a}}{1000} \dots\dots\dots (9.2)$$

where  $F_{a \min}$  : Minimum axial load (N), {kgf}  
 $C_{0a}$  : Basic static load rating (N), {kgf}  
 $n$  : Speed ( $\text{min}^{-1}$ )  
 $N_{\max}$  : Limiting speed (oil lubrication) ( $\text{min}^{-1}$ )

### 9.5.3 Preload of Spherical Thrust Roller Bearings

When spherical thrust roller bearings are used, damage such as scoring may occur due to sliding between the rollers and outer ring raceway. The minimum axial load  $F_{a \min}$  necessary to prevent such sliding is obtained from the following equation:

$$F_{a \min} = \frac{C_{0a}}{1000} \dots\dots\dots (9.3)$$



## 9.6 Technical Data

### 9.6.1 Load and Displacement of Position-Preloaded Bearings

Bearing arrangements refer to multiple identical ball or tapered roller bearings mounted side by side as a set. When two bearings are used, they are often referred to as paired mountings or duplex bearings. In bearing arrangements for machine tool spindles, single-row angular contact ball bearings are most often used for their high rigidity to reduce bearing displacement under load.

Paired mountings fall into three types: back-to-back, with load lines that diverge toward the bearing axis; face-to-face, with load lines that converge toward the bearing axis; and tandem, with parallel load lines. The designations for these arrangements are DB, DF, and DT respectively (Fig. 9.7).

Different arrangements are used depending on the application. DB and DF arrangements can take axial loads in either direction. Since the distances of the load centers of DB arrangements are longer than those of DF arrangements, they are widely used in applications where moment loads occur. DT arrangements can only take axial loads in one direction; however, because the two bearings share load equally between them, this type can be used when load in one direction is large.

By selecting DB or DF arrangements preset with proper preloads, radial and axial displacement of the bearing inner and outer rings can be reduced as much as possible (DT arrangements can not be preloaded in this way). The amount of preload can be adjusted by changing the clearance between bearings  $\delta_{a0}$ , as shown in Figs. 9.9 to 9.11. Preloads are divided into four graduated classifications: Extra Light (EL), Light (L), Medium (M), and Heavy (H). DB and DF arrangements are often used for applications where shaft misalignments and displacements due to load must be minimized. Arrangements of three bearings (triplex) are designated DBD, DFD, and DTD, as shown in Fig. 9.8. Sets of four or five bearings can also be used depending on application requirements. Paired mountings are often used with a preload. Since preload affects various things, such as the rise in bearing temperature during operation, torque, bearing noise, and especially bearing life, it is extremely important to avoid applying excessive preload.

$$\delta_a = c F_a^{2/3} \dots\dots\dots (9.4)$$

where  $c$ : Constant depending on the bearing type and dimensions.

Fig. 9.9 shows the preload curves of a DB arrangement, and Figs. 9.10 and 9.11 show preload curves for a DBD arrangement. If the inner rings of a paired mounting as in Fig. 9.9 are pressed axially, A-side and B-side bearings are deformed by  $\delta_{a0A}$  and  $\delta_{a0B}$  respectively and the clearance (between the inner rings)  $\delta_{a0}$  becomes zero. This condition means that preload  $F_{a0}$  is applied on the arrangement. If external axial load  $F_a$  is applied on the preloaded arrangement from the A-side, then the A-side bearing will be deformed by an additional  $\delta_{a1}$  and the displacement of B-side bearing will be reduced to the same amount as the A-side bearing displacement  $\delta_{a1}$ . Therefore, the displacements of A- and B-side bearings are  $\delta_{aA} = \delta_{a0A} + \delta_{a1}$  and  $\delta_{aB} = \delta_{a0B} + \delta_{a1}$  respectively. In other words, the load on the A-side bearing including preload is  $F_{a0} + F_a - F_a'$  and that on the B-side is  $F_{a0} - F_a'$ .

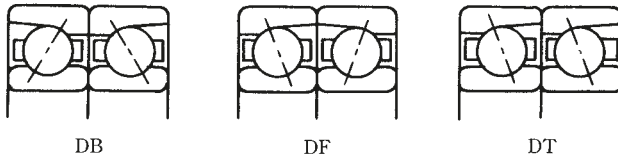


Fig. 9.7 Paired Mounting Bearing Arrangements

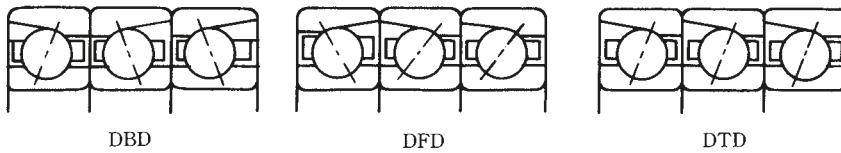


Fig. 9.8 Triplex Bearing Arrangements

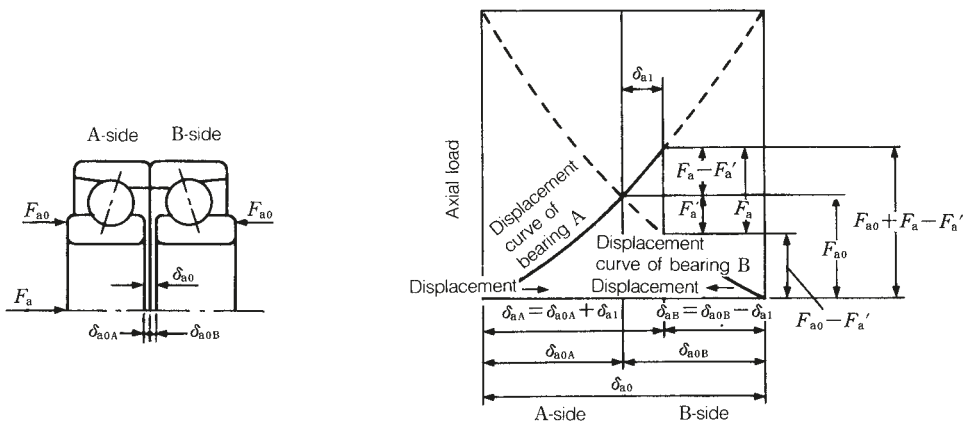


Fig. 9.9 Preload Graph of DB Back-to-Back Arrangement

If the bearing set has an applied preload, the A-side bearing should have sufficient life and load capacity for an axial load ( $F_{a0} + F_a - F'_a$ ) under operating speed conditions. The axial clearance  $\delta_{a0}$  is shown in Tables 9.3 to 9.5 of Section 9.5.1 (Pages A195 to A197).

Fig. 9.10 shows external axial load  $F_a$  applied on AA-side bearings. The axial loads and displacements of AA- and B-side bearings are summarized in Table 9.6.

Fig. 9.11 shows external axial load  $F_a$  applied on an A-side bearing. The axial loads and displacements of A- and BB-side bearings are summarized in Table 9.7.

Figs. 9.12 to 9.17 show the relationship of axial load to axial displacement for DB and DBD arrangements of 7018C and 7018A bearings under several preload ranges.

Table 9.6

Direction	Displacement	Axial load
AA-side	$\delta_{a0A} + \delta_{a1}$	$F_{a0} + F_a - F'_a$
B-side	$\delta_{a0B} - \delta_{a1}$	$F_{a0} - F'_a$

Table 9.7

Direction	Displacement	Axial load
A-side	$\delta_{a0A} + \delta_{a1}$	$F_{a0} + F_a - F'_a$
BB-side	$\delta_{a0B} - \delta_{a1}$	$F_{a0} - F'_a$

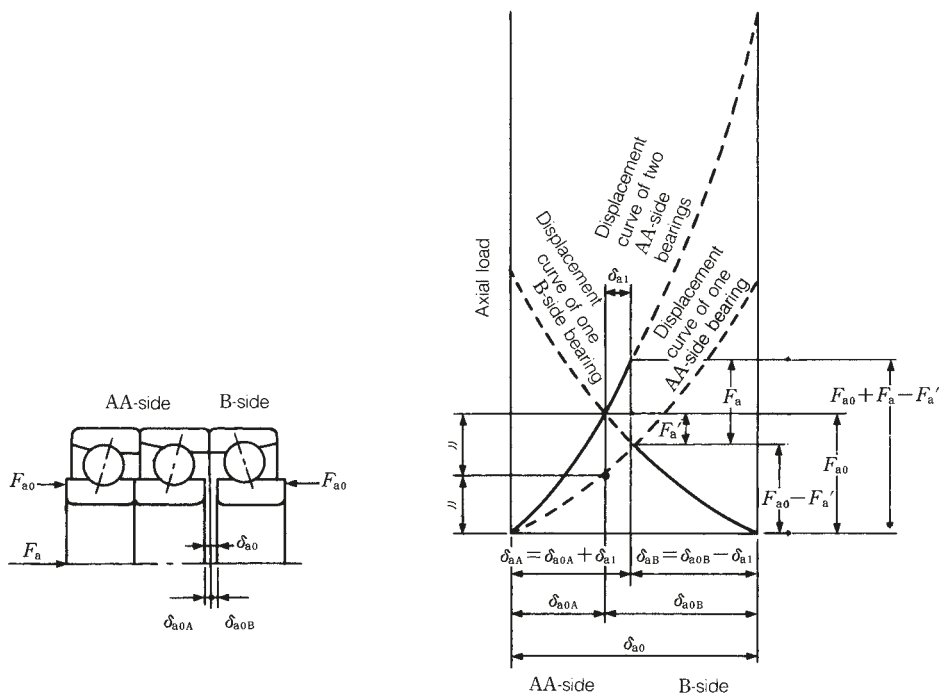
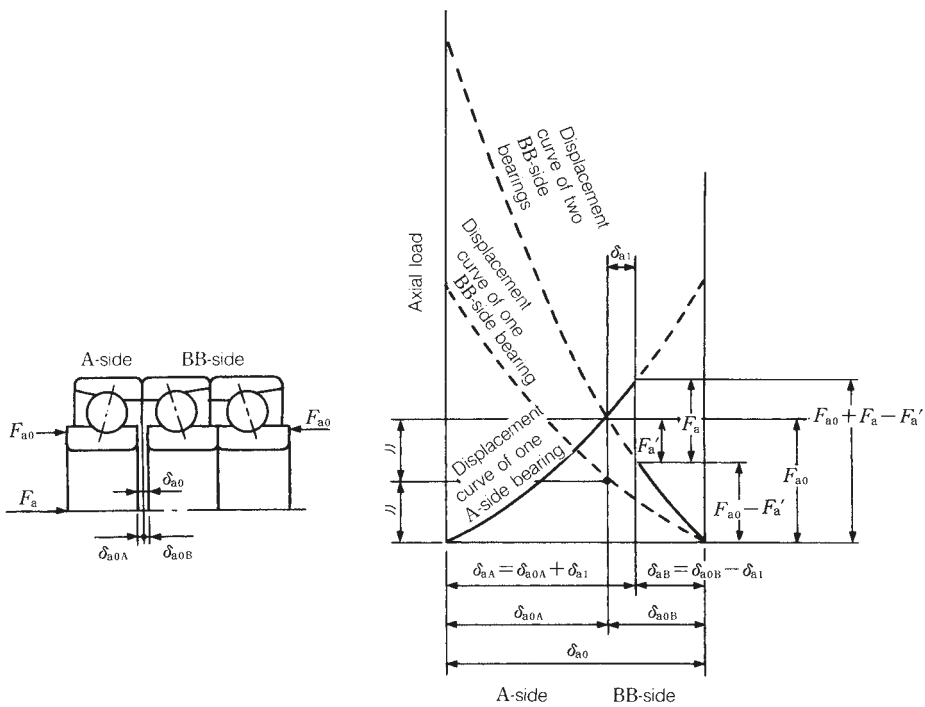


Fig. 9.10 Preload Graph for a DBD Arrangement  
(Axial Load Applied From the AA-Side)



**Fig. 9.11 Preload Graph for a DBD Arrangement  
(Axial Load Applied From A-Side)**

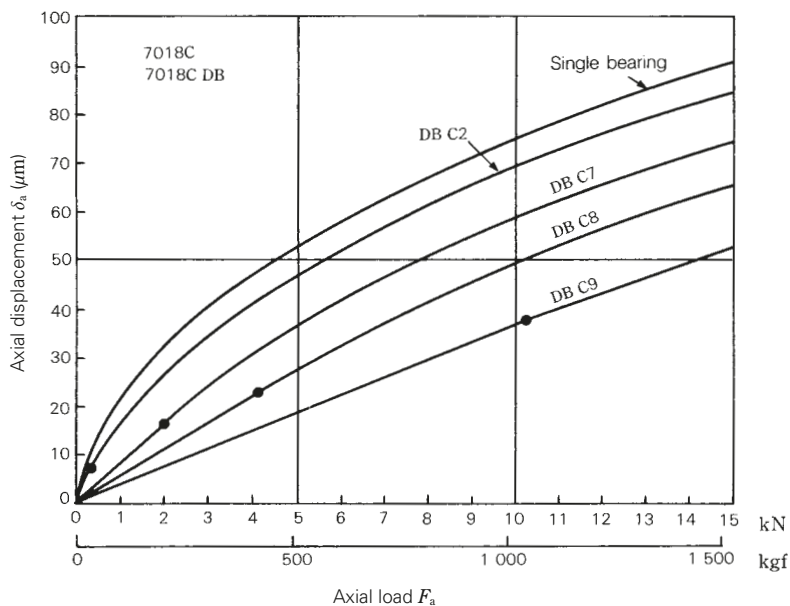


Fig. 9.12

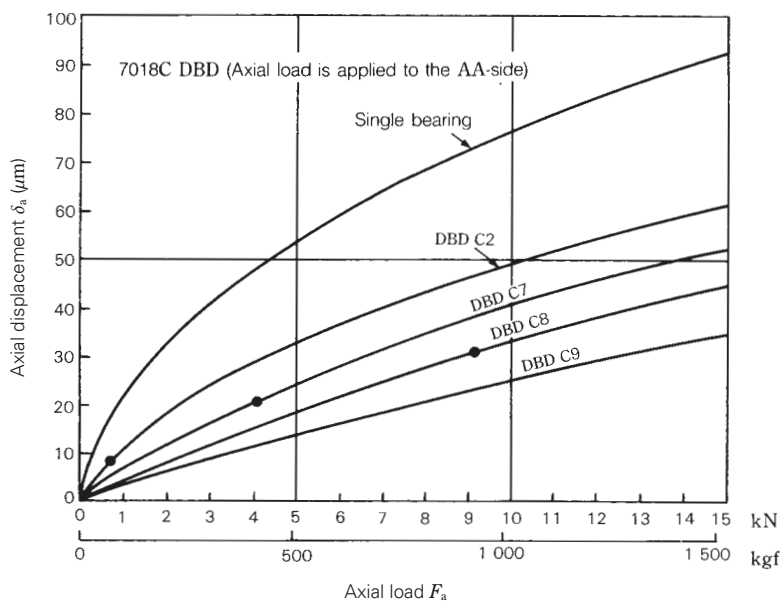


Fig. 9.13

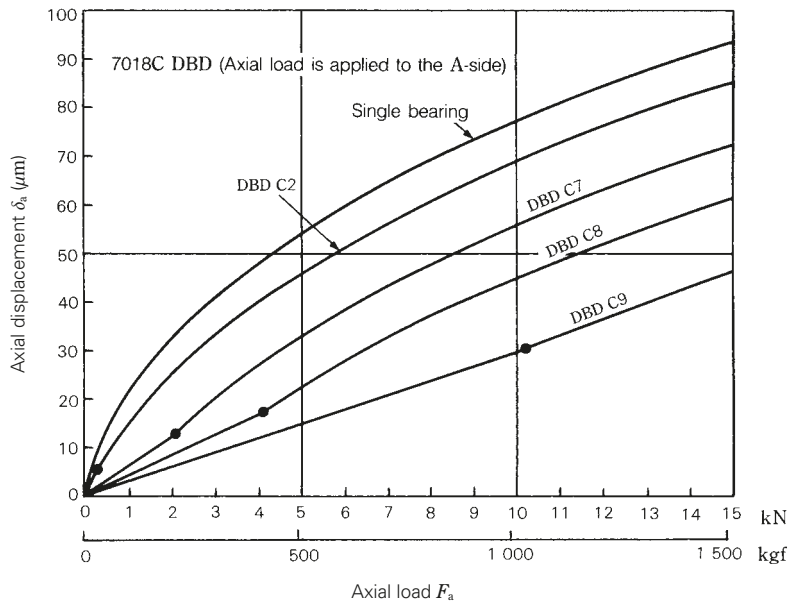


Fig. 9.14

**Remark** The (•) mark on the axial load or displacement curve indicates the point where the preload is zero. Therefore, if the axial load is larger than this, the opposed bearing does not impose a load.

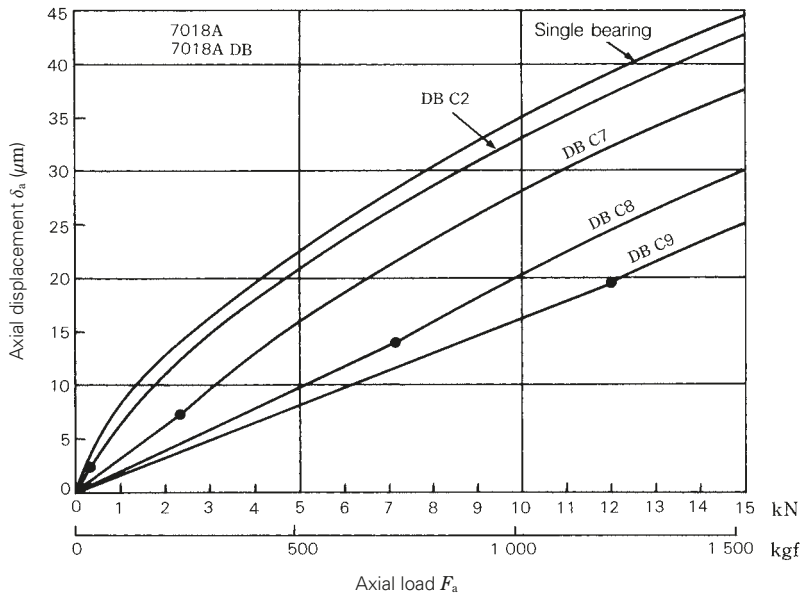


Fig. 9.15

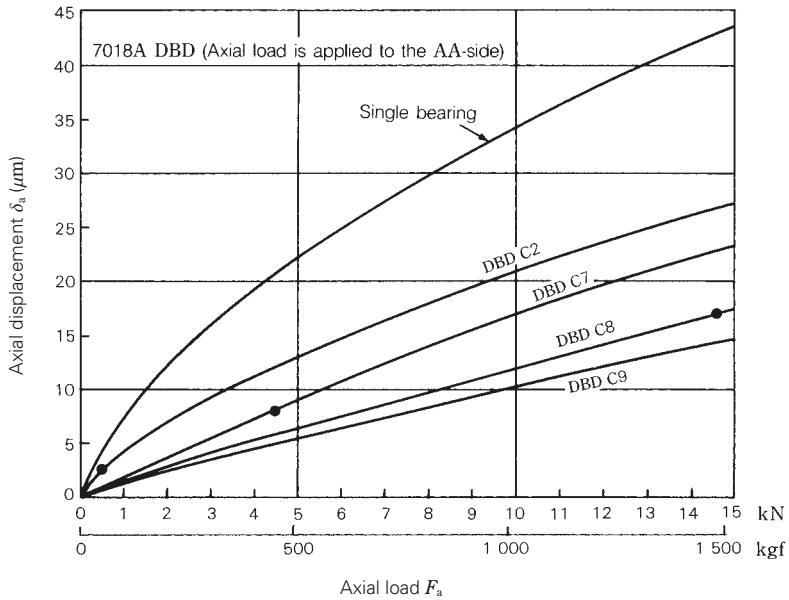


Fig. 9.16

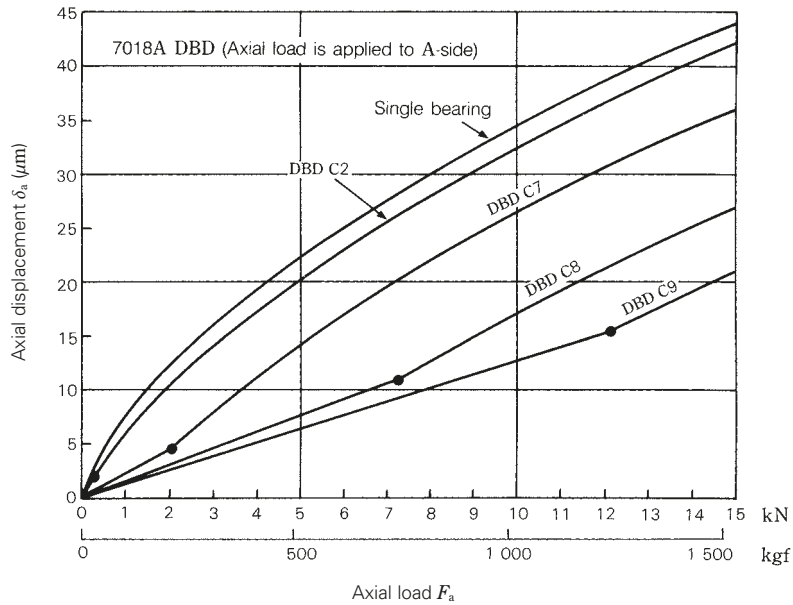


Fig. 9.17

**Remark** The (●) mark on the axial load or displacement curve indicates the point where the preload is zero. Therefore, if the axial load is larger than this, the opposed bearing does not impose a load.

### 9.6.2 Axial Displacement of Deep Groove Ball Bearings

When an axial load  $F_a$  is applied to a radial bearing with contact angle  $\alpha_0$  and the inner ring is displaced  $\delta_a$ , the center of the inner ring raceway radius  $O_i$  is also moved to  $O_i'$  resulting in contact angle  $\alpha$  as shown in Fig. 9.18. If  $\delta_N$  represents the elastic deformation of the raceway and ball in the direction of the rolling element load  $Q$ , Equation (9.5) is derived from Fig. 9.18.

$$(m_0 + \delta_N)^2 = (m_0 \cdot \sin \alpha_0 + \delta_a)^2 + (m_0 \cdot \cos \alpha_0)^2$$

$$\therefore \delta_N = m_0 \left\{ \sqrt{(\sin \alpha_0 + \frac{\delta_a}{m_0})^2 + \cos^2 \alpha_0} - 1 \right\} \dots \dots \dots (9.5)$$

In addition, the following relationship exists between rolling element load  $Q$  and elastic deformation  $\delta_N$ .

$$Q = K_N \cdot \delta_N^{3/2} \dots \dots \dots (9.6)$$

where  $K_N$ : Constant depending on bearing material, type, and dimensions  
If we introduce the relation of

$$m_0 = \left( \frac{r_c}{D_w} + \frac{r_i}{D_w} - 1 \right) D_w = B \cdot D_w$$

Equations (9.5) and (9.6) are

$$Q = K_N (B \cdot D_w)^{3/2} \left\{ \sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0} - 1 \right\}^{3/2}$$

where  $h = \frac{\delta_a}{m_0} = \frac{\delta_a}{B \cdot D_w}$

If we introduce the relation of  $K_N = K \cdot \frac{\sqrt{D_w}}{B^{3/2}}$

$$Q = K \cdot D_w^2 \left\{ \sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0} - 1 \right\}^{3/2} \dots \dots \dots (9.7)$$

On the other hand, the relation between bearing axial load and rolling element load is shown in Equation (9.8) using Fig. 9.19:

$$F_a = Z \cdot Q \cdot \sin \alpha \dots \dots \dots (9.8)$$

Based on Fig. 9.18, we obtain,

$$(m_0 + \delta_N) \sin \alpha = m_0 \cdot \sin \alpha_0 + \delta_a$$

$$\therefore \sin \alpha = \frac{m_0 \cdot \sin \alpha_0 + \delta_a}{m_0 + \delta_N} = \frac{\sin \alpha_0 + h}{1 + \frac{\delta_N}{m_0}}$$

If we substitute Equation (9.5),

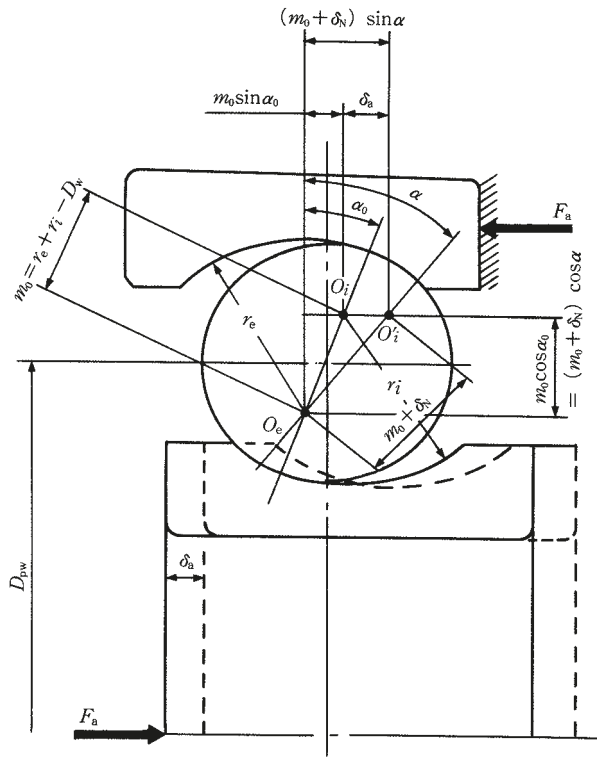
$$\sin \alpha = \frac{\sin \alpha_0 + h}{\sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0}} \dots \dots \dots (9.9)$$

In other words, the relation between the bearing axial load  $F_a$  and axial displacement  $\delta_a$  can be obtained by substituting Equations (9.7) and (9.9) for Equation (9.8).

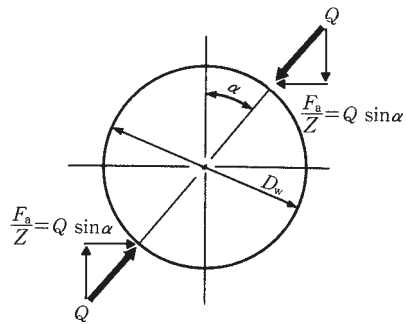
$$F_a = K \cdot Z \cdot D_w^2 \cdot \frac{\left\{ \sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0} - 1 \right\}^{3/2} \times (\sin \alpha_0 + h)}{\sqrt{(\sin \alpha_0 + h)^2 + \cos^2 \alpha_0}} \dots \dots \dots (9.10)$$

where  $K$ : Constant depending on bearing material and design  
 $D_w$ : Ball diameter  
 $Z$ : Number of balls  
 $\alpha_0$ : Initial contact angle  
The initial contact angle for single-row deep groove ball bearings can be obtained using Equation (5) on Page C012

Actual axial deformation varies depending on bearing mounting conditions and factors such as the material and thickness of the shaft and housing and bearing fitting. For more details, consult with NSK.



**Fig. 9.18**



**Fig. 9.19**

Fig. 9.20 shows the relation between axial load and axial displacement for Series 6210 and 6310 single-row deep groove ball bearings with initial contact angles of 0°, 10°, and 15°. The larger the initial contact angle  $\alpha_0$ , the more rigid the bearing will be in the axial direction and the smaller the difference between the axial displacements of 6210 and 6310 under identical axial load. The initial contact angle  $\alpha_0$  depends on the groove radius and the radial clearance.

Fig. 9.21 shows the relation between axial load and axial displacement for Series 72 angular contact ball bearings with initial contact angles of 15° (C), 30° (A), and 40° (B). Series 70 and 73 bearings with identical contact angles and bore diameters can be considered to have almost the same values as Series 72 bearings. Angular contact ball bearings that sustain loads in the axial direction must maintain their running accuracy and reduce elastic deformation from applied loads when used as multiple bearing arrangements with a preload.

To determine the preload to keep the elastic deformation caused by applied loads within the required limits, it is important to know the characteristics of load vs. deformation. The relationship between load and displacement can be expressed by Equation (9.10) as  $F_a \propto \delta_a^{3/2}$  or  $\delta_a \propto F_a^{2/3}$ . In other words, axial displacement  $\delta_a$  is proportional to axial load  $F_a$  to the 2/3 power. When this axial load index is less than one, relative axial displacement will be small, with only a small increase in axial load (Fig. 9.21). The underlying reason for applying a preload is to reduce the amount of displacement.

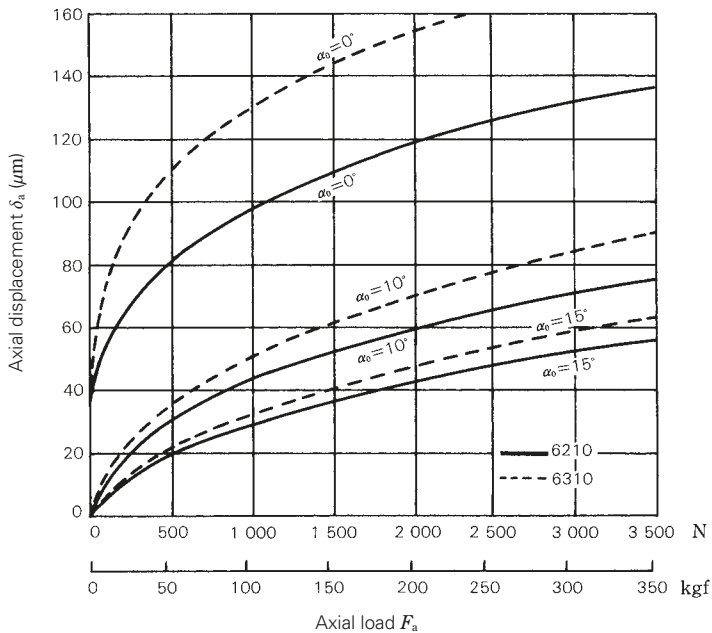


Fig. 9.20 Axial Load and Axial Displacement of Deep Groove Ball Bearings

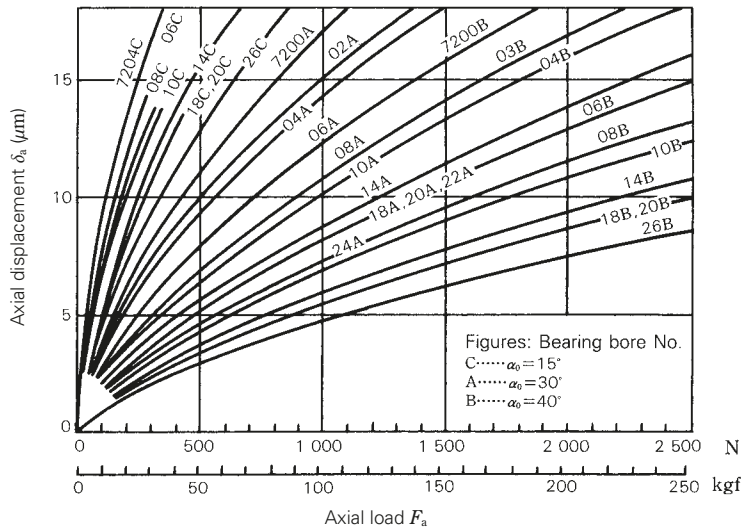


Fig. 9.21 Axial Load and Axial Displacement of Angular Contact Ball Bearings

### 9.6.3 Axial Displacement of Tapered Roller Bearings

Tapered roller bearings are widely used in pairs like angular contact ball bearings. Take care when selecting appropriate tapered roller bearings.

For example, the bearings of machine-tool head spindles and automobile differential pinions are preloaded to increase shaft rigidity.

When a bearing with an applied preload is to be used, it is essential to have some knowledge of the relationship between axial load and axial displacement. For tapered roller bearings, the axial displacement calculated using Palmgren's method in Equation (9.11) generally agrees well with actual measured values.

Actual axial deformation varies depending on the bearing mounting conditions, such as the material and thickness of the shaft and housing and the bearing fitting. For more details, consult with NSK.

$$\delta_a = \left. \begin{aligned} & \frac{0.000077}{\sin \alpha} \cdot \frac{Q^{0.9}}{L_{we}^{0.8}} \quad (N) \\ & = \frac{0.0006}{\sin \alpha} \cdot \frac{Q^{0.9}}{L_{we}^{0.8}} \quad \{kgf\} \end{aligned} \right\} \dots (9.11)$$

where,  $\delta_a$ : Axial displacement of inner, outer ring (mm)

$\alpha$ : Contact angle...1/2 the outer ring angle (°) (Refer to Fig. 9.22)

$Q$ : Load on rolling elements (N), {kgf}

$$Q = \frac{F_a}{Z \sin \alpha}$$

$L_{we}$ : Length of effective contact on roller (mm)

$F_a$ : Axial load (N), {kgf}

$Z$ : Number of rollers

Equation (9.11) can also be expressed as Equation (9.12).

$$\delta_a = K_a \cdot F_a^{0.9} \dots (9.12)$$

$$\begin{aligned} \text{where,} \\ K_a &= \frac{0.000077}{(\sin \alpha)^{1.9} Z^{0.9} L_{we}^{0.8}} \dots (N) \\ &= \frac{0.0006}{(\sin \alpha)^{1.9} Z^{0.9} L_{we}^{0.8}} \dots \{kgf\} \end{aligned}$$

Here  $K_a$  refers to the coefficient determined by bearing internal design.

Axial loads and axial displacement for tapered roller bearings are plotted in Fig. 9.23.

The amount of axial displacement of tapered roller bearings is proportional to the axial load raised to the 0.9 power. The displacement of ball bearings is proportional to the axial load raised to the 0.67 power; thus, the preload required to control displacement is much greater for ball bearings than for tapered roller bearings.

Take caution not to make the preload indiscriminately large on tapered roller bearings, since too large of a preload can cause excessive heat, seizure, and reduced bearing life.

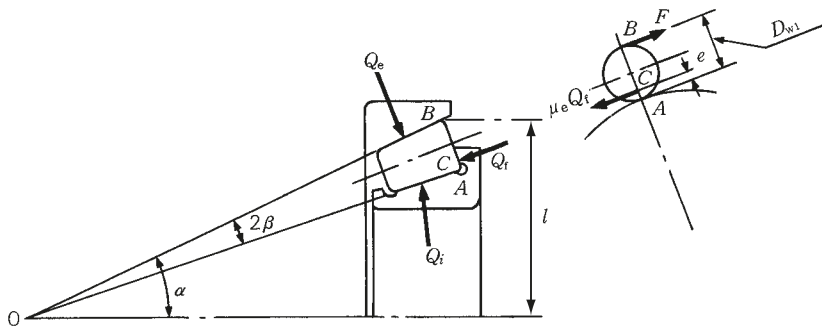


Fig. 9.22

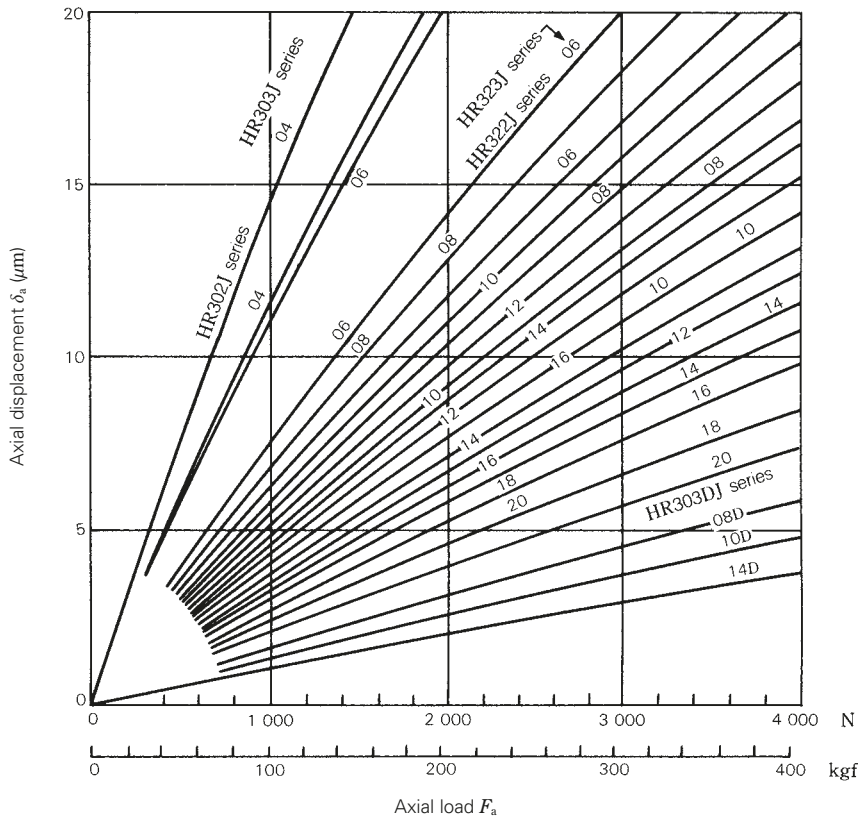
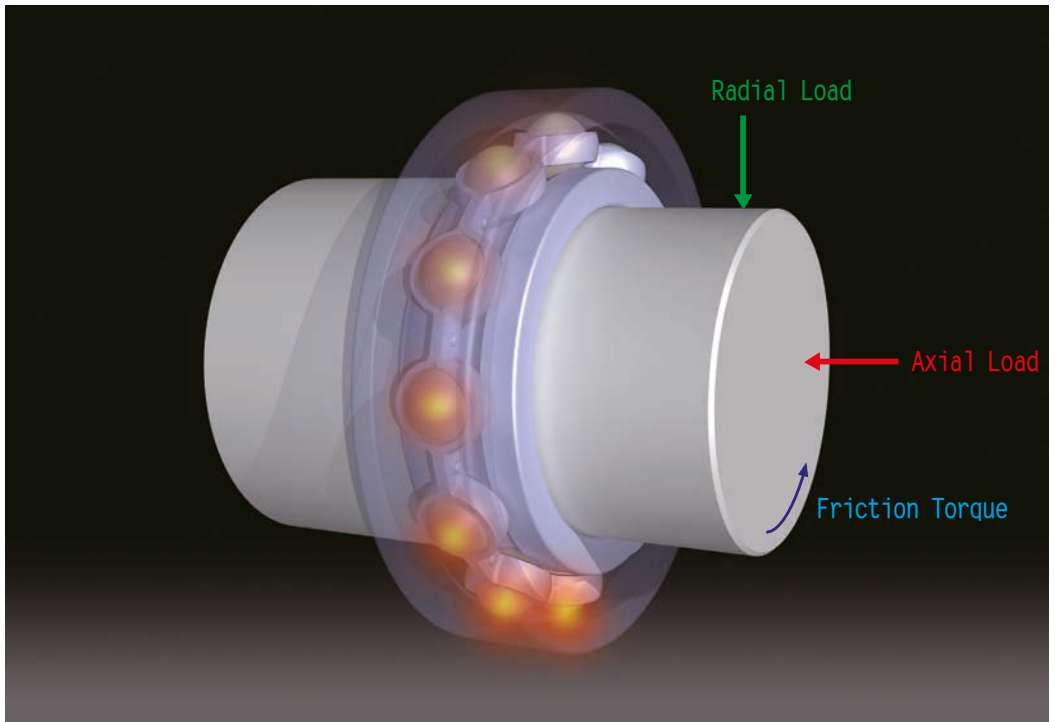


Fig. 9.23 Axial Load and Axial Displacement for Tapered Roller Bearings



## **10. FRICTION**

<b>10.1</b>	<b>Coefficients of Dynamic Friction .....</b>	<b>A 216</b>
<b>10.1.1</b>	<b>Bearing Types and Their Coefficients of Dynamic Friction .....</b>	<b>A 216</b>
<b>10.2</b>	<b>Empirical Equations for Running Torque .....</b>	<b>A 216</b>
<b>10.3</b>	<b>Technical Data .....</b>	<b>A 216</b>
<b>10.3.1</b>	<b>Preload and Starting Torque for Angular Contact Ball Bearings .....</b>	<b>A 216</b>
<b>10.3.2</b>	<b>Empirical Equations for Running Torque of High-Speed Ball Bearings .....</b>	<b>A 218</b>
<b>10.3.3</b>	<b>Preload and Starting Torque for Tapered Roller Bearings .....</b>	<b>A 220</b>
<b>10.3.4</b>	<b>Empirical Equations for Running Torque of Tapered Roller Bearings .....</b>	<b>A 222</b>

# 10. FRICTION

## 10.1 Coefficients of Dynamic Friction

### 10.1.1 Bearing Types and Their Coefficients of Dynamic Friction $\mu$

$$\mu = \frac{M}{P \cdot \frac{d}{2}} \quad (10.1)$$

$M$  : Dynamic friction torque (N·mm), {kgf·mm}

$P$  : Load on a bearing (dynamic equivalent load) (N), {kgf}

$d$  : Shaft diameter, inner ring bore diameter (mm)

**Table 10.1 Coefficients of Dynamic Friction**

Bearing Types	Approximate Values of $\mu$
Deep Groove Ball Bearings	0.0013
Angular Contact Ball Bearings	0.0015
Self-Aligning Ball Bearings	0.0010
Thrust Ball Bearings	0.0011
Cylindrical Roller Bearings	0.0010
Tapered Roller Bearings	0.0022
Spherical Roller Bearings	0.0028
Needle Roller Bearings With Cages	0.0015
Full Complement Needle Roller Bearings	0.0025
Spherical Thrust Roller Bearings	0.0028

## 10.2 Empirical Equations for Running Torque

Dynamic bearing torque (heat generation)  $M = M_l + M_s$

— Load term (determined by bearing type and load)  
 $M_l = f_l F d_m$   
 where  $f_l$  : Coefficient determined by bearing type and load  
 $F$  : Load  
 $d_m$  : Pitch circle diameter of rolling element

— Speed term (determined by oil viscosity, amount, speed)  
 $M_s = f_0 (v_0 n)^{2/3} d m^3$   
 where  $f_0$  : Coefficient determined by bearing and lubricating method  
 $v_0$  : Kinematic viscosity of oil  
 $n$  : Speed

## 10.3 Technical Data

### 10.3.1 Preload and Starting Torque for Angular Contact Ball Bearings

Angular contact ball bearings, like tapered roller bearings, are most often used in pairs rather than alone or in other multiple bearing sets. Back-to-back and face-to-face bearing sets can be preloaded to adjust bearing rigidity. Extra Light (EL), Light (L), Medium (M), and Heavy (H) are standard preloads. Friction torque of the bearing will increase in direct proportion to the preload.

The starting torque of angular contact ball bearings is mainly caused by angular slippage between the balls and contact surfaces on the inner and outer rings. Starting torque for the bearing  $M$  due to such spin is given by the following equation:

$$M = M_s Z \sin \alpha \quad (\text{mN} \cdot \text{m}), \{ \text{kgf} \cdot \text{mm} \} \quad (10.2)$$

where  $M_s$  : Spin friction for contact angle  $\alpha$  centered on the shaft,

$$M_s = \frac{3}{8} \mu_s Q \cdot a \cdot E(k) \quad (\text{mN} \cdot \text{m}), \{ \text{kgf} \cdot \text{mm} \}$$

$\mu_s$  : Contact-surface slip friction coefficient

$Q$  : Load on rolling elements (N), {kgf}

$a$  : (1/2) of contact-ellipse major axis (mm)

$$E(k) : \text{With } k = \sqrt{1 - \left( \frac{b}{a} \right)^2}$$

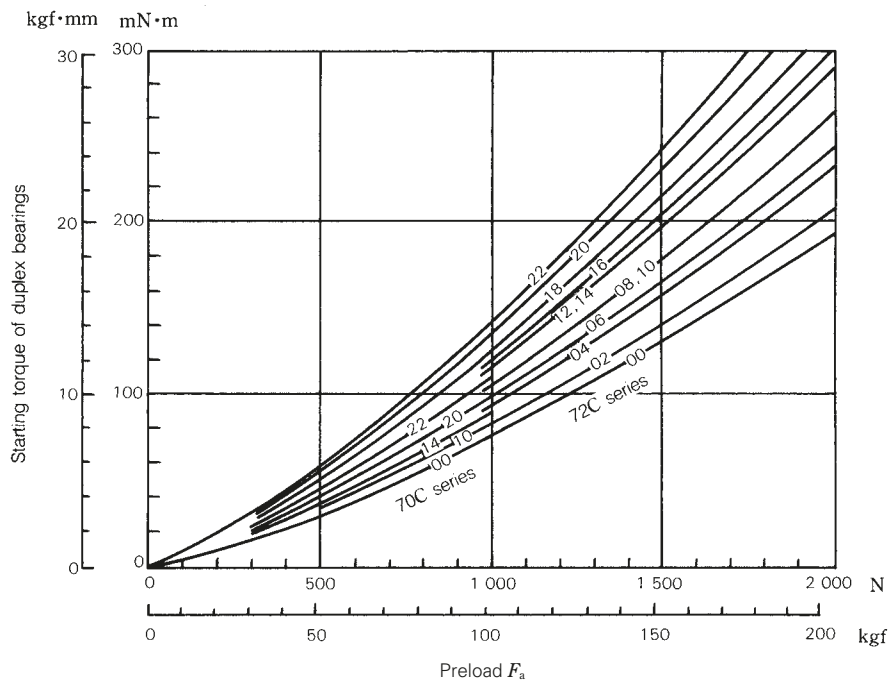
as the population parameter, second class complete ellipsoidal integration

$b$  : (1/2) of contact-ellipse minor axis (mm)

$Z$  : Number of balls

$\alpha$  : Contact angle ( $^\circ$ )

Actual measurements with  $15^\circ$  angular contact ball bearings correlate well with calculated results using  $\mu_s = 0.15$  in Equation (10.2). Fig. 10.1 shows the calculated friction torque for Series 70C and 72C bearings.



**Fig. 10.1 Preload and Starting Torque for DF and DB Angular Contact Ball Bearing ( $\alpha=15^\circ$ ) Arrangements**

### 10.3.2 Empirical Equations for Running Torque of High-Speed Ball Bearings

Empirical equations are presented below for the running torque of high speed ball bearings subject to axial loading and jet lubrication. These equations are based on the results of tests of angular contact ball bearings with bore diameters of 10 to 30 mm, but they can be extrapolated to larger bearings.

Running torque  $M$  can be obtained as the sum of a load term  $M_l$  and speed term  $M_v$  as follows:

$$M = M_l + M_v \text{ (mN} \cdot \text{m)}, \{ \text{kgf} \cdot \text{mm} \} \dots\dots\dots (10.3)$$

Load term  $M_l$  refers to friction with no relation to speed or fluid friction and is expressed by the experimentally-based Equation (10.4).

$$\left. \begin{aligned} M_l &= 0.672 \times 10^{-3} D_{pw}^{0.7} F_a^{1.2} \text{ (mN} \cdot \text{m)} \\ &= 1.06 \times 10^{-3} D_{pw}^{0.7} F_a^{1.2} \{ \text{kgf} \cdot \text{mm} \} \end{aligned} \right\} \dots\dots\dots (10.4)$$

where,  $D_{pw}$ : Pitch diameter of rolling elements (mm)  
 $F_a$ : Axial load (N), {kgf}

Speed term  $M_v$  refers to fluid friction, which depends on angular speed and is expressed by Equation (10.5).

$$\left. \begin{aligned} M_v &= 3.47 \times 10^{-10} D_{pw}^3 n_i^{1.4} Z_B^a Q^b \text{ (mN} \cdot \text{m)} \\ &= 3.54 \times 10^{-11} D_{pw}^3 n_i^{1.4} Z_B^a Q^b \{ \text{kgf} \cdot \text{mm} \} \end{aligned} \right\} \dots\dots\dots (10.5)$$

where,  $n_i$ : Inner ring speed ( $\text{min}^{-1}$ )  
 $Z_B$ : Absolute viscosity of oil at outer ring temperature ( $\text{mPa} \cdot \text{s}$ ), {cp}  
 $Q$ : Oil flow rate ( $\text{kg/min}$ )

Exponents  $a$  and  $b$ , which affect oil viscosity and flow rate factors, depend only on angular speed and are given by Equations (10.6) and (10.7) as follows:

$$a = 24 n_i^{-0.37} \dots\dots\dots (10.6)$$

$$b = 4 \times 10^{-9} n_i^{1.6} + 0.03 \dots\dots\dots (10.7)$$

An example estimation for the running torque of high-speed ball bearings is shown in Fig. 10.2. A comparison of values calculated using these equations and actual measurements is shown in Fig. 10.3. When the contact angle exceeds  $30^\circ$ , the influence of spin friction becomes large, so the running torque given by the equations will be low.

#### Calculation Example

Obtain the running torque of high speed angular contact ball bearing 20BNT02 ( $\phi 20 \times \phi 47 \times 14$ ) under the following conditions:

$n_i = 70\,000 \text{ min}^{-1}$   
 $F_a = 590 \text{ N}$ , {60 kgf}  
 Lubrication: Jet, oil viscosity:  
 10  $\text{mPa} \cdot \text{s}$  {10 cp}  
 oil flow: 1.5  $\text{kg/min}$

From Equation (10.4),

$$\begin{aligned} M_l &= 0.672 \times 10^{-3} D_{pw}^{0.7} F_a^{1.2} \\ &= 0.672 \times 10^{-3} \times 33.5^{0.7} \times 590^{1.2} \\ &= 16.6 \text{ (mN} \cdot \text{m)} \\ M_l &= 1.06 \times 10^{-3} \times 33.5^{0.7} \times 60^{1.2} \\ &= 1.7 \{ \text{kgf} \cdot \text{mm} \} \end{aligned}$$

From Equations (10.6) and (10.7),

$$\begin{aligned} a &= 24 n_i^{-0.37} \\ &= 24 \times 70\,000^{-0.37} = 0.39 \\ b &= 4 \times 10^{-9} n_i^{1.6} + 0.03 \\ &= 4 \times 10^{-9} \times 70\,000^{1.6} + 0.03 = 0.26 \end{aligned}$$

From Equation (10.5),

$$\begin{aligned} M_v &= 3.47 \times 10^{-10} D_{pw}^3 n_i^{1.4} Z_B^a Q^b \\ &= 3.47 \times 10^{-10} \times 33.5^3 \times 70\,000^{1.4} \times 10^{0.39} \times 1.5^{0.26} \\ &= 216 \text{ (mN} \cdot \text{m)} \\ M_v &= 3.54 \times 10^{-11} \times 33.5^3 \times 70\,000^{1.4} \times 10^{0.39} \times 1.5^{0.26} \\ &= 22.0 \{ \text{kgf} \cdot \text{mm} \} \end{aligned}$$

$$\begin{aligned} M &= M_l + M_v = 16.6 + 216 = 232.6 \text{ (mN} \cdot \text{m)} \\ M &= M_l + M_v = 1.7 + 22 = 23.7 \{ \text{kgf} \cdot \text{mm} \} \end{aligned}$$

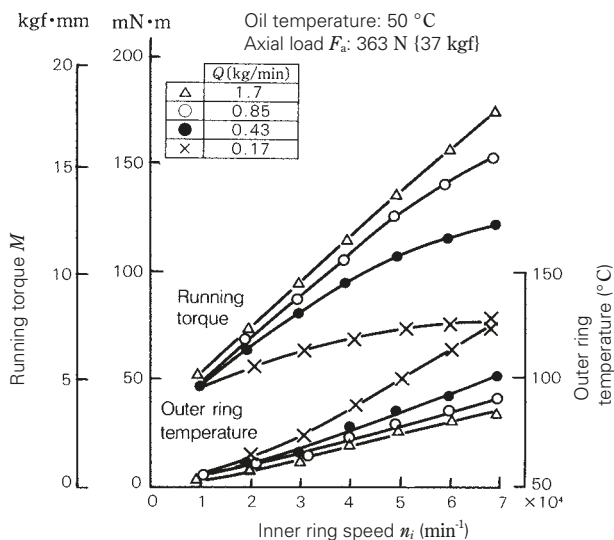


Fig. 10.2 Typical Test Example

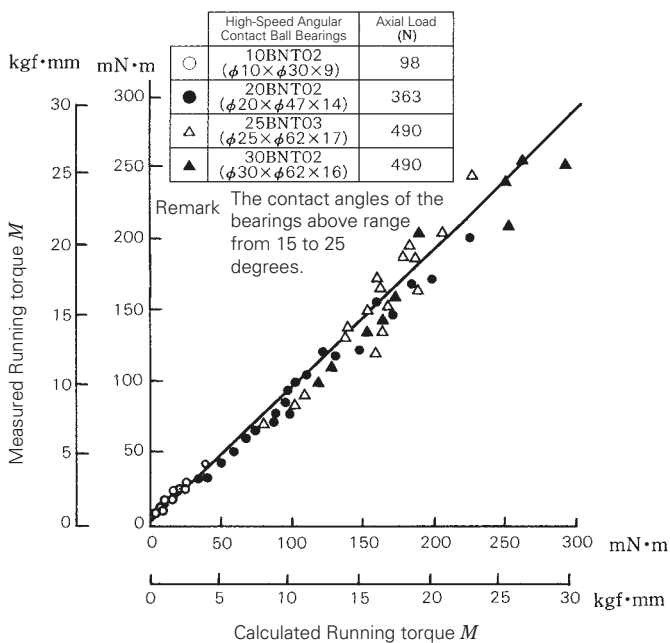


Fig. 10.3 Comparison of Actual Measurements and Calculated Values

### 10.3.3 Preload and Starting Torque for Tapered Roller Bearings

The balance of loads on the bearing rollers when a tapered roller bearing is subjected to axial load  $F_a$  is expressed by the following three Equations:

$$Q_c = \frac{F_a}{Z \sin \alpha} \quad (10.8)$$

$$Q_i = Q_c \cos 2\beta = \frac{\cos 2\beta}{Z \sin \alpha} F_a \quad (10.9)$$

$$Q_t = Q_c \sin 2\beta = \frac{\sin 2\beta}{Z \sin \alpha} F_a \quad (10.10)$$

where  $Q_c$ : Rolling element load on outer ring (N), {kgf}  
 $Q_i$ : Rolling element load on inner ring (N), {kgf}  
 $Q_t$ : Rolling element load on inner ring large end rib, (N), {kgf} (assume  $Q_t \perp Q_i$ )  
 $Z$ : Number of rollers  
 $\alpha$ : Contact angle...one-half included outer ring angle ( $^\circ$ )  
 $\beta$ : One-half the tapered roller angle ( $^\circ$ )  
 $D_{w1}$ : Roller large end diameter (mm) (Fig. 10.4)  
 $e$ : Contact point between roller end and rib (Fig. 10.4)

As represented in Fig. 10.4, when circumferential load  $F$  is applied to the bearing outer ring and the roller turns in the direction of the applied load, the starting torque for contact point  $C$  relative to instantaneous center  $A$  becomes  $e \mu_c Q_i$ .

Therefore, the balance of frictional torque is

$$D_{w1} F = e \mu_c Q_i \text{ (mN} \cdot \text{m)}, \text{ {kgf} \cdot \text{mm}} \quad (10.11)$$

where  $\mu_c$ : Friction coefficient between inner ring large rib and roller end face

Starting torque  $M$  for one bearing is given by

$$M = F Z l$$

$$= \frac{e \mu_c l \sin 2\beta}{D_{w1} \sin \alpha} F_a \quad (10.12)$$

(mN · m), {kgf · mm}

because  $D_{w1} = 2 \overline{OB} \sin \beta$ , and  $l = \overline{OB} \sin \alpha$ .

If we substitute these into Equation (10.12), we obtain

$$M = e \mu_c \cos \beta F_a \text{ (mN} \cdot \text{m)}, \text{ {kgf} \cdot \text{mm}} \quad (10.13)$$

Starting torque  $M$  is sought considering only the slip friction between the roller end and the inner ring large-end rib. However, when the load on a tapered roller bearing reaches or exceeds a certain level (around the preload), the slip friction in the space between the roller end and inner ring large end rib becomes the decisive factor for bearing starting torque, and the torque caused by other factors can be ignored. Values for  $e$  and  $\beta$  in Equation (10.12) are determined by bearing design. Consequently, by assuming a value for  $\mu_c$ , the starting torque can be calculated.

The values for  $\mu_c$  and for  $e$  must be considered as a dispersion; thus, even bearings with the same number can have quite diverse individual starting torques. When using a value for  $e$  determined by the bearing design, the average value for the bearing starting torque can be estimated using  $\mu_c = 0.20$ , which is the average value determined from various test results.

Fig. 10.5 shows the results of calculations for various tapered roller bearing series.

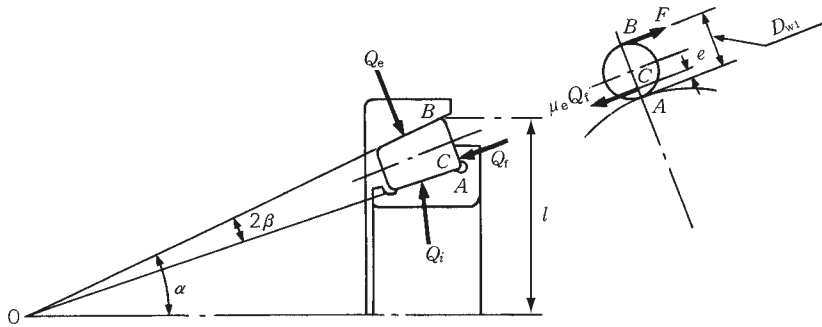


Fig. 10.4

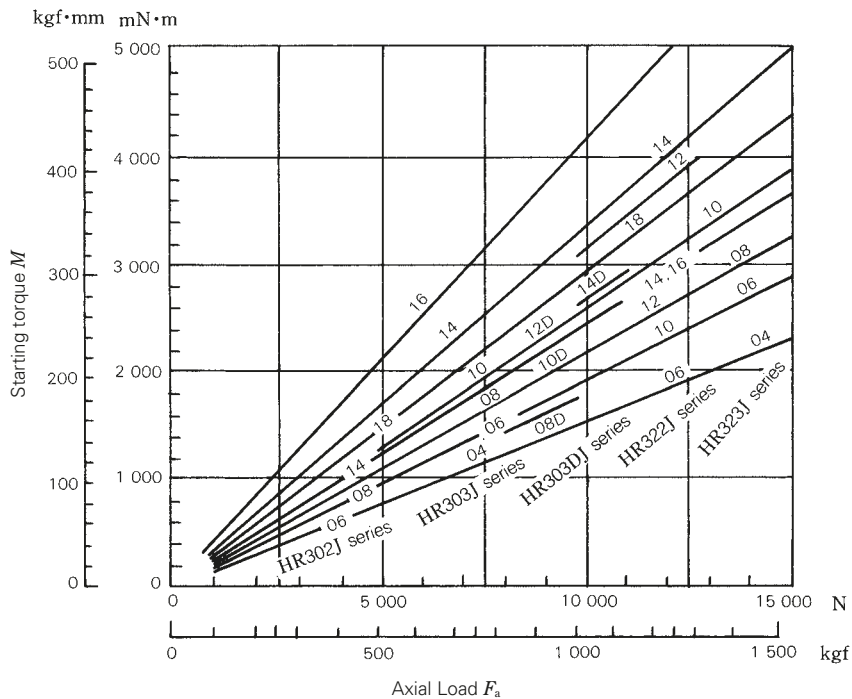


Fig. 10.5 Axial Load and Starting Torque for Tapered Roller Bearings

### 10.3.4 Empirical Equations for Running Torque of Tapered Roller Bearings

When tapered roller bearings operate under axial load, the torque of tapered roller bearings is based on the following two kinds of resistance, which are the major components of friction:

- (1) Rolling resistance (friction) of rollers with outer or inner ring raceways—elastic hysteresis and viscous rolling resistance of EHL
- (2) Sliding friction between inner ring ribs and roller ends.

When an axial load  $F_a$  is applied on tapered roller bearings, the loads shown in Fig. 10.6 are applied on the rollers.

$$Q_e \doteq Q_i = \frac{F_a}{Z \sin \alpha} \dots\dots\dots (10.14)$$

$$Q_i = \frac{F_a \sin 2\beta}{Z \sin \alpha} \dots\dots\dots (10.15)$$

where  $Q_e$ : Rolling element load on outer ring  
 $Q_i$ : Rolling element load on inner ring  
 $Q_i$ : Rolling element load on inner ring large end rib  
 $Z$ : Number of rollers  
 $\alpha$ : Contact angle...One-half included outer ring angle  
 $\beta$ : One-half tapered roller angle

For simplicity, Fig. 10.7 shows a model using the average diameter  $D_w$  along with the following variables:

$M_i, M_e$ : Rolling resistance (moment)  
 $F_{si}, F_{se}, F_{sf}$ : Sliding friction  
 $R_i, R_e$ : Radii at center of inner and outer ring raceways  
 $e$ : Contact height of roller end face with rib

When the balance of sliding friction and moments on the rollers are considered as represented in Fig 10.7, the following equations are obtained:

$$F_{se} - F_{si} = F_{sf} \dots\dots\dots (10.16)$$

$$M_i + M_e = \frac{D_w}{2} F_{se} + \frac{D_w}{2} F_{si} + \left( \frac{D_w}{2} - e \right) F_{sf} \dots\dots\dots (10.17)$$

When the running torque  $M$  applied on the outer (inner) ring is calculated using Equations (10.16) and (10.17) and multiplied by the number of rollers  $Z$ , the following is obtained:

$$\begin{aligned} M &= Z (R_e F_{se} - M_e) \\ &= \frac{Z}{D_w} (R_e M_i + R_i M_e) + \frac{Z}{D_w} R_e e F_{sf} \\ &= M_R + M_S \end{aligned}$$

Therefore, the rolling friction on the raceway surface  $M_R$  and sliding friction on the ribs  $M_S$  are separately obtained.

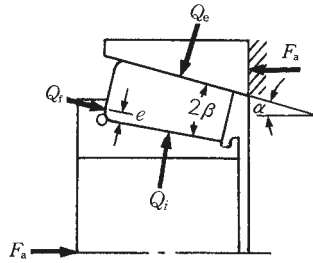


Fig. 10.6 Loads Applied on Roller

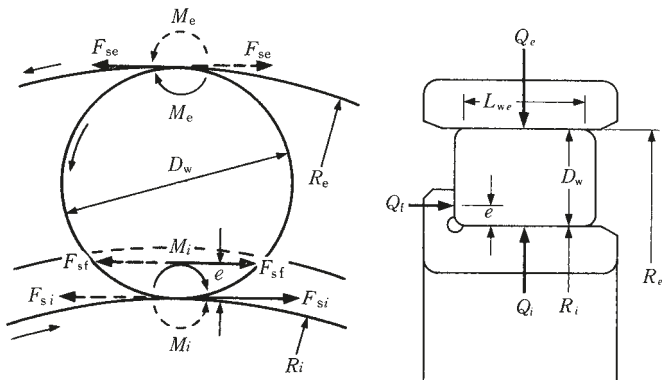


Fig. 10.7 Parts Where Friction is Generated

The running torque  $M$  of a tapered roller bearing can be obtained from the rolling friction on the raceway  $M_R$  and sliding friction on the ribs  $M_S$ .

$$M = M_R + M_S = \frac{Z}{D_w} (R_c M_i + R_i M_e) + \frac{Z}{D_w} R_c e F_{sf} \dots \dots \dots (10.18)$$

## **Sliding Friction on Rib $M_S$**

As a part of  $M_S$ ,  $F_{sf}$  refers to the tangential load caused by sliding, so we can write  $F_{sf} = \mu Q_i$  using the coefficient of dynamic friction  $\mu$ . Further, by substituting in axial load  $F_a$ , the following equation is obtained:

$$M_S = e \mu \cos \beta F_a \dots \dots \dots (10.19)$$

This is identical to the equation for starting torque, but  $\mu$  is not constant and decreases depending on operating conditions and running-in. For this reason, Equation (10.19) can be rewritten as follows:

$$M_S = e \mu_0 \cos \beta F_a f' (A, t, \sigma) \dots \dots \dots (10.20)$$

where  $\mu_0$  is approximately 0.2 and  $f' (A, t, \sigma)$  is a function that decreases with running in and oil film formation but is set equal to one at starting.

## **Rolling Friction on Raceway Surface $M_R$**

Most of the rolling friction on the raceway is from viscous oil resistance (EHL rolling resistance) corresponding to  $M_i$  and  $M_e$  in Equation (10.18). A theoretical equation exists but should be corrected based on the results of experiments. The following equation includes corrective terms:

$$M_{i, e} = \left[ f(w) \left( \frac{1}{1 + 0.29 L^{0.78}} \right) \frac{4.318}{\alpha_0} (G \cdot U)^{0.658} W^{0.0126} R^2 L_{we} \right]_{i, e} \dots \dots \dots (10.21)$$

$$f(w) = \left( \frac{k F_a}{E' D_w L_{we} Z \sin \alpha} \right)^{0.3} \dots \dots \dots (10.22)$$

Therefore,  $M_R$  can be obtained using Equations (10.21) and (10.22) together with the following equation:

$$M_R = \frac{Z}{D_w} (R_c M_i + R_i M_e)$$

## **Running Torque of Bearings $M$**

From these, the running torque of tapered roller bearings  $M$  is given by Equation (10.23).

$$M = \frac{Z}{D_w} (R_c M_i + R_i M_e) + e \mu_0 \cos \beta F_a f' (A, t, \sigma) \dots \dots \dots (10.23)$$

As shown in Figs. 10.8 and 10.9, the values obtained using Equation (10.23) correlate rather well with actual measurements; therefore, estimation of running torque with good accuracy is possible. Please consult NSK with any questions or concerns.

## **[Symbol Definitions]**

$G, W, U$ :	EHL dimensionless parameters
$L$ :	Coefficient of thermal load
$\alpha_0$ :	Pressure coefficient of lubricating oil viscosity
$R$ :	Equivalent radius
$k$ :	Constant
$E'$ :	Equivalent elastic modulus
$\alpha$ :	Contact angle (One-half included outer ring angle)
$R_i, R_e$ :	Inner and outer ring raceway radii (center)
$\beta$ :	Half angle of roller
$i, e$ :	Indication of inner ring or outer ring respectively
$L_{we}$ :	Effective roller length

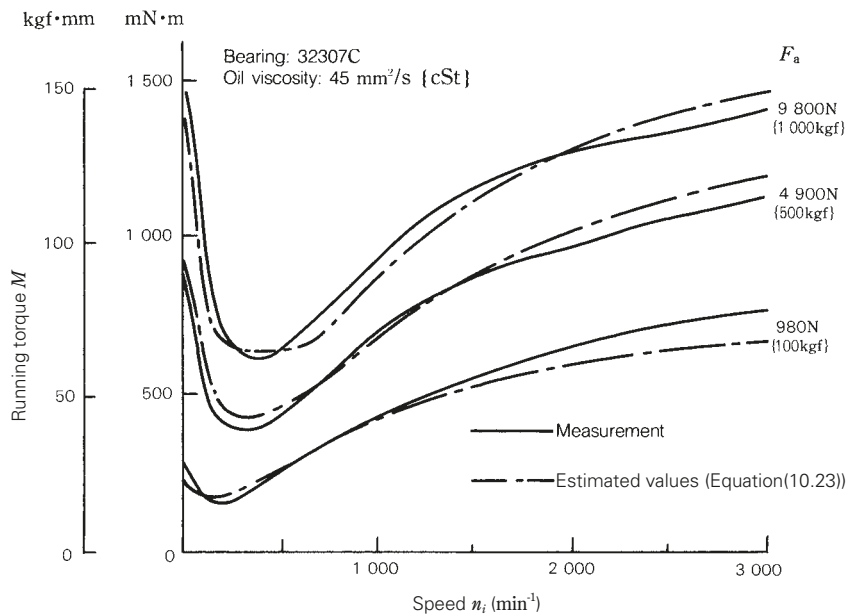


Fig. 10.8 Comparison of Estimated Values With Actual Measurements

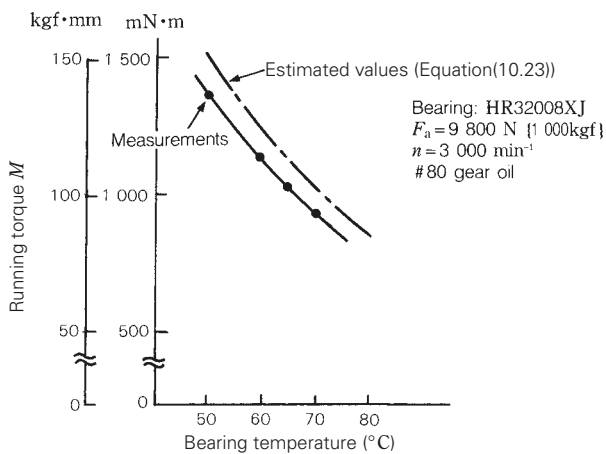


Fig. 10.9 Viscosity Variation and Running Torque



## 11. LUBRICATION

<b>11.1 Purposes of Lubrication</b> .....	A 228
<b>11.2 Lubricating Methods</b> .....	A 228
<b>11.2.1 Grease Lubrication</b> .....	A 228
(1) Grease Quantity .....	A 228
(2) Replacement of Grease .....	A 229
(3) Replenishment Interval .....	A 229
(4) Grease Life of Sealed Ball Bearings .....	A 231
<b>11.2.2 Oil Lubrication</b> .....	A 232
(1) Oil Bath Lubrication .....	A 232
(2) Drip-Feed Lubrication .....	A 232
(3) Splash Lubrication .....	A 232
(4) Circulating Lubrication .....	A 233
(5) Jet Lubrication .....	A 234
(6) Oil Mist Lubrication .....	A 235
(7) Oil/Air Lubricating Method .....	A 235
<b>11.3 Lubricants</b> .....	A 236
<b>11.3.1 Lubricating Grease</b> .....	A 236
(1) Base Oil .....	A 236
(2) Thickener .....	A 236
(3) Additives .....	A 236
(4) Consistency .....	A 236
(5) Mixing Different Types of Grease .....	A 238
<b>11.3.2 Lubricating Oil</b> .....	A 238
<b>11.4 Technical Data</b> .....	A 240
<b>11.4.1 Brands and Properties of Lubricating Greases</b> .....	A 240

# 11. LUBRICATION

## 11.1 Purposes of Lubrication

The main purposes of lubrication are to reduce friction and wear inside the bearings that may cause premature failure. The effects of lubrication may be briefly explained as follows:

### (1) Reduction of Friction and Wear

Direct metallic contact between the basic components of the bearing (bearing rings, rolling elements and cage) is prevented by an oil film that reduces friction and wear in contact areas.

### (2) Extension of Fatigue Life

The rolling fatigue life of bearings depends greatly upon the viscosity and film thickness between the rolling contact surfaces. A heavy film thickness prolongs fatigue life, but life is shortened if the viscosity of the oil is so low that film thickness is insufficient.

### (3) Dissipation of Frictional Heat and Cooling

Circulation lubrication is used to carry away frictional or absorbed heat, prevent the bearing from overheating, and prevent oil from deteriorating.

### (4) Others

Adequate lubrication also helps to prevent foreign material from entering the bearings and guards against corrosion and rusting.

## 11.2 Lubricating Methods

Lubricating methods are first divided into either grease or oil lubrication. Satisfactory bearing performance can be achieved by adopting the lubricating method most suitable for the particular application and operating condition.

In general, oil offers superior lubrication; however, grease lubrication allows for a simpler structure around the bearings. A comparison of grease and oil lubrication is given in Table 11.1.

**Table 11.1 Comparison of Grease and Oil Lubrication**

Item	Grease Lubrication	Oil Lubrication
Housing Structure and Sealing Method	Simple	May be complex. Careful maintenance required
Speed	Limiting speed 65% to 80% that of oil lubrication.	Higher limiting speed
Cooling Effect	Poor	Heat transfer possible using forced oil circulation.
Fluidity	Poor	Good
Full Lubricant Replacement	Sometimes difficult	Compactly easy
Removal of Foreign Matter	Removal of particles from grease is impossible.	Easy
External Contamination Due to Leakage	Surroundings seldom contaminated by leakage.	Often leaks without proper countermeasures. Not suitable if external contamination must be avoided.

### 11.2.1 Grease Lubrication

#### (1) Grease Quantity

The quantity of grease to be packed in a housing depends on the housing design and free space, grease characteristics, and ambient temperature. For example, bearings for main shafts of machine tools where the accuracy may be impaired by a small temperature rise require only a small amount of grease.

Sufficient grease must be packed inside the bearing including the cage guide face. The amount to be packed inside the housing depends on the speed of the application:

When bearing speed is 50% or less of the specified limiting speed, fill 1/2 to 2/3 of the free space.

When bearing speed is 50% or more of the specified limiting speed, fill 1/3 to 1/2 of the free space.

## (2) Replacement of Grease

Grease, once packed, usually need not be replenished for a long time; however, under severe operating conditions, grease should be frequently replenished or replaced. In such cases, the bearing housing should be designed to facilitate grease replenishment and replacement.

When replenishment intervals are short, provide replenishment and discharge ports at appropriate positions so that deteriorated grease is replaced by fresh grease. For example, the housing space on the grease-supply side can be divided into several sections with partitions. The grease on the partitioned side gradually passes through the bearings and old grease forced from the bearing is discharged through a grease valve (Fig. 11.1). If a grease valve is not used, the

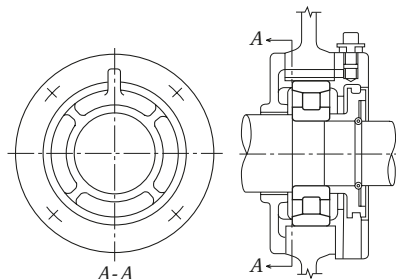


Fig. 11.1 Combination of Partitioned Grease Reservoir and Grease Valve

space on the discharge side must be larger than the partitioned side so that it can retain old grease, which can be removed periodically by removing the cover.

## (3) Replenishment Interval

Even if high-quality grease is used, grease deterioration occurs with time; therefore, periodic replenishment is required. Graphs (1) and (2) in Fig 11.2 show the replenishment time intervals for various bearing types running at different speeds. These graphs show high-quality, lithium-soap mineral oil grease at a bearing temperature of 70 °C under normal load ( $P/C=0.1$ ).

### · Temperature

If the bearing temperature exceeds 70 °C, reduce the replenishment interval by half for every 15 °C increase.

### · Grease

Replenishment intervals can be extended depending on used grease type, especially for ball bearings. For example, high-quality lithium-soap synthetic oil grease may roughly doubles the replenishment interval shown in Fig.11.2 (1). If the temperature of the bearings is less than 70 °C, the usage of lithium-soap mineral oil grease or lithium-soap synthetic oil grease is appropriate.

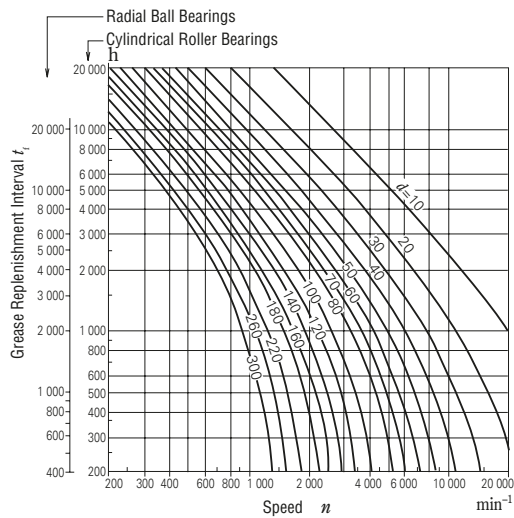
Please consult NSK for details.

### · Load

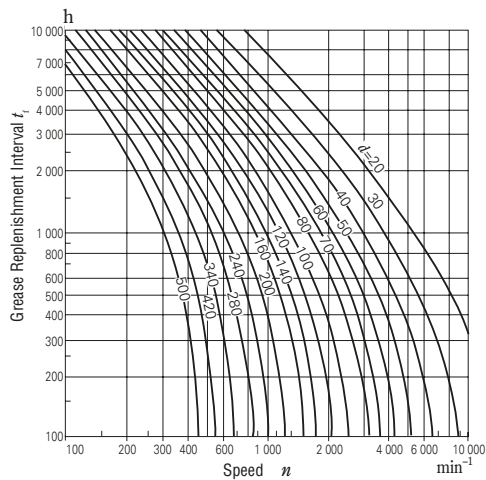
The replenishment interval depends on the magnitude of the bearing load.

Please refer to Fig.11.2 (3) for details.

If  $P/C$  exceeds 0.16, please consult NSK.



(1) Radial Ball Bearings, Cylindrical Roller Bearings



(2) Tapered Roller Bearings, Spherical Roller Bearings

(3) Load factor

$P/C$	$\leq 0.06$	0.1	0.13	0.16
Load factor	1.5	1	0.65	0.45

Fig. 11.2 Grease Replenishment Intervals

#### (4) Grease Life of Sealed Ball Bearings

When grease is packed into single-row deep groove ball bearings, the grease life may be estimated using Equation (11.1), Equation (11.2), or Fig. 11.3:  
(General purpose grease <sup>(1)</sup>)

$$\log t = 6.54 - 2.6 \frac{n}{N_{\max}} - \left(0.025 - 0.012 \frac{n}{N_{\max}}\right) T \quad \text{.....(11.1)}$$

(Wide-range grease <sup>(2)</sup>)

$$\log t = 6.12 - 1.4 \frac{n}{N_{\max}} - \left(0.018 - 0.006 \frac{n}{N_{\max}}\right) T \quad \text{.....(11.2)}$$

where  $t$ : Average grease life (h)

$n$ : Speed ( $\text{min}^{-1}$ )

$N_{\max}$ : Limiting speed with grease lubrication ( $\text{min}^{-1}$ )

(values for ZZ and VV types are listed in the bearing tables)

$T$ : Operating temperature  $^{\circ}\text{C}$

Equation (11.1), Equation (11.2), and Fig. 11.3 apply under the following conditions:

(a) Speed  $n$

$$0.25 \leq \frac{n}{N_{\max}} \leq 1$$

$$\text{when } \frac{n}{N_{\max}} < 0.25, \text{ assume } \frac{n}{N_{\max}} = 0.25$$

(b) Operating Temperature  $T$

For general-purpose grease <sup>(1)</sup>

$$70^{\circ}\text{C} \leq T \leq 110^{\circ}\text{C}$$

For wide-range grease <sup>(2)</sup>

$$70^{\circ}\text{C} \leq T \leq 130^{\circ}\text{C}$$

When  $T < 70^{\circ}\text{C}$  assume  $T = 70^{\circ}\text{C}$

(c) Bearing Loads

The bearing loads should be about 1/10 or less the basic load rating  $C_r$ .

**Notes** <sup>(1)</sup> Mineral-oil base greases (e.g. lithium-soap base grease) often used around  $-10$  to  $110^{\circ}\text{C}$ .

<sup>(2)</sup> Synthetic-oil base greases are usable over a wide temperature range around  $-40$  to  $130^{\circ}\text{C}$ .

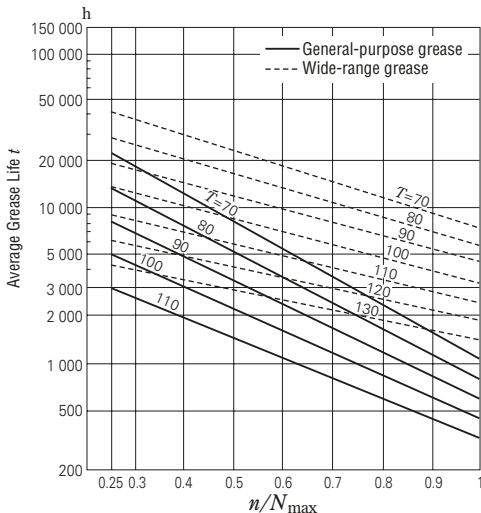


Fig. 11.3 Grease Life of Sealed Ball Bearings

### 11.2.2 Oil Lubrication

#### (1) *Oil-Bath Lubrication*

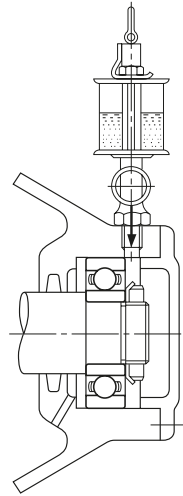
Oil-bath lubrication is widely used with low or medium speeds. The oil level should be at the center of the lowest rolling element. Ideally, provide a sight gauge so the proper oil level may be maintained (Fig. 11.4)

#### (2) *Drip-Feed Lubrication*

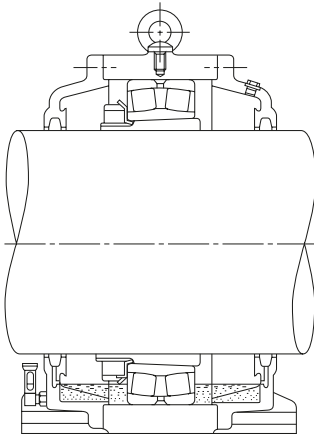
Drip-feed lubrication is widely used for small ball bearings operated at relatively high speeds. As shown in Fig. 11.5, oil is stored in a visible oiler. The oil drip rate is controlled with a screw in the top.

#### (3) *Splash Lubrication*

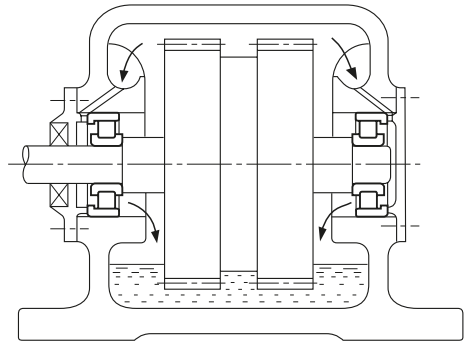
With this method, oil is splashed onto the bearings by gears or a simple rotating disc installed near bearings without submerging the bearings in oil. It is commonly used in automobile transmissions and final drive gears. Fig. 11.6 shows this lubricating method used on a reduction gear.



**Fig. 11.5 Drip-Feed Lubrication**



**Fig. 11.4 Oil-Bath Lubrication**



**Fig. 11.6 Splash Lubrication**

#### (4) *Circulating Lubrication*

Circulating lubrication is commonly used for high-speed operation requiring bearing cooling and for bearings used at high temperatures. As shown in Fig. 11.7 (a), oil is supplied by a pipe on the right side. The oil travels through the bearing and drains out through a pipe on the left. After being cooled in a reservoir, the oil returns to the bearing through a pump and filter. The oil discharge pipe should be larger than the supply pipe so that excessive oil does not back up in the housing.

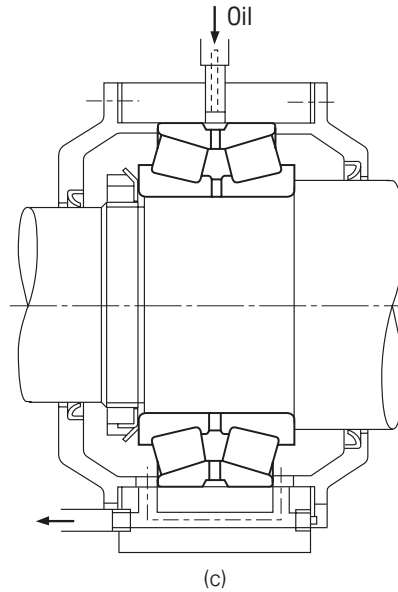
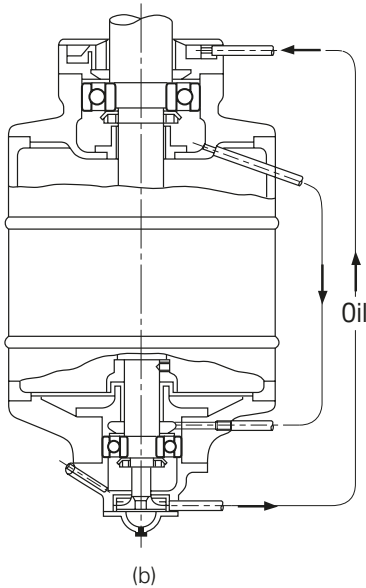
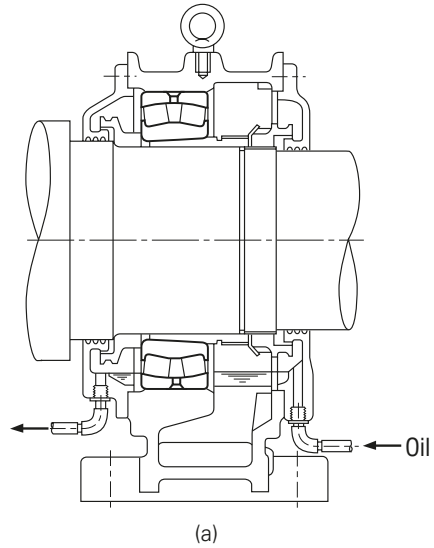


Fig. 11.7 Circulating Lubrication

### (5) Jet Lubrication

Jet lubrication is often used for ultra-high-speed bearings with a  $d_m n$  value ( $d_m$ : pitch diameter of rolling element set in mm;  $n$ : rotational speed in  $\text{min}^{-1}$ ) exceeding one million, such as the bearings in jet engines. Lubricating oil is sprayed under pressure from one or more nozzles directly into the bearing.

Fig. 11.8 shows an example of ordinary jet lubrication. The lubricating oil is sprayed on the inner ring and cage guide face. In high-speed operation, the air surrounding the bearing rotates with it, causing the oil jet to be deflected. The jetting speed of the oil from the nozzle should be more than 20 % of the circumferential speed of the inner ring outer surface, or cage guide face.

More uniform cooling and a better temperature distribution is achieved using more nozzles for a given amount of oil. The oil should be forcibly discharged so that the agitating resistance of the lubricant can be reduced and the oil can effectively carry away the heat.

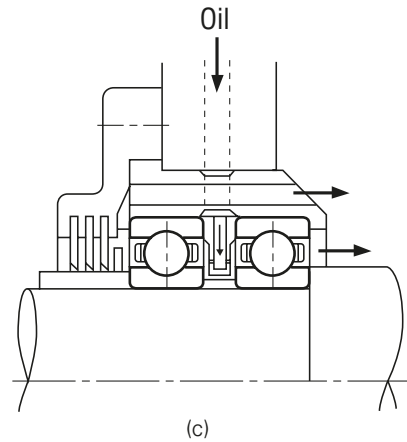
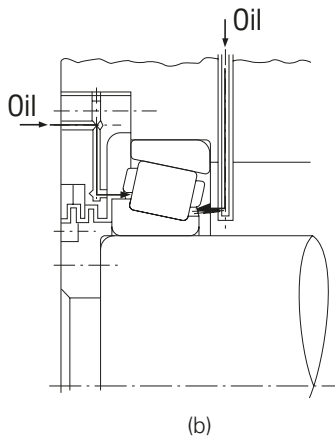
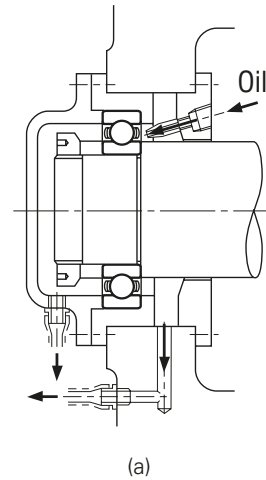


Fig. 11.8 Jet Lubrication

### (6) Oil-Mist Lubrication

Oil-mist lubrication, or oil fog lubrication, utilizes an oil mist sprayed into a bearing. This method has the following advantages:

(a) Because of the small quantity of oil required, the oil agitation resistance is small, and higher speeds are possible.

(b) Contamination of the vicinity around the bearing is limited because the oil leakage is small.

(c) It is relatively easy to continuously supply fresh oil; therefore, bearing life is extended.

This lubricating method is used for bearings in the high-speed spindles of machine tools, high-speed pumps, roll necks of rolling mills, and so on (see example in Fig. 11.9).

Please consult NSK regarding oil-mist lubrication of large bearings.

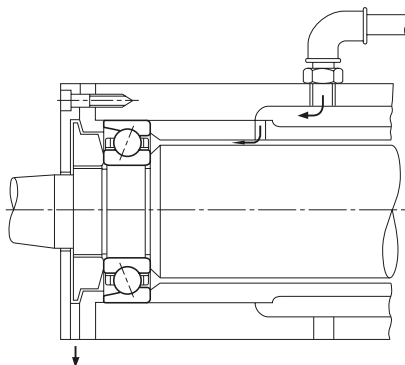


Fig. 11.9 Oil-Mist Lubrication

### (7) Oil-Air Lubricating Method

With the oil-air lubricating method, a very small amount of oil is discharged intermittently by a constant-quantity piston into a pipe carrying a constant flow of compressed air. The oil flows along the wall of the pipe and approaches a constant flow rate.

The major advantages of oil-air lubrication are as follows:

(a) The minimum necessary amount of oil is supplied, making this method suitable for high speeds because less heat is generated.

(b) Since oil is fed continuously, bearing temperature remains stable. Also, because of the small amount of oil, there is almost no atmospheric pollution.

(c) Only fresh oil is fed to the bearings, so oil deterioration need not be considered.

(d) Compressed air is constantly fed to the bearings and keeps internal pressure high. This prevents the entry of dust, cutting fluid, etc.

For these reasons, this method is used in the main spindles of machine tools and other high speed-applications (see example in Fig. 11.10).

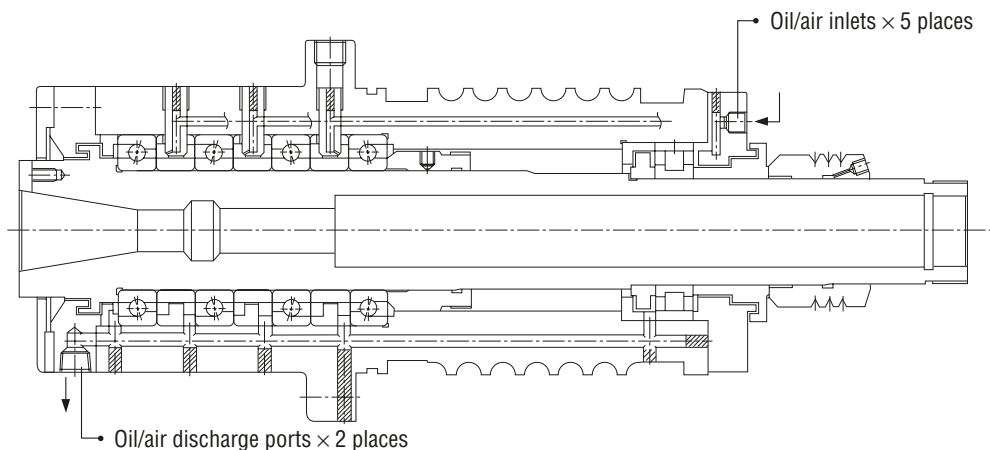


Fig. 11.10 Oil-Air Lubrication

## 11.3 Lubricants

### 11.3.1 Lubricating Grease

Grease is a semisolid lubricant consisting of base oil, a thickener, and additives. The main types and general properties of grease are shown in Table 11.2. Note that different brands of the same type of grease may have different properties.

#### (1) Base Oil

Mineral oils or synthetic oils, such as silicone or diester oil, are often used as the base oil for grease. The lubricating properties of grease depend mainly on the characteristics of its base oil. Therefore, the viscosity of the base oil is just as important when selecting grease as when selecting an oil. Usually, grease made with low viscosity base oils is more suitable for high speeds and low temperatures, while grease made with high viscosity base oils is more suited for high temperatures and heavy loads.

However, the thickener also influences the lubricating properties of grease; therefore, the selection criteria for grease is not the same as for lubricating oil. Moreover, please be aware that ester-based grease will cause acrylic rubber material to swell, and that silicone-based grease will cause silicone-based material to swell.

#### (2) Thickener

Thickeners for lubricating grease include several types of metallic soaps, inorganic thickeners such as silica gel and bentonite, and heat resisting organic thickeners such as polyurea and fluorine compounds.

The type of thickener is closely related to the grease dropping point <sup>(1)</sup>; generally, grease with a high dropping point also has a high temperature capability during operation. However, this type of grease does not have a high working temperature unless the base oil is heat-resistant. The highest possible working temperature for grease should be determined considering the heat resistance of the base oil.

The water resistance of grease depends upon the type of thickener. Sodium-soap grease or compound grease containing sodium soap emulsifies when exposed to water or high humidity and therefore cannot be used where moisture is prevalent. Moreover, note that urea-based grease will cause fluorine-based material to deteriorate.

**Note** <sup>(1)</sup> The grease dropping point is that temperature at which a grease heated in a specified small container becomes sufficiently fluid to drip.

**Table 11.2**

<div> <div>Name (Popular Name)</div> <div>Thickener</div> <div>Base Oil</div> <div>Properties</div> </div>	Lithium Grease		
	Li Soap		
	Mineral Oil	Diester Oil, Polyatomic Ester Oil	Silicone Oil
Dropping Point, °C	170 to 195	170 to 195	200 to 210
Working Temperatures, °C	-20 to +110	-50 to +130	-50 to +160
Working Speed, % <sup>(1)</sup>	70	100	60
Mechanical Stability	Good	Good	Good
Pressure Resistance	Fair	Fair	Poor
Water Resistance	Good	Good	Good
Rust Prevention	Good	Good	Poor
Remarks	General-purpose grease used for numerous applications	Good low-temperature and torque characteristics. Often used for small motors and instrument bearings. Monitor for rust caused by insulation varnish.	Mainly used for high temperature applications. Unsuitable for bearings at high and low speeds, under heavy loads, or with numerous sliding-contact areas (roller bearings, etc.)

**Note** <sup>(1)</sup> The values listed are percentages of the limiting speeds given in the bearing tables.

#### (3) Additives

Grease often contains various additives such as antioxidants, corrosion inhibitors, and extreme pressure additives to give it special properties. Extreme pressure additives are recommended for heavy load applications. For long use without replenishment, an antioxidant should be added.

#### (4) Consistency

Consistency indicates the “softness” of grease. Table 11.3 shows the relation between consistency and operating conditions.

## Grease Properties

	Sodium Grease (Fiber Grease)	Calcium Grease (Cup Grease)	Mixed Base Grease	Complex Base Grease (Complex Grease)	Non-Soap Base Grease (Non-Soap Grease)	
	Na Soap	Ca Soap	Na + Ca Soap, Li + Ca Soap, etc.	Ca Complex Soap, Al Complex Soap, Li Complex Soap, etc.	Urea, Bentonite, Carbon Black, Fluoric Compounds, Heat Resistant Organic Compound, etc.	
	Mineral Oil	Mineral Oil	Mineral Oil	Mineral Oil	Mineral Oil	Synthetic Oil (Ester Oil, Polyatomic Ester Oil, Synthetic Hydrocarbon Oil, Silicone Oil, Fluoric Base Oil)
	170 to 210 -20 to +130 70 Good Fair Poor Poor to Good	70 to 90 -20 to +60 40 Poor Poor Good Good	160 to 190 -20 to +80 70 Good Fair to Good Poor for Na Soap Grease Fair to Good	180 to 300 -20 to +130 70 Good Fair to Good Good Fair to Good	> 230 -10 to +130 70 Good Fair Good Fair to Good	> 230 < +220 40 to 100 Good Fair Good Fair to Good
	Long-and-short- fiber types are available. Long- fiber grease is unsuitable for high speeds. Monitor for water and high temperatures.	Extreme-pressure grease containing high viscosity mineral oil and extreme pressure additives (Pb soap, etc.) with high pressure resistance.	Often used for roller bearings and large ball bearings.	Suitable for extreme pressures mechanically stable	Mineral oil base grease is used for medium to high temperatures. Synthetic-oil base grease is recommended for low or high temperatures. Some silicone and fluoric oil base grease have poor rust prevention and noise characteristics.	

**Remark** The grease properties shown here can vary between brands.

Table 11.3 Consistency and Working Conditions

Consistency Number	0	1	2	3	4
Consistency <sup>(1)</sup> 1/10 mm	355 to 385	310 to 340	265 to 295	220 to 250	175 to 205
Working Conditions (Application)	·For centralized oiling ·When fretting is likely to occur	·For centralized oiling ·When fretting is likely to occur ·For low temperatures	·For general use ·For sealed ball bearings	·For general use ·For sealed ball bearings ·For high temperatures	·For high temperatures ·For grease seals

**Note** <sup>(1)</sup> Consistency: The depth to which a cone descends into grease when a specified weight is applied, indicated in units of 1/10 mm. The larger the value, the softer the grease.

### (5) *Mixing Different Types of Grease*

In general, different brands of grease must not be mixed. Mixing grease with different types of thickeners may destroy its composition and physical properties. Even if thickeners are of the same type, possible differences in the additive may cause detrimental effects.

### 11.3.2 Lubricating Oil

The lubricating oils used for rolling bearings are usually highly refined mineral oils or synthetic oils that have a high oil-film strength and superior oxidation and corrosion resistance. When selecting a lubricating oil, the viscosity during operation is important. If the viscosity is too low, a proper oil film does not form and abnormal wear and seizure may occur. On the other hand, if the viscosity is too high, excessive viscous resistance may cause heating or energy loss. In general, low viscosity oils should be used at high speed; however, the viscosity should increase with

increasing bearing load and size.

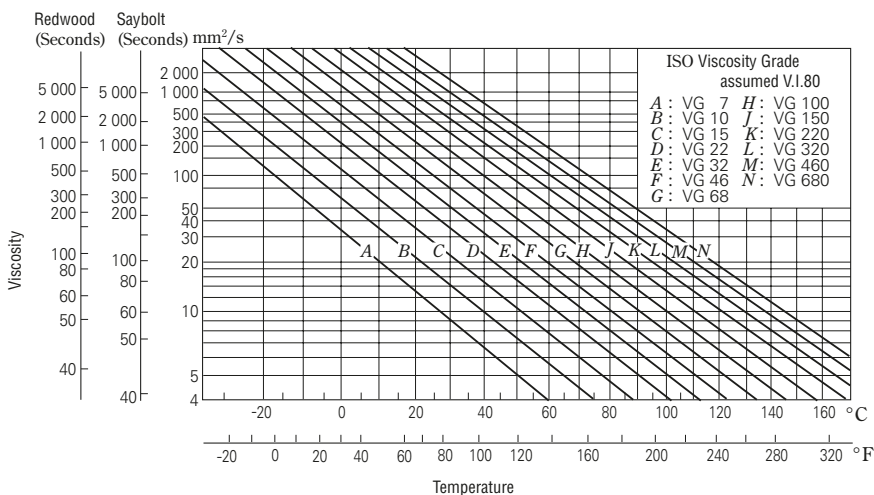
Table 11.4 gives generally recommended viscosities for bearings under normal operating conditions.

Fig. 11.11 shows the relationship between oil temperature and viscosity, and selected lubricating oils are shown in Table 11.5.

**Table 11. 4 Bearing Types and Proper Viscosity of Lubricating Oils**

Bearing Type	Proper Viscosity at Operating Temperature
Ball Bearings and Cylindrical Roller Bearings	Higher than 13mm <sup>2</sup> /s
Tapered Roller Bearings and Spherical Roller Bearings	Higher than 20mm <sup>2</sup> /s
Spherical Thrust Roller Bearings	Higher than 32mm <sup>2</sup> /s

**Remark** 1mm<sup>2</sup>/s=1cSt (centistokes)



**Fig. 11.11 Temperature-Viscosity Chart**

### Oil Replacement Intervals

Oil replacement intervals depend on operating conditions and oil quantity.

In cases where the operating temperature is less than 50 °C and environmental conditions are good with little dust, the oil should be replaced approximately once a year. However, in cases where the oil temperature is near 100 °C, the oil must be changed at least once every three months.

If moisture may enter or if foreign matter may be mixed in the oil, then the oil replacement interval must be shortened.

Do not mix different brands of oil as, like grease, their composition and physical properties may be negatively affected.

**Table 11. 5 Examples of Selection Lubricating Oils**

Operating Temperature	Speed	Light or Normal Load	Heavy or Shock Load
-30 to 0 °C	Less than limiting speed	ISO VG 15, 22, 32 (refrigerating machine oil)	—
0 to 50 °C	Less than 50% of limiting speed	ISO VG 32, 46, 68 (bearing oil, turbine oil)	ISO VG 46, 68, 100 (bearing oil, turbine oil)
	50 to 100% of limiting speed	ISO VG 15, 22, 32 (bearing oil, turbine oil)	ISO VG 22, 32, 46 (bearing oil, turbine oil)
	More than limiting speed	ISO VG 10, 15, 22 (bearing oil)	—
50 to 80 °C	Less than 50% of limiting speed	ISO VG 100, 150, 220 (bearings oil)	ISO VG 150, 220, 320 (bearing oil)
	50 to 100% of limiting speed	ISO VG 46, 68, 100 (bearing oil, turbine oil)	ISO VG 68, 100, 150 (bearing oil, turbine oil)
	More than limiting speed	ISO VG 32, 46, 68 (bearing oil, turbine oil)	—
80 to 110 °C	Less than 50% of limiting speed	ISO VG 320, 460 (bearing oil)	ISO VG 460, 680 (bearing oil, gear oil)
	50 to 100% of limiting speed	ISO VG 150, 220 (bearing oil)	ISO VG 220, 320 (bearing oil)
	More than limiting speed	ISO VG 68, 100 (bearing oil, turbine oil)	—

- Remarks**
1. Use the values listed in the bearing tables for limiting speeds.
  2. Refer to Refrigerating Machine Oils (JIS K 2211), Bearing Oils (JIS K 2239), Turbine Oils (JIS K 2213), and Gear Oils (JIS K 2219) for more information.
  3. If the operating temperature is near the high end of the temperature range listed in the left column, select a high-viscosity oil.
  4. If the operating temperature is lower than -30 °C or higher than 110 °C, please consult NSK.

## 11.4 Technical Data

### 11.4.1 Brands and Properties of Lubricating Grease

**Table 11.6 Brands of**

Brand	Thickener	Base Oil(s)	
EA3 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
EA5 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
EA6 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
EA7 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
EA9 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
ENS GREASE	Urea <sup>(2)</sup>	Polyol ester oil <sup>(4)</sup>	
ECE GREASE	Lithium	Poly- $\alpha$ -olefin oil	
DOW CORNING(R) SH 44 M GREASE	Lithium	Silicone oil <sup>(5)</sup>	
NS HI-LUBE	Lithium	Ester oil + Diester oil <sup>(4)</sup>	
LG2 GREASE	Lithium	Poly- $\alpha$ -olefin oil + Mineral oil	
LGU GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
EMALUBE 8030	Urea <sup>(2)</sup>	Mineral oil	
KP1 GREASE	PTFE	Perfluoropolyether oil	
SHELL ALVANIA GREASE S2	Lithium	Mineral oil	
SHELL ALVANIA GREASE S3	Lithium	Mineral oil	
SHELL SUNLIGHT GREASE 2	Lithium	Mineral oil	
WPH GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
NIGLUBE RSH	Sodium Complex	Glycol oil	
PALMAX RBG	Lithium Complex	Mineral oil	
MULTEMP PS No.2	Lithium	Poly- $\alpha$ -olefin oil + Diester oil <sup>(4)</sup>	
MOLYKOTE(R) FS-3451GREASE	PTFE	Fluorosilicone oil <sup>(5)</sup>	
UME GREASE	Urea <sup>(2)</sup>	Mineral oil	
RW1 GREASE	Urea <sup>(2)</sup>	Mineral oil	
HA1 GREASE	Urea <sup>(2)</sup>	Ether oil	
HA2 GREASE	Urea <sup>(2)</sup>	Ether + Poly- $\alpha$ -olefin oil	
KLUBERSYNTH HB 72-52	Urea <sup>(2)</sup>	Ester oil <sup>(4)</sup>	
NOXLUB KF0921	PTFE	Perfluoropolyether oil	
ECH GREASE	Carbon Black	Perfluoropolyether oil	
FWG GREASE	Urea <sup>(2)</sup>	Mineral oil + Poly- $\alpha$ -olefin oil	
HT1 GREASE	Urea <sup>(2)</sup>	Poly- $\alpha$ -olefin oil	
ARAPEN RB320	Lithium-Calcium	Mineral oil	
SHELL GADUSRAIL S4 HIGH SPEED EUFR	Lithium	Mineral oil	

- Notes**
- <sup>(1)</sup> If grease will be used at the upper or lower limit of the temperature range or in a special environment such as a vacuum, please consult NSK.
  - <sup>(2)</sup> For short-term operation or when adequate cooling is provided, grease may be used at speeds exceeding the above limits provided the supply of grease is appropriate.
  - <sup>(3)</sup> Urea-based grease causes fluorine-based material to deteriorate.
  - <sup>(4)</sup> Ester-based grease causes acrylic rubber material to swell.
  - <sup>(5)</sup> Silicone-based grease causes silicone-based material to swell.

## Lubricating Grease

Dropping Point (°C)	Consistency	Working Temperature Range <sup>(1)</sup> (°C)	Pressure Resistance	Usable Limit Compared to Listed Limiting Speed (Grease) <sup>(2)</sup> (%)
≥ 260	230	-40 to +150	Fair	100
≥ 260	251	-40 to +160	Good	60
≥ 260	220	-40 to +160	Fair	70
≥ 260	243	-40 to +160	Fair	100
≥ 260	314	-40 to +140	Fair	100
≥ 260	264	-40 to +160	Poor	100
≥ 260	235	-10 to +120	Poor	100
210	260	-30 to +130	Poor	60
192	250	-40 to +130	Poor	100
201	199	-20 to +70	Poor	100
≥ 260	201	-40 to +120	Fair	70
≥ 260	280	0 to +130	Good	60
Not applicable	290	-30 to +200	Fair	60
181	275	-10 to +110	Fair	70
182	242	-10 to +110	Fair	70
200	274	-10 to +110	Fair	70
259	240	-40 to +150	Fair	70
≥ 260	270	-20 to +140	Fair	60
216	300	-10 to +130	Good	70
190	275	-50 to +110	Poor	100
Not applicable	285	0 to +180	Fair	70
≥ 260	272	-10 to +130	Fair	70
≥ 260	300	-10 to +130	Fair	70
≥ 260	290	-40 to +160	Fair	70
≥ 260	295	-30 to +170	Fair	70
250	295	-30 to +160	Fair	70
Not applicable	280	-40 to +200	Fair	70
Not applicable	205	-30 to +260	Fair	60
≥ 260	268	-30 to +150	Fair	70
≥ 260	236	-40 to +150	Fair	100
177	305	-10 to +80	Fair	70
188	266	-10 to +110	Fair	100



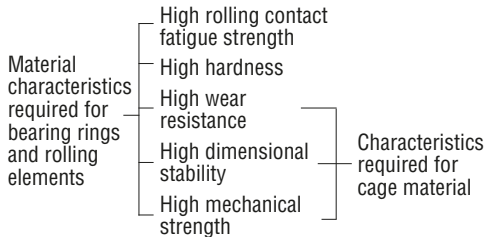
## 12. BEARING MATERIALS

<b>12.1</b>	<b>Materials for Bearing Rings and Rolling Elements</b>	..... A 244
<b>12.2</b>	<b>Cage Materials</b>	..... A 245
<b>12.3</b>	<b>Characteristics of Bearing, Shaft, and Housing Materials</b>	..... A 246
<b>12.4</b>	<b>Technical Data</b>	..... A 248
<b>12.4.1</b>	<b>Comparison of National Standards of Rolling Bearing Steel</b>	..... A 248
<b>12.4.2</b>	<b>Long-Life Bearing Steel (NSK Z Steel)</b>	..... A 250
<b>12.4.3</b>	<b>Dimensional Stability of Bearing Steel</b>	..... A 252
<b>12.4.4</b>	<b>Fatigue Analysis</b>	..... A 254
	(1) Measurement of Fatigue Degree	..... A 254
	(2) Surface and Subsurface Fatigue	..... A 256
<b>12.4.5</b>	<b>Hi-TF Bearings and Super-TF Bearings</b>	..... A 258
	(1) Hi-TF Bearings, Super-TF Bearings, and TF Technology	..... A 258
	(2) TF Technology	..... A 258
	(3) Material Properties of Hi-TF Bearings and Super-TF Bearings	..... A 259
	(4) Service Life Under Contaminated Lubrication Conditions	..... A 260
	(5) Service Life Under Clean Lubrication Conditions	..... A 260
	(6) Service Life Under Boundary Lubrication Conditions	..... A 261
	(7) Wear and Seizure Resistance	..... A 261
	(8) Heat Resistance	..... A 261
<b>12.4.6</b>	<b>Physical Properties of Representative Polymers Used as Bearing Material</b>	..... A 262
<b>12.4.7</b>	<b>Characteristics of Nylon Material for Cages</b>	..... A 264
<b>12.4.8</b>	<b>Heat-Resistant Resin Materials for Cages</b>	..... A 266

## 12. BEARING MATERIALS

Bearing rings and rolling elements of rolling bearings are subjected to repetitive high pressure with a small amount of sliding. Tension, compression, and sliding contact with the rolling elements and either or both of the bearing rings impact the cage.

Therefore, the materials used for the rings, rolling elements, and cages require the following characteristics:



Other necessary characteristics, such as ease of production, shock and heat resistance, and corrosion resistance, are required depending on individual applications.

### 12.1 Materials for Bearing Rings and Rolling Elements

Primarily, high-carbon-chromium bearing steel (Table 12.1) is used for the bearing rings and rolling elements. Most NSK bearings are made of SUJ2 steel, while larger bearings generally use SUJ3 (additional types are listed in Table 12.1). The chemical composition of SUJ2 is approximately the same as AISI 52100, DIN 100 Cr6, and BS 535A99.

Bearings subjected to very severe shock loads often utilize carburized low-carbon alloy steels such as chrome steel, chrome-molybdenum steel, nickel-chrome-molybdenum steel, etc. Such steels, when they are carburized to the proper depth and have sufficient surface hardness, are more shock-resistant than normal, through-hardened bearing steels because of their softer energy-absorbing core. The chemical composition of common carburized bearing steels is listed in Table 12.2.

**Table 12.1 Chemical Composition of High-Carbon-Chromium Bearing Steel (Major Elements)**

Standard	Designation	Chemical Composition (%)						
		C	Si	Mn	P	S	Cr	Mo
JIS G 4805	SUJ 2	0.95 to 1.10	0.15 to 0.35	Less than 0.50	Less than 0.025	Less than 0.025	1.30 to 1.60	—
	SUJ 3	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	Less than 0.025	Less than 0.025	0.90 to 1.20	—
	SUJ 4	0.95 to 1.10	0.15 to 0.35	Less than 0.50	Less than 0.025	Less than 0.025	1.30 to 1.60	0.10 to 0.25
ASTM A 295	52100	0.93 to 1.05	0.15 to 0.35	0.25 to 0.45	Less than 0.025	Less than 0.015	1.35 to 1.60	Less than 0.10

**Table 12.2 Chemical Composition of Carburizing Bearing Steels (Major Elements)**

Standard	Designation	Chemical Composition (%)							
		C	Si	Mn	P	S	Ni	Cr	Mo
JIS G 4052	SCr 420 H	0.17 to 0.23	0.15 to 0.35	0.55 to 0.95	Less than 0.030	Less than 0.030	Less than 0.25	0.85 to 1.25	—
	SCM 420 H	0.17 to 0.23	0.15 to 0.35	0.55 to 0.95	Less than 0.030	Less than 0.030	Less than 0.25	0.85 to 1.25	0.15 to 0.35
	SNCM 220 H	0.17 to 0.23	0.15 to 0.35	0.60 to 0.95	Less than 0.030	Less than 0.030	0.35 to 0.75	0.35 to 0.65	0.15 to 0.30
	SNCM 420 H	0.17 to 0.23	0.15 to 0.35	0.40 to 0.70	Less than 0.030	Less than 0.030	1.55 to 2.00	0.35 to 0.65	0.15 to 0.30
JIS G 4053	SNCM 815	0.12 to 0.18	0.15 to 0.35	0.30 to 0.60	Less than 0.030	Less than 0.030	4.00 to 4.50	0.70 to 1.00	0.15 to 0.30
ASTM A 534	8620 H	0.17 to 0.23	0.15 to 0.35	0.60 to 0.95	Less than 0.025	Less than 0.015	0.35 to 0.75	0.35 to 0.65	0.15 to 0.25
	4320 H	0.17 to 0.23	0.15 to 0.35	0.40 to 0.70	Less than 0.025	Less than 0.015	1.55 to 2.00	0.35 to 0.65	0.20 to 0.30
	9310 H	0.07 to 0.13	0.15 to 0.35	0.40 to 0.70	Less than 0.025	Less than 0.015	2.95 to 3.55	1.00 to 1.40	0.08 to 0.15

**Table 12.3 Chemical Composition of High-Speed Steel for Bearings Used at High Temperatures**

Standard	Designation	Chemical Composition (%)											
		C	Si	Mn	P	S	Cr	Mo	V	Ni	Cu	Co	W
AISI	M50	0.77 to 0.85	Less than 0.25	Less than 0.35	Less than 0.015	Less than 0.015	3.75 to 4.25	4.00 to 4.50	0.90 to 1.10	Less than 0.10	Less than 0.10	Less than 0.25	Less than 0.25

NSK uses highly pure vacuum-degassed bearing steel containing minimal oxygen, nitrogen, and hydrogen compound impurities. The rolling fatigue life of bearings has been remarkably improved using this material combined with the appropriate heat treatment. For special-purpose bearings, high-temperature bearing steel, which has superior heat resistance, and stainless steel with good corrosion resistance may be used. The chemical composition of these special materials are given in Tables 12.3 and 12.4.

## 12.2 Cage Materials

The main types of low carbon steels used for pressed cages are shown in Table 12.5. Depending on the application, brass or stainless steel may be used. For machined cages, high-strength brass (Table 12.6) or carbon steel (Table 12.5) is used. Synthetic resin is also sometimes used.

**Table 12.4 Chemical Composition of Stainless Steel for Rolling Bearing (Major Elements)**

Standard	Designation	Chemical Composition (%)						
		C	Si	Mn	P	S	Cr	Mo
JIS G 4303	SUS 440 C	0.95 to 1.20	Less than 1.00	Less than 1.00	Less than 0.040	Less than 0.030	16.00 to 18.00	Less than 0.75
SAE J 405	51440 C	0.95 to 1.20	Less than 1.00	Less than 1.00	Less than 0.040	Less than 0.030	16.00 to 18.00	Less than 0.75

**Table 12.5 Chemical Composition of Steel Sheet and Carbon Steel for Cages (Major Elements)**

Classification	Standard	Designation	Chemical Composition (%)				
			C	Si	Mn	P	S
Steel sheet and strip for pressed cages	JIS G 3141	SPCC	Less than 0.12	—	Less than 0.50	Less than 0.04	Less than 0.045
	BAS 361	SPB 2	0.13 to 0.20	Less than 0.30	0.25 to 0.60	Less than 0.03	Less than 0.030
	JIS G 3311	S 50 CM	0.47 to 0.53	0.15 to 0.35	0.60 to 0.90	Less than 0.03	Less than 0.035
Carbon steel for machined cages	JIS G 4051	S 25 C	0.22 to 0.28	0.15 to 0.35	0.30 to 0.60	Less than 0.03	Less than 0.035

**Remark** BAS refers to the Japanese Bearing Association Standard.

**Table 12.6 Chemical Composition of High-Strength Brass for Machined Cages**

Standard	Designation	Chemical Composition (%)							
		Cu	Zn	Mn	Fe	Al	Sn	Ni	Impurities
									Pb Si
JIS H 5120	CAC301 (HBsC 1)	55.0 to 60.0	33.0 to 42.0	0.1 to 1.5	0.5 to 1.5	0.5 to 1.5	Less than 1.0	Less than 1.0	Less than 0.4 Less than 0.1
JIS H 3250	C 6782	56.0 to 60.5	Residual	0.5 to 2.5	0.1 to 1.0	0.2 to 2.0	—	—	Less than 0.5 —

**Remark** Improved HBsC 1 is also used.

## 12.3 Characteristics of Bearing, Shaft, and Housing Materials

Rolling bearings must be able to support high loads, run at high speeds, and endure long periods of operation. It is also important to know the material characteristics of the shaft and housing to maximize bearing performance. Physical and mechanical properties of typical bearing, shaft, and housing materials are shown in Table 12.7.

	Material	Heat Treatment
Bearing	SUJ2	Quenching, tempering
	SUJ2	Spheroidizing annealing
	SCr420	Quenching, low temp tempering
	SAE4320 (SNCM420)	Quenching, low temp tempering
	SNCM815	Quenching, low temp tempering
	SUS440C	Quenching, low temp tempering
	SPCC	Annealing
	S25C	Annealing
Shaft	CAC301 (HB-C1)	—
	S45C	Quenching, 650 °C tempering
	SCr430	Quenching, 520 to 620 °C fast cooling
	SCr440	Quenching, 520 to 620 °C fast cooling
	SCM420	Quenching, 150 to 200 °C air cooling
	SNCM439	Quenching, 650 °C tempering
	SC46	Normalizing
Housing	SUS420J2	1 038 °C oil cooling, 400 °C air cooling
	FC200	Casting
	FCD400	Casting
	A1100	Annealing
	AC4C	Casting
	ADC10	Casting
	SUS304	Annealing

**Note** \* JIS standard or reference value.

\*\* Though the Rockwell C scale is generally

**Remark** Proportional limits of SUJ2 and SCr420

Table 12.7 Physical and Mechanical Properties of Bearing, Shaft, and Housing Materials

	Density g/cm <sup>3</sup>	Specific Heat kJ/(kg·K)	Thermal Conduc- tivity W/(m·K)	Electric Resistance μΩ·cm	Linear Expansion Coeff. (0 to 100 °C) × 10 <sup>-6</sup> /°C	Young's Modulus MPa (kgf/mm <sup>2</sup> )	Yield Point MPa (kgf/mm <sup>2</sup> )	Tensile Strength MPa (kgf/mm <sup>2</sup> )	Elong- ation %	Hardness HB	Remarks
	7.83	0.47	46	22	12.5	208 000 (21 200)	1 370 (140)	1 570 to 1 960 (160 to 200)	0.5 Max.	650 to 740	High-carbon- chrome bearing steel No. 2
	7.86				11.9		420 (43)	647 (66)	27	180	
	7.83		48	21	12.8		882 (90)	1 225 (125)	15	370	Chrome steel
			44	20	11.7		902 (92)	1 009 (103)	16	**293 to 375	Nickel- chrome- molybde- num steel
			7.89	40	35		—	—	*1 080 (110) Min.	*12 Min.	*311 to 375
	7.68	0.46	24	60	10.1	200 000 (20 400)	1 860 (190)	1 960 (200)	—	**580	Martensitic stainless steel
	7.86	0.47	59	15	11.6	206 000 (21 000)	—	*275 (28) Min.	*32 Min.	—	Cold rolled steel plate
		0.48	50	17	11.8		323 (33)	431 (44)	33	120	Carbon steel for machine structures
	8.5	0.38	123	6.2	19.1	103 000 (10 500)	—	*431 (44) Min.	*20 Min.	—	High-tension brass
	7.83	0.48	47	18	12.8	207 000 (21 100)	440 (45)	735 (75)	25	217	Carbon steel for machine structures
				22	12.5	208 000 (21 100)	*637 (65) Min.	*784 (80) Min.	*18 Min.	*229 to 293	Chrome steel
			45	23			*784 (80) Min.	*930 (95) Min.	*13 Min.	*269 to 331	
		0.47	48	21	12.8		—	*930 (95) Min.	*14 Min.	*262 to 352	Chrome- molybde- num steel
			38	30	11.3	207 000 (21 100)	920 (94)	1 030 (105)	18	320	Nickel- chrome- molybde- num steel
	—	—	—	—	—	206 000 (21 000)	294 (30)	520 (53)	27	143	Low-carbon cast steel
	7.75	0.46	22	55	10.4	200 000 (20 400)	1 440 (147)	1 650 (168)	10	400	Martensitic stainless steel
	7.3	0.50	43	—		98 000 (10 000)	—	*200 (20) Min.	—	*217 Max.	Gray cast iron
	7.0	0.48	20	—	11.7	169 000 (17 200)	*250 (26) Min.	*400 (41) Min.	*12 Min.	*201 Max.	Spheroidal graphite cast iron
	2.69	0.90	222	3.0	23.7	70 600 (7 200)	34 (3.5)	78 (8)	35	—	Pure aluminum
	2.68	0.88	151	4.2	21.5	72 000 (7 350)	88 (9)	167 (17)	7	—	Aluminum alloy for sand casting
	2.74	0.96	96	7.5	22.0	71 000 (7 240)	167 (17)	323 (33)	4	—	Aluminum alloy for die casting
	8.03	0.50	15	72	15.7 to 16.8	193 000 (19 700)	245 (25)	588 (60)	60	150	Austenitic stainless steel

used, Brinell hardness is shown for comparison.  
are 833 MPa (85 kgf/mm<sup>2</sup>) and 440 MPa (45 kgf/mm<sup>2</sup>) respectively.

## 12.4 Technical Data

### 12.4.1 Comparison of National Standards of Rolling Bearing Steel

The Dimension Series of rolling bearings as mechanical elements have been standardized internationally, and the material to be used for them specified in ISO 683/17 *Heat-treated steels, alloy steels, and free-cutting steels--Part 17: Ball and roller bearing steels*. However, materials are also standardized according to the standards of individual countries and, in some cases, manufacturer modifications.

As internationalization continues, more references to these steel standards will be made. Some applicable standards and their features are described and compared in Tables 12.8 and 12.9.

Table 12.8

JIS G 4805	ASTM	Other Major National Standards
SUJ2	—	—
—	A 295-89 52100	—
—	—	100Cr6 (DIN)
—	—	100C6 (NF)
—	—	535A99 (BS)
SUJ3	—	—
—	A 485-03 Grade 1	—
—	A 485-03 Grade 2	—
SUJ4	—	—
SUJ5	—	—
—	A 485-03 Grade 3	—

**Note** \*1:  $P \leq 0.025$ ,  $S \leq 0.025$

**Remark** ASTM: Standard of American Society

JIS G 4052 G 4053	ASTM A 534-90	
		C
SCr420H	—	0.17 to 0.23
—	5120H	0.17 to 0.23
SCM420H	—	0.17 to 0.23
—	4118H	0.17 to 0.23
SNCM220H	—	0.17 to 0.23
—	8620H	0.17 to 0.23
SNCM420H	—	0.17 to 0.23
—	4320H	0.17 to 0.23
SNCM815	—	0.12 to 0.18
—	9310H	0.07 to 0.13

**Note** \*2:  $P \leq 0.030$ ,  $S \leq 0.030$  \*3:  $P \leq 0.025$ ,  $S \leq 0.015$

**Applicable National Standards and Chemical Composition of High-Carbon-Chrome Bearing Steel**

	Chemical Composition (%)						Application	Remarks
	C	Si	Mn	Cr	Mo	Others		
	0.95 to 1.10	0.15 to 0.35	≤0.50	1.30 to 1.60	≤0.08	*1	Typical steel for small- and medium-size bearings	Equivalent to each other though there are slight differences in the ranges.
	0.93 to 1.05	0.15 to 0.35	0.25 to 0.45	1.35 to 1.60	≤0.10	P≤0.025 S≤0.015		
	0.90 to 1.05	0.15 to 0.35	0.25 to 0.40	1.40 to 1.65	—	—		
	0.95 to 1.10	0.15 to 0.35	0.20 to 0.40	1.35 to 1.60	≤0.08	P≤0.030 S≤0.025		
	0.95 to 1.10	0.10 to 0.35	0.40 to 0.70	1.20 to 1.60	—	*1		
	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	0.90 to 1.20	≤0.08	*1	For large-size bearings	SUJ3 is equivalent to Grade 1. Grade 2 has better quenching capability
	0.90 to 1.05	0.45 to 0.75	0.90 to 1.20	0.90 to 1.20	≤0.10	P≤0.025 S≤0.015		
	0.85 to 1.00	0.50 to 0.80	1.40 to 1.70	1.40 to 1.80	≤0.10	P≤0.025 S≤0.015		
	0.95 to 1.10	0.15 to 0.35	≤0.50	1.30 to 1.60	0.10 to 0.25	*1	Rarely used	Better quenching capability than SUJ2
	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	0.90 to 1.20	0.10 to 0.25	*1	For extra large bearings and thin-walled bearings	Though Grade 3 is equivalent to SUJ5, quenching capability of Grade 3 is better than SUJ5.
	0.95 to 1.10	0.15 to 0.35	0.65 to 0.90	1.10 to 1.50	0.20 to 0.30	P≤0.025 S≤0.015		

of Testing Materials, DIN: German Standard, NF: French Standard, BS: British Standard

**Table 12.9 JIS and ASTM Standards and Chemical Composition of Carburizing Bearing Steel**

	Chemical Composition (%)						Application	Remarks
	Si	Mn	Ni	Cr	Mo	Others		
	0.15 to 0.35	0.55 to 0.95	≤0.25	0.85 to 1.25	—	*2	For small bearings	Similar steel type
	0.15 to 0.35	0.60 to 1.00	—	0.60 to 1.00	—	*3		
	0.15 to 0.35	0.55 to 0.95	≤0.25	0.85 to 1.25	0.15 to 0.35	*2	For small bearings	Similar steel type, though quenching capability of 4118H is inferior to SCM420H
	0.15 to 0.35	0.60 to 1.00	—	0.30 to 0.70	0.08 to 0.15	*3		
	0.15 to 0.35	0.60 to 0.95	0.35 to 0.75	0.35 to 0.65	0.15 to 0.30	*2	For small bearings	Equivalent, though there are slight differences
	0.15 to 0.35	0.60 to 0.95	0.35 to 0.75	0.35 to 0.65	0.15 to 0.25	*3		
	0.15 to 0.35	0.40 to 0.70	1.55 to 2.00	0.35 to 0.65	0.15 to 0.30	*2	For medium bearings	Equivalent, though there are slight differences
	0.15 to 0.35	0.40 to 0.70	1.55 to 2.00	0.35 to 0.65	0.20 to 0.30	*3		
	0.15 to 0.35	0.30 to 0.60	4.00 to 4.50	0.70 to 1.00	0.15 to 0.30	*2	For large bearings	Similar steel type
	0.15 to 0.35	0.40 to 0.70	2.95 to 3.55	1.00 to 1.45	0.08 to 0.15	*3		

## 12.4.2 Long-Life Bearing Steel (NSK Z Steel)

The rolling fatigue life of high-carbon chrome bearing steel (SUJ2, SAE52100) used for rolling bearings is greatly affected by non-metallic inclusions. Non-metallic inclusions are roughly divided into three-types: sulfide, oxide, and nitride. A long-term life test showed that oxide non-metallic inclusions exert a particularly adverse effect on rolling fatigue life.

Fig. 12.1 shows the parameter (oxygen content) indicating the amount of oxide non-metallic inclusions as it relates to life.

The oxygen amount in steel was minimized as much as possible by reducing impurities (Ti, S) substantially, thereby achieving a decrease in oxide non-metallic inclusions. The resulting long-life steel is known as Z steel. Z steel is an achievement of improved steelmaking facilities and operating conditions made possible by cooperation with steel makers using data from numerous life tests. A graph of the oxygen content in steel over the last 25 years is shown in Fig. 12.2.

The results of a life test with the sample materials in Fig. 12.2 are shown in Fig. 12.3. Life tends to become longer with decreasing oxygen content in steel. High-quality Z steel has a life span which is about 1.8 times longer than that of conventional degassed steel.

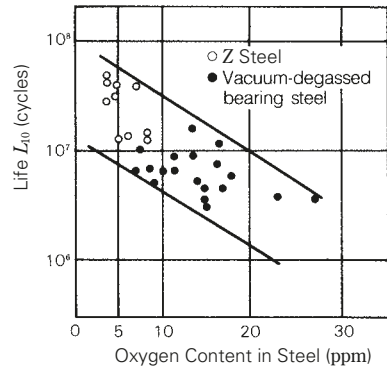


Fig. 12.1 Oxygen Content in Steel and Life of Bearing Steel

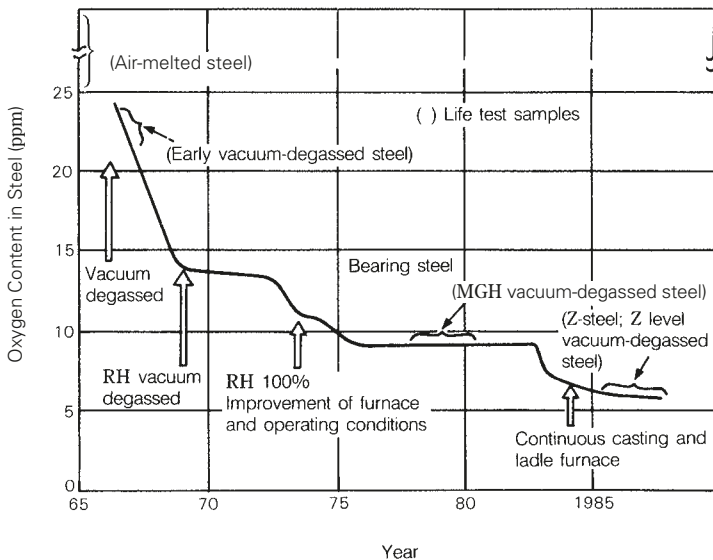
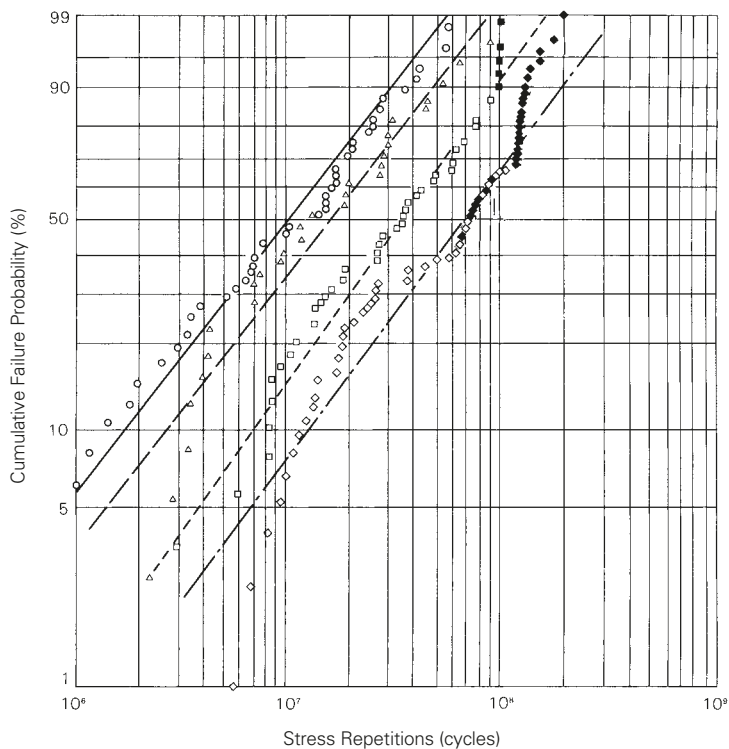


Fig. 12.2 Change in Oxygen Content of NSK Bearing Steels



Classification	Test quantity	Failed quantity	Weibull slope	$L_{10}$	$L_{50}$
○ Air-melted steel	44	44	1.02	$1.67 \times 10^6$	$1.06 \times 10^7$
△ Vacuum-degassed steel	30	30	1.10	$2.82 \times 10^6$	$1.55 \times 10^7$
□ MGH vacuum-degassed steel	46	41	1.16	$6.92 \times 10^6$	$3.47 \times 10^7$
◇ Z steel	70	39	1.11	$1.26 \times 10^7$	$6.89 \times 10^7$

**Remark** Testing of bearings marked with ■ and ◆ had not yet completed.

**Fig. 12.3 Bearing Steel Life Test Results**

## 12.4.3 Dimensional Stability of Bearing Steel

Sectional changes or changes in the dimensions of rolling bearings over time is called aging deformation. When the inner ring develops expansion due to such deformation, there is a resulting decrease in the interference between the shaft and inner ring. This becomes one of the causes of inner ring creep. Creep (a phenomenon where the shaft and inner ring slip mutually) causes the bearing to generate excess heat that may result in seizure, resulting in critical damage to the entire machine. Consequently, appropriate measures must be taken against aging deformation of the bearing depending on the application.

Aging deformation of bearings may be attributed to secular thermal decomposition of retained austenite in steel after heat treatment. The bearing develops gradual expansion along with phase transformation.

The dimensional stability of the bearings, therefore, varies in accordance with the relative relationship between tempering during heat treatment and the bearing's operating temperature. Dimensional stability increases with rising tempering temperature while retained austenite decomposition gradually expands as the bearing's operating temperature rises.

Fig. 12.4 shows how temperature influences the bearing's dimensional stability. The right side of the figure shows the interference between the inner ring and shaft for various shaft tolerance classes as percentages of the shaft diameter. As is evident from Fig. 12.4, dimensional stability becomes more unfavorable as the bearing's temperature rises. Under these conditions, the interference between the shaft and inner ring of a general bearing is expected to decrease gradually. In this view, loosening of the fit surface must be prevented by using a bearing that has undergone a dimensional stabilization treatment.

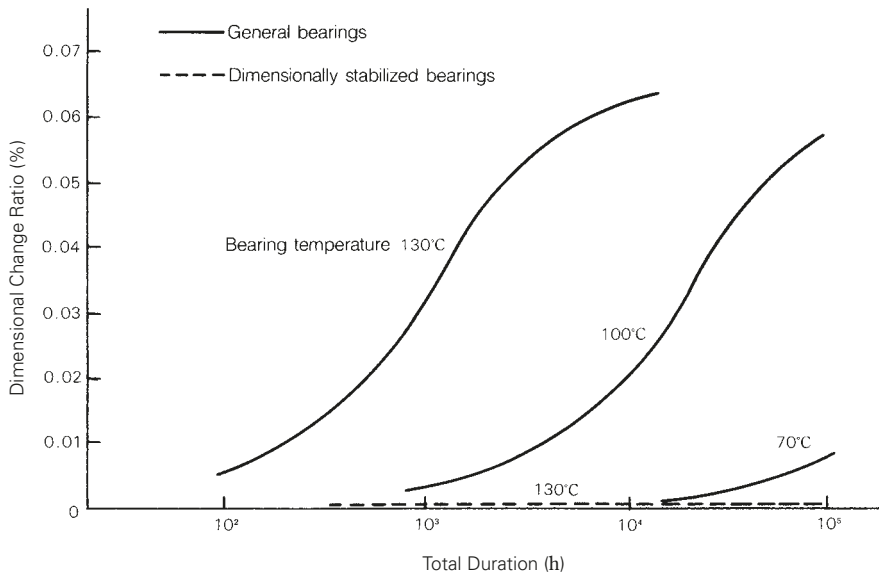
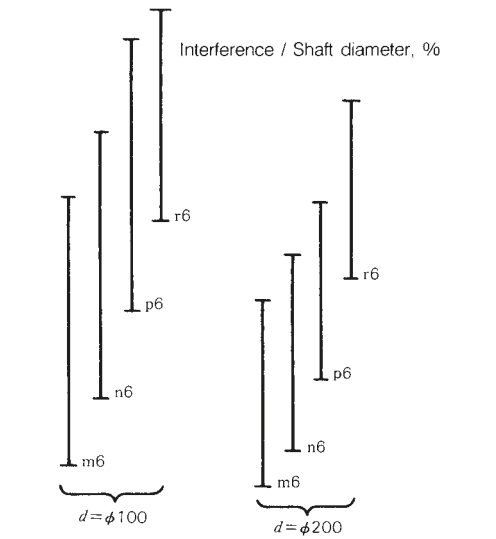


Fig. 12.4 Bearing Temperature and Dimensional Change Ratio

When bearing temperature is high, there is a possibility of inner ring creep. Please contact NSK beforehand in order to select an appropriate bearing.



## 12.4.4 Fatigue Analysis

In order to fully predict the fatigue life of rolling bearings and estimate residual life, knowledge of all fatigue breakdown phenomena of bearings is essential. Unfortunately, this means it will take some time before we reach a stage enabling perfect prediction and estimation. However, rolling fatigue proceeds under compressive stress at the contact point and is known to cause material changes until breakdown occurs. In many cases, it is possible to estimate the degree of fatigue in bearings by detecting this material change. However, this estimation method is not effective in cases where defects in the raceway surface cause premature cracking or where chemical corrosion occurs on the raceway. In these two cases, flaking progresses ahead of material change.

### (1) *Measurement of Fatigue Degree*

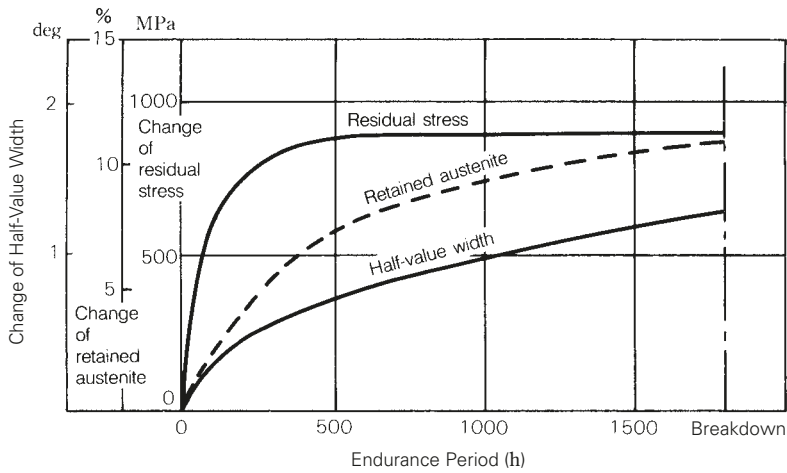
The progress of fatigue in a bearing can be determined by using an X-ray to measure changes in residual stress, diffraction half-value width, and amount of retained austenite.

These values change as fatigue progresses as shown in Fig. 12.5. As residual stress grows early and approaches a saturation value, it can be used to detect extremely small fatigue. For large fatigue, change of the diffraction half-value width and retained austenite amount correlate with the progress of fatigue. These measurements are consolidated into one parameter (fatigue index) to determine a relationship with the endurance test period of a bearing.

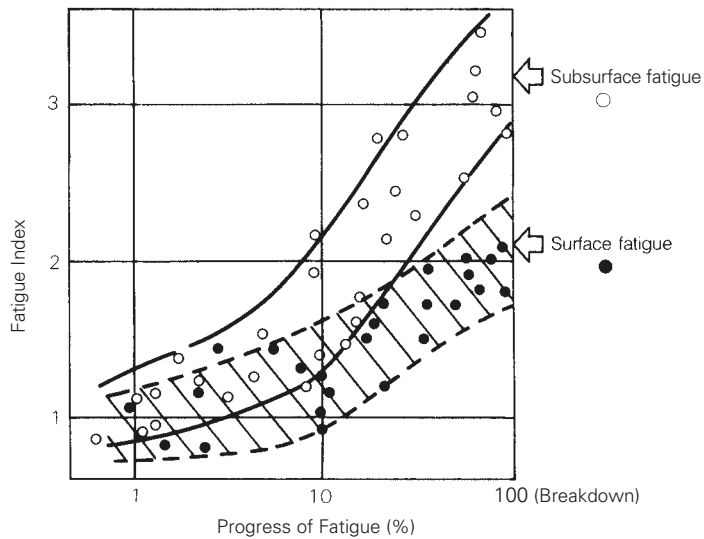
Measured values were collected by carrying out endurance tests with many ball, tapered roller, and cylindrical roller bearings under various loads and lubrication conditions. Simultaneously, measurements were made on bearings used in actual machines.

Fig. 12.6 summarizes the data. Variance is considerable, reflecting the complexity of fatigue. Nevertheless, there is a correlation between the fatigue index and the endurance test period or operating hours. The degree of fatigue can be handled quantitatively, albeit with some uncertainty.

The description of “subsurface fatigue” in Fig. 12.6 applies when fatigue is governed by internal shearing stress. On the other hand, “surface fatigue” is correlated with earlier and more severe fatigue resulting from contamination or breakdown of the lubricating oil film.



**Fig. 12.5 Change in X-Ray Measurements**



**Fig. 12.6 Fatigue Progress and Fatigue Index**

**(2) Surface and Subsurface Fatigue**

Rolling bearings have an extremely smooth finish surface and enjoy relatively satisfactory lubrication conditions. Generally, internal shearing stress below the rolling surface governs the failure of a bearing.

When shearing stress caused by rolling contact reaches a maximum level at a certain depth below the surface, a crack (the origin of a breakdown) occurs under the surface. When the raceway is broken due to such subsurface fatigue, the fatigue index measured by depth increases according to the theoretical calculation of shearing stress, as evident from the example ball bearing shown in Fig. 12.7. The fatigue pattern shown in Fig. 12.7 usually occurs when lubrication conditions are satisfactory and a sufficiently thick oil film is present at rolling contact points. The basic dynamic load rating described in this catalog is determined using data from bearing failures according to the above internal fatigue pattern. Fig. 12.8 shows an example cylindrical roller bearing with an unsatisfactory oil film subjected to an endurance test. It is evident that the amount of surface fatigue increases much earlier than indicated by the calculated life.

In this test, all bearings failed before subsurface fatigue became apparent. Thus, bearing failure due to surface fatigue is mostly attributed to lubrication conditions such as insufficient oil film due to excessively low oil viscosity or entry of foreign material or moisture into the lubricant.

Therefore, bearing failure induced by surface fatigue occurs before that of subsurface fatigue in most bearing applications, even though subsurface fatigue is the metric used to determine the original life.

Fatigue analysis has shown that bearings used in actual machines overwhelmingly show the surface fatigue pattern of failure instead of the subsurface pattern.

Knowing the distribution of the fatigue index of bearings in use leads to an increased understanding of residual life, lubrication, and load conditions.

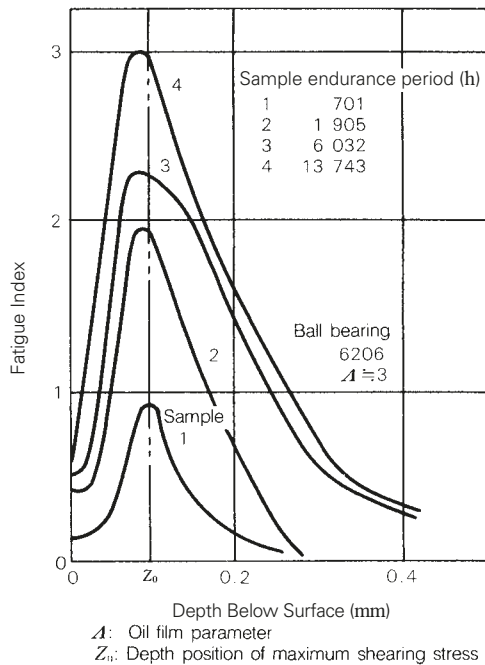


Fig. 12.7 Progress of Subsurface Fatigue

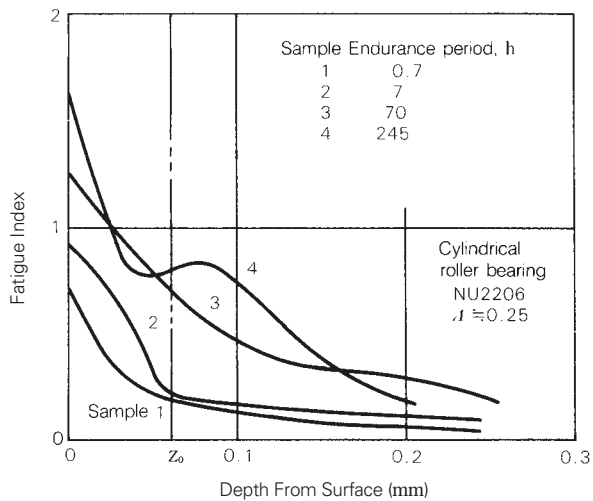


Fig. 12.8 Progress of Surface Fatigue

## 12.4.5 Hi-TF Bearings and Super-TF Bearings

### (1) Hi-TF Bearings, Super-TF Bearings, and TF Technology

In its quest for longer bearing service life, NSK has spent many years analyzing the mechanisms of fatigue in bearings, researching and developing materials and heat treatment processes, and optimizing for operating conditions. The range of approaches to achieving longer service life taken by our research team is shown in Fig. 12.9. Technology incorporated in our Hi-TF bearings and Super-TF bearings is designed to maximize service life under conditions where bearings are subject to surface-originated flaking.

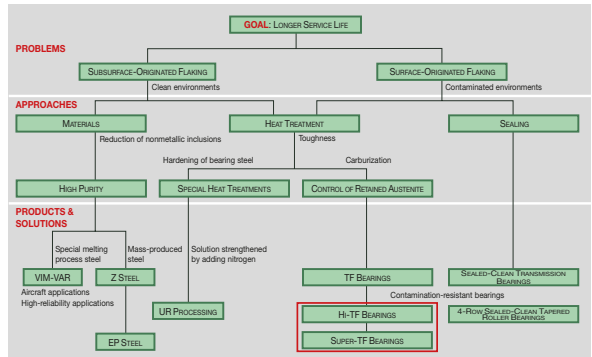


Fig. 12.9 Approaches to Achieving Longer Service Life in Bearings

### (2) TF Technology

Bearings may be required to operate under clean or dirty conditions; under dirty conditions, their lubricating oil is easily contaminated. Metal particles or casting sand in the lubricating oil make dents in the contact surfaces. As shown in Fig. 12.10, stress is concentrated around these dents and eventually leads to cracking and to surface-originated flaking. The concentration of stress around a dent is expressed by the equation  $[P/P_0 \propto (r/c)^{-0.24}]$ , where " $r$ " is the radius at the shoulder of the dent and " $2c$ " is the shoulder-to-shoulder width of the dent. The greater the value of " $r/c$ ", the smaller the stress concentration and the longer the service life of the bearing.

NSK is a world leader in the research and development of materials that reduce the concentration of stress around surface dents. As shown in Fig. 12.11, our work has revealed that a high level of retained austenite is an extremely effective means of maximizing the  $r/c$  value around surface dents in the bearing material. TF technology is a unique heat treatment process developed by NSK to optimize the level of retained austenite in bearing materials.

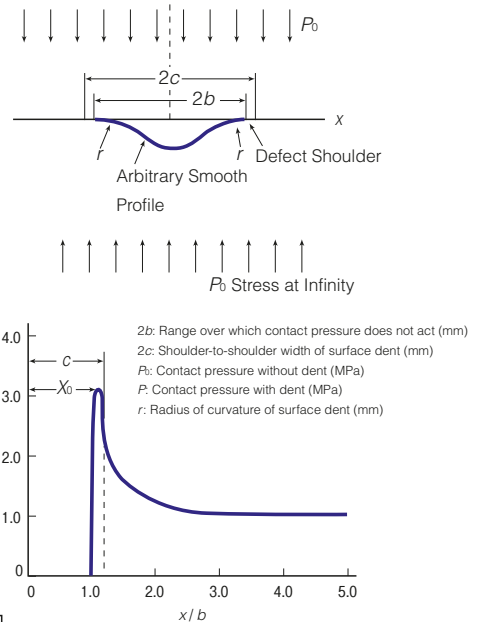


Fig. 12.10 Concentration of Stress around a Surface Dent

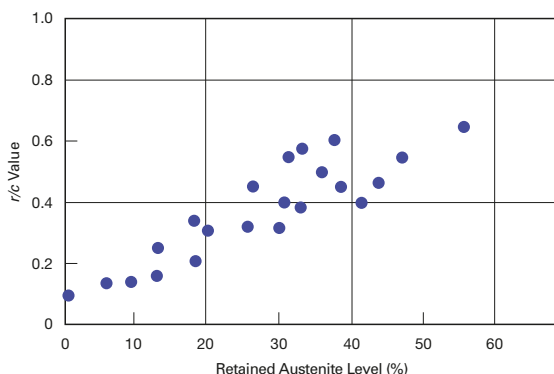


Fig. 12.11 Relationship of  $r/c$  Value to Retained Austenite Level

### (3) Material Properties of Hi-TF Bearings and Super-TF Bearings

NSK has developed Hi-TF and Super-TF bearings as two Series of bearings that offer longer service life exceeding that of TF Bearings. As mentioned, the approach to achieving long service life taken in Super-TF bearings is to minimize the concentration of stress around the shoulders of surface dents. A high level of retained austenite helps achieve this and maximizes  $r/c$  values. However, austenite itself has a soft microstructure and reduces the hardness of the bearing material. In order to meet the seemingly conflicting needs for greater hardness of the bearing material and a higher level of retained austenite, NSK adopted a technique that both promotes uniform distribution and reduces the diameter of carbide and carbonitride particles in the bearing material.

To this end, our researchers developed a new type of steel that has the proper quantity of elements used in the formation of carbides and developed a proprietary process to impart minute carbides and nitride into the material surface. Hi-TF bearings contain a specific amount of added chrome, while Super-TF bearings contain a specific amount of added chrome and molybdenum. Figures 12.12 and 12.13 illustrate the image analysis results of carbide distribution in the structures of Super-TF bearings and ordinary carburized steel bearings. It is clear that Super-TF bearings have a greater amount of fine-size carbide and carbonitride particles. Fig. 12.14 shows that the formations of finer carbide and carbonitride particles give Hi-TF bearings and Super-TF bearings a greater degree of hardness and higher retained austenite levels than those of TF Bearings. As a result, Hi-TF bearings and Super-TF bearings achieve a higher  $r/c$  value. (Fig. 12.15)

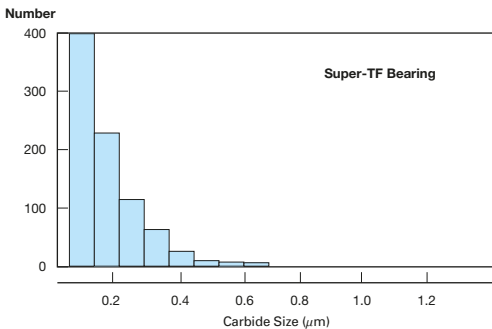


Fig. 12.12 Average Diameter of Carbide and Carbonitride Particles in a Super-TF Bearing

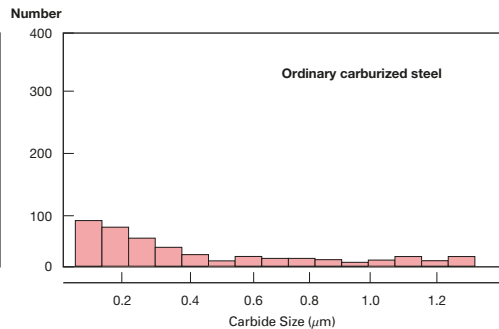


Fig. 12.13 Average Diameter of Carbide Particles in an Ordinary Carburized Steel Bearing

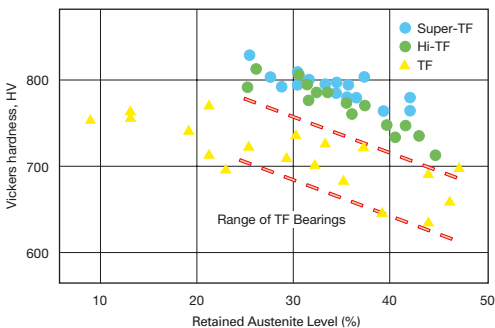


Fig. 12.14 Relationship of Material Hardness and Retained Austenite Level

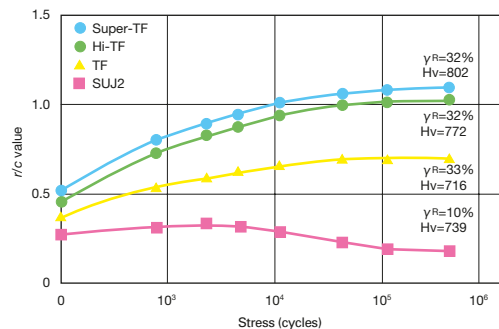


Fig. 12.15 Change of  $r/c$  Value Under Repeated Stress

## (4) Service Life Under Contaminated Lubrication Conditions

Table 12.10 and Fig. 12.17 show the results of service life tests conducted under contaminated lubrication conditions with L44649/10 tapered roller bearings. If the service life of an ordinary carburized steel bearing of this type is taken as 1, then the  $L_{10}$  life of TF, Hi-TF, and Super-TF bearings would be 4.5, 7.1, and 10.2 respectively (Table 12.10). Hi-TF bearings and Super-TF bearings thus offer over seven to ten times the service life of ordinary carburized steel bearings. Service life is generally affected both by the conditions in which the bearing is used and by the amount of contamination in the lubricant. Under contaminated lubrication conditions, service life may fall to as little as 1/5 the catalog life.

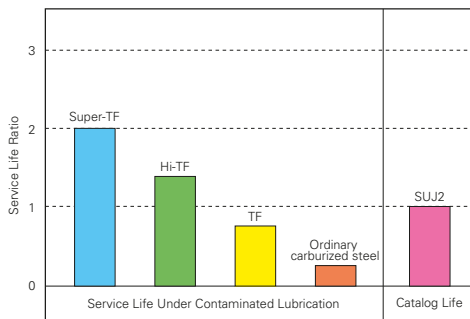
Hi-TF bearings and Super-TF bearings can achieve for the first time service life that exceeds the catalog life of existing products under contaminated lubrication.

Ordinary Carburized Steel	TF	Hi-TF	Super-TF
1	4.5	7.1	10.2

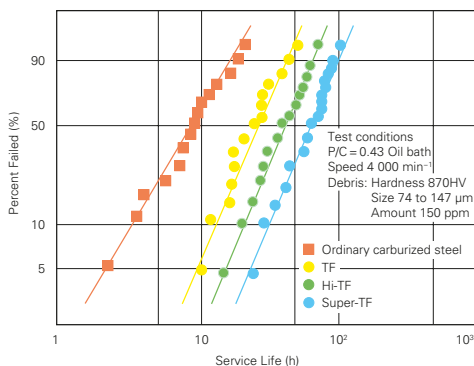
**Table 12.10 Comparison of Service Life of L44649/10 Tapered Roller Bearings**

## (5) Service Life under Clean Lubrication Conditions

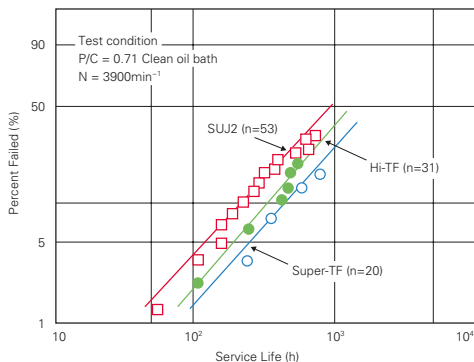
Fig. 12.18 shows the results of service life tests under clean lubrication conditions using Series 6206 deep groove ball bearings. Under clean lubrication, Hi-TF Bearings and Super-TF Bearings show a slightly longer service life than those made with SUJ2 steel. The most important factor is the cleanliness of the steel from which the bearing is made. Material with a greater degree of purity offers a greater degree of long-life performance.



**Fig. 12.16 Comparison of Service Life Under Contaminated Lubrication**



**Fig. 12.17 Service Life of L44649/10 Bearings Under Contaminated Lubrication**



**Fig. 12.18 Service Life Tests of 6206 Bearings Under Clean Lubrication**

### (6) Service Life Under Boundary Lubrication Conditions

Under boundary lubrication conditions where there is an insufficient EHL film, metal-to-metal contact occurs, thus reducing bearing life. Fig. 12.19 shows the results of service life tests conducted under conditions where oil film parameter  $\Lambda$ , which represents the ratio of the thickness of the oil film to the roughness of the surface, is very small ( $\Lambda=0.3$ ). At this very small ratio, peeling damage occurs (Fig. 12.20), but in Hi-TF bearings and Super-TF bearings, the concentration of stress around the projections of the contact area is reduced, giving a service life approximately 4.7 times and 5.5 times greater than that of ordinary carburized steel bearings.

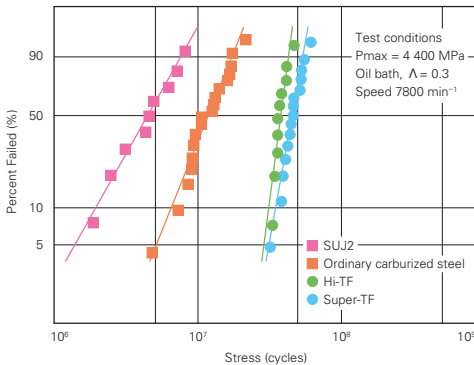


Fig. 12.19 Service Life Tests Under Boundary Lubrication Conditions

### (7) Wear and Seizure Resistance

Besides extending service life under contaminated lubrication conditions, another goal is to increase the bearing's resistance to wear and seizure by ensuring the dispersion of a large number of fine carbides and nitrides in the bearing material. Fig. 12.21 presents the results of a Sawin wear test that shows the degree of wear and the seizure limit for different types of bearing material. The test reveals that Hi-TF bearings and Super-TF bearings have superior wear resistance to both SUJ2 steel and TF bearings. Hi-TF bearings and Super-TF bearings are also 20 % to 40 % more resistant to seizure than both SUJ2 steel and TF bearings.

### (8) Heat Resistance

Fig. 12.22 shows the results of service life tests conducted with Series 6206 ball bearings at 160 °C under clean lubrication conditions. Test results reveal that Super-TF bearings (heat-resistant specifications) have approximately 4 times the service life of SUJ2X26 steel bearings.

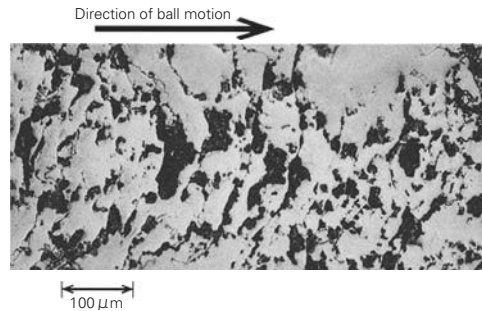


Fig. 12.20 Peeling Damage

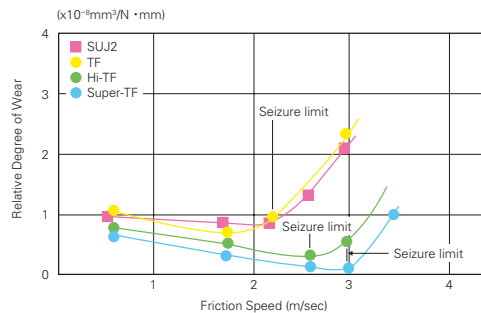


Fig. 12.21 Comparison of Wear Resistance

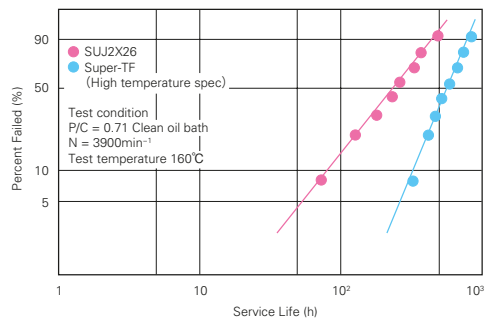


Fig. 12.22 Service Life Test of 6206 Under High Temperature Clean Lubrication

#### 12.4.6 Physical Properties of Representative Polymers Used as Bearing Material

Because of their light weight, easy formability, and high corrosion resistance, polymers are widely used as cage materials. Polymers may be used independently, but they are usually combined with functional fillers to form a composite material. Composites can be customized to have specific properties and thus be used as bearing materials. For example, fillers can be used to impart attributes such as low friction, low wear, non-stick slip characteristics, high limit *PV* values, non-scrubbing of counterpart material, mechanical properties, heat resistance, and so on.

Table 12.11 shows characteristics of representative polymer materials used for bearings.

Plastics	Elastic Modulus (GPa) <sup>(1)</sup>
Polyethylene HDPE UHMWPE	0.115 0.5
Polyamide Nylon 6 Nylon 66	2.5 3.0
Nylon 11	1.25
Polytetra fluoroethylene PTFE	0.40
Poly butylene terephthalate PBT	2.7
Polyacetal POM Homo-polymer Co-polymer	3.2 2.9
Polyether sulfon PES	2.46
Polysulfon PSf	2.5
Polyallylate (Aromatic polyester)	1.3 3.0
Polyphenylene sulfide PPS (GF 40%)	4.2
Polyether ether keton PEEK	1.7
Poly-meta-phenylene isophthalic amide	10 (fiber) 7.7 (mold)
Polypromellitic imide (Aromatic polyimide) PI	3 (film) 2.5 to 3.2 (mold)
Polyamide imide PAI	4.7
Polyether imide (Aromatic polyimide) PI	3.6
Polyamino bis-maleimide	—

**Notes** <sup>(1)</sup> GPa  $\div 10^4$  kgf/cm<sup>2</sup> =  $10^2$  kgf/mm<sup>2</sup>  
<sup>(2)</sup> If there is a slash mark "/" in the thermal  
<sup>(3)</sup> Reference value

Table 12.11 Characteristics of Representative Polymers

	Strength GPa (¹)	Density g/cm³	Specific Elastic Modulus × 10⁴ mm	Specific Strength × 10⁴ mm	Melting point °C	Glass Transition Temp °C	Thermal Deformation Temperature °C (²)	Continuous Operating Temperature °C	Remarks
	0.03 0.025	0.96 0.94	12.6 53.2	3.3 2.7	132 136	—20 —20	75/50 75/50	— —	High creep and toughness, softening
	0.07 0.08	1.13 1.14	221.2 263.2	6.2 7.0	215 264	50 60	150/57 180/60	80 to 120 80 to 120	High water absorption and toughness
	0.04	1.04	120.2	3.8	180	—	150/55	Lower than nylon 6 or 66	Low water absorption
	0.028	2.16	18.5	1.3	327	115	120/—	260	High creep, sintering, low friction, low adhesion, inert. Stable at 290 °C
	0.06	1.31	206.1	4.6	225	30	230/215	155	
	0.07 0.06	1.42 1.41	225.3 205.7	4.9 4.3	175 165	—13 —	170/120 155/110	— 104	High hardness and toughness, low water absorption
	0.086	1.37	179.6	6.3	—	225	210/203	180	Usable up to 200 °C. Chemically stable
	0.07	1.24	201.6	5.6	—	190	181/175	150	
	0.07 0.075	1.35 1.40	96.3 214.3	5.2 5.4	350 350	— —	293 293	300 260 to 300	Inert, high hardness, used as filler for PTFE. Stable up to 320 °C
	0.14	1.64	256.1	8.5	275	94	>260	220	Hot cured at 360 °C
	0.093	1.30	130.8	7.2	335	144	152	240	
	0.7 0.18	1.38 1.33	724.6 579	50.7 13.5	375 415 (decomposition)	>230 >230	280 280	220 220	Fire retardant, heat-resistant fiber
	0.17	1.43	203	7.0	Heat decomposition	417 decomposition	360/250	300 (³)	No change in inert gas up to 350 °C
	0.1	1.43	203	7.0	Heat decomposition	417 decomposition	360/250	260	Usable up to 300 °C for bearings. Sintering, no fusion (molded products)
	0.2	1.41	333.3	14.2	—	280	260	210	Usable up to 290 °C as an adhesive or enamel. Improved polyimide for melt molding
	0.107	1.27	240.9	—	—	215	210/200	170	Improved polyimide for melt molding
	0.35	1.6	—	21.9	—	—	330 (³)	260	

deformation temperature column, the left value applies to 451 kPa, while all other values apply to 1.82 MPa.

## 12.4.7 Characteristics of Nylon Cage Material

Recently, plastic cages are increasingly used in place of metal cages in bearings. Advantages of using plastic cages include:

- (1) Light weight and favorable for use with high-speed rotation
- (2) Self-lubricating functionality and low wear. Abrasion powders are usually not produced when plastic cages are used, so a highly clean internal state can be maintained.
- (3) Low noise appropriate for silent environments
- (4) Highly corrosion resistant, no rusting
- (5) Highly shock resistant, proving durable under high moment loading
- (6) Easy molding of complicated shapes ensures high freedom of cage shape selection. Thus, better cage performance can be obtained.

Disadvantages when compared with metal cages include low heat resistance and a limited operating temperature range (normally 120 °C). Care is also necessary for use because plastic cages are sensitive to certain chemicals. Polyamide resin is a representative plastic cage material. Among polyamide resins, nylon-66 is often used because of its high heat resistance and mechanical properties.

Polyamide resin contains the amide coupling ( $-NHCO-$ ) with hydrogen bonding capability in its molecular chain and is characterized by its regulation of mechanical properties and water absorption according to concentration and hydrogen bonding state. High water absorption (Fig. 12.23) of nylon 66 is generally regarded as a shortcoming because it causes dimensional distortion and deterioration of rigidity. On the other hand, water absorption helps enhance flexibility and prevents cage damage during bearing assembly when a cage is required to have a substantial holding interference for the rolling elements. This also improves toughness which is effective for shock absorption during operation. As such, this so-called shortcoming may be considered as an advantage under certain conditions.

Nylon can be improved substantially in strength and heat resistance by adding a small amount of fiber. Therefore, materials reinforced by glass fiber may be used depending on the cage type and application. To maintain deformation of the cage during bearing

assembly, a relatively small amount of glass fiber is commonly used to reinforce the cage. (Table 12.12) Nylon-66 demonstrates vastly superior performance under light operating conditions and has wide application possibilities as a mainstream plastic cage material. However, it often develops sudden deterioration under severe conditions (in high-temperature oil, etc.). Therefore, carefully monitor this material during practical operation.

As an example, Table 12.13 shows the time necessary for the endurance performance of various nylon-66 materials to drop to 50% of the initial value under several different cases. Material deterioration in oil varies depending on the kind of oil. Deterioration is excessive if the oil contains an extreme-pressure agent. Sulfurous extreme-pressure agents accelerate

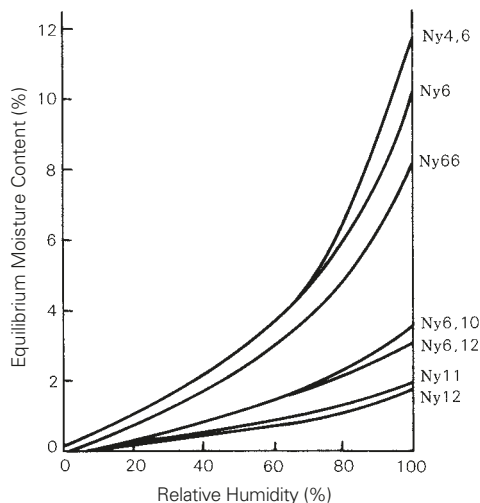


Fig. 12.23 Equilibrium Moisture Content and Relative Humidity of Various Nylons

deterioration more than phosphorous extreme-pressure agents and such deterioration occurs more rapidly with rising temperatures.

On the other hand, material deteriorates less in grease or air than in oil. In addition, materials reinforced with glass fiber can suppress deterioration by the reinforcement effect of glass fibers, thereby helping to extend the durability period.

**Table 12.12 Example Applications With Fiber Reinforced Nylon Cages**

	Bearing Type	Main Applications	Cage Material
Ball Bearing	Miniature ball bearings	VCR, IC cooling fans	Nylon 66 (Glass fiber content: 0 to 10%)
	Deep groove ball bearings	Alternators, fan motors for air conditioners	
	Angular contact ball bearings	Magnetic clutches, automotive wheels	
Roller Bearing	Needle roller bearings	Automotive transmissions	Nylon 66 (Glass fiber content: 10 to 25%)
	Tapered roller bearings	Automotive wheels	
	ET-type cylindrical roller bearings	General	
	H-type spherical roller bearings	General	

**Table 12.13 Environmental Resistance of Nylon-66 Resin**

Environment	Temperature, °C	Glass Content	Time Until Physical Property Value Drops to 50% (h)				Remarks
			500	1000	1500	2000	
Oil	Gear oil	120 0 D	→	→	→	→	Contains an extreme pressure additive
		140 0 D	→	→	→	→	
	Synthetic lubricating oil	100 A	→	→	→	→	Contains an extreme pressure additive
		120 A	→	→	→	→	
		130 0 A C	→	→	→	→	
		150 0 B D	→	→	→	→	
	Hydraulic oil	80 0 D	→	→	→	→	Contains an extreme pressure additive
		120 0 D	→	→	→	→	
		150 0 D	→	→	→	→	
	ATF oil	120 0 D	→	→	→	→	
		140 0 A D	→	→	→	→	
	Engine oil	120 0 D	→	→	→	→	
Grease	Grease	80 0 D	→	→	→	→	
		120 0 D	→	→	→	→	
		130 A D	→	→	→	→	
Air	Air	160 0 A C	→	→	→	→	
		180 0 B	→	→	→	→	

Remarks: Glass content: A<B<C<D

## 12.4.8 Heat-Resistant Resin Materials for Cages

Currently, polyamide resin shows superior performance under medium-intensity operating environmental conditions. This feature plus its relative inexpensiveness has led to its use in increasing quantities. However, contact with acids or oils containing an extreme pressure agent or continuous use at or above 120 °C deteriorates and ages the material over time.

Super-engineering plastics should be used for the cage materials of bearings running in severe environments, such as temperatures over 150 °C or with corrosive chemicals present. Though super-engineering plastics have good material heat resistance, chemical resistance, rigidity at high temperature, and mechanical strength, they have problems with characteristics required of cage materials, such as toughness during molding or bearing assembly, weld strength, and fatigue resistance. Furthermore, the costs of these materials are high. Table 12.14 shows the properties of typical super-engineering plastics that can be injection molded into cage shapes.

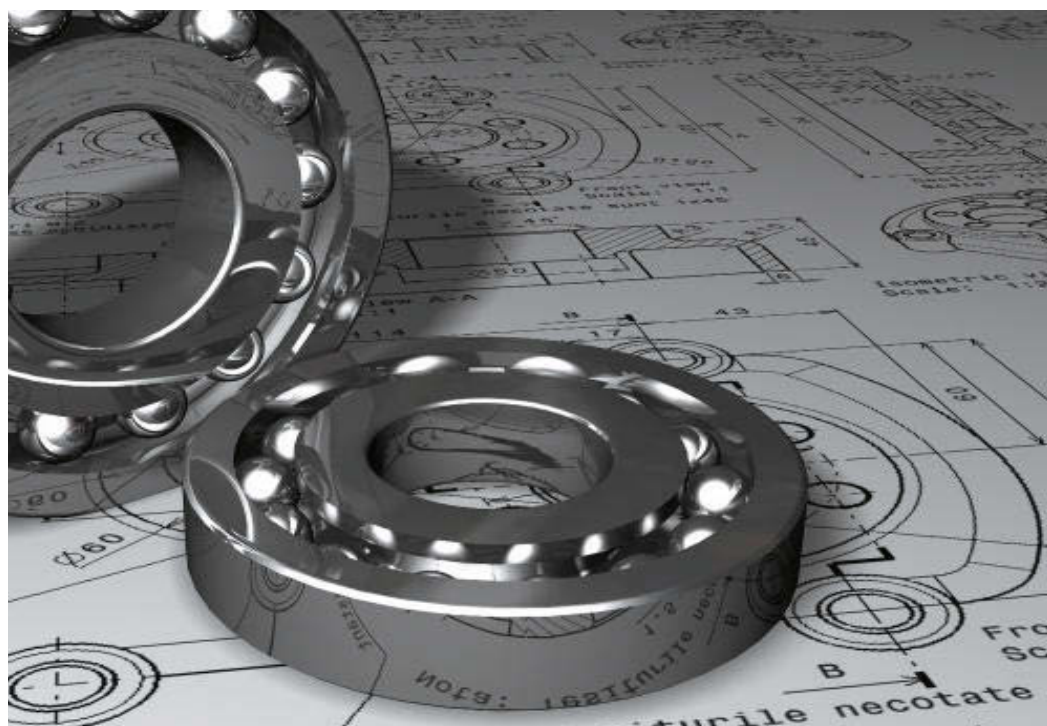
Among the materials in Table 12.14, though branch-type polyphenylene sulfide (PPS) is often used, the cage design is restricted since forced-removal from the die is difficult due to poor toughness and brittleness. Moreover, PPS is not ideal as a cage material since the claw, stay, ring, or flange of the cage can be easily broken on the bearing assembly line. On the other hand, the heat-resistant plastic cage developed by NSK, is made of linear-chain high molecules which have been polymerized from molecular chains. These molecular chains do not contain branches or crosslinking, so they have high toughness compared to the former material (branch PPS). Linear PPS is not only superior in heat resistance, oil resistance, and chemical resistance, but also has good mechanical characteristics such as the potential for snap fitting (an important characteristic for cages), and high-temperature rigidity.

NSK has reduced the disadvantages associated with linear PPS, chiefly difficulty of removal from the die and slow crystallization speed, thereby establishing it as a material suitable for cages. Thus, linear PPS satisfies the required capabilities for a heat-resistant cage material that considers cost and performance.

Classification	Polyether Sulfone (PES)
Resin	Amorphous resin
Continuous Temp.	180 °C
Physical Properties	<ul style="list-style-type: none"> <li>●Poor toughness (Care necessary regarding cage shape)</li> <li>●Low weld strength</li> <li>●Small fatigue resistance</li> </ul>
Environmental Properties	<ul style="list-style-type: none"> <li>●Water absorption (Poor dimensional stability)</li> <li>●Good aging resistance</li> <li>●Poor stress cracking resistance</li> </ul>
Material Cost (Superiority)	3
Cage Application	<ul style="list-style-type: none"> <li>●Many performance problems</li> <li>●High material price</li> </ul>

**Table 12.14 Properties of Typical Super-Engineering Plastic Materials for Cages**

	Polyether Imide (PEI)	Polyamide Imide (PAI)	Polyether Etherketon (PEEK)	Branch Polyphenylene Sulfide (PPS)	Linear Polyphenylene Sulfide (L-PPS)
	Amorphous resin	Amorphous resin	Crystalline resin	Crystalline resin	Crystalline resin
	170 °C	210 °C	240 °C	220 °C	220 °C
	<ul style="list-style-type: none"> <li>•Poor toughness</li> <li>•Low weld strength</li> <li>•Low fatigue resistance</li> </ul>	<ul style="list-style-type: none"> <li>•Very brittle (No forced-removal molding)</li> <li>•Special heat treatment before use</li> <li>•High rigidity, after heat treatment</li> </ul>	<ul style="list-style-type: none"> <li>•Excellent toughness, wear, and fatigue resistance</li> <li>•Small weld strength</li> </ul>	<ul style="list-style-type: none"> <li>•Excellent mechanical properties</li> <li>•Slightly low toughness</li> </ul>	<ul style="list-style-type: none"> <li>•Excellent mechanical properties</li> <li>•Good toughness</li> <li>•Good dimensional stability (No water absorption)</li> </ul>
	<ul style="list-style-type: none"> <li>•Good aging resistance</li> <li>•Poor stress cracking resistance</li> </ul>	<ul style="list-style-type: none"> <li>•Good environmental resistance</li> </ul>	<ul style="list-style-type: none"> <li>•Good environmental resistance</li> </ul>	<ul style="list-style-type: none"> <li>•Good environmental resistance</li> </ul>	<ul style="list-style-type: none"> <li>•Good environmental resistance (not affected by most chemicals, doesn't deteriorate in high temperature oil with extreme pressure additives).</li> </ul>
	2	5	4	1	1
	<ul style="list-style-type: none"> <li>•Many performance problems</li> <li>•High material cost</li> </ul>	<ul style="list-style-type: none"> <li>•Good performance</li> <li>•High material and molding cost (For special applications)</li> </ul>	<ul style="list-style-type: none"> <li>•Excellent performance</li> <li>•High material cost (For special applications)</li> </ul>	<ul style="list-style-type: none"> <li>•Problems with toughness</li> <li>•Cost is high compared to performance</li> </ul>	<ul style="list-style-type: none"> <li>•Reasonable cost for performance (For general applications)</li> </ul>



## **13. DESIGN OF SHAFTS AND HOUSINGS**

<b>13.1 Accuracy and Surface Finish of Shafts and Housings .....</b>	<b>A 270</b>
<b>13.2 Shoulder and Fillet Dimensions .....</b>	<b>A 270</b>
<b>13.3 Bearing Seals .....</b>	<b>A 272</b>
<b>13.3.1 Non-Contact Seals .....</b>	<b>A 272</b>
<b>(1) Oil Groove Seals .....</b>	<b>A 273</b>
<b>(2) Flinger (Slinger) Type Seals .....</b>	<b>A 273</b>
<b>(3) Labyrinth Seals .....</b>	<b>A 273</b>
<b>13.3.2 Contact Seals .....</b>	<b>A 274</b>
<b>(1) Oil Seals .....</b>	<b>A 274</b>
<b>(2) Felt Seals .....</b>	<b>A 275</b>

# 13. DESIGN OF SHAFTS AND HOUSINGS

## 13.1 Accuracy and Surface Finish of Shafts and Housings

If the accuracy of a shaft or housing does not meet the specification, the performance of the bearings will be affected and they will not perform to their full capability. For example, inaccuracy in the squareness of the shaft shoulder may cause misalignment of the bearing inner and outer rings, which may reduce the bearing fatigue life by adding an edge load in addition to the normal load. Cage fracture and seizure sometimes occur for this reason. Housings should be rigid in order to provide firm bearing support and are also advantageous in regards to noise, load distribution, etc.

For normal operating conditions, a turned finish or smooth bored finish is sufficient for the fitting surface; however, a ground finish is necessary for applications where vibration and noise must be low or where heavy loads are applied.

In cases where two or more bearings are mounted in a single-piece housing, the fitting surfaces of the housing bore should be designed so both bearing seats may be finished together in one operation, such as inline boring. In the case of split housings, take care in the fabrication of the housing so that the outer ring does not become deformed during installation. The tolerance and surface finish of shafts and housings for normal operating conditions are listed in Table 13.1.

**Table 13.1 Tolerance and Roughness of Shaft and Housing**

Item	Class of Bearings	Shaft	Housing Bore
Tolerance for Out-of-Roundness	Normal, Class 6	$\frac{IT3}{2}$ to $\frac{IT4}{2}$	$\frac{IT4}{2}$ to $\frac{IT5}{2}$
	Class 5, Class 4	$\frac{IT2}{2}$ to $\frac{IT3}{2}$	$\frac{IT2}{2}$ to $\frac{IT3}{2}$
Tolerance for Cylindricity	Normal, Class 6	$\frac{IT3}{2}$ to $\frac{IT4}{2}$	$\frac{IT4}{2}$ to $\frac{IT5}{2}$
	Class 5, Class 4	$\frac{IT2}{2}$ to $\frac{IT3}{2}$	$\frac{IT2}{2}$ to $\frac{IT3}{2}$
Tolerance for Shoulder Runout	Normal, Class 6	IT3	IT3 to IT4
	Class 5, Class 4	IT3	IT3
Roughness of Fitting Surfaces $R_a$	Small Bearings	0.8	1.6
	Large Bearings	1.6	3.2

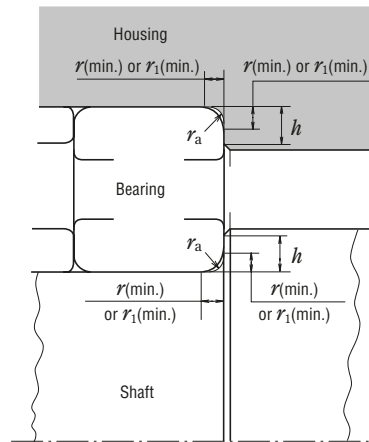
**Remarks** This table gives general recommendation using the radius measuring method. The basic tolerance (IT) class should be selected in accordance with the bearing tolerance class. Please refer to the Appendix Table 11 (Page E016) for IT values.

If the outer ring is mounted in the housing bore with interference or a thin cross-section bearing is mounted on a shaft and housing, the tolerance of the shaft and housing should be tighter since this affects the bearing raceway directly.

## 13.2 Shoulder and Fillet Dimensions

The shoulders of the shaft or housing in contact with the face of a bearing must be perpendicular to the shaft center line (refer to Table 13.1). The front face side shoulder bore of the housing for a tapered roller bearing should be parallel with the bearing axis in order to avoid interference with the cage.

The fillets of the shaft and housing should not come in contact with the bearing chamfer; therefore, the fillet radius  $r_a$  must be smaller than the minimum bearing chamfer dimension  $r$  or  $r_1$ .



**Fig. 13.1 Chamfer Dimensions, Fillet Radius of Shaft and Housing, and Shoulder Height**

The shoulder heights for both shafts and housings for radial bearings should be sufficient to provide good support over the face of the bearings, but enough face should extend beyond the shoulder to permit use of special dismounting tools. The recommended minimum shoulder heights for Metric Series radial bearings are listed in Table 13.2.

Nominal dimensions associated with bearing mounting, including the proper shoulder diameters, are listed in the bearing tables. Sufficient shoulder height is particularly important for supporting the side ribs of tapered roller bearings and for cylindrical roller bearings subjected to high axial loads.

The values of  $h$  and  $r_a$  in Table 13.2 should be adopted in those cases where the fillet radius of the shaft or housing is as shown in Fig. 13.2 (a), while the values in Table 13.3 are generally used with an undercut fillet radius produced when grinding the shaft as shown in Fig. 13.2 (b).

**Table 13. 2 Recommended Minimum Shoulder Heights for Use With Metric Series Radial Bearings**

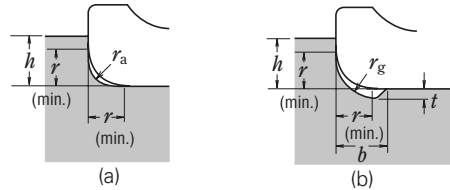
Units : mm

Nominal Chamfer Dimensions	Shaft or Housing		
	Fillet Radius	Minimum Shoulder Heights $h$ (min.)	
		Deep Groove Ball Bearings (1), Self-Aligning Ball Bearings, Cylindrical Roller Bearings (1), Solid Needle Roller Bearings	Angular Contact Ball Bearings, Tapered Roller Bearings (2), Spherical Roller Bearings
$r$ (min.) or $r_1$ (min.)	$r_a$ (max.)		
0.05	0.05	0.2	—
0.08	0.08	0.3	—
0.1	0.1	0.4	—
0.15	0.15	0.6	—
0.2	0.2	0.8	—
0.3	0.3	1	1.25
0.6	0.6	2	2.5
1	1	2.5	3
1.1	1	3.25	3.5
1.5	1.5	4	4.5
2	2	4.5	5
2.1	2	5.5	6
2.5	2	—	6
3	2.5	6.5	7
4	3	8	9
5	4	10	11
6	5	13	14
7.5	6	16	18
9.5	8	20	22
12	10	24	27
15	12	29	32
19	15	38	42

**Note** (1) When axial loads are applied, the shoulder height must be sufficiently higher than these values.

(2) When heavy axial loads are applied, the shoulder height must be sufficiently higher than these values.

**Remarks** 1. The corner fillet radius is also applicable to thrust bearings.  
2. The shoulder diameter is listed instead of shoulder height in the bearing tables.

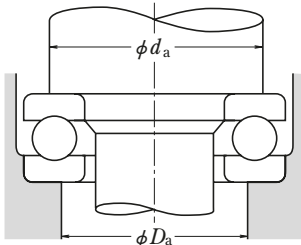
**Fig. 13. 2 Chamfer Dimensions, Fillet Radius, and Shoulder Height****Table 13. 3 Shaft Undercut**

Units : mm

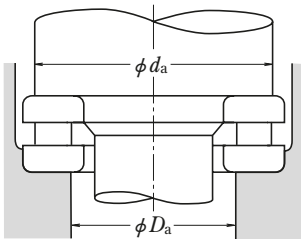
Chamfer Dimensions of Inner and Outer Rings $r$ (min.) or $r_1$ (min.)	Undercut Dimensions		
	$t$	$r_g$	$b$
1	0.2	1.3	2
1.1	0.3	1.5	2.4
1.5	0.4	2	3.2
2	0.5	2.5	4
2.1	0.5	2.5	4
2.5	0.5	2.5	4
3	0.5	3	4.7
4	0.5	4	5.9
5	0.6	5	7.4
6	0.6	6	8.6
7.5	0.6	7	10

For thrust bearings, the squareness and contact area of the supporting face for the bearing rings must be adequate. In the case of thrust ball bearings, the housing shoulder diameter  $D_a$  should be less than the pitch circle diameter of the balls, and the shaft shoulder diameter  $d_a$  should be greater than the pitch circle diameter of the balls (Fig. 13.3).

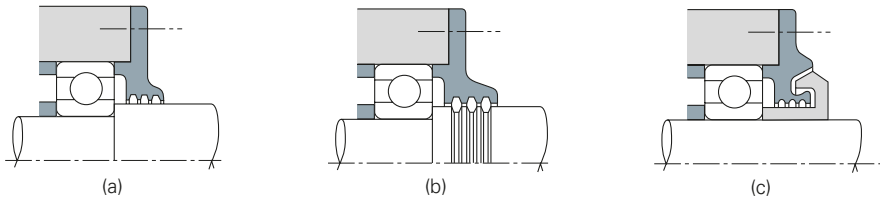
For thrust roller bearings, the full contact length between rollers and rings should be supported by the shaft and housing shoulder (Fig. 13.4). These diameters,  $d_a$  and  $D_a$ , are listed in the bearing tables.



**Fig. 13.3 Face-Supporting Diameters for Thrust Ball Bearings**



**Fig. 13.4 Face-Supporting Diameters for Thrust Roller Bearings**



**Fig. 13.5 Example Oil Grooves**

## 13.3 Bearing Seals

To insure the longest possible life of a bearing, seals may be necessary to prevent leakage of lubricant or entry of dust, water, or other harmful material such as metallic particles. The seals must be free from excessive running friction and chance of seizure. They should also be easy to assemble and disassemble. Be sure to select a suitable seal for individual applications that considers the lubricating method.

### 13.3.1 Non-Contact Seals

Various sealing devices that do not contact the shaft are available, such as oil grooves, flingers, and labyrinths. Satisfactory sealing can usually be obtained with such seals because of their close running clearance. Centrifugal force may also assist in preventing internal contamination and leakage of the lubricant.

#### (1) Oil Groove Seals

Oil groove seals function by the use of a small gap between the shaft and housing cover in combination with multiple grooves in the housing cover and/or shaft surface (Fig. 13.5 (a), (b)). Since the use of oil grooves alone is not completely effective except at low speeds, a flinger or labyrinth seal is often combined with an oil groove seal (Fig. 13.5 (c)). The entry of dust can be impeded by packing a grease with a consistency of about 200 (NLGI Grade 4) into the grooves of the shaft and/or housing.

The smaller the gap between the shaft and housing, the greater the sealing effect; however, the shaft and housing must not come in contact while running. The recommended gaps are given in Table 13.4.

The recommended groove width is approximately 3 to 5 mm, with a depth of about 4 to 5 mm. When sealing using grooves only, there should be three or more grooves.

## (2) Flinger (Slinger) Seals

A flinger is designed to force water and dust away by centrifugal force acting on any contaminants on the shaft. Sealing mechanisms with flingers inside the housing, as shown in Fig. 13.6 (a) and (b), are mainly intended to prevent oil leakage and are used in environments with relatively little dust. Dust and moisture cannot enter due to the centrifugal force of flingers as shown in Fig. 13.6 (c) and (d).

**Table 13.4 Gaps Between Shafts and Housings for Oil-Groove Type Seals**

Units : mm	
Nominal Shaft Diameter	Radial Gap
Under 50	0.25 to 0.4
50-200	0.5 to 1.5

## (3) Labyrinth Seals

Labyrinth seals are formed by interdigitated segments attached to the shaft and housing that are separated by a very small gap. They are particularly suitable for preventing oil leakage from the shaft at high speeds.

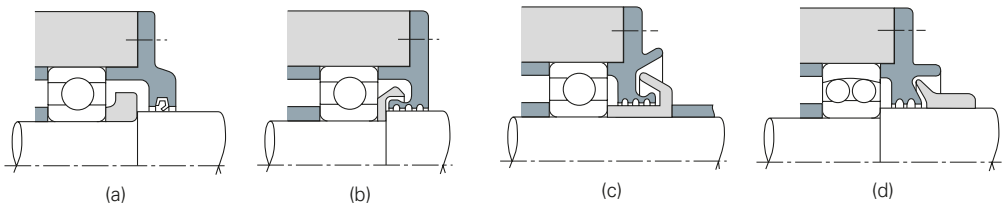
The type shown in Fig. 13.7 (a) is widely used because of its ease of assembly, but those shown in Fig. 13.7 (b) and (c) have better seal effectiveness.

Normal radial and axial labyrinth seal gaps are shown in Table 13.5.

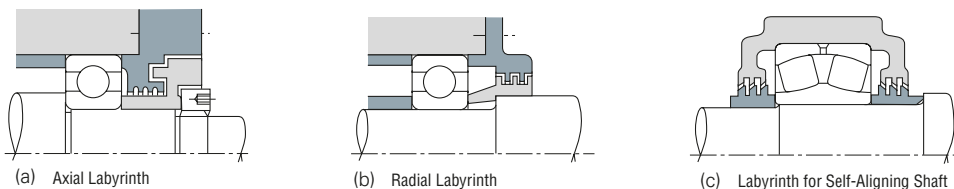
**Table 13.5 Labyrinth Seal Gaps**

Units : mm

Nominal Shaft Diameter	Labyrinth Gaps	
	Radial Gap	Axial Gap
Under 50	0.25 to 0.4	1 to 2
50-200	0.5 to 1.5	2 to 5



**Fig. 13.6 Example Flinger Configurations**



**Fig. 13.7 Example Labyrinth Designs**

## 13.3.2 Contact Seals

Contact seals function by physical contact between the shaft and seal, which may be made of synthetic rubber, synthetic resin, felt, etc. Oil seals with synthetic rubber lips are most frequently used.

### (1) Oil Seals

Many types of oil seals are used to prevent lubricant from leaking while also preventing dust, water, and other foreign matter from entry (Figs. 13.8 and 13.9)

In Japan, such oil seals are standardized (refer to JIS B 2402) by size and type. Since many oil seals are equipped with circumferential springs to maintain adequate contact force, oil seals can follow the non-uniform rotational movement of a shaft to some degree.

Synthetic rubber seal lip materials are often used, including nitrile, acrylate, silicone, fluorine, and tetrafluoride ethylene. The maximum allowable operating temperature for each material increases in this same order.

Synthetic rubber oil seals may cause troubles such as overheating, wear, and seizure unless there is an oil film between the seal lip and shaft. Therefore, some lubricant should be applied to the seal lip when the seals are installed. Furthermore, the lubricant inside the housing should spread slightly between the sliding

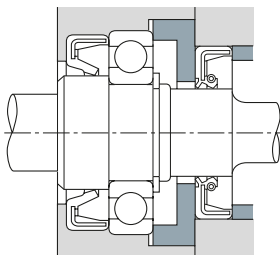
surfaces. However, please be aware that ester-based grease will cause acrylic rubber material to swell while low aniline point mineral oil, silicone-based grease, and silicon-based oil will cause silicone-based material to swell. Moreover, urea-based grease will cause fluorine-based material to deteriorate.

The permissible circumferential speed for oil seals varies depending on type, finish of the shaft surface, liquid to be sealed, temperature, shaft eccentricity, etc. The temperature range for oil seals is restricted by the lip material. Approximate circumferential surface speeds and permitted temperatures under favorable conditions are listed in Table 13.6.

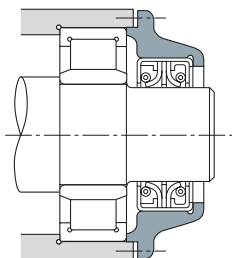
When oil seals are used at high circumferential surface speed or under high internal pressure, the contact surface of the shaft must be smoothly finished, and shaft eccentricity should be under 0.02 to 0.05 mm.

The hardness of the shaft's contact surface should be over HRC40 by heat treatment or hard-chrome plating in order to gain abrasion resistance. If possible, a hardness over HRC 55 is recommended.

The approximate level of contact surface finish required for several shaft circumferential surface speeds is given in Table 13.7.



**Fig. 13.8 Example of Application of Oil Seal (1)**



**Fig. 13.9 Example of Application of Oil Seal (2)**

**Table 13.6 Permissible Circumferential Surface Speeds and Temperature Ranges for Oil Seals**

Seal Materials		Permissible Circumferential Speeds(m/sec)	Operating Temperature Range(°C) (¹)
Synthetic Rubber	Nitrile Rubber	Under 16	−25 to +100
	Acrylic Rubber	Under 25	−15 to +130
	Silicone Rubber	Under 32	−70 to +200
	Fluorine-contains Rubber	Under 32	−30 to +200
Tetrafluoride Ethylene Resin		Under 15	−50 to +220

**Note** (¹) The upper limit of the temperature range may be raised about 20 °C for operation at short intervals.

**Table 13.7 Shaft Circumferential Surface Speeds and Finish of Contact Surfaces**

Circumferential Surface Speeds(m/s)	Surface Finish $R_a$ (μm)
Under 5	0.8
5 to 10	0.4
Over 10	0.2

**(2) Felt Seals**

Felt seals are one of the simplest and most common seals used in transmission shafts and other applications.

However, since oil permeation and leakage are unavoidable if oil is used, this type of seal is used

only for grease lubrication, primarily to prevent dust and other foreign matter from entry. Felt seals are not suitable for circumferential surface speeds exceeding 4m/sec; therefore, they should be replaced with synthetic rubber seals if the application allows.



# BEARING HANDLING AND MAINTENANCE



## Part B

### BEARING HANDLING AND MAINTENANCE

1. BEARING HANDLING ..... B 005
2. BEARING DAMAGE AND  
COUNTERMEASURES (Bearing Doctor) ..... B 021



# 1. BEARING HANDLING

1.1	Precautions for Proper Handling of Bearings .....	B 006
1.2	Bearing Storage .....	B 006
1.2.1	Bearing Storage Location .....	B 006
1.2.2	How to Store Bearings .....	B 006
1.3	Mounting .....	B 006
1.3.1	Mounting of Bearings With Cylindrical Bores .....	B 006
1.3.2	Mounting of Bearings With Tapered Bores .....	B 008
1.4	Operation Inspection .....	B 008
1.5	Dismounting .....	B 011
1.5.1	Dismounting of Outer Rings .....	B 011
1.5.2	Dismounting of Bearings With Cylindrical Bores .....	B 011
1.5.3	Dismounting of Bearings With Tapered Bores .....	B 012
1.6	Inspection of Bearings .....	B 013
1.6.1	Bearing Cleaning .....	B 013
1.6.2	Inspection and Evaluation of Bearings .....	B 013
1.7	Checking the Shaft and Housing .....	B 014
1.7.1	Checking the Shaft .....	B 014
1.7.2	Checking the Housing .....	B 016
1.8	Maintenance and Inspection .....	B 017
1.8.1	Detecting and Correcting Irregularities .....	B 017
1.8.2	Diagnosis With Sound and Vibration .....	B 018

# 1. BEARING HANDLING

## 1.1 Precautions for Proper Handling of Bearings

Since rolling bearings are high-precision machine parts, they must be handled accordingly. Even if high quality bearings are used, their expected performance cannot be achieved if they are not handled properly. Be sure to take the following precautions:

### (1) Keep Bearings and Surrounding Area Clean

Dust, dirt, and debris, even if invisible to the naked eye, have harmful effects on bearings. Prevent the entry of foreign matter by keeping the bearings and their environment as clean as possible.

### (2) Handle Carefully

Heavy shocks during handling may cause bearings to be scratched or otherwise damaged, possibly resulting in their failure. Excessively strong impacts may cause brinelling, breaking, or cracking.

### (3) Use Proper Tools

Always use proper and well-maintained equipment when handling bearings and avoid general-purpose tools.

### (4) Prevent Corrosion

Since perspiration on the hands and various other contaminants may cause corrosion, keep hands clean when handling bearings and wear gloves if possible. Monitor for rust caused by corrosive gases or moisture.

## 1.2 Bearing Storage

To prevent rusting, each bearing is treated and packed with an anticorrosive agent, but the effectiveness of this varies greatly depending on the storage environment. Keep bearings in-box until needed and select a suitable place to store replacement bearings.

### 1.2.1 Bearing Storage Location

Bearings must be stored indoors in a place that is not exposed to wind or rain. In addition, an indoor environment where temperature and/or humidity is high is unsuitable for storage because such places deteriorate the anticorrosive. Be sure to store the bearings in a place where variation in environmental temperature is small.

### 1.2.2 How to Store Bearings

After considering the size and weight of the bearings to be stocked, secure enough space and proper carrying equipment to transport bearings safely. Proper storage shelves are recommended, with the lowest tray of the shelf at least 30 cm above the floor. Avoid putting bearings directly on the floor. The effectiveness of the anticorrosive varies depending on the storage environment, but it is generally effective for about one to three years. If storing the bearing for a longer

time, a special storage method must be used, such as immersing the bearing in turbine oil.

## 1.3 Mounting

The method of mounting strongly affects bearing accuracy, life, and performance. Bearing characteristics should first be thoroughly studied before mounting. Handling procedures for bearings should be fully investigated by design engineers and standards should be established regarding the following:

- (1) Cleaning of bearings and related parts
- (2) Confirmation of dimensions and finish of related parts
- (3) Mounting
- (4) Inspection after mounting
- (5) Supply of lubricants

Bearings should not be unpacked until immediately before mounting. When using grease lubrication, grease should be packed in the bearings without cleaning them first. Even when using oil lubrication, cleaning the bearings is not required. However, bearings for instruments or for high-speed operation must first be cleaned with clean filtered oil in order to remove the anti-corrosion agent. After the bearings are cleaned with filtered oil, they should be protected to prevent corrosion.

Prelubricated bearings must be used without cleaning. Bearing mounting methods depend on the bearing type and type of fit. As bearings are usually used on rotating shafts, the inner rings often require a tight fit. Bearings with cylindrical bores are usually mounted by pressing them onto shafts (press fit) or by first heating them to expand their diameter before they cool and shrink on a shaft (shrink fit). Bearings with tapered bores can be mounted directly on tapered shafts or on cylindrical shafts with tapered sleeves.

Bearings are usually mounted in housings with a loose fit. However, in cases where the outer ring has an interference fit, a press may be used. Bearings can be interference-fitted by cooling them with dry ice before mounting. In this case, a rust preventive treatment must be applied to the bearing because moisture in the air will condense on the bearing surface.

### 1.3.1 Mounting of Bearings With Cylindrical Bores

#### (1) Press Fits

Press fitting is widely used for small bearings. A mounting tool is placed on the inner ring as shown in Fig. 1.1 and the bearing is slowly pressed onto the shaft until the side of the inner ring rests against the shoulder of the shaft. The mounting tool must not be placed on the outer ring during press mounting since the bearing may be damaged. Before mounting, applying oil to the fitted shaft surface is recommended for smooth insertion. Mounting using a hammer should only be performed for small ball bearings with minimally tight fits when a press is not available. This

method should not be used for tight interference fits or for medium- or large-size bearings. Any time a hammer is used, a mounting tool must be placed on the inner ring.

When both the inner and outer rings of non-separable bearings, such as deep groove ball bearings, require a tight fit, a mounting tool is placed on both rings as shown in Fig. 1.2 and both rings are fitted at the same time using a screw or hydraulic press. A mounting

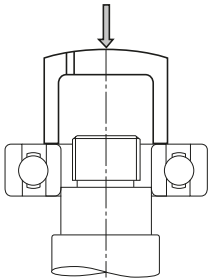


Fig. 1.1 Press Fitting Inner Ring

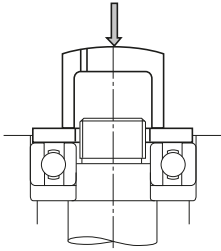


Fig. 1.2 Simultaneous Press Fitting of Inner and Outer Rings

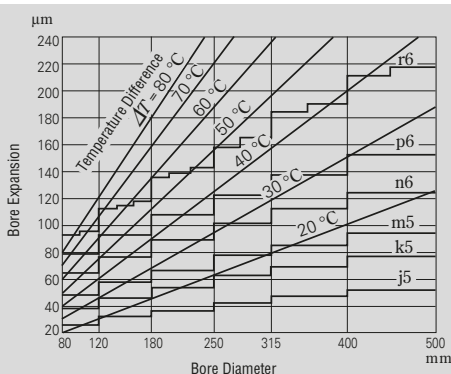


Fig. 1.3 Temperature and Thermal Expansion of Inner Ring

tool, such as shown in Fig. 1.2, should always be used for mounting self-aligning ball bearings since the outer ring may deflect.

For separable bearings, such as cylindrical roller bearings and tapered roller bearings, the inner and outer rings may be mounted separately. Assembly of the inner and outer rings, which were previously mounted separately, should be done carefully to align the inner and outer rings correctly. Careless or forced assembly may cause scratches on rolling contact surfaces.

## (2) Shrink Fits

Since press fitting large bearings requires considerable force, shrink fits are widely used. The bearings are first heated to expand them before mounting.

This method prevents excessive force from being imposed on the bearings and allows for mounting in a short time.

The expansion of the inner ring under various temperature differences and bearing sizes is shown in Fig. 1.3.

Note the following when performing shrink fits:

- Do not heat bearings above 120°C.
- Put the bearings on a wire net or suspend them in an oil tank to prevent them from touching the tank's bottom directly.
- 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 slightly during mounting.
- After mounting, the bearings will shrink in the axial and radial directions while cooling. Therefore, press the bearing firmly against the shaft shoulder using locating methods to avoid a clearance between the bearing and shoulder.

## NSK Bearing Induction Heaters

NSK Bearing Heaters, which use electromagnetic induction to heat bearings, are widely used as an alternative to heating in oil.

In NSK Bearing Heaters, electricity (AC) in a coil produces a magnetic field that induces a current inside the bearing that generates heat without using flames or oil. Consequently, uniform heating in a short time is possible, making shrink fitting efficient and clean.

NSK induction heating equipment is useful when relatively frequent mounting and dismounting is necessary, such as with cylindrical roller bearings for roll necks of rolling mills and for railway journal boxes. See Page B11 for more information on dismounting.

### 1.3.2 Mounting of Bearings with Tapered Bores

Bearings with tapered bores are mounted on tapered shafts directly or on cylindrical shafts with adapters or withdrawal sleeves (Figs. 1.4 and 1.5). Large spherical roller bearings are often mounted using hydraulic pressure. Fig. 1.6 shows a bearing mounting utilizing a sleeve and hydraulic nut. Fig. 1.7 shows a mounting method where holes drilled in the sleeve are used to feed oil under pressure to the bearing seat. As the bearing expands radially, the sleeve is inserted axially with adjusting bolts.

Spherical roller bearings should be mounted while checking their radial internal clearance reduction and referring to the drive-up distances listed in Table 1.1. The radial clearance must be measured using clearance gauges.

In this measurement, as shown in Fig. 1.8, the clearance for both rows of rollers must be measured simultaneously, and these two values should be kept roughly the same by adjusting the relative position of the outer and inner rings.

When a large bearing is mounted on a shaft, the outer ring may be deformed into an oval shape by its own weight. If the clearance is measured at the lowest part of the deformed bearing, the measured value may be larger than the true value. If an incorrect radial internal clearance is obtained in this manner and the values in Table 1.1 are used, then the interference fit may

become too tight and the true residual clearance may become too small. In this case, as shown in Fig. 1.9, one half of the total clearance at points *a*, *b*, and *c* may be used as the residual clearance. For reference, points *a* and *b* are located on a horizontal line that passes through the bearing center while *c* is located at the lowest position of the bearing. When a self-aligning ball bearing is mounted on a shaft with an adapter, be sure that the residual clearance does not become too small. Allow for sufficient clearance for easy alignment of the outer ring.

### 1.4 Operation Inspection

After mounting has been completed, a running test should be conducted to determine if the bearing has been mounted correctly. Small machines may be manually operated to ensure that they rotate smoothly. Check for sticking due to foreign matter or visible flaws; uneven torque caused by improper mounting or an improper mounting surface; and excessive torque caused by inadequate clearance, mounting error, or seal friction. If there are no abnormalities, powered operation may be started.

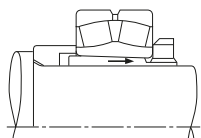


Fig. 1.4 Mounting With Adapter

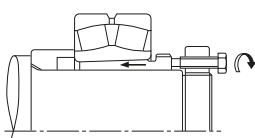


Fig. 1.5 Mounting With Withdrawal Sleeve

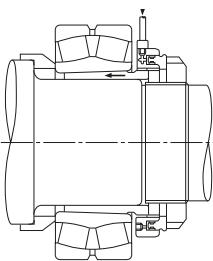


Fig. 1.6 Mounting With Hydraulic Nut

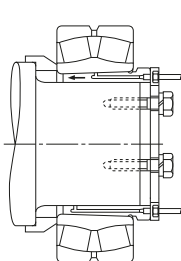


Fig. 1.7 Mounting With Special Sleeve and Hydraulic Pressure

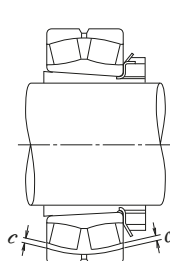


Fig. 1.8 Clearance Measurement of a Spherical Roller Bearing

Table 1.1 Mounting of Spherical Roller Bearings With Tapered Bores

Units : mm

Bearing Bore Diameter  <i>d</i>		Reduction in Radial Clearance		Axial Drive-Up Distance				Minimum Permissible Residual Clearance	
				Taper 1 : 12		Taper 1 : 30		<i>CN</i>	<i>C3</i>
over	incl.	min.	max.	min.	max.	min.	max.		
30	40	0.025	0.030	0.40	0.45	—	—	0.010	0.025
40	50	0.030	0.035	0.45	0.55	—	—	0.015	0.030
50	65	0.030	0.035	0.45	0.55	—	—	0.025	0.035
65	80	0.040	0.045	0.60	0.70	—	—	0.030	0.040
80	100	0.045	0.055	0.70	0.85	1.75	2.15	0.035	0.050
100	120	0.050	0.060	0.75	0.90	1.9	2.25	0.045	0.065
120	140	0.060	0.070	0.90	1.10	2.25	2.75	0.055	0.080
140	160	0.065	0.080	1.0	1.3	2.5	3.25	0.060	0.100
160	180	0.070	0.090	1.1	1.4	2.75	3.5	0.070	0.110
180	200	0.080	0.100	1.3	1.6	3.25	4.0	0.070	0.110
200	225	0.090	0.110	1.4	1.7	3.5	4.25	0.080	0.130
225	250	0.100	0.120	1.6	1.9	4	4.75	0.090	0.140
250	280	0.110	0.140	1.7	2.2	4.25	5.5	0.100	0.150
280	315	0.120	0.150	1.9	2.4	4.75	6.0	0.110	0.160
315	355	0.140	0.170	2.2	2.7	5.5	6.75	0.120	0.180
355	400	0.150	0.190	2.4	3.0	6	7.5	0.130	0.200
400	450	0.170	0.210	2.7	3.3	6.75	8.25	0.140	0.220
450	500	0.190	0.240	3.0	3.7	7.5	9.25	0.160	0.240
500	560	0.210	0.270	3.4	4.3	8.5	11.0	0.170	0.270
560	630	0.230	0.300	3.7	4.8	9.25	12.0	0.200	0.310
630	710	0.260	0.330	4.2	5.3	10.5	13.0	0.220	0.330
710	800	0.280	0.370	4.5	5.9	11.5	15.0	0.240	0.390
800	900	0.310	0.410	5.0	6.6	12.5	16.5	0.280	0.430
900	1 000	0.340	0.460	5.5	7.4	14.0	18.5	0.310	0.470
1 000	1 120	0.370	0.500	5.9	8.0	15.0	20.0	0.360	0.530

**Remark** The values for reduction in radial internal clearance are for bearings with CN clearance. For bearings with C3 clearance, the maximum values listed should be used for the reduction in radial internal clearance.

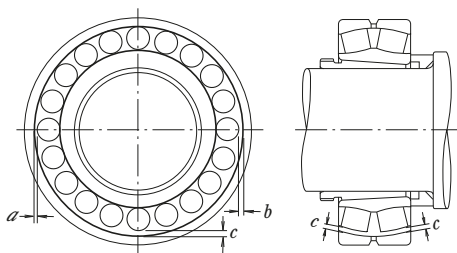


Fig. 1.9 Measuring Clearance in Large Spherical Roller Bearing

After a pre-operation examination, large machines that cannot be turned by hand should be started with no load. After the machine starts, immediately cut off the power and allow the machine to coast to a stop. Confirm that there are no abnormalities such as vibration, noise, contact with the rotating parts, or similar. Powered operation should be started slowly without load and observed carefully until it is determined that no abnormalities exist. Then, gradually increase the speed, load, and other conditions to their normal levels. Be sure to monitor for abnormal noise, excessive rise of bearing temperature, leakage and contamination of lubricants, etc. If any abnormality is found, stop the test immediately and inspect the machine. If possible, the bearing should be dismantled for examination.

Although bearing temperature can generally be estimated by the temperature of the outside surface of the housing, it is better to directly measure the temperature of the outer ring through oil holes. The bearing temperature should rise gradually to a steady state within one to two hours after operation starts. If the wrong bearing or mounting is used, bearing temperature may increase rapidly and become abnormally high. The cause of this abnormal temperature may be excessive lubricant, insufficient bearing clearance, incorrect mounting, or excessive friction of the seals.

In high-speed operation, an incorrect selection of bearing type or lubricating method may also cause abnormal temperature rise.

The sound of a bearing may be checked with a noise locator or vibration monitoring equipment. Abnormal conditions may be indicated by a loud metallic sound or other irregular noise. Possible causes include incorrect lubrication, poor alignment of the shaft and housing, or the entry of foreign matter into the bearing. Details and countermeasures for various irregularities are listed in Table 1.2.

**Table 1.2 Causes of and Countermeasures for Operating Irregularities**

Irregularities		Possible Causes	Countermeasures
Noise	Loud Metallic Sound <sup>(1)</sup>	Abnormal load	Improve the fit, internal clearance, preload, and/or position of housing shoulder.
		Incorrect mounting	Improve the machining accuracy and alignment of the shaft and housing, improve the accuracy of the mounting, or change the mounting method
		Insufficient or improper lubricant	Replenish the lubricant or select another lubricant.
		Contact of rotating parts	Modify the seal (labyrinth, etc.).
	Rhythmic Sound	Flaws, corrosion, or scratches on raceways	Clean or replace the bearing, improve the seals, and use clean lubricant.
		Brinelling	Replace the bearing and use care when handling bearings.
		Flaking on raceway	Replace the bearing.
	Irregular Sound	Excessive clearance	Improve the fit, clearance and preload.
		Entry of foreign particles	Clean or replace the bearing, improve the seals, and use clean lubricant.
		Flaws or flaking on balls	Replace the bearing.
Abnormal Temperature Rise		Excessive lubricant	Reduce the amount of lubricant and/or select a stiffer grease.
		Insufficient or improper lubricant	Replenish lubricant or select another appropriate lubricant.
		Abnormal load	Improve the fit, internal clearance, preload, and/or position of housing shoulder.
		Incorrect mounting	Improve the machining accuracy and alignment of the shaft and housing, improve the accuracy of the mounting, or change the mounting method.
		Creep on fitted surface, excessive seal friction	Replace the bearing, change the seal type, and correct the shaft and housing to consider the fit.
Vibration (Runout)		Brinelling	Replace the bearing and use care when handling bearings.
		Flaking	Replace the bearing.
		Incorrect mounting	Correct the squareness between the shaft and housing shoulder or side of spacer.
		Entry of foreign particles	Clean or replace the bearing, improve the seals.
Leakage or Discoloration of Lubricant		Too much lubricant, entry of foreign matter or abrasion chips	Replace the bearing or lubricant, reduce the amount of lubricant, select a stiffer grease, and clean the housing and adjacent parts.

**Note** <sup>(1)</sup> Intermittent squealing or high-pitched noise may be heard in medium- to large-sized cylindrical roller bearings or ball bearings operating under grease lubrication in low-temperature environments. Under such low-temperature conditions, bearing temperature will not rise, and fatigue life and grease performance are not affected. Although intermittent squealing or high-pitched noises may occur under these conditions, the bearing is fully functional and can continue to be used. If greater noise reduction or quieter operation properties are needed, please contact your nearest NSK branch office.

## 1.5 Dismounting

A bearing may be removed for periodic inspection or for other reasons. If the removed bearing is to be used again or is removed only for inspection, it should be dismantled as carefully as when it was mounted. If the bearing has a tight fit, removal may be difficult. The means for removal should be considered in the original design of the adjacent parts of the machine. When dismantling, the procedure and sequence of removal should first be studied using the machine plan and while considering the type of mounting fit in order to perform the operation properly.

### 1.5.1 Dismounting of Outer Rings

In order to remove an outer ring that is tightly fitted into a housing with push-out holes, first place bolts in the push-out holes at several locations along the circumference as shown in Fig. 1.10, and remove the outer ring by uniformly tightening the bolts. These bolt holes should always be fitted with blank plugs when not being used for dismantling. For separable bearings, such as tapered roller bearings, some notches should be made at several positions in the housing shoulder, as shown in Fig. 1.11, so that the outer ring may be pressed out with a dismantling tool or by tapping.

### 1.5.2 Dismounting of Bearings With Cylindrical Bores

If the mounting design allows space to press out the inner ring, this is an easy and fast method. In this case, withdrawal force should be imposed only on the inner ring (Fig. 1.12). Withdrawal tools like those shown in Figs. 1.13 and 1.14 are often used.

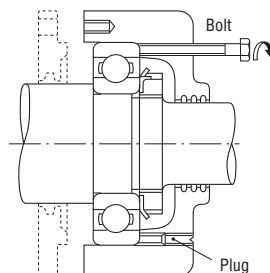


Fig. 1.10 Removal of Outer Ring With Dismounting Bolts

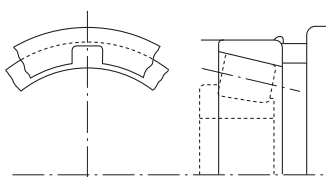


Fig. 1.11 Removal Notches

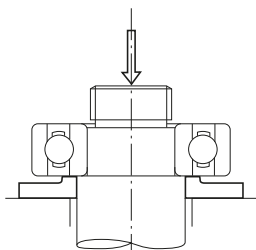


Fig. 1.12 Removal of Inner Ring Using a Press

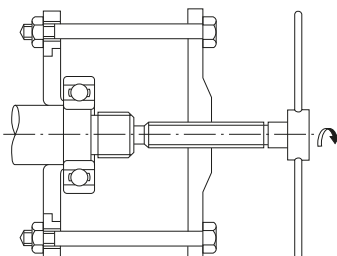


Fig. 1.13 Removal of Inner Ring Using a Withdrawal Tool (1)

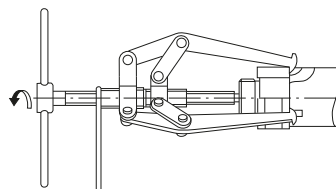


Fig. 1.14 Removal of Inner Ring Using a Withdrawal Tool (2)

In both cases, the claws of the tools must substantially engage the face of the inner ring; therefore, consider the size of the shaft shoulder during design or cut grooves in the shoulder to accommodate the withdrawal tools (Fig. 1.14).

The oil-injection method is usually used for the dismantling of large bearings. Oil pressure is applied through holes in the shaft and allows for easy dismantling. For extra wide bearings, the oil-injection method is used together with a withdrawal tool. Induction heating is used to remove the inner rings of NU- and NJ-type cylindrical roller bearings. The inner rings are expanded by brief local heating, and then removed (Fig. 1.15). Induction heating is also used to mount several bearings of these types on a shaft.

### 1.5.3 Dismounting of Bearings With Tapered Bores

When dismantling relatively small bearings with adapters, the inner ring is held by a stop fastened to the shaft and the nut is loosened several turns. As shown in Fig. 1.18, this is followed by hammering on the sleeve using a suitable tool. Fig. 1.16 shows one procedure for dismantling a withdrawal sleeve by tightening the removal nut. If this procedure is difficult, it may be possible to drill and tap bolt holes in the nut and remove the sleeve by tightening the bolts as shown in Fig. 1.17.

Large bearings may be removed easily using oil pressure. Fig. 1.19 illustrates the removal of a bearing by forcing oil under pressure through a hole and groove in a tapered shaft to expand the inner ring. The bearing may suddenly move axially when the interference is relieved during this procedure so a stop nut is recommended for protection. Fig. 1.20 shows a removal using a hydraulic nut.

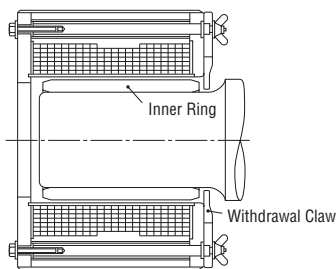


Fig. 1.15 Removal of Inner Ring Using an Induction Heater

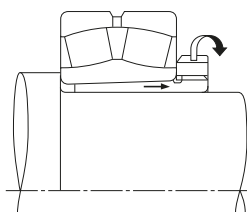


Fig. 1.16 Removal of Withdrawal Sleeve Using a Withdrawal Nut (1)

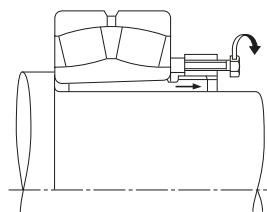


Fig. 1.17 Removal of Withdrawal Sleeve Using a Withdrawal Nut (2)

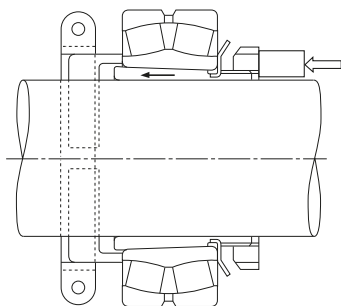


Fig. 1.18 Removal of Adapter With a Stop and Axial Pressure

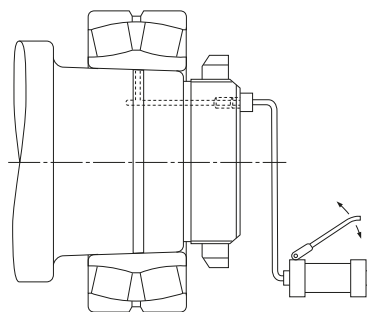


Fig. 1.19 Removal Using an Oil Injection Hydraulic Pump

## 1.6 Inspection of Bearings

### 1.6.1 Bearing Cleaning

When bearings are inspected, first record the appearance of the bearings and check the amount and condition of the residual lubricant. After the lubricant has been sampled, the bearings should be cleaned. In general, light oil or kerosene may be used as a cleaning solution.

Dismounted bearings should first be given a preliminary cleaning followed by a finishing rinse. Each bath should have a metal net to submerge the bearings in oil without touching the sides or bottom of the tank. If the bearings are rotated with foreign matter in them during preliminary cleaning, the raceways may be damaged. Lubricant and other deposits should be removed in the oil bath during an initial rough cleaning with a soft brush or similar. After the bearing is relatively clean, give it a finishing rinse. The finishing rinse should be performed carefully by rotating the bearing while keeping it immersed in the rinsing oil. Always keep the rinsing oil clean.

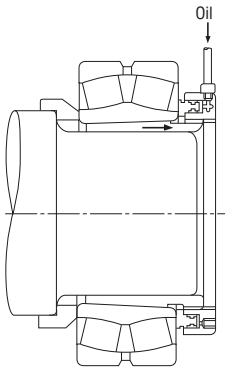


Fig. 1.20 Removal Using a Hydraulic Nut

### 1.6.2 Inspection and Evaluation of Bearings

After being thoroughly cleaned, examine the condition of bearing raceways and external surfaces, the amount of cage wear, the increase in internal clearance, and degradation of tolerances. Carefully check these points and examine for possible damage or other abnormalities to determine if the bearing can be reused.

For small, non-separable ball bearings, hold the bearing horizontally in one hand, and then rotate the outer ring to confirm that it turns smoothly. Separable bearings such as tapered roller bearings may be checked by individually examining their rolling elements and the outer ring raceway.

Large bearings cannot be rotated manually; however, the rolling elements, raceway surfaces, cages, and contact surface of the ribs should be carefully examined visually. The more important a bearing is, the more carefully it should be inspected.

The determination to reuse a bearing should be made only after considering the degree of bearing wear, the function of the machine, the importance of the bearing in the machine, operating conditions, and the time until the next inspection. However, if any of the following are true, reuse is not possible and replacement is necessary:

- (a) Cracks exist in the inner or outer rings, rolling elements, or cage.
- (b) Flaking is present on the raceway or rolling elements.
- (c) There is significant smearing of the raceway surfaces, ribs, or rolling elements.
- (d) The cage is significantly worn or rivets are loose.
- (e) Rust or scoring is present on the raceway surfaces or rolling elements.
- (f) Any significant impact or brinell traces exist on the raceway surfaces or rolling elements.
- (g) There is significant evidence of creep on the bore or periphery of the outer ring.
- (h) Discoloration by heat is evident.
- (i) Significant damage to the seals or shields of grease-sealed bearings has occurred.

## 1.7 Checking the Shaft and Housing

### 1.7.1 Checking the Shaft

#### (a) Cylindrical Shaft

- (1) Dimensional check of shaft  
Use an outside micrometer to measure the shaft size at the place where the bearing will be mounted to confirm that the bearing size is correct. The measurement positions are shown in Fig. 1.21.
- (2) Check of shaft outside surface  
Check the surface of shaft where the bearing will be mounted for scratches, dents, rust, or stepped wear.
  - If there are scratches or dents:  
Round the edge with an oil stone and/or sandpaper to smooth the surface.

- If there is rust:  
Remove rust with an oil stone and/or sandpaper to smooth the surface.
  - If there is stepped wear:  
After measuring the shaft, determine if correction is possible.
- (3) Anticorrosive agent  
After completing the check, apply an anticorrosive agent.

#### (b) Tapered Shaft

- (1) Check of shaft shape  
Measure the shape of the shaft where the bearing will be mounted to confirm that it is correct. The measurement positions are shown in Fig. 1.22. Use a taper gauge (sine bar system) for measurement (Fig. 1.22).

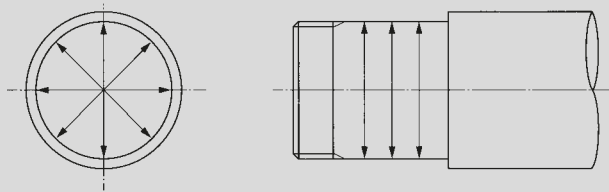


Fig. 1.21 Cylindrical Shaft

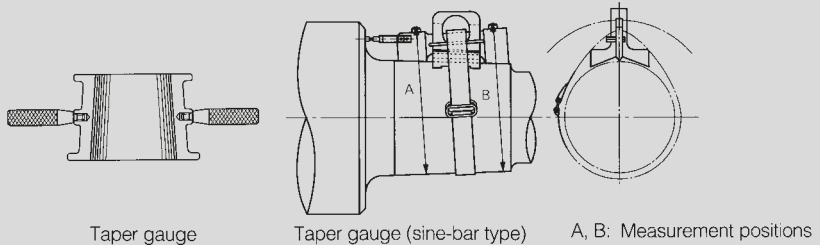


Fig. 1.22 Tapered Shaft

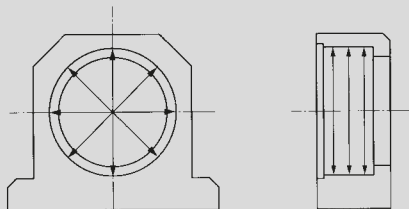


Fig. 1.23 Integrated Housing

**(2) Check of shaft outside surface**

Check the shaft surface where the bearing will be mounted for scratches, dents, rust, or stepped wearing.

- If there are scratches or dents:

Round edge with an oil stone and/or sandpaper to smooth the surface.

- If there is rust:

Remove rust with an oil stone and/or sandpaper to smooth the surface.

Inspect the shape of the tapered section with a taper gauge. Apply a thin coat of bluing over the entire surface of taper gauge bore face, and insert the gauge slowly after matching it to the center of the tapered shaft. Move the gauge back and forth and pull it out slowly. Note the surface of the tapered shaft covered with blue dye.

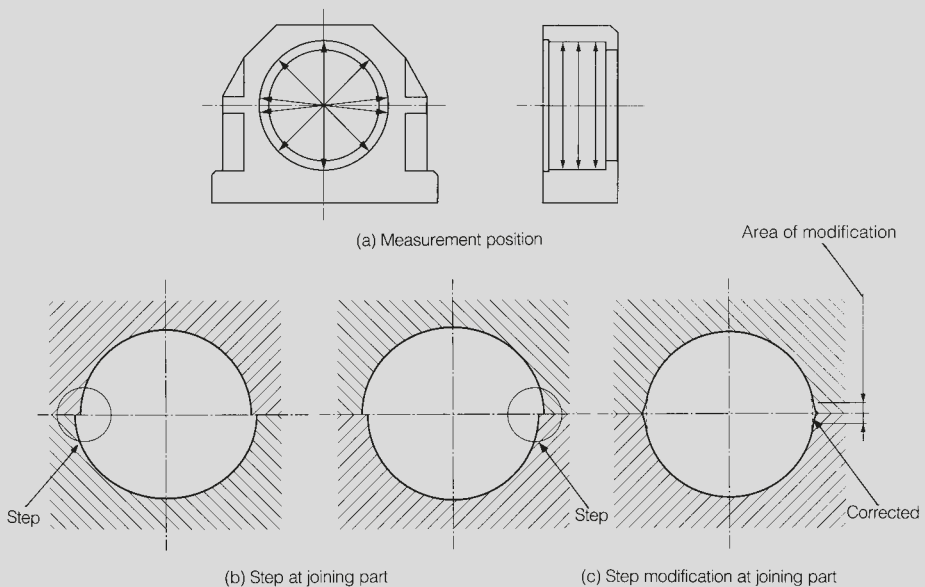
If the blue area is over 80%, the shaft may be reused. When using a sine-bar taper gauge, follow the instructions given by the manufacturer.

- If there is stepped wear:

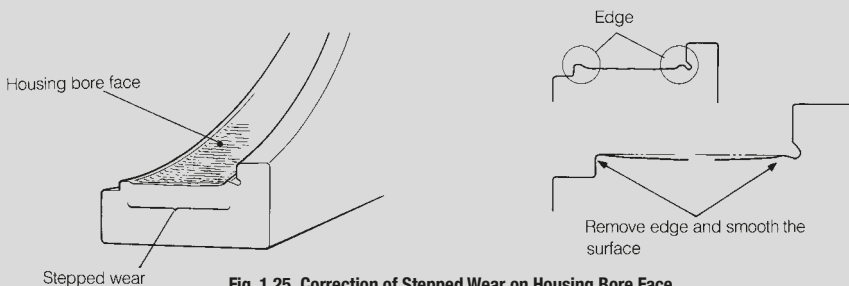
After measuring the shaft, determine if correction is possible.

**(3) Anticorrosive agent**

After completing the check, apply an anticorrosive agent.



**Fig. 1.24 Split Housing**



**Fig. 1.25 Correction of Stepped Wear on Housing Bore Face**

## 1.7.2 Checking the Housing

### (a) Integrated Housing

- (1) Check of housing bore size  
Measure the housing bore where the bearing will be mounted to confirm that the size is correct. The measurement position is shown in Fig. 1.23. Use an inside micrometer for measurement.
- (2) Check of housing bore face  
Check the surface of the housing bore where the bearing will be mounted for scratches, dents, rust, or stepped wear.
  - If there are scratches or dents:  
Round edges with an oil stone and/or sandpaper to smooth the surface.
  - If there is rust:  
Remove rust with an oil stone and/or sandpaper to smooth the surface.
  - If there is stepped wear (Fig. 1.25):  
After measuring the housing bore, decide if correction and reuse is possible. If the measured value of the housing bore is within its tolerance, use an oil stone and/or sandpaper to remove any sections with stepped wear and smooth the surface before reuse. If stepped wear is severe, either plate or apply thermal spraying to reconstitute the correct housing size before reuse.
- (3) Anticorrosive agent  
After completing the check, apply an anticorrosive agent.

### (b) Split Housing

- (1) Check of housing bore size  
When using a split housing, correctly assemble the housing without the bearing and measure bore dimensions at the place where the bearing will be mounted to confirm that the dimensions are correct. The measurement position is shown in Fig. 1.24 (a). Use an inside micrometer for measurement.
- (2) Check of housing bore face  
Check the surface of the housing bore where the bearing will be mounted for scratches, dents, rust, or stepped wear.
  - If there are scratches or dents:  
Round edges with an oil stone and/or sandpaper to smooth the surface.
  - If there is rust:  
Remove rust with an oil stone and/or sandpaper to smooth the surface.
  - If there is stepped wear (Fig. 1.25):  
After measuring the housing bore, decide if correction is possible. If the measured value of the housing bore is within its tolerance, use an oil stone and/or sandpaper to remove any sections with stepped wear and smooth the surface before reuse.
  - If the stepped wear is severe:  
Either plate or apply thermal spraying to reconstitute the correct housing size before reuse.
  - If there is a step:  
Steps may occur where the split halves of the housing join. If a step is found, correct it as shown in Fig. 1.24 (c).
- (3) Anticorrosive agent  
After completing the check, apply an anticorrosive agent.

## **1.8 Maintenance and Inspection**

### **1.8.1 Detecting and Correcting Irregularities**

In order to maintain the original performance of a bearing for as long as possible, proper maintenance and inspection must be performed. If proper procedures are used, many bearing problems can be avoided and the reliability, productivity, and operating costs of the equipment containing the bearings are all improved. Periodic maintenance should be performed following specified procedures. This periodic maintenance encompasses the supervision of operating conditions, the supply or replacement of lubricants, and regular periodic inspection. Items that should be regularly checked during operation include bearing noise, vibration, temperature, and lubrication.

If an irregularity is found during operation, the cause should be determined and proper corrective actions should be taken after referring to Table 1.2. If necessary, the bearing should be dismantled and examined in detail. Refer to Section 1.6 Inspection of Bearings for dismantling and inspection procedures.

## 1.8.2 Diagnosis with Sound and Vibration

### Classification of sounds and vibrations

Sounds and vibration accompany the rotation of rolling bearings. The tone and amplitude of such sounds and vibration vary depending on the type of bearing, mounting conditions, operational conditions, etc. The sounds 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 1.3 below. However, boundaries between groups are not definite. Even if some types of sounds or vibrations are inherent in the bearings, the volume might be related to the manufacturing process. Conversely,

some types of sounds or vibrations, even if caused by manufacturing, cannot be eliminated under normal conditions.

By recording the sounds and vibrations of a rotating machine and analyzing them, the cause may be inferred. As shown by the figures on the next page, a mechanically normal bearing shows a stable waveform. However, a bearing with damage such as a scratch shows a waveform with wide swings indicating large-amplitude sounds at regular intervals (refer to Figs. 1.26 and 1.27).

**Table 1.3 Classification of Sounds and Vibrations in a Rolling Bearing**

	Sound Type		Vibration		Features
Structural	Race noise		Free vibration of raceway ring		Continuous noise: basic unavoidable noise that all bearings generate
	Roller/ball click noise		Free vibration of raceway ring, free vibration of cage		Regular noise at a certain interval: found in large bearings and horizontal shafts, radial loads and low rpm
	Squeal noise		Free vibration of raceway ring		Intermittent or continuous: generally found in large cylindrical roller bearings and under radial load, grease lubrication, and particular speeds
	Cage noise	“CK” sound	Free vibration of cage		Regular noise at a set interval: generated by all bearing types
		“CG” sound	Vibration of cage		Intermittent or continuous: lubrication with certain greases
		Tapping sound	Free vibration of cage		Set interval: slightly irregular under radial load and during initial stage
Rumbling		Vibration from passage of rolling element		Continuous: found in all bearing types under radial load	
Manufacturing	Chatter noise		Vibration due to waviness	Inner ring	Continuous noise
				Outer ring	Continuous noise
				Rolling element	Continuous with rollers, occasional with balls
Handling	Flaw noise		Vibration due to flaw	Inner ring	Regular noise at a set interval
				Outer ring	
				Rolling element	
	Contamination noise		Vibration due to contamination		Irregular
Other	Seal noise		Free vibration of a seal		Contact seal
	Lubricant noise		—		Irregular
	Rumbling		Runout	$f_r$	Continuous
				$f_c$	Continuous
				$f_r - 2f_c$	Continuous

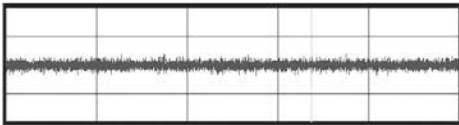
$n$ : Positive integer (1, 2, 3...)

$Z$ : Number of rolling elements

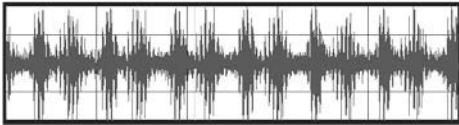
$f_{Bn}$ : Natural frequency of ring in radial bending mode (Hz)

$f_{MI}$ : Natural frequency in the mode of angular vibration in inertia of outer ring-spring system (Hz)

$f_r$ : Rotation frequency of inner ring (Hz)



Sound waveform of a normal bearing



Sound waveform of a scratched bearing

Fig. 1.26

When the inner ring raceway surface is damaged  
 Bore diameter: 100 mm  
 Recording and analysis method: Envelope analysis of sounds recorded by microphone for a test machine  
 Number of rotations: 50 min<sup>-1</sup>

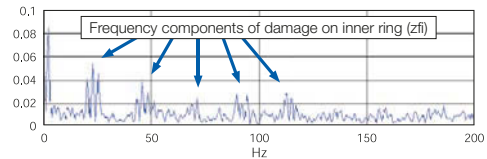


Fig. 1.27

## Generated Frequency (Frequency Analysis)

FFT of Original Wave		FFT After Envelope (Basic No.)	Source	Countermeasures
Radial (Angular) Direction	Axial Direction			
$f_{RIN} \cdot f_{MI}$	$f_{AIN} \cdot f_{AM}$	—	Selective resonance from waviness (rolling friction)	Improve rigidity around bearings, provide appropriate radial clearance, use high-viscosity lubricant and high-quality bearings.
$f_{RIN} \cdot f_{MI}$	$f_{AIN} \cdot f_{AM}$	$Zf_c$	Collision of rolling elements with inner ring or cage	Reduce radial clearance, apply preload, use high-viscosity oil
$(\approx f_{R2N} \cdot f_{R3N})$	—	?	Self-induced vibration caused by sliding friction at rolling surface	Reduce radial clearance, apply preload, change grease, replace with bearings with countermeasures
Natural frequency of cage		$f_c$	Collision of cage with rolling elements or rings	Apply preload, use high-viscosity lubricant, reduce mounting error
Natural frequency of cage		?	Self-induced vibration caused by friction at cage guide surface	Change grease brand, replace with cage with countermeasures
Natural frequency of cage		$Zf_c$	Collision of cage and rolling element caused by grease resistance	Reduce radial clearance, apply preload, use low-viscosity lubricant
$Zf_c$	—	—	Displacement of inner ring due to rolling element passage	Reduce radial clearance, apply preload
$nZf_i \pm f_r (nZ \pm 1 \text{ peaks})$	$nZf_i (nZ \text{ peaks})$	—	Inner ring raceway waviness, irregularity of shaft exterior	Use high-quality bearings, improve shaft accuracy
$nZf_c (nZ \pm 1 \text{ peaks})$	$nZf_c (nZ \text{ peaks})$	—	Outer ring raceway waviness, irregular housing bore	Use high-quality bearings, improve housing bore accuracy
$2nf_b \pm f_c (2n \text{ peaks})$	$2nf_b (2n \text{ peaks})$	—	Rolling element waviness	Use high-quality bearings
$f_{RIN} \cdot f_{MI}$	$f_{AIN} \cdot f_{AM}$	$Zf_i$	Nicks, dents, rust, flaking on inner ring raceway	Replace bearing and take care when handling
		$Zf_c$	Nicks, dents, rust, flaking on inner ring raceway	Replace bearing and take care when handling
		$2f_b$	Nicks, dents, rust, flaking on rolling elements	Replace bearing and take care when handling
$f_{RIN} \cdot f_{MI}$	$f_{AIN} \cdot f_{AM}$	Irregular	Entry of dirt and debris	Wash the bearing, improve sealing
Natural frequency of seal		$(f_s)$	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	Use high-quality bearings
$f_c$	—	—	Ball variation in bearing, rolling elements non-equidistant	Use high-quality bearings
$f_r - 2f_c$	—	—	Non-linear vibration due to rigid variation by ball variation	Use high-quality bearings

$f_c$ : 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 an 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)



## 2. BEARING DAMAGE AND COUNTERMEASURES (Bearing Doctor)

2.1 Bearing Damage .....	B 022
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2.2 Running Traces and Applied Loads .....	B 022
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2.3 Bearing Damage and Countermeasures .....	B 024
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2.3.1 Flaking (Spalling) .....	B 025
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2.3.2 Peeling .....	B 029
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2.3.3 Scoring .....	B 030
---------------------	-------

2.3.4 Smearing .....	B 032
----------------------	-------

2.3.5 Fracture .....	B 034
----------------------	-------

2.3.6 Cracks .....	B 035
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2.3.7 Cage Damage .....	B 037
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2.3.8 Denting .....	B 039
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2.3.9 Pitting .....	B 040
---------------------	-------

2.3.10 Wear .....	B 041
-------------------	-------

2.3.11 Fretting .....	B 043
-----------------------	-------

2.3.12 False Brinelling .....	B 044
-------------------------------	-------

2.3.13 Seizure .....	B 045
----------------------	-------

2.3.14 Creep .....	B 047
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2.3.15 Electrical Corrosion .....	B 048
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2.3.16 Rust and Corrosion .....	B 049
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2.3.17 Mounting Flaws .....	B 050
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2.3.18 Discoloration .....	B 051
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Appendix Bearing Diagnostic Chart .....	B 052
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## 2. BEARING DAMAGE AND COUNTERMEASURES (Bearing Doctor)

### 2.1 Bearing Damage

In general, if rolling bearings are used correctly they will survive to their predicted fatigue life. However, they often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure can be caused by improper mounting, improper handling, improper or insufficient lubrication, entry of foreign matter, or abnormal heat generation.

For instance, the causes of rib scoring may include insufficient lubrication, use of improper lubricant, a faulty lubrication system, entry of foreign matter, bearing mounting error, excessive deflection of the shaft, or any combination of these. Thus, it is difficult to determine the real cause of some premature failures.

If all the conditions at the time of failure and before the failure are known, including the application, operating conditions, and environment, then, by studying the nature of the failure and its probable causes, the possibility of similar future failures can be reduced.

### 2.2 Running Traces and Applied Loads

As the bearing rotates, the raceways of the inner ring and outer ring contact the rolling elements. This results in a wear trace on both the rolling elements and raceways. Running traces are useful because they indicate load conditions; they should be carefully checked when the bearing is disassembled.

If running traces are clearly defined, it is possible to determine whether the bearing was carrying a radial load, axial load, or moment load. Furthermore, the roundness of the bearing can be determined. Check whether unexpected bearing loads or large mounting errors occurred, and determine the probable cause of the bearing damage.

Fig. 2.2 shows running traces generated in deep groove bearings under various load conditions. Fig. 2.2 (a) shows the most common running trace generated when the inner ring rotates under a radial load only. Figs. 2.2 (e) through (h) show several different running traces that reflect a shortened life due to adverse effects on the bearings.

Similarly, Fig. 2.2 shows different roller bearing running traces. Fig. 2.2 (i) shows an outer ring running trace when a radial load is properly applied to a cylindrical roller bearing with a load on a rotating inner ring. Fig. 2.2 (j) shows a running trace resulting from shaft bending or relative inclination between

the inner and outer rings. This misalignment leads to the generation of slightly shaded (dull) bands in the width direction. Traces are diagonal at the beginning and end of the loading zone. Fig. 2.2 (k) shows the running trace on the outer ring under radial load for double-row tapered roller bearings where a single load is applied to the rotating inner ring while Fig. 2.2 (l) shows the running trace on the outer ring under axial load. When misalignment exists between the inner and the outer rings, the application of a radial load causes running traces to appear on the outer ring as shown in Fig. 2.2 (m).

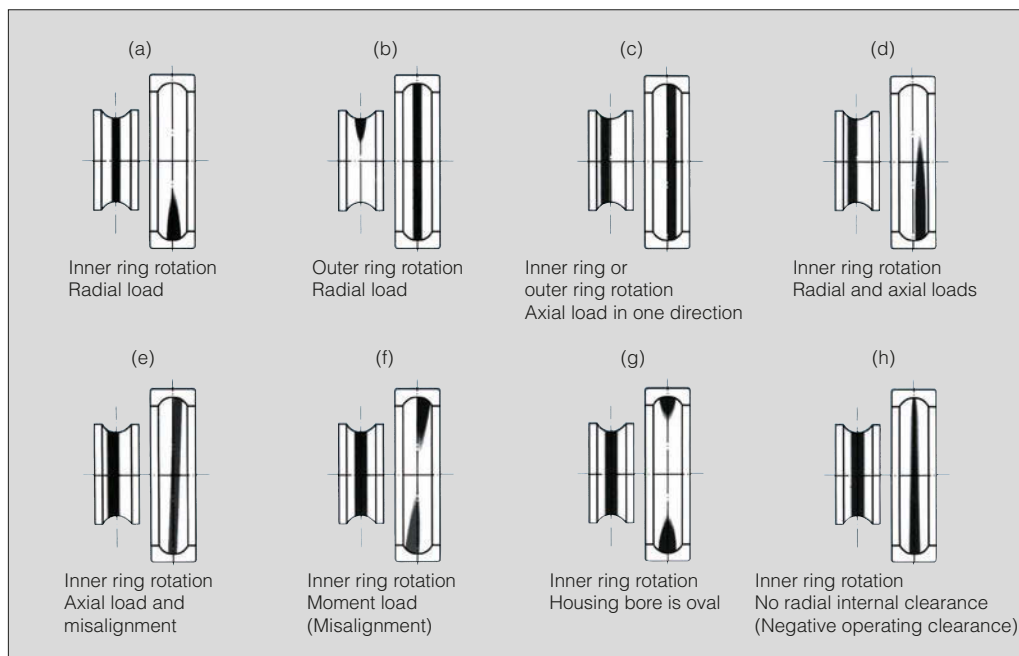


Fig. 2.2 Typical Running Traces of Deep Groove Ball Bearings

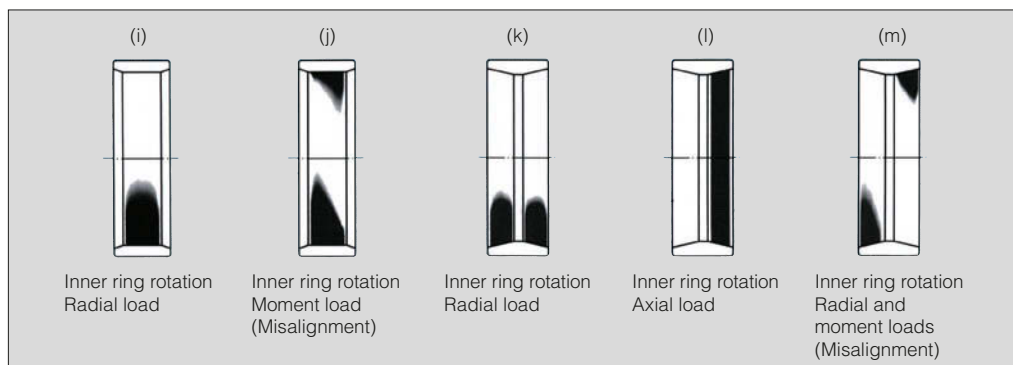


Fig. 2.2 Typical Running Traces of Roller Bearings

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## 2.3 Bearing Damage and Countermeasures

Sections 2.3.1 through 2.3.18 show various types of bearing damage and countermeasures. Please consult these sections when trying to determine the cause of bearing damage. The bearing diagnostic chart in the Appendix on Page B46 may be useful as a quick reference guide.

### 2.3.1 Flaking (Spalling)

Damage	Possible Causes	Countermeasures
Small pieces of bearing material split off from the smooth surface of the raceway or rolling elements due to rolling fatigue and create regions with a rough and coarse texture.	<ul style="list-style-type: none"> <li>• Excessive load</li> <li>• Poor mounting (misalignment)</li> <li>• Moment load</li> <li>• Entry of foreign debris or water</li> <li>• Poor lubrication, improper lubricant</li> <li>• Unsuitable bearing clearance</li> <li>• Improper precision of shaft or housing, unevenness in housing rigidity, large shaft bending</li> <li>• Rust, corrosion pits, smearing, dents (Brinelling)</li> </ul>	<ul style="list-style-type: none"> <li>➢ Reconfirm the bearing application and check load conditions</li> <li>➢ Improve the mounting method</li> <li>➢ Improve the sealing mechanism, prevent rusting during idle periods</li> <li>➢ Use a lubricant with the proper viscosity, improve the lubrication method</li> <li>➢ Check the precision of the shaft and housing</li> <li>➢ Check the bearing internal clearance</li> </ul>



**Photo 1-1**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Flaking around half of the circumference of the raceway surface  
**Cause:** Poor lubrication due to entry of cutting coolant into bearing



**Photo 1-2**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Flaking diagonally along raceway  
**Cause:** Poor alignment between shaft and housing during mounting



**Photo 1-3**

**Part:** Outer ring of Photo 1-4  
**Symptom:** Flaking of raceway surface at ball pitch  
**Cause:** Dents due to shock load while stationary



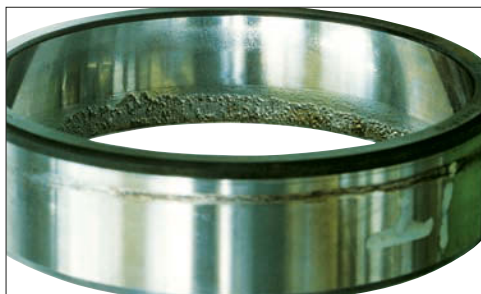
**Photo 1-4**

**Part:** Balls of Photo 1-3  
**Symptom:** Flaking of ball surface  
**Cause:** Dents due to shock load while stationary



**Photo 1-5**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Flaking of only one raceway over its entire circumference  
**Cause:** Excessive axial load



**Photo 1-6**

**Part:** Outer ring of Photo 1-5  
**Symptom:** Flaking of only one raceway over its entire circumference  
**Cause:** Excessive axial load



**Photo 1-7**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Flaking of one raceway (loading area)  
**Cause:** Poor lubrication



**Photo 1-8**

**Part:** Rollers of a cylindrical roller bearing  
**Symptom:** Premature flaking of rolling surfaces axially  
**Cause:** Scratches caused during improper mounting



**Photo 1-9**

**Part:** Outer ring of a four-row tapered roller bearing  
**Symptom:** Flaking of raceway (loading area)  
**Cause:** Excessive moment load



**Photo 1-10**

**Part:** Enlargement of raceway surface in Photo 1-9  
**Symptom:** Flaking of one side of the raceway  
**Cause:** Excessive pressure due to misalignment

**Photo 1-11**

**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Discoloration and flaking on outer ring raceway surface  
**Cause:** Poor lubrication under high temperatures

**Photo 1-12**

**Part:** Outer ring of a cylindrical roller bearing for Sendzimir mills  
**Symptom:** Flaking of outside surface  
**Cause:** Progression of fatigue in outer ring material (Prolonged grinding on outer ring outside surface)

**Photo 1-13**

**Part:** Inner ring of a cylindrical roller bearing for Sendzimir mills  
**Symptom:** Flaking of the raceway surface  
**Cause:** Severe operating conditions and low-viscosity oil lubrication

**Photo 1-14**

**Part:** Roller of a cylindrical roller bearing  
**Symptom:** Flaking of rolling surfaces  
**Cause:** Progression from a flaw or crack in roller during mounting

**Photo 1-15**

**Part:** Inner ring of deep groove ball bearing  
**Symptom:** Flaking of raceway at ball pitch  
**Cause:** Dents due to shock load during mounting

**Photo 1-16**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Flaking of raceway at ball pitch  
**Cause:** Dents due to shock load while stationary

## Example 1. Combined Flaking Damage



**Photo 1-15**

**Part:** Outer ring of a cylindrical roller bearing  
**Symptom:** Rust, flaking, and crack on raceway surface  
**Cause:** Rust at the pitch interval led to flaking during operation. Further operation resulted in cracking.

## Example 2. Combined Flaking Damage



**Photo 1-16**

**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Flaking, cracking, and wear combined on the outer ring raceway  
**Cause:** Wear in two places due to poor lubrication (primary damage) progressed to flaking in one spot (secondary damage) that later became a crack (tertiary damage).

### 2.3.2 Peeling

Damage	Possible Causes	Countermeasures
Dull or cloudy spots appear on the bearing surface along with light wear. Tiny cracks are generated from these dull spots downward to a depth of 5 to 10 $\mu\text{m}$ . Small particles fall off and extensive minor flaking occurs.	<ul style="list-style-type: none"> <li>• Unsuitable lubricant</li> <li>• Entry of debris into lubricant</li> <li>• Rough surface due to poor lubrication</li> <li>• Surface roughness of mating parts</li> </ul>	<ul style="list-style-type: none"> <li>➢ Select a different lubricant</li> <li>➢ Improve the sealing mechanism</li> <li>➢ Improve the surface finish of the mating parts</li> </ul>



**Photo 2-1**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Round peeling on the center of the raceway surface  
**Cause:** Poor lubrication



**Photo 2-2**

**Part:** Enlargement of pattern in Photo 2-1



**Photo 2-3**

**Part:** Convex rollers from Photo 2-1  
**Symptom:** Round peeling on the center of the rolling surfaces  
**Cause:** Poor lubrication



**Photo 2-4**

**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Peeling near the shoulder of the raceway over the entire circumference  
**Cause:** Poor lubrication

### 2.3.3 Scoring

Damage	Possible Causes	Countereasures
<p>Surface damage due to accumulated small seizures caused by sliding under improper lubrication or under severe operating conditions.</p> <p>Linear damage appears circumferentially on the raceway surface and rolling surface.</p> <p>Cycloidal shaped damage appears on the roller end, while scoring on the rib surface appears on the contacting roller end.</p>	<ul style="list-style-type: none"> <li>Excessive load, excessive preload</li> <li>Poor lubrication</li> <li>Particles caught in the surface</li> <li>Inclination of inner and outer rings</li> <li>Shaft bending</li> <li>Poor precision of the shaft and housing</li> </ul>	<ul style="list-style-type: none"> <li>Check the size of the load</li> <li>Adjust the preload</li> <li>Improve the lubricant and the lubrication method</li> <li>Check the precision of the shaft and housing</li> </ul>



**Photo 3-1**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Scoring on large rib face of inner ring  
**Cause:** Roller slippage due to sudden acceleration and deceleration



**Photo 3-2**

**Part:** Convex rollers of Photo 3-1  
**Symptom:** Scoring on roller end face  
**Cause:** Roller slippage due to sudden acceleration and deceleration



**Photo 3-3**

**Part:** Inner ring of a tapered roller thrust bearing  
**Symptom:** Scoring on the face of inner ring rib  
**Cause:** Worn particles mixed with lubricant and breakdown of oil film due to excessive load



**Photo 3-4**

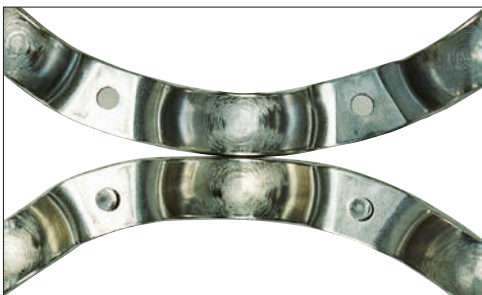
**Part:** Rollers of a double-row cylindrical roller bearing  
**Symptom:** Scoring on the roller end face  
**Cause:** Poor lubrication and excessive axial load

**Photo 3-5**

**Part:** Inner ring of a spherical thrust roller bearing  
**Symptom:** Scoring on the rib face of inner ring  
**Cause:** Debris caught in the surface and excessive axial load

**Photo 3-6**

**Part:** Convex rollers of Photo 3-5  
**Symptom:** Scoring on the roller end face  
**Cause:** Debris caught in surface and excessive axial load

**Photo 3-7**

**Part:** Cage of a deep groove ball bearing  
**Symptom:** Scoring on the pressed-steel cage pockets  
**Cause:** Entry of debris

**Photo 3-8**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Notable scoring on the face of an outer ring rib  
**Cause:** Excessive axial load

## 2.3.4 Smearing

Damage	Possible Causes	Countereasures
Surface damage that occurs from many small seizures between bearing components caused by oil film rupture and/or sliding. Surface roughening occurs along with melting.	<ul style="list-style-type: none"> <li>• High speed and light load</li> <li>• Sudden acceleration/deceleration</li> <li>• Improper lubricant</li> <li>• Entry of water</li> </ul>	<ul style="list-style-type: none"> <li>➢ Improve the preload</li> <li>➢ Improve the bearing clearance</li> <li>➢ Use a lubricant with good oil film formation</li> <li>➢ Improve the lubrication method</li> <li>➢ Improve the sealing mechanism</li> </ul>



**Photo 4-1**

**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Smearing circumferentially on raceway surface  
**Cause:** Roller slippage due to excessive grease filling



**Photo 4-2**

**Part:** Outer ring of Photo 4-1  
**Symptom:** Smearing circumferentially on raceway surface  
**Cause:** Roller slippage due to excessive grease filling



**Photo 4-3**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Smearing circumferentially on raceway surface  
**Cause:** Poor lubrication

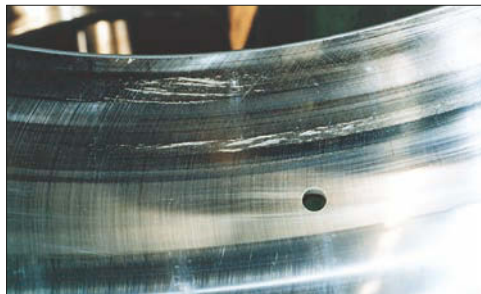


**Photo 4-4**

**Part:** Outer ring of Photo 4-3  
**Symptom:** Smearing circumferentially on raceway surface  
**Cause:** Poor lubrication

**Photo 4-5**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Partial smearing circumferentially on raceway surface  
**Cause:** Poor lubrication

**Photo 4-6**

**Part:** Outer ring of Photo 4-5  
**Symptom:** Partial smearing circumferentially on raceway surface  
**Cause:** Poor lubrication

**Photo 4-7**

**Part:** Convex rollers of Photo 4-5  
**Symptom:** Smearing at the center of the rolling surface  
**Cause:** Poor lubrication

**Photo 4-8**

**Part:** Rollers of a large cylindrical roller bearing  
**Symptom:** Smearing on rolling surface  
**Cause:** Light load and poor lubrication

**Photo 4-9**

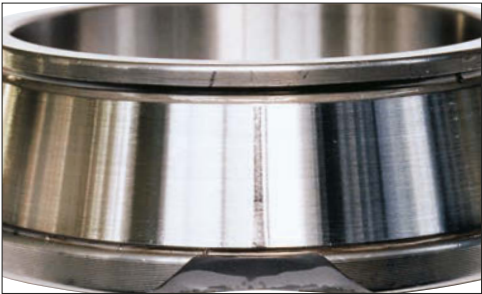
**Part:** Outer ring of a large tapered roller bearing  
**Symptom:** Smearing on outer ring raceway surface  
**Cause:** High speed, light load, and poor lubrication

### 2.3.5 Fracture

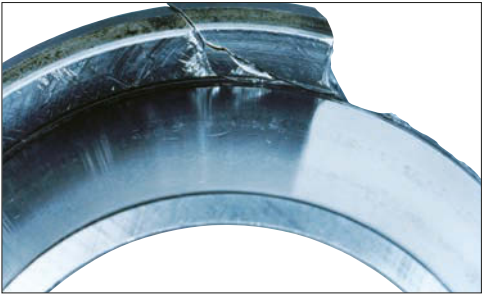
Damage	Possible Causes	Countermeasures
Small pieces broken off due to excessive load or shock load act locally on a part of the roller corner or rib of a raceway ring.	<ul style="list-style-type: none"> <li>• Shock during mounting</li> <li>• Excessive load</li> <li>• Poor handling, such as dropping</li> </ul>	<ul style="list-style-type: none"> <li>➢ Improve the mounting method (shrink fit, use of proper tools)</li> <li>➢ Reconsider load conditions</li> <li>➢ Provide enough backup and support for the bearing rib</li> </ul>



**Photo 5-1**  
**Part:** Inner ring of a double-row cylindrical roller bearing  
**Symptom:** Chipping at the center rib  
**Cause:** Excessive load during mounting



**Photo 5-2**  
**Part:** Inner ring of a tapered roller bearing  
**Symptom:** Fracture at the large rib  
**Cause:** Large shock during mounting



**Photo 5-3**  
**Part:** Inner ring of a spherical thrust roller bearing  
**Symptom:** Fracture at the large rib  
**Cause:** Repeated load



**Photo 5-4**  
**Part:** Outer ring of a solid type needle roller bearing  
**Symptom:** Fracture at the outer ring rib  
**Cause:** Roller inclination due to excessive loading (needle rollers are long compared to their diameter; under excessive or uneven loading, rollers become inclined and push against the ribs)

### 2.3.6 Cracks

Damage	Possible Causes	Countermeasures
Fissures in the raceway ring and rolling elements. Continued use in this condition leads to larger cracks or fractures.	<ul style="list-style-type: none"> <li>• Excessive interference</li> <li>• Excessive load, shock load</li> <li>• Progression of flaking</li> <li>• Heat generation and fretting caused by contact between mounting parts and raceway ring</li> <li>• Heat generation due to creep</li> <li>• Poor taper angle of tapered shaft</li> <li>• Poor cylindricality of shaft</li> <li>• Interference with bearing chamfer due to a large shaft corner radius</li> </ul>	<ul style="list-style-type: none"> <li>➢ Correct the interference</li> <li>➢ Check load conditions</li> <li>➢ Improve the mounting method</li> <li>➢ Use an appropriate shaft shape</li> </ul>



**Photo 6-1**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Thermal cracks on the outer ring side face  
**Cause:** Abnormal heat generation due to contact sliding between the mating part and face of outer ring



**Photo 6-2**

**Part:** Roller of a tapered roller thrust bearing  
**Symptom:** Thermal cracks at large end face of roller  
**Cause:** Heat generation due to sliding with the inner ring rib under poor lubrication



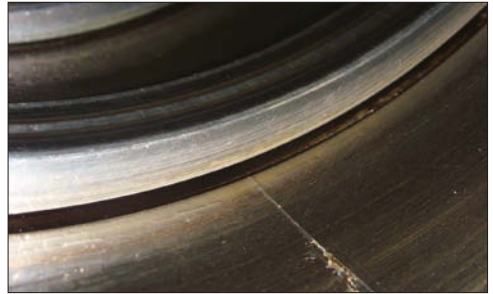
**Photo 6-3**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Cracks propagated outward in the axial and circumferential directions from the flaking origin on the raceway surface  
**Cause:** Flaking from a flaw due to shock load



**Photo 6-4**

**Part:** Outer ring of a double-row cylindrical roller bearing (outer ring rotation)  
**Symptom:** Cracks on outside surface  
**Cause:** Flat wear and heat generation due to non-rotation of the outer ring



**Photo 6-5**

**Part:** Outer ring of a cylindrical roller bearing for Sendzimir mills  
**Symptom:** Fatigue crack on outer ring raceway surface  
**Cause:** Bending stress (large rotating outer ring load)



**Photo 6-6**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Axial cracks on raceway surface  
**Cause:** Large fitting stress due to temperature difference between shaft and inner ring



**Photo 6-7**

**Part:** Cross section of a fractured inner ring in Photo 6-6  
**Symptom:** Flaking origin directly beneath the raceway surface



**Photo 6-8**

**Part:** Roller of a spherical roller bearing  
**Symptom:** Axial cracks on rolling surface



**Photo 6-9**

**Part:** Outer ring of four-row tapered roller bearing  
**Symptom:** Secondary damage after flaking on outer ring raceway surface

### 2.3.7 Cage Damage

Damage	Possible Causes	Countermeasures
Various damage including cage deformation, fracture, and wear; fracture of cage pillar; deformation of side face; and wear of pocket surface or guide surface.	<ul style="list-style-type: none"> <li>• Poor mounting (bearing misalignment)</li> <li>• Poor handling</li> <li>• Large moment load</li> <li>• Shock and large vibration</li> <li>• Excessive rotation speed, sudden acceleration/deceleration</li> <li>• Poor lubrication</li> <li>• Temperature rise</li> </ul>	<ul style="list-style-type: none"> <li>➢ Check the mounting method</li> <li>➢ Check the temperature, rotation, and load conditions</li> <li>➢ Reduce vibration</li> <li>➢ Select a different cage type</li> <li>➢ Select a different lubrication method or lubricant</li> </ul>



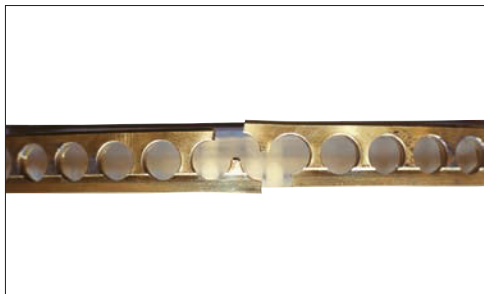
**Photo 7-1**

**Part:** Cage of a deep groove ball bearing  
**Symptom:** Fracture of pressed-steel cage pocket



**Photo 7-2**

**Part:** Cage of an angular contact ball bearing  
**Symptom:** Pocket pillar fractures from a cast-iron machined cage  
**Cause:** Abnormal load action on cage due to misaligned mounting between inner and outer rings



**Photo 7-3**

**Part:** Cage of an angular contact ball bearing  
**Symptom:** Fracture of machined high-tension-brass cage



**Photo 7-4**

**Part:** Cage of a tapered roller bearing  
**Symptom:** Pillar fractures of pressed-steel cage



**Photo 7-5**

**Part:** Cage of an angular contact ball bearing  
**Symptom:** Pressed-steel cage deformation  
**Cause:** Shock load due to poor handling



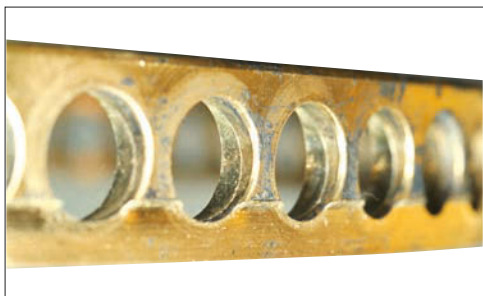
**Photo 7-6**

**Part:** Cage of a cylindrical roller bearing  
**Symptom:** Deformation of the side face of a machined high-tension-brass cage  
**Cause:** Large shock load during mounting



**Photo 7-7**

**Part:** Cage of a cylindrical roller bearing  
**Symptom:** Deformation and wear of a machined high-tension-brass cage



**Photo 7-8**

**Part:** Cage of an angular contact ball bearing  
**Symptom:** Stepped wear on the outside surface and pocket surface of a machined high-tension-brass cage

### 2.3.8 Denting

Damage	Possible Causes	Countermeasures
When debris such as small metallic particles are caught in the rolling contact zone, denting occurs on the raceway surface or rolling element surface. Denting can occur at the rolling element pitch interval if there is a shock during mounting (Brinell dents).	<ul style="list-style-type: none"> <li>• Debris such as metallic particles caught in the surface</li> <li>• Excessive load</li> <li>• Shock during transport or mounting</li> </ul>	<ul style="list-style-type: none"> <li>➢ Wash the housing</li> <li>➢ Improve the sealing mechanism</li> <li>➢ Filter the lubrication oil</li> <li>➢ Improve the mounting and handling methods</li> </ul>



**Photo 8-1**  
**Part:** Inner ring of a double-row tapered roller bearing  
**Symptom:** Frosted raceway surface  
**Cause:** Debris caught in the surface



**Photo 8-2**  
**Part:** Outer ring of a double-row tapered roller bearing  
**Symptom:** Indentations on raceway surface  
**Cause:** Debris caught in the surface



**Photo 8-3**  
**Part:** Inner ring of a tapered roller bearing  
**Symptom:** Small and large indentations over entire raceway surface  
**Cause:** Debris caught in the surface



**Photo 8-4**  
**Part:** Tapered rollers of Photo 8-3  
**Symptom:** Small and large indentations over the rolling surface  
**Cause:** Debris caught in the surface

### 2.3.9 Pitting

Damage	Possible Causes	Countermeasures
The surface of the rolling element or raceway has small holes and a dull luster.	<ul style="list-style-type: none"> <li>• Debris caught in the lubricant</li> <li>• Exposure to moisture in the atmosphere</li> <li>• Poor lubrication</li> </ul>	<ul style="list-style-type: none"> <li>➢ Improve the sealing mechanism</li> <li>➢ Filter the lubrication oil thoroughly</li> <li>➢ Use another appropriate lubricant</li> </ul>



**Photo 9-1**

**Part:** Outer ring of a slewing bearing

**Symptom:** Pitting on the raceway surface

**Cause:** Rust at bottom of indentations



**Photo 9-2**

**Part:** Ball of Photo 9-1

**Symptom:** Pitting on the rolling element surface

### 2.3.10 Wear

Damage	Possible Causes	Countermeasures
Surface deterioration due to sliding friction at the surface of the raceway, rolling elements, roller end faces, rib face, cage pockets, etc.	<ul style="list-style-type: none"> <li>• Entry of debris</li> <li>• Progression from rust and electrical corrosion</li> <li>• Poor lubrication</li> <li>• Sliding due to irregular motion of rolling elements</li> </ul>	<ul style="list-style-type: none"> <li>➢ Improve the sealing mechanism</li> <li>➢ Clean the housing</li> <li>➢ Filter the lubrication oil thoroughly</li> <li>➢ Check the lubricant and lubrication method</li> <li>➢ Prevent misalignment</li> </ul>



**Photo 10-1**  
**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Pits and wave-shaped wear on raceway surface  
**Cause:** Electrical erosion



**Photo 10-2**  
**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Wear with a wavy or concave-and-convex texture on loaded side of raceway surface  
**Cause:** Entry of debris under repeated vibration while stationary



**Photo 10-3**  
**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Wear on loaded side of raceway surface  
**Cause:** Low speed, heavy load, and poor lubrication (no oil film)



**Photo 10-4**  
**Part:** Outer ring of a spherical roller bearing (enlargement)  
**Symptom:** Combined flaking and wear on the raceway  
**Cause:** Insufficient oil film due to poor lubrication led to wear (primary damage) that progressed to flaking (secondary damage)



**Photo 10-5**

**Part:** Outer ring of a tapered roller bearing  
**Symptom:** Wear on outer ring raceway surface  
**Cause:** Insufficient oil film and wear due to poor lubrication



**Photo 10-6**

**Part:** Inner ring of a double-row tapered roller bearing  
**Symptom:** Fretting wear of raceway and stepped wear on the rib face  
**Cause:** Progression of fretting due to excessive load while stationary



**Photo 10-7**

**Part:** Tapered rollers of Photo 10-6  
**Symptom:** Stepped wear on the roller head and face  
**Cause:** Progression of fretting due to excessive load while stationary

### 2.3.11 Fretting

Damage	Possible Causes	Countermeasures
A type of wear due to repeated sliding between two surfaces. Fretting occurs at the fitting surface and at the contact area between the raceway ring and rolling elements. Fretting corrosion is another term used to describe reddish brown or black worn particles.	<ul style="list-style-type: none"> <li>• Poor lubrication</li> <li>• Vibration with a small amplitude</li> <li>• Insufficient interference</li> </ul>	<ul style="list-style-type: none"> <li>➢ Use a proper lubricant</li> <li>➢ Apply a preload</li> <li>➢ Check the interference fit</li> <li>➢ Apply a film of lubricant to the fitting surface</li> </ul>



**Photo 11-1**

**Part:** Inner ring of a deep groove ball bearing  
**Symptom:** Fretting on the bore surface  
**Cause:** Vibration



**Photo 11-2**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Notable fretting over entire circumference of bore surface  
**Cause:** Insufficient interference fit



**Photo 11-3**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Fretting on the raceway surface at roller pitch intervals

## 2.3.12 False Brinelling

Damage	Possible Causes	Countermeasures
Hollow spots that resemble Brinell dents that are due to wear caused by vibration and swaying at the contact points between the rolling elements and raceway.	<ul style="list-style-type: none"> <li>• Oscillation and vibration of a stationary bearing during transport, etc.</li> <li>• Oscillating motion with a small amplitude</li> <li>• Poor lubrication</li> </ul>	<ul style="list-style-type: none"> <li>➢ Secure the shaft and housing during transport</li> <li>➢ Transport with the inner and outer rings packed separately</li> <li>➢ Reduce vibration by preloading</li> <li>➢ Use another appropriate lubricant</li> </ul>



**Photo 12-1**

**Part:** Inner ring of a deep groove ball bearing  
**Symptom:** False brinelling on the raceway  
**Cause:** Vibration from an external source while stationary



**Photo 12-2**

**Part:** Outer ring of Photo 12-1  
**Symptom:** False brinelling on the raceway  
**Cause:** Vibration from an external source while stationary



**Photo 12-3**

**Part:** Outer ring of a thrust ball bearing  
**Symptom:** False brinelling of raceway surface at ball pitch  
**Cause:** Repeated vibration with a small oscillating angle



**Photo 12-4**

**Part:** Rollers of a cylindrical roller bearing  
**Symptom:** False brinelling on rolling surface  
**Cause:** Vibration from an external source while stationary

### 2.3.13 Seizure

Damage	Possible Causes	Countermeasures
When sudden overheating occurs during rotation, the bearing becomes discolored. If operation continues, the raceway rings, rolling elements, and cage will soften, melt, and deform as damage accumulates.	<ul style="list-style-type: none"> <li>• Poor lubrication</li> <li>• Excessive load (excessive preload)</li> <li>• Excessive rotational speed</li> <li>• Excessively small internal clearance</li> <li>• Entry of water and debris</li> <li>• Poor precision of shaft and housing, excessive shaft bending</li> </ul>	<ul style="list-style-type: none"> <li>➢ Review the lubricant and lubrication method</li> <li>➢ Re-investigate the suitability of the bearing type selected</li> <li>➢ Review the preload, bearing clearance, and fitting</li> <li>➢ Improve the sealing mechanism</li> <li>➢ Check the precision of the shaft and housing</li> <li>➢ Improve the mounting method</li> </ul>



**Photo 13-1**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Discoloration and melting of raceway.  
Worn particles from the cage rolled off and attached to the raceway.  
**Cause:** Insufficient lubrication



**Photo 13-2**

**Part:** Convex rollers of Photo 13-1  
**Symptom:** Discoloration and melting of roller rolling surface, adhesion of worn particles from cage  
**Cause:** Insufficient lubrication



**Photo 13-3**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Raceway discoloration, melting at ball pitch intervals  
**Cause:** Excessive preload



**Photo 13-4**

**Part:** Outer ring in Photo 13-3  
**Symptom:** Raceway discoloration, melting at ball pitch intervals  
**Cause:** Excessive preload



**Photo 13-5**

**Part:** Balls and cage of Photo 13-3  
**Symptom:** Cage damaged by melting, balls discolored and melted  
**Cause:** Excessive preload



**Photo 13-6**

**Part:** Rollers of a large tapered roller bearing  
**Symptom:** Seizure at large end face of roller  
**Cause:** Poor lubrication and excessive axial load



**Photo 13-7**

**Part:** Cylindrical roller bearing  
**Symptom:** Seizure of roller at ring raceway surface  
**Cause:** Excessively small internal clearance generated heat from motion of the inner ring and rollers under high speed and light load

### 2.3.14 Creep

Damage	Possible Causes	Countermeasures
A phenomenon in bearings where relative slippage occurs at the fitting surfaces. Creep causes a shiny appearance, occasionally with scoring or wear.	<ul style="list-style-type: none"> <li>• Insufficient interference or loose fit</li> <li>• Insufficient sleeve tightening</li> </ul>	<ul style="list-style-type: none"> <li>➢ Check interference and prevent rotation</li> <li>➢ Correct the sleeve tightening</li> <li>➢ Review precision of the shaft and housing</li> <li>➢ Apply axial preload</li> <li>➢ Tighten the raceway ring side face</li> <li>➢ Apply adhesive to the fitting surface</li> <li>➢ Apply a film of lubricant to the fitting surface</li> </ul>



**Photo 14-1**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Creep accompanied by scoring of bore surface  
**Cause:** Insufficient interference



**Photo 14-2**

**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Creep over entire circumference of outside surface  
**Cause:** Loose fit between outer ring and housing

### 2.3.15 Electrical Erosion

Damage	Possible Causes	Countermeasures
When electric current passes through a bearing, arcing and burning occur throughout the thin oil film at points of contact between the race and rolling elements. The points of contact are melted locally to form "fluting" or groove-like corrugations which can be seen by the naked eye. Magnification of these grooves reveals crater-like depressions that indicate melting by arcing.	<ul style="list-style-type: none"> <li>• Electric potential difference between inner and outer rings</li> <li>• High-frequency electric potential difference generated by instruments or substrates used near a bearing.</li> </ul>	<ul style="list-style-type: none"> <li>➢ Design electric circuits that prevent current flow through the bearings</li> <li>➢ Insulate the bearing</li> </ul>



**Photo 15-1**  
**Part:** Inner ring of a tapered roller bearing  
**Symptom:** Striped pattern of erosion on the raceway surface



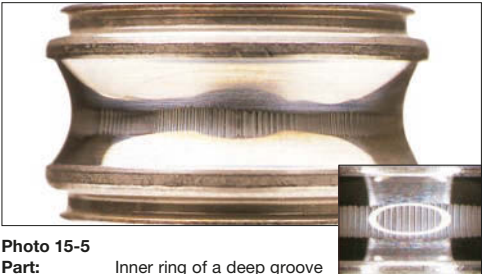
**Photo 15-2**  
**Part:** Tapered rollers in Photo 15-1  
**Symptom:** Striped pattern of erosion on the rolling surface



**Photo 15-3**  
**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Belt pattern of electrical erosion accompanied by pits on the raceway surface



**Photo 15-4**  
**Part:** Balls of a deep groove ball bearing  
**Symptom:** A dark color covering the entire ball surface



**Photo 15-5**  
**Part:** Inner ring of a deep groove ball bearing  
**Symptom:** Fluting on the raceway surface (high frequency)



**Photo 15-6**  
**Part:** Outer ring of a deep groove ball bearing  
**Symptom:** Fluting on the raceway surface (high frequency)

### 2.3.16 Rust and Corrosion

Damage	Possible Causes	Countermeasures
Pits on the surface of rings and rolling elements. These may occur at the rolling element pitch on the rings or over entire bearing surfaces.	<ul style="list-style-type: none"> <li>• Entry of corrosive gas or water</li> <li>• Improper lubricant</li> <li>• Formation of water droplets due to condensation</li> <li>• High temperature and high humidity while stationary</li> <li>• Poor rust preventive treatment during transport</li> <li>• Improper storage conditions</li> <li>• Improper handling</li> </ul>	<ul style="list-style-type: none"> <li>➢ Improve the sealing mechanism</li> <li>➢ Review the lubrication method</li> <li>➢ Apply an anti-rust treatment during idle periods</li> <li>➢ Improve storage methods</li> <li>➢ Improve handling</li> </ul>



Photo 16-1

**Part:** Outer ring of a cylindrical roller bearing  
**Symptom:** Rust on the rib face and raceway surface  
**Cause:** Poor lubrication due to water entry



Photo 16-2

**Part:** Outer ring of a slewing ring  
**Symptom:** Rust on raceway surface at ball pitch  
**Cause:** Condensation during stationary periods



Photo 16-3

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Rust on raceway surface at roller pitch  
**Cause:** Entry of water into lubricant

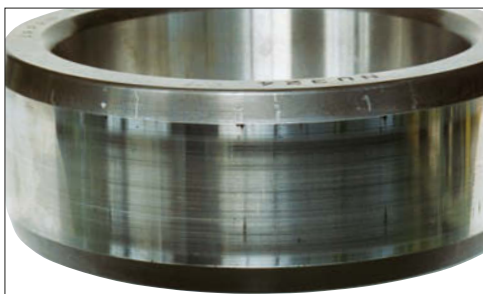


Photo 16-4

**Part:** Rollers of a spherical roller bearing  
**Symptom:** Pit-shaped rust on rolling contact surface, corroded portions  
**Cause:** Condensation during storage

## 2.3.17 Mounting Flaws

Damage	Possible Causes	Countermeasures
Straight-line scratches on surface of raceways or rolling elements caused during mounting or dismounting.	<ul style="list-style-type: none"> <li>• Inclination of inner and outer rings during mounting or dismounting</li> <li>• Shock load during mounting or dismounting</li> </ul>	<ul style="list-style-type: none"> <li>➢ Use appropriate jigs and tools</li> <li>➢ Avoid shock load by using a press machine</li> <li>➢ Center the relative mating parts during mounting</li> </ul>



**Photo 17-1**

**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Axial scratches on raceway surface  
**Cause:** Inclination of inner and outer rings during mounting



**Photo 17-2**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Axial scratches at roller pitch intervals on raceway surface  
**Cause:** Inclination of inner and outer rings during mounting

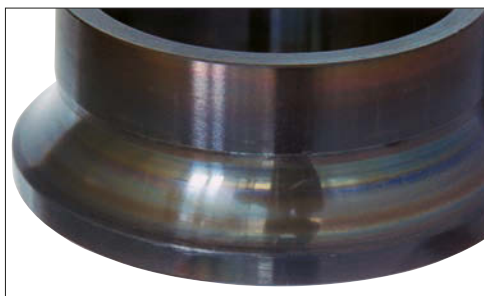


**Photo 17-3**

**Part:** Rollers of a cylindrical roller bearing  
**Symptom:** Axial scratches on rolling surface  
**Cause:** Inclination of inner and outer rings during mounting

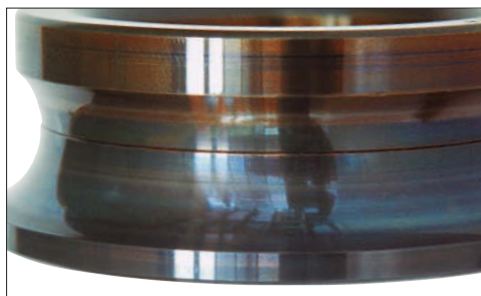
### 2.3.18 Discoloration

Damage	Possible Causes	Countermeasures
Changed coloring of cage, rolling elements, or raceway ring due to reactions with lubricant and high temperature.	<ul style="list-style-type: none"> <li>• Poor lubrication</li> <li>• Oil stain due to a reaction with lubricant</li> <li>• High temperature</li> </ul>	➤ Improve the lubrication method



**Photo 18-1**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Bluish or purplish discoloration on raceway surface  
**Cause:** Heat generation due to poor lubrication



**Photo 18-2**

**Part:** Inner ring of a four-point contact ball bearing  
**Symptom:** Bluish or purplish discoloration on raceway surface  
**Cause:** Heat generation due to poor lubrication

# Appendix: Bearing Diagnostic Chart

Damage	Location (Phenomenon)	Cause												Remarks	
		Handling		Bearing Surroundings			Lubri-cation	Load		Speed					
		Storage, Transport	Mounting	Shaft, Housing	Seal, Water, Debris	Temperature	Lubricant	Lubrication Method	Excessive Load, Shock Load	Moment Load	Ultra-Small Load	High Speed, High Acceleration/Deceleration	Shaking, Vibration, Stationary		
2.3.1 Flaking (Spalling)	Raceway, rolling surface		○	○	○		○	○	○	○				○	
2.3.2 Peeling	Raceway, rolling surface				○		○	○			○	○			
	Bearing outside surface (rolling contact)			○*	○		○	○							*Mating part
2.3.3 Scoring	Roller end face surface, rib surface		○	○	○		○	○	○	○		○			
	Cage guide surface, pocket surface		○		○		○	○							
2.3.4 Smearing	Raceway, rolling surface				○		○	○			○	○			
2.3.5 Fracture	Raceway collar, rollers	○	○	○					○	○					
2.3.6 Cracks	Raceway rings, rolling elements		○	○		○			○	○					
	Rib surface, roller end face, cage guide surface (thermal crack)			○				○	○	○					
2.3.7 Cage damage	Deformation, fracture		○	○					○	○					
	Wear		○		○		○	○	○	○		○			
2.3.8 Denting	Raceway, rolling surface, (many small dents)				○			○							
	Raceway (debris on the rolling element pitch)	○	○						○				○		
2.3.9 Pitting	Raceway, rolling surface				○		○	○							
2.3.10 Wear	Raceway, rolling surface, rib surface, roller end face		○		○		○	○							
2.3.11 Fretting	Raceway, rolling surface	○	○	○			○	○	○			○	○		
	Bearing outside & bore, side surface (contact with housing and shaft)		○	○					○						
2.3.12 False brinelling	Raceway, rolling surface	○					○	○					○		
2.3.13 Seizure	Raceway ring, rolling element, cage		○	○	○		○	○	○	○		○		○	
2.3.14 Creep	Fitting surface		○	○		○	○*	○*	○			○			*Clearance fit
2.3.15 Electrical erosion	Raceway, rolling surface		○*	○*											*Electricity passing through the rolling element
2.3.16 Rust and corrosion	Raceway ring, rolling element, cage	○	○		○	○	○	○							
2.3.17 Mounting flaws	Raceway, rolling surface		○	○											
2.3.18 Discoloration	Raceway ring, rolling element, cage					○	○	○							

**Remark** This chart is not comprehensive; it lists only the more commonly occurring damages, causes, and locations.



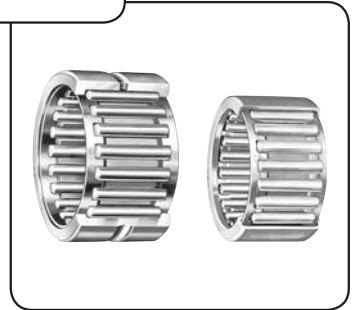
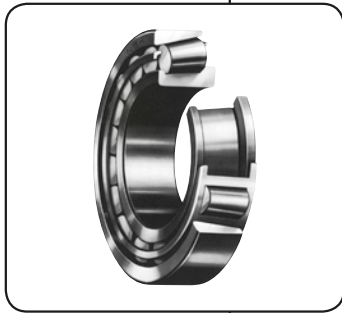
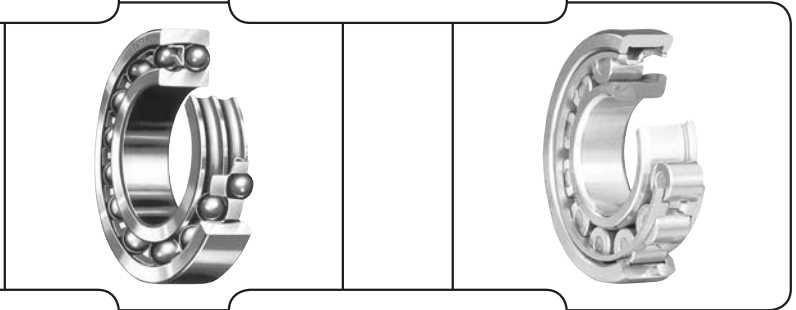








# BEARING TABLES



## Part C

### BEARING TABLES

1. DEEP GROOVE BALL BEARINGS .....	C 005
2. EXTRA SMALL BALL BEARINGS AND MINIATURE BALL BEARINGS .....	C 053
3. ANGULAR CONTACT BALL BEARINGS .....	C 071
4. SELF-ALIGNING BALL BEARINGS .....	C 113
5. CYLINDRICAL ROLLER BEARINGS .....	C 123
6. TAPERED ROLLER BEARINGS .....	C 181
7. SPHERICAL ROLLER BEARINGS .....	C 257
8. THRUST BALL BEARINGS .....	C 295
9. THRUST CYLINDRICAL ROLLER BEARINGS .....	C 313
10. THRUST TAPERED ROLLER BEARINGS .....	C 321
11. THRUST SPHERICAL ROLLER BEARINGS .....	C 331
12. NEEDLE ROLLER BEARINGS .....	C 341
13. BALL BEARING UNITS .....	C 343
14. PLUMMER BLOCKS .....	C 345
15. ACCESSORIES FOR ROLLING BEARINGS .....	C 347





# 1. DEEP GROOVE BALL BEARINGS

INTRODUCTION ..... C 006

## TECHNICAL DATA

Radial and Axial Internal Clearances and Contact Angles for  
Single-Row Deep Groove Ball Bearings ..... C 012

Features and Operating Temperature Range of Ball Bearing  
Seal Material ..... C 016

Free Space and Grease Filling Amount for Deep Groove  
Ball Bearings ..... C 018

## BEARING TABLES

Single-Row Deep Groove Ball Bearings  
Open, Shielded, and Sealed Types

Open Type

Creep-Free Bearings™

Maximum Ball Bearings

Magneto Bearings

Bore Diameter 10 – 240 mm ..... C 020

Bore Diameter 260 – 800 mm ..... C 040

Bore Diameter 10 – 100 mm ..... C 046

Bore Diameter 25 – 110 mm ..... C 048

Bore Diameter 4 – 20 mm ..... C 050



## DESIGN, TYPES, AND FEATURES

### SINGLE-ROW DEEP GROOVE BALL BEARINGS

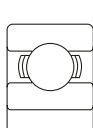
Single-row deep groove ball bearings are classified into the types shown below.

The proper amount of good quality grease is packed in shielded and sealed ball bearings. A comparison of the features of each type is shown in Table 1.

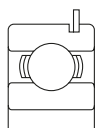
**Table 1 Features of Sealed Ball Bearings**

Type	Shielded (ZZ Type)	Rubber Non-Contact Seal (VV Type)	Rubber Contact Seal (DDU Type)
Torque	Low	Low	Higher than ZZ and VV types due to contact seal
Speed capability	Good	Good	Limited by contact seals
Grease-sealing effectiveness	Good	Better than ZZ type	Slightly better than VV type
Dust resistance	Good	Better than ZZ type (usable in moderately dusty environments)	Best (usable even in very dusty environments)
Water resistance	Not suitable	Not suitable	Good (usable even if fluid is splashed on bearing)
Operating temperature <sup>(1)</sup>	-10 to +110 °C	-10 to +110 °C	-10 to +100 °C

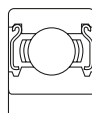
**Note** <sup>(1)</sup> The above temperature range applies to standard bearings. By using cold- or heat-resistant grease or changing the type of rubber, the operating temperature range can be extended. Please contact NSK for such applications.



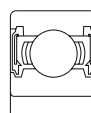
**Open**



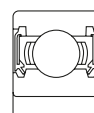
**With Snap Ring**



**Shielded (ZZ Type)**



**Rubber Non-Contact Sealed (VV Type)**



**Rubber Contact Sealed (DDU Type)**

Pressed cages are usually used for deep groove ball bearings. For large bearings, machined brass cages are used (refer to Table 2).

Machined cages are also used for high-speed applications.

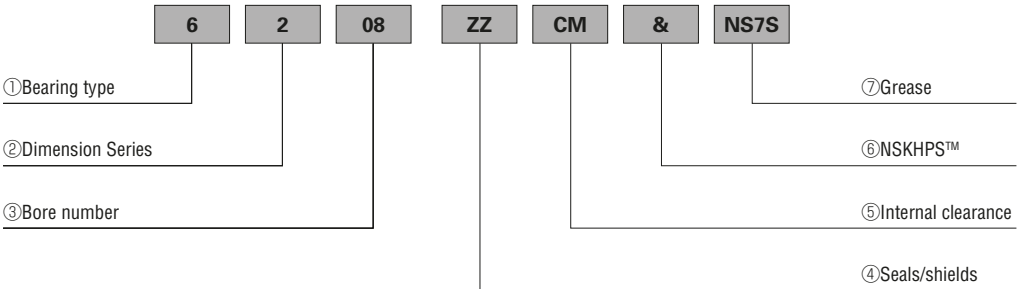
**Table 2 Standard Cages for Deep Groove Ball Bearings**

Series	Pressed Steel Cages	Machined Brass Cages
68	6800 – 6838	6840 – 68/800
69	6900 – 6936	6938 – 69/800
160	16001 – 16026	16028 – 16064
60	6000 – 6040	6044 – 60/670
62	6200 – 6240	6244 – 6272
63	6300 – 6332	6334 – 6356

## □ Formulation of Bearing Designations

Single-row deep groove ball bearings

Example:



① Bearing type	6 : Single-row deep groove ball bearings
② Dimension Series	2 : 02 Series, 3 : 03 Series, 9 : 19 Series, 0 : 10 Series
③ Bore number	Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore bore number X 5 (mm)
④ Seals/shields	ZZ : Shield on both sides, DDU: Rubber contact seal on both sides, VV: Rubber non-contact seal on both sides, Z: Shield on one side, DU: Rubber contact seal on one side V: Rubber non-contact seal on one side
⑤ Internal clearance	Omitted : CN clearance* <sup>1</sup> , C3 : Clearance greater than CN, C4 : Clearance greater than C3, CM : For electric motors* <sup>1</sup>
⑥ NSKHPS™ designation	& : NSKHPS™ Bearings
⑦ Grease designation* <sup>2</sup>	NS7 : NS HI-LUBE

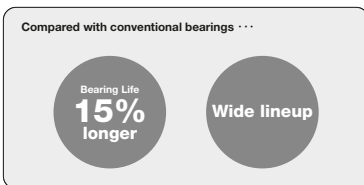
\*1 CM clearance may be used instead of CN clearance (the reverse is not possible).

\*2 The grease designation is required when seals/shields are used on both sides.

## NSKHPS™ Deep Groove Ball Bearings

### Features

Compared with conventional bearings:



#### ● Improved reliability

Bearing life is 15% longer than conventional bearings thanks to optimization of the bearing's internal design and improvement of processing technology. As a result, NSKHPS™ bearings contribute to reducing maintenance costs and facilitate the downscaling of related equipment.

#### ● New product lineup

The standard dimensions are identical to standard size bearings. NSK has expanded the lineup of NSKHPS™ bearings by focusing on a wide range of sizes offering a high degree of versatility for various general-purpose applications.

## ■ DEEP GROOVE BALL BEARINGS

### Creep-Free Bearings™

Creep-Free bearings, which come with two O-rings mounted in the outer ring, help to prevent creep by restricting the amount of clearance between the outer ring and housing.

No special machining is required; therefore bearings can be used with the same housing as standard bearings.

In creep limit load tests, the more housing clearance is reduced, the greater the improvements in creep prevention due to the tension of the O-ring mounted in the outer ring.



### Features

#### ■ Prevents creep

O-rings help prevent creep.

#### ■ Reusable housing

Very little abrasion occurs on the bore surface of the housing, making reuse possible.

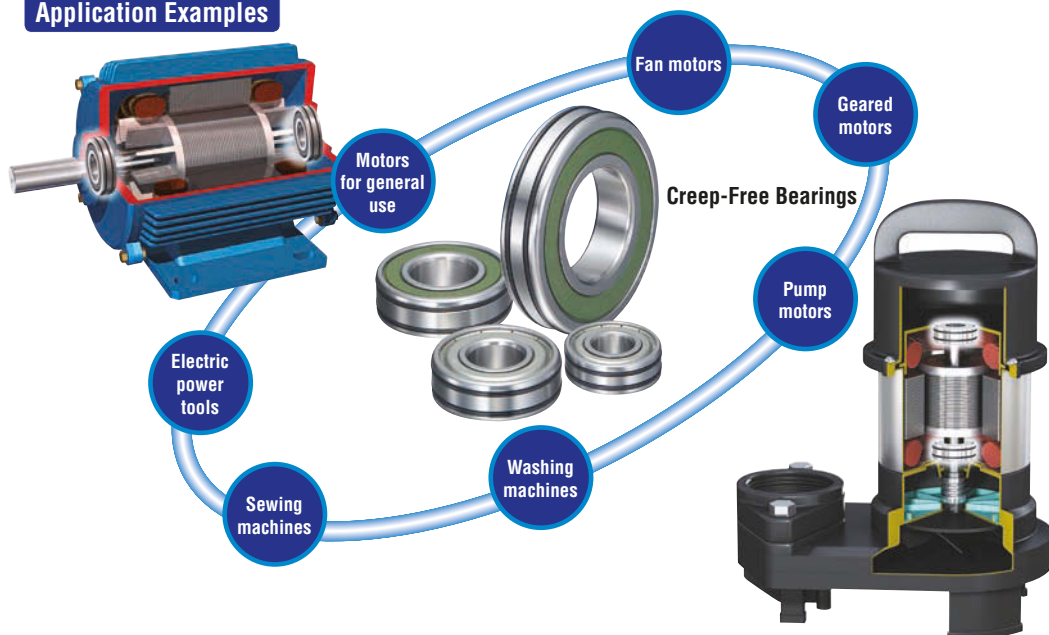
#### ■ Easy to assemble

Assembly is easy since bearings can be fitted with a loose tolerance.

#### ■ No special machining of the housing required

Bearings can be easily replaced since boundary dimensions are identical to standard bearings. No reworking of the housing is required.

### Application Examples



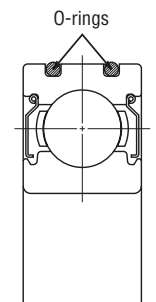


Fig. 1 Structure of Creep-Free Bearings

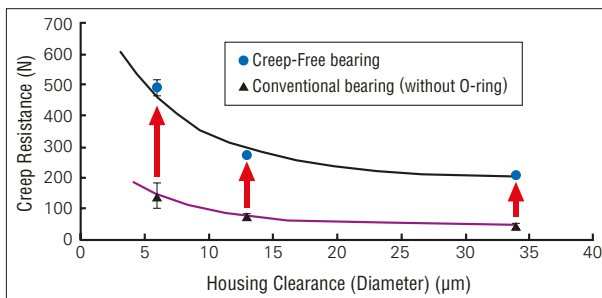


Fig. 2 Creep Limit Load Test (Example Bearing 6204)

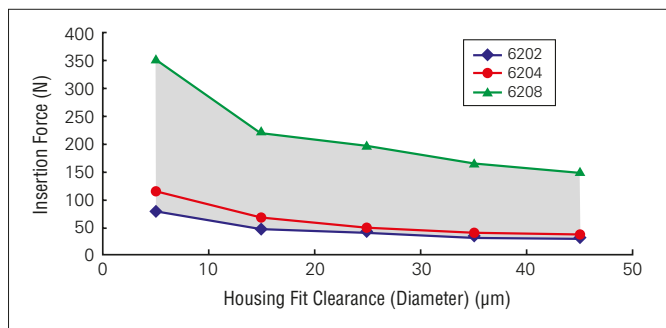


Fig. 3 Fit and Insertion Force

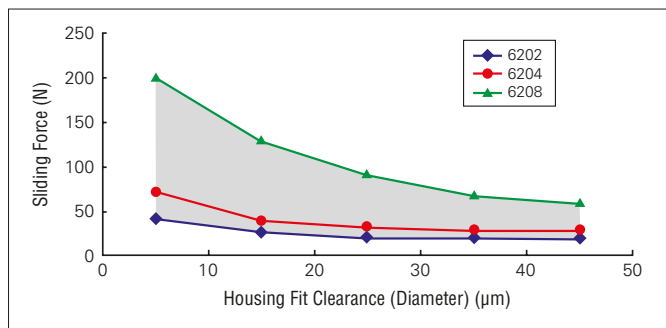


Fig. 4 Fit and Sliding Force



### Note on Mounting Creep-Free Bearings

- When oil or grease is applied to the outer diameter of the bearing, use a mineral oil or a synthetic hydrocarbon oil (NSK's EA2, etc.).
- Nitrile rubber is used as the standard specification O-ring material (operating temperature range:  $-30$  to  $120$  °C). Please contact NSK for use under special environments such as high temperatures.

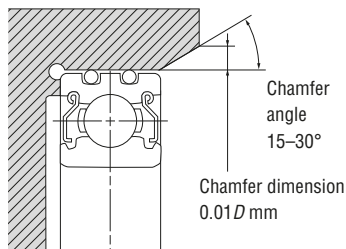
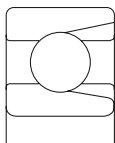


Fig. 5 Housing Shape and Dimension

Note that "free" in the product name "Creep-Free" bearings should not be understood as meaning that creep is nonexistent.



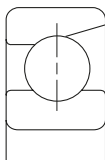
### MAXIMUM BALL BEARINGS

Maximum ball bearings contain a larger number of balls than normal deep groove ball bearings because of filling slots in the inner and outer rings. Because of their filling slots, they are not suitable for applications with high axial loads.

BL2 and BL3 types of bearings have boundary dimensions equal to those of Series 62 and 63 deep groove ball bearings respectively. Besides the open type, ZZ type shielded bearings are also available.

When using these bearings, it is important for the filling slot in the outer ring to be outside of the loaded zone as much as possible.

The cages are made of pressed steel.



### MAGNETO BEARINGS

The groove in the inner ring is slightly shallower than that of deep groove ball bearings and one side of the outer ring is relieved. Consequently, the outer ring is separable, which is convenient for mounting.

Pressed cages are standard, but for high-speed applications, machined synthetic resin cages are used.

### PRECAUTIONS FOR USE OF DEEP GROOVE BALL BEARINGS

If the bearing load is too small during operation, slippage may occur between the balls and raceways, which may result in smearing. The higher the weight of the balls and cage, the more likely this will occur, especially for large bearings. If very small bearing loads are expected, please contact NSK for selection of an appropriate bearing.

**TOLERANCES AND RUNNING ACCURACY**

<b>SINGLE-ROW DEEP GROOVE BALL BEARINGS</b> .....	Table 7.2 (Pages A128 to A131)
<b>NSKHPS DEEP GROOVE BALL BEARINGS</b>	
Tolerance for Dimensions : ISO Normal	
Running Accuracy : ISO Normal	
<b>MAXIMUM BALL BEARINGS</b> .....	Table 7.2 (Pages A128 to A131)
<b>MAGNETO BEARINGS</b> .....	Table 7.5 (Pages A138 and A139)

**RECOMMENDED FITS**

<b>SINGLE-ROW DEEP GROOVE BALL BEARINGS</b> .....	Table 8.3 (Page A164)
	Table 8.5 (Page A165)
<b>MAXIMUM BALL BEARINGS</b> .....	Table 8.3 (Page A164)
	Table 8.5 (Page A165)
<b>MAGNETO BEARINGS</b> .....	Table 8.3 (Page A164)
	Table 8.5 (Page A165)

**INTERNAL CLEARANCES**

<b>SINGLE-ROW DEEP GROOVE BALL BEARINGS</b> .....	Table 8.10 (Page A169)
<b>NSKHPS DEEP GROOVE BALL BEARINGS</b>	
INTERNAL CLEARANCE SYMBOL : CN, C3, C4, CM	
<b>MAXIMUM BALL BEARINGS</b> .....	Table 8.10 (Page A169)
<b>MAGNETO BEARINGS</b> .....	Table 8.12 (Page A169)

**LIMITING SPEEDS (GREASE/OIL)**

The limiting speeds for grease and oil lubrication listed in the bearing tables should be adjusted depending on bearing load. Furthermore, higher speeds are attainable by changing the lubrication method, cage design, etc. Refer to Page A098 for detailed information.

## TECHNICAL DATA

### Radial and Axial Internal Clearances and Contact Angles for Single-Row Deep Groove Ball Bearings

#### (1) Radial and Axial Internal Clearances

The internal clearance in single-row bearings is specified as the radial internal clearance. The bearing internal clearance is the amount of relative displacement possible between the bearing rings when one ring is fixed and the other ring does not bear a load. The amount of movement along the bearing radius is called the radial clearance, and the amount along the axis is called the axial clearance.

The geometric relation between radial and axial clearance is shown in Fig. 1.

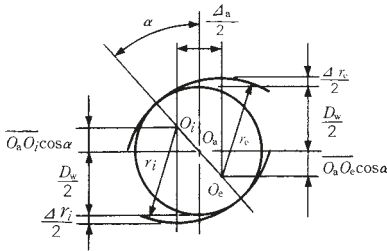


Fig. 1 Relationship Between  $\Delta_r$  and  $\Delta_a$

Symbols used in Fig. 1

- $O_a$ : Ball center
- $O_e$ : Center of groove curvature, outer ring
- $O_i$ : Center of groove curvature, inner ring
- $D_w$ : Ball diameter (mm)
- $r_e$ : Radius of outer ring groove (mm)
- $r_i$ : Radius of inner ring groove (mm)
- $\alpha$ : Contact angle (°)
- $\Delta_r$ : Radial clearance (mm)
- $\Delta_a$ : Axial clearance (mm)

It is apparent from Fig. 1 that  $\Delta_r = \Delta_r + \Delta_r$ .

Various equations for clearance, contact angle, etc. can be derived from geometric relationships:

$$\Delta_r = 2(1 - \cos \alpha)(r_e + r_i - D_w) \quad (1)$$

$$\Delta_a = 2 \sin \alpha (r_e + r_i - D_w) \quad (2)$$

$$\frac{\Delta_a}{\Delta_r} = \cot \frac{\alpha}{2} \quad (3)$$

$$\Delta_a \doteq 2(r_e + r_i - D_w)^{1/2} \Delta_r^{1/2} \quad (4)$$

$$\alpha = \cos^{-1} \left( \frac{r_e + r_i - D_w - \frac{\Delta_r}{2}}{r_e + r_i - D_w} \right) \quad (5)$$

$$= \sin^{-1} \left( \frac{\Delta_a/2}{r_e + r_i - D_w} \right) \quad (6)$$

Because  $(r_e + r_i - D_w)$  is a constant, fixed relationships between  $\Delta_r$ ,  $\Delta_a$ , and  $\alpha$  exist for all the various bearing types.

As previously mentioned, the clearances for deep groove ball bearings are given as radial clearances, but there are specific applications where an axial clearance is desirable as well. The relationship between deep groove ball bearing radial clearance  $\Delta_r$  and axial clearance  $\Delta_a$  is given in Equation (4). To simplify,

$$\Delta_a \doteq K \Delta_r^{1/2} \quad (7)$$

where  $K$ : Constant depending on bearing design

$$K = 2(r_e + r_i - D_w)^{1/2}$$

Fig. 2 shows one example. The various values for  $K$  are presented by bearing size in Table 1 below.

#### Example

Assume bearing 6312 has a radial clearance of 0.017 mm. From Table 1,  $K=2.09$ . Therefore, the axial clearance  $\Delta_a$  is:

$$\Delta_a = 2.09 \times \sqrt{0.017} = 2.09 \times 0.13 = 0.27 \text{ (mm)}$$

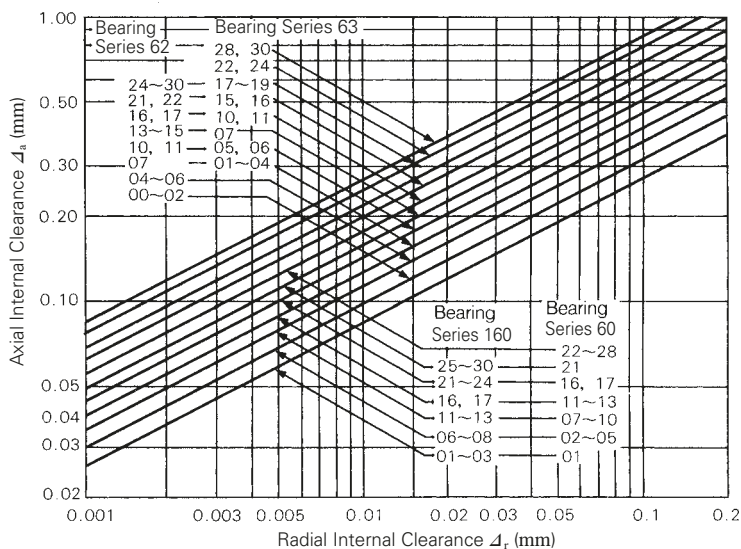


Fig. 2 Radial Clearance  $\Delta_r$  and Axial Clearance  $\Delta_a$  of Deep Groove Ball Bearings

Table 1 Constant Values of  $K$  for Radial and Axial Clearance Conversion

Bearing Bore No.	$K$			
	Series 160	Series 60	Series 62	Series 63
00	—	—	0.93	1.14
01	0.80	0.80	0.93	1.06
02	0.80	0.93	0.93	1.06
03	0.80	0.93	0.99	1.11
04	0.90	0.96	1.06	1.07
05	0.90	0.96	1.06	1.20
06	0.96	1.01	1.07	1.19
07	0.96	1.06	1.25	1.37
08	0.96	1.06	1.29	1.45
09	1.01	1.11	1.29	1.57
10	1.01	1.11	1.33	1.64
11	1.06	1.20	1.40	1.70
12	1.06	1.20	1.50	2.09
13	1.06	1.20	1.54	1.82
14	1.16	1.29	1.57	1.88
15	1.16	1.29	1.57	1.95
16	1.20	1.37	1.64	2.01
17	1.20	1.37	1.70	2.06
18	1.29	1.44	1.76	2.11
19	1.29	1.44	1.82	2.16
20	1.29	1.44	1.88	2.25
21	1.37	1.54	1.95	2.32
22	1.40	1.64	2.01	2.40
24	1.40	1.64	2.06	2.40
26	1.54	1.70	2.11	2.49
28	1.54	1.70	2.11	2.59
30	1.57	1.76	2.11	2.59

## (2) Relation Between Radial Clearance and Contact Angle

Single-row deep groove ball bearings are sometimes used as thrust bearings. In such applications, the contact angle should be as large as possible.

The contact angle for ball bearings is determined by the geometric relationship between the radial clearance and radii of the inner and outer grooves. Using Equations (1) to (6), Fig. 3 shows the particular relationship between the radial clearance and contact angle of bearings in Series 62 and 63 bearings. The initial contact angle,  $\alpha_0$ , refers to the initial contact angle when axial load is zero. Application of any load to the bearing will change this contact angle.

If the initial contact angle  $\alpha_0$  exceeds 20°, check whether or not the contact area of the ball and raceway touch the edge of the raceway shoulder (refer to Section 8.1.2).

For applications where an axial load alone is applied, the radial clearance for deep groove ball bearings is normally greater than the normal clearance in order to ensure that the contact angle is relatively large. The initial contact angles for C3 and C4 clearances are given for selected bearing sizes in Table 2 below.

**Table 2 Initial Contact Angle  $\alpha_0$ , With C3 and C4 Clearances**

Bearing Designation	$\alpha_0$ with C3	$\alpha_0$ with C4
6205	12.5° to 18°	16.5° to 22°
6210	11.5° to 16.5°	13.5° to 19.5°
6215	11.5° to 16°	15.5° to 19.5°
6220	10.5° to 14.5°	14° to 17.5°
6305	11° to 16°	14.5° to 19.5°
6310	9.5° to 13.5°	12° to 16°
6315	9.5° to 13.5°	12.5° to 15.5°
6320	9° to 12.5°	12° to 15°

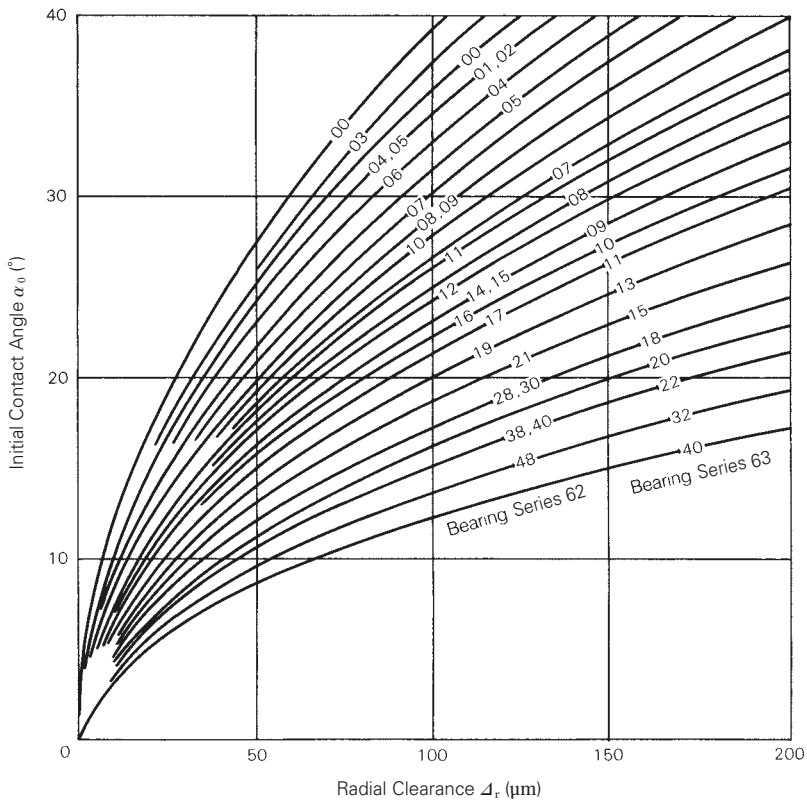


Fig. 3 Radial Clearance and Contact Angle



## Features and Operating Temperature Range of Ball Bearing Seal Material

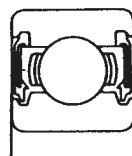
Sealed ball bearings are shown in Figs. 1 and 2. There are two seal types: non-contact seals and contact seals. Nitrile rubber is used for general-purpose applications, while polyacrylic, silicon, and fluoroc rubber are used based on operating temperature requirements. All rubbers have their own unique characteristics and must be selected while considering the application environment and operating conditions.

Table 1 shows principal features of each rubber material and the operating temperature range of the bearing seal. The operating temperature range of Table 1 is a guideline for continuous operation. Thermal aging of rubber is related to temperature and time. Rubber may be used in a much wider range of operating temperatures depending on the operating time and frequency.

Heat generation due to friction on the lip can be ignored in non-contact seals. Thermal factors, which cause aging of the rubber, refer to physical changes due to atmospheric and bearing temperatures. Accordingly, increased hardness or loss of elasticity due to thermal aging exerts only a negligible effect on seal performance. A rubber non-contact seal can thus be used in a greater range of operating temperatures than contact seals.

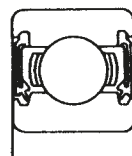
However, there are some disadvantages. Problems with friction-generated wear at the seal lip, thermal plastic deformation, and hardening may occur, causing the contact pressure between the lip and slide surface to decrease and result in a clearance. This clearance is low and does not degrade sealing performance (it does not cause dust entry or grease leakage). In most cases, this minor plastic deformation or increased hardness presents no practical problems.

However, in external environments with large amounts of dust and water, the bearing seal is used as an auxiliary seal and a main seal should be provided separately. As mentioned, the operating temperature range of rubber material is only a guideline for selection. Since heat resistant rubber is expensive, strive to understand temperature conditions so that an economical selection can be made. Pay attention not only to heat resistance, but also to the distinctive features of each rubber.



Rubber non-contact seal (VV)

Fig. 1



Rubber contact seal (DDU)

Fig. 2

Table 1 Features and Operating Temperature Range of Rubber Materials

Material		Nitrile Rubber	Polyacrylic Rubber	Silicon Rubber	Fluorine Rubber
Key features		<ul style="list-style-type: none"> <li>Most popular seal material</li> <li>Superior mechanical properties and resistance to oil and wear</li> <li>Readily ages under direct sunlight</li> <li>Less expensive than other rubbers</li> </ul>	<ul style="list-style-type: none"> <li>Superior heat and oil resistances</li> <li>Large compression causes permanent deformation</li> <li>Inferior cold resistance</li> <li>One of the less expensive high-temperature materials</li> <li>Swells in contact with ester oil based grease</li> </ul>	<ul style="list-style-type: none"> <li>High heat and cold resistances</li> <li>Inferior mechanical properties besides resistance to permanent deformation by compression. Note the tear strength</li> <li>Swells in contact with low-anilinepoint mineral oil, silicone grease, and silicone oil</li> </ul>	<ul style="list-style-type: none"> <li>High heat resistance</li> <li>Superior oil and chemical resistances</li> <li>Cold resistance similar to nitrile rubber</li> <li>Deteriorates in contact with urea grease</li> </ul>
Operating Temperature Range <sup>(1)</sup> (°C)	Non-Contact Seal	−50 to +130	−30 to +170	−100 to +250	−50 to +220
	Contact Seal	−30 to +110	−15 to +150	−70 to +200	−30 to +200

**Note** <sup>(1)</sup> This operating temperature refers to the temperature of rubber seal materials.



### Free Space and Grease Filling Amount for Deep Groove Ball Bearings

Grease lubrication can simplify the bearing's peripheral construction. Thanks to enhanced grease quality, grease lubrication is now employed in place of oil lubrication in many fields. Be sure to select a grease appropriate for operating conditions. Take care with the filling amount, since too much or too little grease greatly affects the temperature rise and torque. The amount of grease needed depends on such factors as housing construction, free space, grease brand, and environment.

As a general guideline, the bearing is first filled with an appropriate amount of grease. Apply grease onto the cage guide surface, then, fill the free space, which excludes the spindle and bearing inside the housing, with the following amount of grease:

When bearing speed is 50% or less of the specified limiting speed, fill  $\frac{1}{2}$  to  $\frac{2}{3}$  of the free space.

When bearing speed is 50% or more of the specified limiting speed, fill  $\frac{1}{3}$  to  $\frac{1}{2}$  of the free space.

In general, low speeds require more grease while high speeds require less grease. Depending on the particular application, the filling amount may have to be reduced further to reduce the torque and prevent heat generation. When bearing speed is extremely low on the other hand, grease may be packed almost full to prevent dust and water entry. Accordingly, one must know the extent of the housing's free space for the specific bearing to determine the correct filling amount. The volume of free space is shown in Table 1 for an open deep groove ball bearing for reference.

Note that the free space of the open type deep groove ball bearing is the volume obtained by subtracting the volume of the balls and cage from the space formed between inner and outer rings.

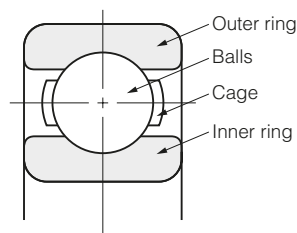


Table 1 Free Space of Open Deep Groove Ball Bearings

Units : cm<sup>3</sup>

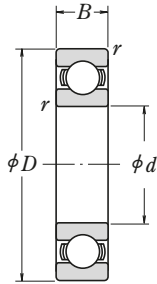
Bearing Bore No.	Bearing Free Space			Bearing Bore No.	Bearing Free Space		
	Bearing Series				Bearing Series		
	60	62	63		60	62	63
00	1.2	1.5	2.9	14	34	61	148
01	1.2	2.1	3.5	15	35	67	180
02	1.6	2.7	4.8	16	47	84	213
03	2.0	3.7	6.4	17	48	104	253
04	4.0	6.0	7.9	18	63	127	297
05	4.6	7.7	12	19	66	155	345
06	6.5	11	19	20	68	184	425
07	9.2	15	25	21	88	216	475
08	11	20	35	22	114	224	555
09	14	23	49	24	122	310	675
10	15	28	64	26	172	355	830
11	22	34	79	28	180	415	1 030
12	23	45	98	30	220	485	1 140
13	24	54	122	32	285	545	1 410

**Remark** The table above shows the free space of bearings using pressed-steel cages. The free space of a bearing using a high-tension machined-brass cage is about 50 to 60% of the value in this table.



# ■ SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 10 – 17 mm



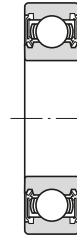
Open



Shielded  
ZZ



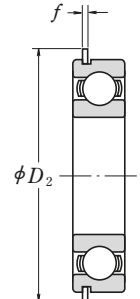
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



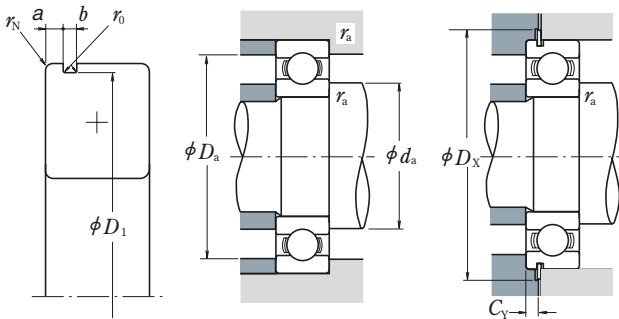
With Snap  
Ring Groove  
N



With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil				
								Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed
10	19	5	0.3	1 720	840	14.8	34 000	24 000	40 000		6800	ZZ	VV DD
	22	6	0.3	2 700	1 270	14.0	32 000	22 000	38 000		6900	ZZ	VV DD
	26	8	0.3	4 550	1 970	12.4	30 000	22 000	36 000		6000	ZZ	VV DDU
	30	9	0.6	5 350	2 390	13.2	28 000	18 000	34 000	*	6200	ZZ	VV DDU
	30	9	0.6	5 100	2 390	13.2	24 000	18 000	30 000		6200	ZZ	VV DDU
	35	11	0.6	8 500	3 450	11.2	26 000	17 000	30 000	*	6300	ZZ	VV DDU
	35	11	0.6	8 100	3 450	11.2	22 000	17 000	26 000		6300	ZZ	VV DDU
	21	5	0.3	1 920	1 040	15.3	32 000	20 000	38 000		6801	ZZ	VV DD
	24	6	0.3	2 890	1 460	14.5	30 000	20 000	36 000		6901	ZZ	VV DD
	28	7	0.3	5 100	2 370	13.0	28 000	—	32 000		16001	—	—
12	28	8	0.3	5 350	2 370	13.0	32 000	18 000	38 000	*	6001	ZZ	VV DDU
	28	8	0.3	5 100	2 370	13.0	28 000	18 000	32 000		6001	ZZ	VV DDU
	32	10	0.6	7 150	3 050	12.3	26 000	17 000	32 000	*	6201	ZZ	VV DDU
	32	10	0.6	6 800	3 050	12.3	22 000	17 000	28 000		6201	ZZ	VV DDU
	37	12	1	10 200	4 200	11.1	24 000	16 000	28 000	*	6301	ZZ	VV DDU
	37	12	1	9 700	4 200	11.1	20 000	16 000	24 000		6301	ZZ	VV DDU
	24	5	0.3	2 070	1 260	15.8	28 000	17 000	34 000		6802	ZZ	VV DD
	28	7	0.3	4 350	2 260	14.3	26 000	17 000	30 000		6902	ZZ	VV DD
	32	8	0.3	5 600	2 830	13.9	24 000	—	28 000		16002	—	—
	32	9	0.3	5 850	2 830	13.9	26 000	15 000	32 000	*	6002	ZZ	VV DDU
15	32	9	0.3	5 600	2 830	13.9	24 000	15 000	28 000		6002	ZZ	VV DDU
	35	11	0.6	8 000	3 750	13.2	22 000	14 000	28 000	*	6202	ZZ	VV DDU
	35	11	0.6	7 650	3 750	13.2	20 000	14 000	24 000		6202	ZZ	VV DDU
	42	13	1	12 000	5 450	12.3	19 000	13 000	24 000	*	6302	ZZ	VV DDU
	42	13	1	11 400	5 450	12.3	17 000	13 000	20 000		6302	ZZ	VV DDU
	26	5	0.3	2 630	1 570	15.7	26 000	15 000	30 000		6803	ZZ	VV DD
	30	7	0.3	4 600	2 550	14.7	24 000	15 000	28 000		6903	ZZ	VV DDU
	35	8	0.3	6 000	3 250	14.4	22 000	—	26 000		16003	—	—
	35	10	0.3	6 300	3 250	14.4	24 000	13 000	28 000	*	6003	ZZ	VV DDU
	35	10	0.3	6 000	3 250	14.4	22 000	13 000	26 000		6003	ZZ	VV DDU
17	40	12	0.6	10 100	4 800	13.2	20 000	12 000	24 000	*	6203	ZZ	VV DDU
	40	12	0.6	9 550	4 800	13.2	17 000	12 000	20 000		6203	ZZ	VV DDU
	47	14	1	14 300	6 650	12.4	17 000	11 000	20 000	*	6303	ZZ	VV DDU
	47	14	1	13 600	6 650	12.4	15 000	11 000	18 000		6303	ZZ	VV DDU

- Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.  
(2) When heavy axial loads are applied, *d*<sub>a</sub> and *D*<sub>a</sub> can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.  
(3) Ring types N and NR are applicable only to open bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.  
(4) Snap ring groove dimensions and snap ring dimensions do not conform to ISO15.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

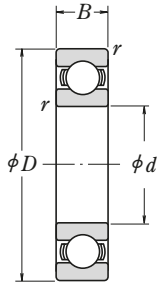
$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

With Snap Ring Groove		Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i> max.	<i>b</i> min.	<i>D</i> <sub>1</sub> max.	<i>r</i> <sub>0</sub> max.	<i>r</i> <sub>N</sub> min.	<i>D</i> <sub>2</sub> max.	<i>f</i> max.	<i>d</i> <sub>a</sub> <sup>(2)</sup> min.	<i>D</i> <sub>a</sub> <sup>(2)</sup> max.	<i>r</i> <sub>a</sub> max.	<i>D</i> <sub>x</sub> min.	<i>C</i> <sub>Y</sub> max.	approx.	
— <sup>(3)</sup>	NR <sup>(3)</sup>	1.05	—	—	—	—	—	—	12	12	17	0.3	—	—	0.005
NR <sup>(4)</sup>	NR <sup>(4)</sup>	1.35	0.87	24.5	0.2	0.3	24.8	0.7	12	12.5	20	0.3	25.5	1.5	0.009
—	—	—	—	—	—	—	28.7	0.84	12	13	24	0.3	29.4	1.9	0.018
—	—	—	—	—	—	—	—	—	14	16	26	0.6	—	—	0.032
N	NR	2.06	1.35	28.17	0.4	0.5	34.7	1.12	14	16	26	0.6	35.5	2.9	0.032
—	—	—	—	—	—	—	—	—	14	16.5	31	0.6	—	—	0.052
N	NR	2.06	1.35	33.17	0.4	0.5	39.7	1.12	14	16.5	31	0.6	40.5	2.9	0.052
—	—	—	—	—	—	—	—	—	14	14	19	0.3	—	—	0.006
N <sup>(3)</sup>	NR <sup>(3)</sup>	1.05	0.8	22.8	0.2	0.2	26.8	0.7	14	14.5	22	0.3	27.5	1.5	0.010
—	—	—	—	—	—	—	—	—	14	—	26	0.3	—	—	0.019
—	—	—	—	—	—	—	—	—	14	15.5	26	0.3	—	—	0.022
N <sup>(4)</sup>	NR <sup>(4)</sup>	1.35	0.87	26.5	0.2	0.3	30.7	0.84	14	15.5	26	0.3	31.4	1.9	0.022
—	—	—	—	—	—	—	—	—	16	17	28	0.6	—	—	0.037
N	NR	2.06	1.35	30.15	0.4	0.5	36.7	1.12	16	17	28	0.6	37.5	2.9	0.037
—	—	—	—	—	—	—	—	—	17	18	32	1	—	—	0.060
N	NR	2.06	1.35	34.77	0.4	0.5	41.3	1.12	17	18	32	1	42	2.9	0.060
—	—	—	—	—	—	—	—	—	17	17	22	0.3	—	—	0.007
N <sup>(3)</sup>	NR <sup>(3)</sup>	1.30	0.95	26.7	0.25	0.3	30.8	0.85	17	17	26	0.3	31.5	1.8	0.015
—	—	—	—	—	—	—	—	—	17	—	30	0.3	—	—	0.027
—	—	—	—	—	—	—	—	—	17	19	30	0.3	—	—	0.031
N	NR	2.06	1.35	30.15	0.4	0.3	36.7	1.12	17	19	30	0.3	37.5	2.9	0.031
—	—	—	—	—	—	—	—	—	19	20.5	31	0.6	—	—	0.045
N	NR	2.06	1.35	33.17	0.4	0.5	39.7	1.12	19	20.5	31	0.6	40.5	2.9	0.045
—	—	—	—	—	—	—	—	—	20	22.5	37	1	—	—	0.083
N	NR	2.06	1.35	39.75	0.4	0.5	46.3	1.12	20	22.5	37	1	47	2.9	0.083
—	—	—	—	—	—	—	—	—	19	19	24	0.3	—	—	0.007
N <sup>(3)</sup>	NR <sup>(3)</sup>	1.30	0.95	28.7	0.25	0.3	32.8	0.85	19	19.5	28	0.3	33.5	1.8	0.017
—	—	—	—	—	—	—	—	—	19	—	33	0.3	—	—	0.033
—	—	—	—	—	—	—	—	—	19	21.5	33	0.3	—	—	0.041
N	NR	2.06	1.35	33.17	0.4	0.3	39.7	1.12	19	21.5	33	0.3	40.5	2.9	0.041
—	—	—	—	—	—	—	—	—	21	23.5	36	0.6	—	—	0.067
N	NR	2.06	1.35	38.1	0.4	0.5	44.6	1.12	21	23.5	36	0.6	45.5	2.9	0.067
—	—	—	—	—	—	—	—	—	22	25.5	42	1	—	—	0.113
N	NR	2.46	1.35	44.6	0.4	0.5	52.7	1.12	22	25.5	42	1	53.5	3.3	0.113

- Remarks**
1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
  2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
  3. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 20 – 30 mm



Open



Shielded  
ZZ



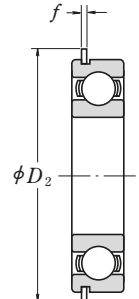
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N



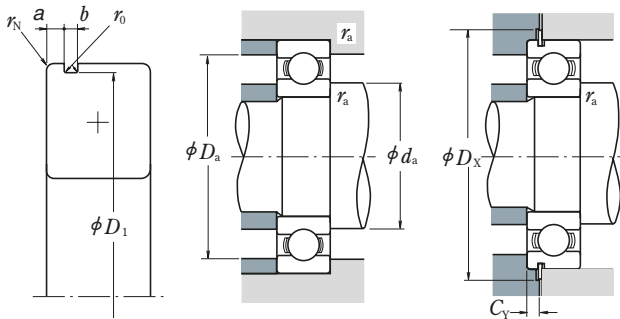
With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil				
							Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
20	32	7	0.3	4 000	2 470	15.5	22 000	13 000	26 000	6804	ZZ	VV	DD
	37	9	0.3	6 400	3 700	14.7	19 000	12 000	22 000	6904	ZZ	VV	DDU
	42	8	0.3	7 900	4 450	14.5	18 000	—	20 000	16004	—	—	—
	42	12	0.6	9 850	5 000	13.8	20 000	11 000	24 000	* 6004	ZZ	VV	DDU
	42	12	0.6	9 400	5 000	13.8	18 000	11 000	20 000	6004	ZZ	VV	DDU
	47	14	1	13 400	6 600	13.1	17 000	11 000	20 000	* 6204	ZZ	VV	DDU
	47	14	1	12 800	6 600	13.1	15 000	11 000	18 000	6204	ZZ	VV	DDU
	52	15	1.1	16 700	7 900	12.4	16 000	10 000	19 000	* 6304	ZZ	VV	DDU
	52	15	1.1	15 900	7 900	12.4	14 000	10 000	17 000	6304	ZZ	VV	DDU
	44	12	0.6	9 400	5 050	14.0	17 000	11 000	20 000	60/22	ZZ	VV	DDU
	50	14	1	12 900	6 800	13.5	14 000	9 500	16 000	62/22	ZZ	VV	DDU
	56	16	1.1	18 400	9 250	12.4	13 000	9 500	16 000	63/22	ZZ	VV	DDU
25	37	7	0.3	4 500	3 150	16.1	18 000	10 000	22 000	6805	ZZ	VV	DD
	42	9	0.3	7 050	4 550	15.4	16 000	10 000	19 000	6905	ZZ	VV	DDU
	47	8	0.3	8 850	5 600	15.1	15 000	—	18 000	16005	—	—	—
	47	12	0.6	10 600	5 850	14.5	18 000	9 500	22 000	* 6005	ZZ	VV	DDU
	47	12	0.6	10 100	5 850	14.5	15 000	9 500	18 000	6005	ZZ	VV	DDU
	52	15	1	14 700	7 850	13.9	15 000	9 000	18 000	* 6205	ZZ	VV	DDU
	52	15	1	14 000	7 850	13.9	13 000	9 000	15 000	6205	ZZ	VV	DDU
	62	17	1.1	21 600	11 200	13.2	13 000	8 000	16 000	* 6305	ZZ	VV	DDU
	62	17	1.1	20 600	11 200	13.2	11 000	8 000	13 000	6305	ZZ	VV	DDU
	52	12	0.6	12 500	7 400	14.5	14 000	8 500	16 000	60/28	ZZ	VV	DDU
	58	16	1	16 600	9 500	13.9	12 000	8 000	14 000	62/28	ZZ	VV	DDU
	68	18	1.1	26 700	14 000	12.4	10 000	7 500	13 000	63/28	ZZ	VV	DDU
30	42	7	0.3	4 700	3 650	16.4	15 000	9 000	18 000	6806	ZZ	VV	DD
	47	9	0.3	7 250	5 000	15.8	14 000	8 500	17 000	6906	ZZ	VV	DDU
	55	9	0.3	11 200	7 350	15.2	13 000	—	15 000	16006	—	—	—
	55	13	1	13 900	8 300	14.7	15 000	8 000	18 000	* 6006	ZZ	VV	DDU
	55	13	1	13 200	8 300	14.7	13 000	8 000	15 000	6006	ZZ	VV	DDU
	62	16	1	20 400	11 300	13.8	12 000	7 500	15 000	* 6206	ZZ	VV	DDU
	62	16	1	19 500	11 300	13.8	11 000	7 500	13 000	6206	ZZ	VV	DDU
	72	19	1.1	28 000	15 000	13.3	11 000	6 700	13 000	* 6306	ZZ	VV	DDU
	72	19	1.1	26 700	15 000	13.3	9 500	6 700	12 000	6306	ZZ	VV	DDU

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied, *d*<sub>a</sub> and *D*<sub>a</sub> can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

(3) Ring types N and NR are applicable only to open bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

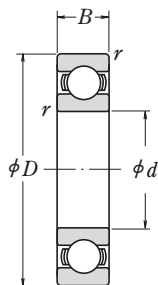
$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup>	<i>D</i> <sub>a</sub> <sup>(2)</sup>	<i>r</i> <sub>a</sub>	<i>D</i> <sub>x</sub>	<i>C</i> <sub>Y</sub>	approx.	
		max.	min.	max.	max.	min.	max.	max.	min.	max.	max.	min.	max.		
N	NR	1.30	0.95	30.7	0.25	0.3	34.8	0.85	22	22	30	0.3	35.5	1.8	0.017
N	NR	1.70	0.95	35.7	0.25	0.3	39.8	0.85	22	24	35	0.3	40.5	2.3	0.037
—	—	—	—	—	—	—	—	—	22	—	40	0.3	—	—	0.048
—	—	—	—	—	—	—	—	—	24	25.5	38	0.6	—	—	0.068
N	NR	2.06	1.35	39.75	0.4	0.5	46.3	1.12	24	25.5	38	0.6	47	2.9	0.068
—	—	—	—	—	—	—	—	—	25	26.5	42	1	—	—	0.107
N	NR	2.46	1.35	44.6	0.4	0.5	52.7	1.12	25	26.5	42	1	53.5	3.3	0.107
—	—	—	—	—	—	—	—	—	26.5	28	45.5	1	—	—	0.145
N	NR	2.46	1.35	49.73	0.4	0.5	57.9	1.12	26.5	28	45.5	1	58.5	3.3	0.145
N	NR	2.06	1.35	41.75	0.4	0.5	48.3	1.12	26	26.5	40	0.6	49	2.9	0.074
N	NR	2.46	1.35	47.6	0.4	0.5	55.7	1.12	27	29.5	45	1	56.5	3.3	0.119
N	NR	2.46	1.35	53.6	0.4	0.5	61.7	1.12	28.5	30.5	49.5	1	62.5	3.3	0.179
N	NR	1.30	0.95	35.7	0.25	0.3	39.8	0.85	27	27	35	0.3	40.5	1.8	0.021
N <sup>(3)</sup>	NR <sup>(3)</sup>	1.70	0.95	40.7	0.25	0.3	44.8	0.85	27	28.5	40	0.3	45.5	2.3	0.042
—	—	—	—	—	—	—	—	—	27	—	45	0.3	—	—	0.059
—	—	—	—	—	—	—	—	—	29	30	43	0.6	—	—	0.079
N	NR	2.06	1.35	44.6	0.4	0.5	52.7	1.12	29	30	43	0.6	53.5	2.9	0.079
—	—	—	—	—	—	—	—	—	30	32	47	1	—	—	0.129
N	NR	2.46	1.35	49.73	0.4	0.5	57.9	1.12	30	32	47	1	58.5	3.3	0.129
—	—	—	—	—	—	—	—	—	31.5	36	55.5	1	—	—	0.235
N	NR	3.28	1.9	59.61	0.6	0.5	67.7	1.7	31.5	36	55.5	1	68.5	4.6	0.235
N	NR	2.06	1.35	49.73	0.4	0.5	57.9	1.12	32	34	48	0.6	58.5	2.9	0.096
N	NR	2.46	1.35	55.6	0.4	0.5	63.7	1.12	33	35.5	53	1	64.5	3.3	0.175
N	NR	3.28	1.9	64.82	0.6	0.5	74.6	1.7	34.5	38	61.5	1	76	4.6	0.287
N	NR	1.30	0.95	40.7	0.25	0.3	44.8	0.85	32	32	40	0.3	45.5	1.8	0.024
N	NR	1.70	0.95	45.7	0.25	0.3	49.8	0.85	32	34	45	0.3	50.5	2.3	0.052
—	—	—	—	—	—	—	—	—	32	—	53	0.3	—	—	0.087
—	—	—	—	—	—	—	—	—	35	36.5	50	1	—	—	0.116
N	NR	2.08	1.35	52.6	0.4	0.5	60.7	1.12	35	36.5	50	1	61.5	2.9	0.116
—	—	—	—	—	—	—	—	—	35	38.5	57	1	—	—	0.199
N	NR	3.28	1.9	59.61	0.6	0.5	67.7	1.7	35	38.5	57	1	68.5	4.6	0.199
—	—	—	—	—	—	—	—	—	36.5	42.5	65.5	1	—	—	0.345
N	NR	3.28	1.9	68.81	0.6	0.5	78.6	1.7	36.5	42.5	65.5	1	80	4.6	0.345

- Remarks**
1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
  2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
  3. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 32 – 45 mm



Open



Shielded  
ZZ



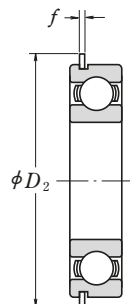
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N



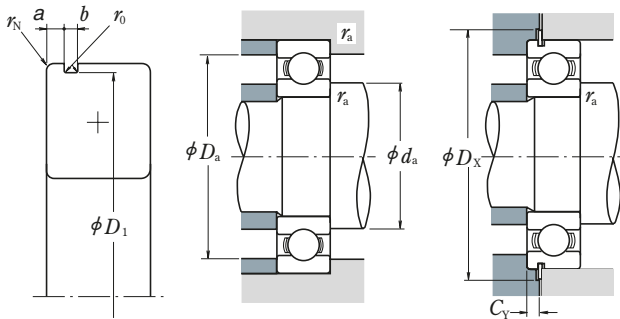
With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil	Open	Shielded	Sealed
							Open Z · ZZ V · VV	DU DDU	Open Z			
32	58	13	1	15 100	9 150	14.5	12 000	7 500	14 000	60/32	ZZ	VV DDU
	65	17	1	20 700	11 600	13.6	10 000	7 100	12 000	62/32	ZZ	VV DDU
	75	20	1.1	29 900	17 000	13.2	9 000	6 300	11 000	63/32	ZZ	VV DDU
35	47	7	0.3	4 900	4 100	16.7	14 000	7 500	16 000	6807	ZZ	VV DD
	55	10	0.6	10 600	7 250	15.5	12 000	7 500	15 000	6907	ZZ	VV DDU
	62	9	0.3	11 700	8 200	15.6	11 000	—	13 000	16007	—	—
	62	14	1	16 800	10 300	14.8	13 000	6 700	15 000	* 6007	ZZ	VV DDU
	62	14	1	16 000	10 300	14.8	11 000	6 700	13 000	6007	ZZ	VV DDU
	72	17	1.1	27 000	15 300	13.8	11 000	6 300	13 000	* 6207	ZZ	VV DDU
	72	17	1.1	25 700	15 300	13.8	9 500	6 300	11 000	6207	ZZ	VV DDU
	80	21	1.5	35 000	19 200	13.2	10 000	6 000	12 000	* 6307	ZZ	VV DDU
	80	21	1.5	33 500	19 200	13.2	8 500	6 000	10 000	6307	ZZ	VV DDU
40	52	7	0.3	6 350	5 550	17.0	12 000	6 700	14 000	6808	ZZ	VV DD
	62	12	0.6	13 700	10 000	15.7	11 000	6 300	13 000	6908	ZZ	VV DDU
	68	9	0.3	12 600	9 650	16.0	10 000	—	12 000	16008	—	—
	68	15	1	17 600	11 500	15.3	12 000	6 000	14 000	* 6008	ZZ	VV DDU
	68	15	1	16 800	11 500	15.3	10 000	6 000	12 000	6008	ZZ	VV DDU
	80	18	1.1	30 500	17 900	14.0	9 500	5 600	12 000	* 6208	ZZ	VV DDU
	80	18	1.1	29 100	17 900	14.0	8 500	5 600	10 000	6208	ZZ	VV DDU
	90	23	1.5	43 000	24 000	13.2	9 000	5 300	11 000	* 6308	ZZ	VV DDU
	90	23	1.5	40 500	24 000	13.2	7 500	5 300	9 000	6308	ZZ	VV DDU
45	58	7	0.3	6 600	6 150	17.2	11 000	6 000	13 000	6809	ZZ	VV DD
	68	12	0.6	14 100	10 900	15.9	9 500	5 600	12 000	6909	ZZ	VV DDU
	75	10	0.6	14 900	11 400	15.9	9 000	—	11 000	16009	—	—
	75	16	1	22 000	15 200	15.3	10 000	5 300	12 000	* 6009	ZZ	VV DDU
	75	16	1	20 900	15 200	15.3	9 000	5 300	11 000	6009	ZZ	VV DDU
	85	19	1.1	33 000	20 400	14.4	9 000	5 300	11 000	* 6209	ZZ	VV DDU
	85	19	1.1	31 500	20 400	14.4	7 500	5 300	9 000	6209	ZZ	VV DDU
	100	25	1.5	55 500	32 000	13.1	7 500	4 800	9 500	* 6309	ZZ	VV DDU
	100	25	1.5	53 000	32 000	13.1	6 700	4 800	8 000	6309	ZZ	VV DDU

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

(3) Does not conform to ISO15.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

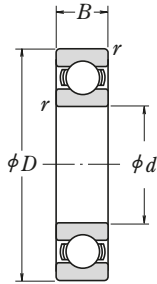
	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)					Mass (kg) approx.
			a max.	b min.	D <sub>1</sub> max.	r <sub>0</sub> max.	r <sub>N</sub> min.	D <sub>2</sub> max.	f max.	d <sub>a</sub> <sup>(2)</sup> min.	D <sub>a</sub> <sup>(2)</sup> max.	r <sub>a</sub> max.	D <sub>x</sub> min.	C <sub>Y</sub> max.	
N	NR		2.08	1.35	55.6	0.4	0.5	63.7	1.12	37	38.5	53	1	64.5	0.122
N	NR		3.28	1.9	62.6	0.6	0.5	70.7	1.7	37	40	60	1	71.5	0.225
N	NR		3.28	1.9	71.83	0.6	0.5	81.6	1.7	38.5	44.5	68.5	1	83	0.389
N	NR		1.30	0.95	45.7	0.25	0.3	49.8	0.85	37	37	45	0.3	50.5	0.027
N	NR		1.70	0.95	53.7	0.25	0.5	57.8	0.85	39	39	51	0.6	58.5	0.075
—	—	—	—	—	—	—	—	—	—	37	—	60	0.3	—	0.107
—	—	—	—	—	—	—	—	—	—	40	41.5	57	1	—	0.151
N	NR		2.08	1.9	59.61	0.6	0.5	67.7	1.7	40	41.5	57	1	68.5	0.151
—	—	—	—	—	—	—	—	—	—	41.5	44.5	65.5	1	—	0.284
N	NR		3.28	1.9	68.81	0.6	0.5	78.6	1.7	41.5	44.5	65.5	1	80	0.284
N	NR		3.28	1.9	76.81	0.6	0.5	86.6	1.7	43	47	72	1.5	—	0.464
—	—	—	—	—	—	—	—	—	—	43	47	72	1.5	88	0.464
N	NR		1.30	0.95	50.7	0.25	0.3	54.8	0.85	42	42	50	0.3	55.5	0.031
N	NR		1.70	0.95	60.7	0.25	0.5	64.8	0.85	44	46	58	0.6	65.5	0.112
—	—	—	—	—	—	—	—	—	—	42	—	66	0.3	—	0.13
—	—	—	—	—	—	—	—	—	—	45	47.5	63	1	—	0.19
N	NR		2.49	1.9	64.82	0.6	0.5	74.6	1.7	45	47.5	63	1	76	0.19
—	—	—	—	—	—	—	—	—	—	46.5	50.5	73.5	1	—	0.366
N	NR		3.28	1.9	76.81	0.6	0.5	86.6	1.7	46.5	50.5	73.5	1	88	0.366
N	NR		3.28	2.7	86.79	0.6	0.5	96.5	2.46	48	53	82	1.5	—	0.636
—	—	—	—	—	—	—	—	—	—	48	53	82	1.5	98	0.636
N	NR		1.30	0.95	56.7	0.25	0.3	60.8	0.85	47	47.5	56	0.3	61.5	0.038
N	NR		1.70	0.95	66.7	0.25	0.3 <sup>(*)</sup>	70.8	0.85	49	50	64	0.6	72	0.126
—	—	—	—	—	—	—	—	—	—	49	—	71	0.6	—	0.167
—	—	—	—	—	—	—	—	—	—	50	53.5	70	1	—	0.241
N	NR		2.49	1.9	71.83	0.6	0.5	81.6	1.7	50	53.5	70	1	83	0.241
—	—	—	—	—	—	—	—	—	—	51.5	55.5	78.5	1	—	0.42
N	NR		3.28	1.9	81.81	0.6	0.5	91.6	1.7	51.5	55.5	78.5	1	93	0.42
N	NR		3.28	2.7	96.8	0.6	0.5	106.5	2.46	53	61.5	92	1.5	—	0.829
—	—	—	—	—	—	—	—	—	—	53	61.5	92	1.5	108	0.829

## Remarks

1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 50 – 60 mm



Open



Shielded  
ZZ



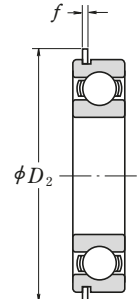
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

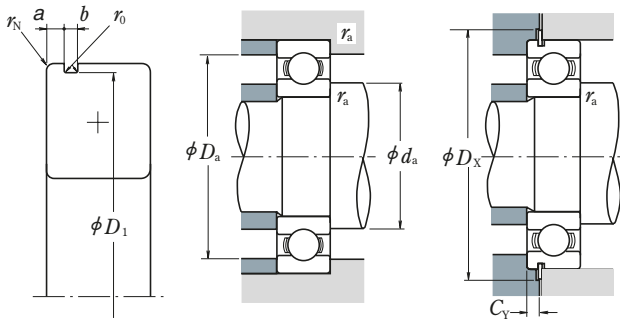


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f<sub>0</sub></i>	Grease		Oil	Open	Shielded	Sealed	
							Open Z · ZZ V · VV	DU DDU	Open Z				
50	65	7	0.3	6 400	6 200	17.2	9 500	5 300	11 000	6810	ZZ	VV	DDU
	72	12	0.6	14 500	11 700	16.1	9 000	5 300	11 000	6910	ZZ	VV	DDU
	80	10	0.6	15 400	12 400	16.1	8 500	—	10 000	16010	—	—	—
	80	16	1	22 900	16 600	15.6	9 500	4 800	11 000	* 6010	ZZ	VV	DDU
	80	16	1	21 800	16 600	15.6	8 500	4 800	10 000	* 6010	ZZ	VV	DDU
	90	20	1.1	37 000	23 200	14.4	8 000	4 800	10 000	* 6210	ZZ	VV	DDU
	90	20	1.1	35 000	23 200	14.4	7 100	4 800	8 500	* 6210	ZZ	VV	DDU
	110	27	2	65 000	38 500	13.2	7 100	4 300	8 500	* 6310	ZZ	VV	DDU
	110	27	2	62 000	38 500	13.2	6 000	4 300	7 500	* 6310	ZZ	VV	DDU
	72	9	0.3	8 800	8 500	17.0	8 500	4 800	10 000	6811	ZZ	VV	DDU
	80	13	1	16 000	13 300	16.2	8 000	4 500	9 500	6911	ZZ	VV	DDU
	90	11	0.6	19 400	16 300	16.2	7 500	—	9 000	16011	—	—	—
55	90	18	1.1	29 700	21 200	15.3	8 500	4 500	10 000	* 6011	ZZ	VV	DDU
	90	18	1.1	28 300	21 200	15.3	7 500	4 500	9 000	* 6011	ZZ	VV	DDU
	100	21	1.5	45 500	29 300	14.3	7 500	4 300	9 000	* 6211	ZZ	VV	DDU
	100	21	1.5	43 500	29 300	14.3	6 300	4 300	7 500	* 6211	ZZ	VV	DDU
	120	29	2	75 000	44 500	13.1	6 700	4 000	8 000	* 6311	ZZ	VV	DDU
	120	29	2	71 500	44 500	13.1	5 600	4 000	6 700	* 6311	ZZ	VV	DDU
	78	10	0.3	11 500	10 900	16.9	8 000	4 500	9 500	6812	ZZ	VV	DD
	85	13	1	19 400	16 300	16.2	7 500	4 300	9 000	6912	ZZ	VV	DDU
	95	11	0.6	20 000	17 500	16.3	7 100	—	8 500	16012	—	—	—
	95	18	1.1	31 000	23 200	15.6	8 000	4 000	9 500	* 6012	ZZ	VV	DDU
	95	18	1.1	29 500	23 200	15.6	7 100	4 000	8 500	* 6012	ZZ	VV	DDU
	110	22	1.5	55 000	36 000	14.3	6 700	3 800	8 000	* 6212	ZZ	VV	DDU
60	110	22	1.5	52 500	36 000	14.3	5 600	3 800	7 100	* 6212	ZZ	VV	DDU
	130	31	2.1	86 000	52 000	13.1	6 000	3 600	7 100	* 6312	ZZ	VV	DDU
	130	31	2.1	82 000	52 000	13.1	5 300	3 600	6 300	* 6312	ZZ	VV	DDU

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied,  $d_a$  and  $D_a$  can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

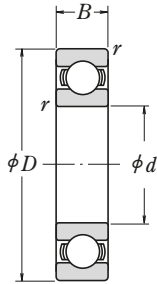
With Snap Ring Groove	With Snap Ring Groove	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup> min.	<i>D</i> <sub>a</sub> <sup>(2)</sup> max.	<i>r</i> <sub>a</sub> max.	<i>D</i> <sub>x</sub> min.	<i>C</i> <sub>Y</sub> max.	approx.	
		max.	min.	max.	max.	min.	max.	max.							
N	NR	1.30	0.95	63.7	0.25	0.3	67.8	0.85	52	52.5	63	0.3	68.5	1.8	0.050
		1.70	0.95	70.7	0.25	0.5	74.8	0.85	54	55	68	0.6	76	2.3	0.135
		—	—	—	—	—	—	—	54	—	76	0.6	—	—	0.175
—	—	—	—	—	—	—	—	—	55	58.5	75	1	—	—	0.261
		—	—	—	—	—	—	—	55	58.5	75	1	88	3.8	0.261
		—	—	—	—	—	—	—	56.5	60	83.5	1	—	—	0.459
N	NR	3.28	2.7	86.79	0.6	0.5	96.5	2.46	56.5	60	83.5	1	98	5.4	0.459
		—	—	—	—	—	—	—	59	68	101	2	—	—	1.06
N	NR	3.28	2.7	106.81	0.6	0.5	116.6	2.46	59	68	101	2	118	5.4	1.06
N	NR	1.70	0.95	70.7	0.25	0.3	74.8	0.85	57	59	70	0.3	76	2.3	0.081
		2.10	1.3	77.9	0.4	0.5	84.4	1.12	60	61.5	75	1	86	2.9	0.189
		—	—	—	—	—	—	—	59	—	86	0.6	—	—	0.257
—	—	—	—	—	—	—	—	—	61.5	64	83.5	1	—	—	0.381
		—	—	—	—	—	—	—	61.5	64	83.5	1	98	5	0.381
		—	—	—	—	—	—	—	63	66.5	92	1.5	—	—	0.619
N	NR	3.28	2.7	96.8	0.6	0.5	106.5	2.46	63	66.5	92	1.5	108	5.4	0.619
		—	—	—	—	—	—	—	64	72.5	111	2	—	—	1.37
N	NR	4.06	3.1	115.21	0.6	0.5	129.7	2.82	64	72.5	111	2	131.5	6.5	1.37
N	NR	1.70	1.3	76.2	0.4	0.3	82.7	1.12	62	64	76	0.3	84	2.5	0.103
		2.10	1.3	82.9	0.4	0.5	89.4	1.12	65	66	80	1	91	2.9	0.192
		—	—	—	—	—	—	—	64	—	91	0.6	—	—	0.281
—	—	—	—	—	—	—	—	—	66.5	69	88.5	1	—	—	0.412
		—	—	—	—	—	—	—	66.5	69	88.5	1	103	5	0.412
		—	—	—	—	—	—	—	68	74.5	102	1.5	—	—	0.783
N	NR	3.28	2.7	106.81	0.6	0.5	116.6	2.46	68	74.5	102	1.5	118	5.4	0.783
		—	—	—	—	—	—	—	71	79	119	2	—	—	1.72
N	NR	4.06	3.1	125.22	0.6	0.5	139.7	2.82	71	79	119	2	141.5	6.5	1.72

## Remarks

1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.
4. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# ■ SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 65 – 75 mm



Open



Shielded  
ZZ



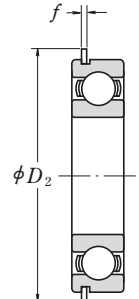
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

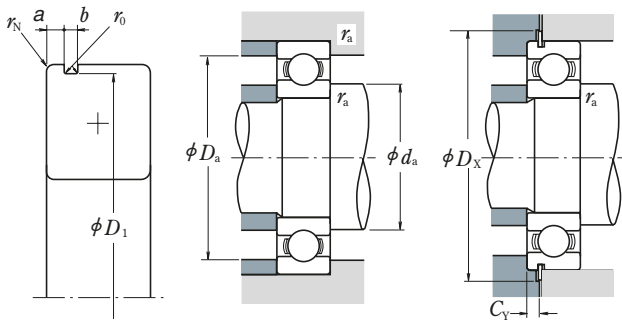


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations				
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f<sub>0</sub></i>	Grease		Oil	Open	Shielded	Sealed		
							Open Z · ZZ V · VV	DU DDU	Open Z					
65	85	10	0.6	11 900	12 100	17.0	7 500	4 000	8 500	6813	ZZ	VV	DD	
	90	13	1	17 400	16 100	16.6	7 100	4 000	8 500	6913	ZZ	VV	DDU	
	100	11	0.6	20 500	18 700	16.5	6 700	—	8 000	16013	—	—	—	
	100	18	1.1	32 000	25 200	15.8	7 500	4 000	9 000	* 6013	ZZ	VV	DDU	
	100	18	1.1	30 500	25 200	15.8	6 700	4 000	8 000	6013	ZZ	VV	DDU	
	120	23	1.5	60 000	40 000	14.4	6 300	3 600	7 500	* 6213	ZZ	VV	DDU	
	120	23	1.5	57 500	40 000	14.4	5 300	3 600	6 300	* 6213	ZZ	VV	DDU	
	140	33	2.1	97 500	60 000	13.2	5 600	3 400	6 700		6313	ZZ	VV	DDU
	140	33	2.1	92 500	60 000	13.2	4 800	3 400	6 000		6313	ZZ	VV	DDU
	70	90	10	0.6	12 100	12 700	17.2	6 700	3 800	8 000	6814	ZZ	VV	DD
		100	16	1	23 700	21 200	16.3	6 300	3 600	7 500	6914	ZZ	VV	DDU
		110	13	0.6	26 800	23 600	16.3	6 000	—	7 100	16014	—	—	—
110		20	1.1	40 000	31 000	15.6	7 100	3 600	8 500	* 6014	ZZ	VV	DDU	
110		20	1.1	38 000	31 000	15.6	6 000	3 600	7 100	6014	ZZ	VV	DDU	
125		24	1.5	65 500	44 000	14.5	6 000	3 400	7 100	* 6214	ZZ	VV	DDU	
125		24	1.5	62 000	44 000	14.5	5 000	3 400	6 300	* 6314	ZZ	VV	DDU	
150		35	2.1	109 000	68 000	13.2	5 300	3 200	6 300		6314	ZZ	VV	DDU
150		35	2.1	104 000	68 000	13.2	4 500	3 200	5 300		6314	ZZ	VV	DDU
75		95	10	0.6	12 500	13 900	17.3	6 300	3 600	7 500	6815	ZZ	VV	DDU
		105	16	1	24 400	22 600	16.5	6 000	3 400	7 100	6915	ZZ	VV	DDU
		115	13	0.6	27 600	25 300	16.4	5 600	—	6 700	16015	—	—	—
	115	20	1.1	41 500	33 500	15.8	6 700	3 400	8 000	* 6015	ZZ	VV	DDU	
	115	20	1.1	39 500	33 500	15.8	5 600	3 400	6 700	6015	ZZ	VV	DDU	
	130	25	1.5	69 500	49 500	14.7	5 600	3 200	6 700	* 6215	ZZ	VV	DDU	
	130	25	1.5	66 000	49 500	14.7	4 800	3 200	5 600	* 6315	ZZ	VV	DDU	
	160	37	2.1	119 000	77 000	13.2	4 800	2 800	6 000		6315	ZZ	VV	DDU
	160	37	2.1	113 000	77 000	13.2	4 300	2 800	5 000		6315	ZZ	VV	DDU
	160	37	2.1											

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied, *d*<sub>a</sub> and *D*<sub>a</sub> can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

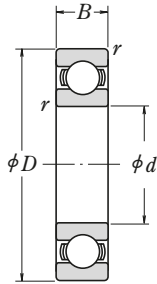
With Snap Ring Groove	With Snap Ring Groove	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup> min.	<i>D</i> <sub>a</sub> <sup>(2)</sup> max.	<i>r</i> <sub>a</sub> max.	<i>D</i> <sub>x</sub> min.	<i>C</i> <sub>Y</sub> max.	approx.	
		max.	min.	max.	max.	min.	max.	max.							
N	NR	1.70	1.3	82.9	0.4	0.5	89.4	1.12	69	69	81	0.6	91	2.5	0.128
N	NR	2.10	1.3	87.9	0.4	0.5	94.4	1.12	70	71.5	85	1	96	2.9	0.218
—	—	—	—	—	—	—	—	—	69	—	96	0.6	—	—	0.30
N	NR	2.87	2.7	96.8	0.6	0.5	106.5	2.46	71.5	73	93.5	1	—	—	0.439
—	—	—	—	—	—	—	—	—	71.5	73	93.5	1	108	5	0.439
—	—	—	—	—	—	—	—	—	73	80	112	1.5	—	—	1.0
N	NR	4.06	3.1	115.21	0.6	0.5	129.7	2.82	73	80	112	1.5	131.5	6.5	1.0
N	NR	4.90	3.1	135.23	0.6	0.5	149.7	2.82	76	85.5	129	2	—	—	2.11
—	—	—	—	—	—	—	—	—	76	85.5	129	2	152	7.3	2.11
N	NR	1.70	1.3	87.9	0.4	0.5	94.4	1.12	74	74.5	86	0.6	96	2.5	0.134
N	NR	2.50	1.3	97.9	0.4	0.5	104.4	1.12	75	77.5	95	1	106	3.3	0.349
—	—	—	—	—	—	—	—	—	74	—	106	0.6	—	—	0.441
N	NR	2.87	2.7	106.81	0.6	0.5	116.6	2.46	76.5	80.5	103.5	1	—	—	0.608
—	—	—	—	—	—	—	—	—	76.5	80.5	103.5	1	118	5	0.608
—	—	—	—	—	—	—	—	—	78	84	117	1.5	—	—	1.09
N	NR	4.06	3.1	120.22	0.6	0.5	134.7	2.82	78	84	117	1.5	136.5	6.5	1.09
N	NR	4.90	3.1	145.24	0.6	0.5	159.7	2.82	81	92	139	2	—	—	2.57
—	—	—	—	—	—	—	—	—	81	92	139	2	162	7.3	2.57
N	NR	1.70	1.3	92.9	0.4	0.5	99.4	1.12	79	79.5	91	0.6	101	2.5	0.149
N	NR	2.50	1.3	102.6	0.4	0.5	110.7	1.12	80	82	100	1	112	3.3	0.364
—	—	—	—	—	—	—	—	—	79	—	111	0.6	—	—	0.463
N	NR	2.87	2.7	111.81	0.6	0.5	121.6	2.46	81.5	85.5	108.5	1	—	—	0.649
—	—	—	—	—	—	—	—	—	81.5	85.5	108.5	1	123	5	0.649
—	—	—	—	—	—	—	—	—	83	90	122	1.5	—	—	1.19
N	NR	4.06	3.1	125.22	0.6	0.5	139.7	2.82	83	90	122	1.5	141.5	6.5	1.19
N	NR	4.90	3.1	155.22	0.6	0.5	169.7	2.82	86	98.5	149	2	—	—	3.08
—	—	—	—	—	—	—	—	—	86	98.5	149	2	172	7.3	3.08

## Remarks

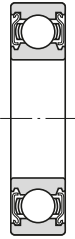
1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.
4. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 80 – 90 mm



Open



Shielded  
ZZ



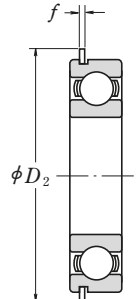
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

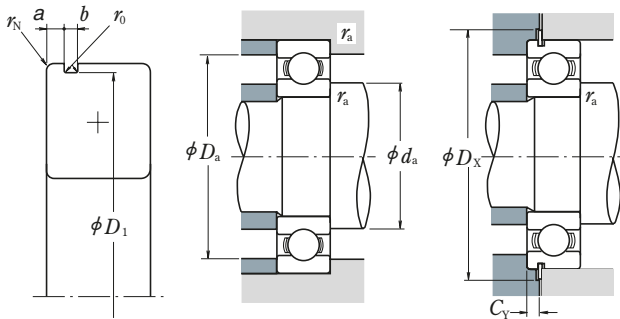


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil	Open	Shielded	Sealed
							Open Z · ZZ V · VV	DU DDU	Open Z			
80	100	10	0.6	12 700	14 500	17.4	6 000	3 400	7 100	<b>6816</b>	<b>ZZ</b>	<b>VV DDU</b>
	110	16	1	25 000	24 000	16.6	5 600	3 200	6 700	<b>6916</b>	<b>ZZ</b>	<b>VV DDU</b>
	125	14	0.6	32 000	29 600	16.4	5 300	—	6 300	<b>16016</b>	—	—
	125	22	1.1	50 000	40 000	15.6	6 300	3 200	7 100	* <b>6016</b>	<b>ZZ</b>	<b>VV DDU</b>
	125	22	1.1	47 500	40 000	15.6	5 300	3 200	6 300	* <b>6016</b>	<b>ZZ</b>	<b>VV DDU</b>
	140	26	2	76 500	53 000	14.6	5 300	3 000	6 300	* <b>6216</b>	<b>ZZ</b>	<b>VV DDU</b>
	140	26	2	72 500	53 000	14.6	4 500	3 000	5 300	<b>6216</b>	<b>ZZ</b>	<b>VV DDU</b>
	170	39	2.1	129 000	86 500	13.3	4 500	2 800	5 600	* <b>6316</b>	<b>ZZ</b>	<b>VV DDU</b>
	170	39	2.1	123 000	86 500	13.3	4 000	2 800	4 800	<b>6316</b>	<b>ZZ</b>	<b>VV DDU</b>
	110	13	1	18 700	20 000	17.1	5 600	3 200	6 700	<b>6817</b>	<b>ZZ</b>	<b>VV DDU</b>
	120	18	1.1	32 000	29 600	16.4	5 300	3 000	6 300	<b>6917</b>	<b>ZZ</b>	<b>VV DDU</b>
	130	14	0.6	33 000	31 500	16.5	5 000	—	6 000	<b>16017</b>	—	—
85	130	22	1.1	52 000	43 000	15.8	6 000	3 000	7 100	* <b>6017</b>	<b>ZZ</b>	<b>VV DDU</b>
	130	22	1.1	49 500	43 000	15.8	5 000	3 000	6 000	* <b>6017</b>	<b>ZZ</b>	<b>VV DDU</b>
	150	28	2	88 000	62 000	14.5	4 800	2 800	6 000	* <b>6217</b>	<b>ZZ</b>	<b>VV DDU</b>
	150	28	2	84 000	62 000	14.5	4 300	2 800	5 000	<b>6217</b>	<b>ZZ</b>	<b>VV DDU</b>
	180	41	3	139 000	97 000	13.3	4 300	2 600	5 000	* <b>6317</b>	<b>ZZ</b>	<b>VV DDU</b>
	180	41	3	133 000	97 000	13.3	3 800	2 600	4 500	<b>6317</b>	<b>ZZ</b>	<b>VV DDU</b>
	115	13	1	19 000	21 000	17.2	5 300	3 000	6 300	<b>6818</b>	<b>ZZ</b>	<b>VV DDU</b>
	125	18	1.1	33 000	31 500	16.5	5 000	2 800	6 000	<b>6918</b>	<b>ZZ</b>	<b>VV DDU</b>
	140	16	1	41 500	39 500	16.3	4 800	—	5 600	<b>16018</b>	—	—
	140	24	1.5	61 000	50 000	15.6	5 600	2 800	6 300	* <b>6018</b>	<b>ZZ</b>	<b>VV DDU</b>
	140	24	1.5	58 000	50 000	15.6	4 800	2 800	5 600	* <b>6018</b>	<b>ZZ</b>	<b>VV DDU</b>
	160	30	2	101 000	71 500	14.5	4 500	2 600	5 600	* <b>6218</b>	<b>ZZ</b>	<b>VV DDU</b>
90	160	30	2	96 000	71 500	14.5	4 000	2 600	4 800	<b>6218</b>	<b>ZZ</b>	<b>VV DDU</b>
	190	43	3	150 000	107 000	13.3	4 000	2 400	4 800	* <b>6318</b>	<b>ZZ</b>	<b>VV DDU</b>
	190	43	3	143 000	107 000	13.3	3 600	2 400	4 300	<b>6318</b>	<b>ZZ</b>	<b>VV DDU</b>
	190	43	3									

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

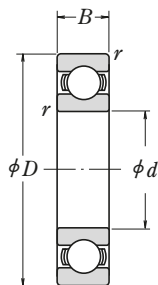
With Snap Ring Groove	With Snap Ring Groove	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup> min.	<i>D</i> <sub>a</sub> <sup>(2)</sup> max.	<i>r</i> <sub>a</sub> max.	<i>D</i> <sub>x</sub> min.	<i>C</i> <sub>Y</sub> max.	approx.	
		max.	min.	max.	max.	min.	max.	max.							
N	NR	1.7	1.3	97.9	0.4	0.5	104.4	1.12	84	84.5	96	0.6	106	2.5	0.151
		2.5	1.3	107.6	0.4	0.5	115.7	1.12	85	87.5	105	1	117	3.3	0.391
		—	—	—	—	—	—	—	84	—	121	0.6	—	—	0.621
N	NR	—	—	—	—	—	—	—	86.5	91	118.5	1	—	—	0.872
		2.87	3.1	120.22	0.6	0.5	134.7	2.82	86.5	91	118.5	1	136.5	5.3	0.872
		—	—	—	—	—	—	—	89	95.5	131	2	—	—	1.42
N	NR	4.90	3.1	135.23	0.6	0.5	149.7	2.82	89	95.5	131	2	152	7.3	1.42
		—	—	—	—	—	—	—	91	104.5	159	2	—	—	3.67
N	NR	5.69	3.5	163.65	0.6	0.5	182.9	3.1	91	104.5	159	2	185	8.4	3.67
N	NR	2.10	1.3	107.6	0.4	0.5	115.7	1.12	90	90.5	105	1	117	2.9	0.263
		3.30	1.3	117.6	0.4	0.5	125.7	1.12	91.5	94.5	113.5	1	127	4.1	0.55
		—	—	—	—	—	—	—	89	—	126	0.6	—	—	0.652
N	NR	—	—	—	—	—	—	—	91.5	96	123.5	1	—	—	0.918
		2.87	3.1	125.22	0.6	0.5	139.7	2.82	91.5	96	123.5	1	141.5	5.3	0.918
		—	—	—	—	—	—	—	94	102	141	2	—	—	1.76
N	NR	4.90	3.1	145.24	0.6	0.5	159.7	2.82	94	102	141	2	162	7.3	1.76
		—	—	—	—	—	—	—	98	110.5	167	2.5	—	—	4.28
N	NR	5.69	3.5	173.66	0.6	0.5	192.9	3.1	98	110.5	167	2.5	195	8.4	4.28
N	NR	2.10	1.3	112.6	0.4	0.5	120.7	1.12	95	95.5	110	1	122	2.9	0.276
		3.30	1.3	122.6	0.4	0.5	130.7	1.12	96.5	98.5	118.5	1	132	4.1	0.585
		—	—	—	—	—	—	—	95	—	135	1	—	—	0.873
N	NR	—	—	—	—	—	—	—	98	103	132	1.5	—	—	1.19
		3.71	3.1	135.23	0.6	0.5	149.7	2.82	98	103	132	1.5	152	6.1	1.19
		—	—	—	—	—	—	—	99	107.5	151	2	—	—	2.18
N	NR	4.90	3.1	155.22	0.6	0.5	169.7	2.82	99	107.5	151	2	172	7.3	2.18
		—	—	—	—	—	—	—	103	117	177	2.5	—	—	4.98
N	NR	5.69	3.5	183.64	0.6	0.5	202.9	3.1	103	117	177	2.5	205	8.4	4.98

## Remarks

1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.
4. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# ■ SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 95 – 105 mm



Open



Shielded  
ZZ



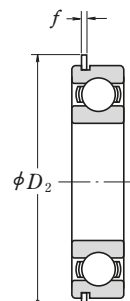
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

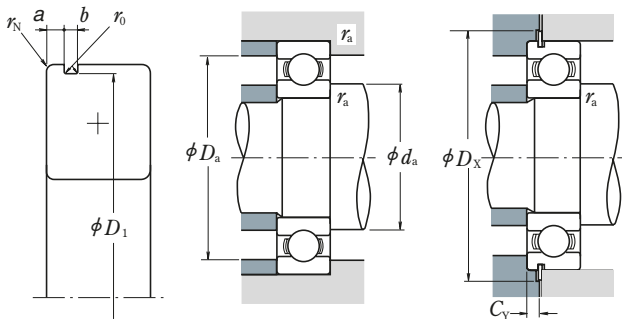


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil				
							Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
95	120	13	1	19 300	22 000	17.2	5 000	2 800	6 000	<b>6819</b>	<b>ZZ</b>	<b>VV</b>	<b>DD</b>
	130	18	1.1	33 500	33 500	16.6	4 800	2 800	5 600	<b>6919</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	145	16	1	43 000	42 000	16.4	4 500	—	5 300	<b>16019</b>	—	—	—
	145	24	1.5	63 500	54 000	15.8	5 300	2 600	6 000	* <b>6019</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	145	24	1.5	60 500	54 000	15.8	4 500	2 600	5 300	<b>6019</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	170	32	2.1	114 000	82 000	14.4	4 300	2 600	5 000	* <b>6219</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	170	32	2.1	109 000	82 000	14.4	3 800	2 600	4 500	<b>6219</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	200	45	3	160 000	119 000	13.3	3 400	2 400	4 300	* <b>6319</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	200	45	3	153 000	119 000	13.3	3 000	2 400	3 600	<b>6319</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	125	13	1	19 600	23 000	17.3	4 800	2 800	5 600	<b>6820</b>	<b>ZZ</b>	<b>VV</b>	<b>DD</b>
	140	20	1.1	43 000	42 000	16.4	4 500	2 600	5 300	<b>6920</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	150	16	1	42 500	42 000	16.5	4 300	—	5 300	<b>16020</b>	—	—	—
100	150	24	1.5	63 000	54 000	15.9	5 000	2 600	6 000	* <b>6020</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	150	24	1.5	60 000	54 000	15.9	4 300	2 600	5 300	<b>6020</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	180	34	2.1	128 000	93 000	14.4	4 000	2 400	4 800	* <b>6220</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	180	34	2.1	122 000	93 000	14.4	3 600	2 400	4 300	<b>6220</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	215	47	3	173 000	141 000	13.2	2 800	2 200	3 400	<b>6320</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	130	13	1	19 800	23 900	17.4	4 800	2 600	5 600	<b>6821</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	145	20	1.1	42 500	42 000	16.5	4 300	—	5 300	<b>6921</b>	<b>ZZ</b>	<b>VV</b>	—
	160	18	1	52 000	50 500	16.3	4 000	—	4 800	<b>16021</b>	—	—	—
	160	26	2	76 000	66 000	15.8	4 500	2 400	5 600	* <b>6021</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	160	26	2	72 500	66 000	15.8	4 000	2 400	4 800	<b>6021</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	190	36	2.1	140 000	105 000	14.4	3 800	2 200	4 500	* <b>6221</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	190	36	2.1	133 000	105 000	14.4	3 400	2 200	4 000	<b>6221</b>	<b>ZZ</b>	<b>VV</b>	<b>DDU</b>
	225	49	3	184 000	154 000	13.2	2 600	2 000	3 200	<b>6321</b>	<b>ZZ</b>	—	<b>DDU</b>

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

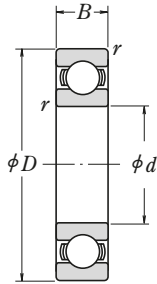
With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions <i>D</i> <sub>2</sub> <i>f</i> (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup>	<i>D</i> <sub>a</sub> <sup>(2)</sup>	<i>r</i> <sub>a</sub>	<i>D</i> <sub>x</sub>	<i>C</i> <sub>Y</sub>	approx.	
		max.	min.	max.	max.	min.	max.	max.	min.	max.	max.	min.	max.		
<b>N</b>	<b>NR</b>	2.10	1.3	117.6	0.4	0.5	125.7	1.12	100	101.5	115	1	127	2.9	0.297
<b>N</b>	<b>NR</b>	3.30	1.3	127.6	0.4	0.5	135.7	1.12	101.5	103.5	123.5	1	137	4.1	0.601
—	—	—	—	—	—	—	—	—	100	—	140	1	—	—	0.904
<b>N</b>	<b>NR</b>	—	—	—	—	—	—	—	103	108.5	137	1.5	—	—	1.23
—	—	3.71	3.1	140.23	0.6	0.5	154.7	2.82	103	108.5	137	1.5	157	6.1	1.23
—	—	—	—	—	—	—	—	—	106	114	159	2	—	—	2.64
<b>N</b>	<b>NR</b>	5.69	3.5	163.65	0.6	0.5	182.9	3.1	106	114	159	2	185	8.4	2.64
<b>N</b>	<b>NR</b>	5.69	3.5	193.65	0.6	0.5	212.9	3.1	108	123.5	187	2.5	—	—	5.76
—	—	—	—	—	—	—	—	—	108	123.5	187	2.5	215	8.4	5.76
<b>N</b>	<b>NR</b>	2.10	1.3	122.6	0.4	0.5	130.7	1.12	105	105.5	120	1	132	2.9	0.31
<b>N</b>	<b>NR</b>	3.30	1.9	137.6	0.6	0.5	145.7	1.7	106.5	111	133.5	1	147	4.7	0.828
—	—	—	—	—	—	—	—	—	105	—	145	1	—	—	0.945
<b>N</b>	<b>NR</b>	—	—	—	—	—	—	—	108	112.5	142	1.5	—	—	1.29
—	—	3.71	3.1	145.24	0.6	0.5	159.7	2.82	108	112.5	142	1.5	162	6.1	1.29
—	—	—	—	—	—	—	—	—	111	121.5	169	2	—	—	3.17
<b>N</b>	<b>NR</b>	5.69	3.5	173.66	0.6	0.5	192.9	3.1	111	121.5	169	2	195	8.4	3.17
—	—	—	—	—	—	—	—	—	113	133	202	2.5	—	—	7.04
<b>N</b>	<b>NR</b>	2.10	1.3	127.6	0.4	0.5	135.7	1.12	110	110.5	125	1	137	2.9	0.324
<b>N</b>	<b>NR</b>	3.30	1.9	142.6	0.6	0.5	150.7	1.7	111.5	116	138.5	1	152	4.7	0.856
—	—	—	—	—	—	—	—	—	110	—	155	1	—	—	1.24
<b>N</b>	<b>NR</b>	—	—	—	—	—	—	—	114	120	151	2	—	—	1.58
—	—	3.71	3.1	155.22	0.6	0.5	169.7	2.82	114	120	151	2	172	6.1	1.58
—	—	—	—	—	—	—	—	—	116	127.5	179	2	—	—	3.79
<b>N</b>	<b>NR</b>	5.69	3.5	183.64	0.6	0.5	202.9	3.1	116	127.5	179	2	205	8.4	3.79
—	—	—	—	—	—	—	—	—	118	138	212	2.5	—	—	8.09

## Remarks

1. Diameter Series 7 (extra-thin wall) bearings are also available; please contact NSK for details.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.
4. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 110 – 150 mm



Open



Shielded  
ZZ · ZS



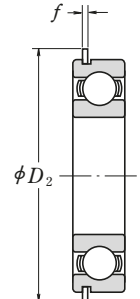
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

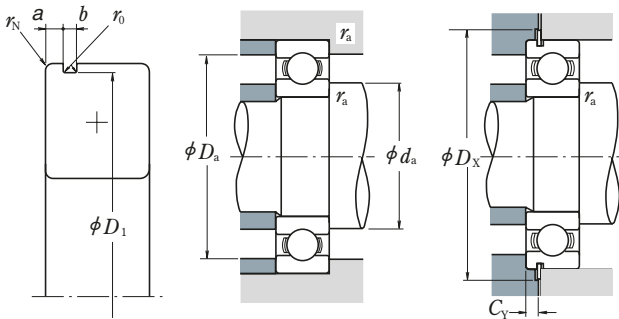


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil				
							Open Z V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
110	140	16	1	28 100	32 500	17.1	4 300	2 400	5 300	6822	ZZ	VV	DDU
	150	20	1.1	43 500	44 500	16.6	4 300	2 400	5 000	6922	ZZ	VV	DDU
	170	19	1	57 500	56 500	16.3	3 800	—	4 500	16022	—	—	—
	170	28	2	89 000	73 000	15.5	4 500	2 200	5 300	* 6022	ZZ	VV	DDU
	170	28	2	85 000	73 000	15.5	3 800	2 200	4 500	6022	ZZ	VV	DDU
	200	38	2.1	144 000	117 000	14.3	2 800	2 200	3 400	6222	ZZ	VV	DDU
	240	50	3	205 000	179 000	13.2	2 400	—	3 000	6322	ZZ	—	—
	150	16	1	28 900	35 500	17.3	4 000	2 200	4 800	6824	ZZ	VV	DD
	165	22	1.1	53 000	54 000	16.5	3 800	—	4 500	6924	ZZ	—	—
	180	19	1	56 500	57 500	16.5	3 600	—	4 300	16024	—	—	—
120	180	28	2	92 500	80 000	15.7	4 000	2 200	4 800	* 6024	ZZ	VV	DDU
	180	28	2	88 000	80 000	15.7	3 600	2 200	4 300	6024	ZZ	VV	DDU
	215	40	2.1	155 000	131 000	14.4	2 600	2 000	3 200	6224	ZZ	VV	DDU
	260	55	3	207 000	185 000	13.5	2 200	1 800	2 800	6324	ZZS	—	DDU
	165	18	1.1	37 000	44 000	17.1	3 600	2 000	4 300	6826	ZZS	VV	DD
	180	24	1.5	65 000	67 500	16.5	3 400	—	4 000	6926	ZZ	—	—
130	200	22	1.1	75 500	77 500	16.4	3 000	—	3 600	16026	—	—	—
	200	33	2	106 000	101 000	15.8	3 000	1 900	3 600	6026	ZZ	—	DDU
	230	40	3	167 000	146 000	14.5	2 400	—	3 000	6226	ZZ	—	—
	280	58	4	229 000	214 000	13.6	2 200	—	2 600	6326	ZZS	—	—
	175	18	1.1	38 500	48 000	17.3	3 400	1 900	4 000	6828	ZZ	VV	DDU
	190	24	1.5	66 500	72 000	16.6	3 200	—	3 800	6928	ZZS	VV	—
140	210	22	1.1	77 500	82 500	16.5	2 800	—	3 400	16028	—	—	—
	210	33	2	110 000	109 000	16.0	2 800	1 800	3 400	6028	ZZ	—	DDU
	250	42	3	166 000	150 000	14.9	2 200	1 700	2 800	6228	ZZS	—	DDU
	300	62	4	253 000	246 000	13.6	2 000	—	2 400	6328	ZZS	—	—
	190	20	1.1	47 500	58 500	17.1	3 200	1 800	3 800	6830	ZZ	VV	DDU
	210	28	2	85 000	90 500	16.5	2 600	1 700	3 200	6930	ZZS	—	DDU
150	225	24	1.1	84 000	91 000	16.6	2 600	—	3 000	16030	—	—	—
	225	35	2.1	126 000	126 000	15.9	2 600	1 700	3 000	6030	ZZ	VV	DDU
	270	45	3	176 000	168 000	15.1	2 000	—	2 600	6230	ZZS	—	—
	320	65	4	274 000	284 000	13.9	1 800	—	2 200	6330	ZZS	—	—

**Notes** (1) For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

(2) When heavy axial loads are applied,  $d_a$  and  $D_a$  can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

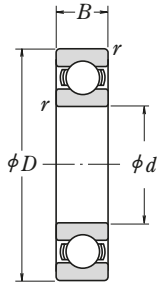
$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup>	<i>D</i> <sub>a</sub> <sup>(2)</sup>	<i>r</i> <sub>a</sub>	<i>D</i> <sub>x</sub>	<i>C</i> <sub>Y</sub>	approx.	
		max.	min.	max.	max.	min.	max.	max.	min.	max.	max.	min.	max.		
N	NR	2.50	1.9	137.6	0.6	0.5	145.7	1.7	115	117	135	1	147	3.9	0.497
N	NR	3.30	1.9	147.6	0.6	0.5	155.7	1.7	116.5	121	143.5	1	157	4.7	0.893
—	—	—	—	—	—	—	—	—	115	—	165	1	—	—	1.51
—	—	—	—	—	—	—	—	—	119	124.5	161	2	—	—	1.94
N	NR	3.71	3.5	163.65	0.6	0.5	182.9	3.1	119	124.5	161	2	185	6.4	1.94
N	NR	5.69	3.5	193.65	0.6	0.5	212.9	3.1	121	134	189	2	215	8.4	4.45
—	—	—	—	—	—	—	—	—	123	147	227	2.5	—	—	9.51
N	NR	2.50	1.9	147.6	0.6	0.5	155.7	1.7	125	127	145	1	157	3.9	0.537
N	NR	3.70	1.9	161.8	0.6	0.5	171.5	1.7	126.5	132	158.5	1	173	5.1	1.21
—	—	—	—	—	—	—	—	—	125	—	175	1	—	—	1.6
—	—	—	—	—	—	—	—	—	129	134.5	171	2	—	—	2.08
N	NR	3.71	3.5	173.66	0.6	0.5	192.9	3.1	129	134.5	171	2	195	6.4	2.08
—	—	—	—	—	—	—	—	—	131	146	204	2	—	—	5.29
—	—	—	—	—	—	—	—	—	133	161	247	2.5	—	—	12.5
N	NR	3.30	1.9	161.8	0.6	0.5	171.5	1.7	136.5	138	158.5	1	173	4.7	0.758
N	NR	3.70	1.9	176.8	0.6	0.5	186.5	1.7	138	144	172	1.5	188	5.1	1.57
—	—	—	—	—	—	—	—	—	136.5	—	193.5	1	—	—	2.4
N	NR	5.69	3.5	193.65	0.6	0.5	212.9	3.1	139	148.5	191	2	215	8.4	3.26
—	—	—	—	—	—	—	—	—	143	157	217	2.5	—	—	5.96
—	—	—	—	—	—	—	—	—	146	175	264	3	—	—	15.2
N	NR	3.30	1.9	171.8	0.6	0.5	181.5	1.7	146.5	148.5	168.5	1	183	4.7	0.832
N	NR	3.70	1.9	186.8	0.6	0.5	196.5	1.7	148	153.5	182	1.5	198	5.1	1.67
—	—	—	—	—	—	—	—	—	146.5	—	203.5	1	—	—	2.84
—	—	—	—	—	—	—	—	—	149	158.5	201	2	—	—	3.48
—	—	—	—	—	—	—	—	—	153	171.5	237	2.5	—	—	7.68
—	—	—	—	—	—	—	—	—	156	187	284	3	—	—	18.5
N	NR	3.30	1.9	186.8	0.6	0.5	196.5	1.7	156.5	160	183.5	1	198	4.7	1.15
—	—	—	—	—	—	—	—	—	159	166	201	2	—	—	3.01
—	—	—	—	—	—	—	—	—	156.5	—	218.5	1	—	—	3.62
—	—	—	—	—	—	—	—	—	161	170	214	2	—	—	4.24
—	—	—	—	—	—	—	—	—	163	186	257	2.5	—	—	10
—	—	—	—	—	—	—	—	—	166	203	304	3	—	—	22.7

- Remarks**
1. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
  2. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.
  3. Bearings denoted by an asterisk (\*) are NSKHPS™ deep groove ball bearings.

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 160 mm



Open



Shielded  
ZZ · ZJS



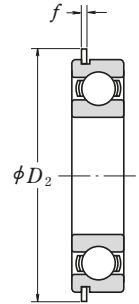
Non-Contact  
Sealed  
VV



Contact  
Sealed  
DD · DDU



With Snap  
Ring Groove  
N

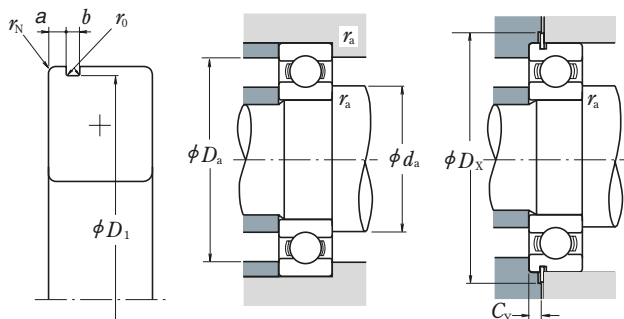


With Snap Ring  
NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f</i> <sub>0</sub>	Grease		Oil	Open	Shielded	Sealed
							Open Z · ZZ V · VV	DU DDU	Open Z			
160	200	20	1.1	48 500	61 000	17.2	2 600	1 700	3 200	<b>6832</b>	<b>ZZS</b>	<b>VV</b>
	220	28	2	87 000	96 000	16.6	2 600	1 600	3 000	<b>6932</b>	<b>ZZS</b>	<b>—</b>
	240	25	1.5	99 000	108 000	16.5	2 400	—	2 800	<b>16032</b>	<b>—</b>	<b>—</b>
	240	38	2.1	137 000	135 000	15.9	2 400	1 600	2 800	<b>6032</b>	<b>ZZ</b>	<b>—</b>
	290	48	3	185 000	186 000	15.4	1 900	—	2 400	<b>6232</b>	<b>ZZS</b>	<b>—</b>
	340	68	4	278 000	287 000	13.9	1 700	—	2 000	<b>6332</b>	<b>ZZS</b>	<b>—</b>
										<b>DDU</b>	<b>DDU</b>	<b>DDU</b>

**Notes** <sup>(1)</sup> For tolerances of snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.

<sup>(2)</sup> When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

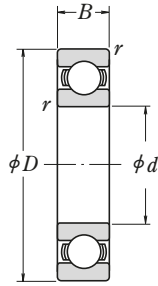
$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions <sup>(1)</sup> (mm)					Snap Ring <sup>(1)</sup> Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		<i>a</i>	<i>b</i>	<i>D</i> <sub>1</sub>	<i>r</i> <sub>0</sub>	<i>r</i> <sub>N</sub>	<i>D</i> <sub>2</sub>	<i>f</i>	<i>d</i> <sub>a</sub> <sup>(2)</sup>	<i>D</i> <sub>a</sub> <sup>(2)</sup>	<i>r</i> <sub>a</sub>	<i>D</i> <sub>x</sub>	<i>C</i> <sub>Y</sub>		
		max.	min.	max.	max.	min.	max.	max.	min.	max.	max.	max.	min.	max.	approx.
<b>N</b>	<b>NR</b>	3.30	1.9	196.8	0.6	0.5	206.5	1.7	166.5	170.5	193.5	1	208	4.7	1.23
—	—	—	—	—	—	—	—	—	169	176	211	2	—	—	2.71
—	—	—	—	—	—	—	—	—	168	—	232	1.5	—	—	4.2
—	—	—	—	—	—	—	—	—	171	181.5	229	2	—	—	5.15
—	—	—	—	—	—	—	—	—	173	202	277	2.5	—	—	12.8
—	—	—	—	—	—	—	—	—	176	215.5	324	3	—	—	26.2

- Remarks**
1. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
  2. Please consult NSK about the snap ring groove dimensions of Dimension Series 18 and 19 sealed and shielded bearings when the diameter is 50 mm or more.

# ■ SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 170 – 240 mm



Open



Shielded  
ZZS

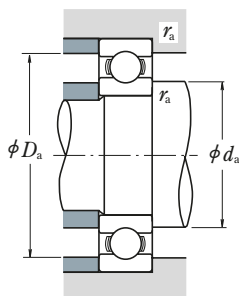


Non-Contact  
Sealed  
VV

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )			Bearing Designations			
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f<sub>0</sub></i>	Grease		Oil				
								Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed
170	215	22	1.1	60 000	75 000	17.1	2 600	1 600	3 000	6834	ZZS	VV	DDU
	230	28	2	86 000	97 000	16.7	2 400	—	2 800	6934	ZZS	—	—
	260	28	1.5	114 000	126 000	16.5	2 200	—	2 600	16034	—	—	—
	260	42	2.1	161 000	161 000	15.8	2 200	—	2 600	6034	ZZS	VV	—
	310	52	4	212 000	224 000	15.3	1 800	—	2 200	6234	ZZS	—	—
	360	72	4	325 000	355 000	13.6	1 600	—	2 000	6334	—	—	—
180	225	22	1.1	60 500	78 500	17.2	2 400	—	2 800	6836	—	VV	—
	250	33	2	119 000	128 000	16.4	2 200	—	2 600	6936	ZZS	—	—
	280	31	2	145 000	157 000	16.3	2 000	—	2 400	16036	—	—	—
	280	46	2.1	180 000	185 000	15.6	2 000	—	2 400	6036	ZZS	VV	—
	320	52	4	227 000	241 000	15.1	1 700	—	2 000	6236	ZZS	—	—
	380	75	4	355 000	405 000	13.9	1 500	—	1 800	6336	—	—	—
190	240	24	1.5	73 000	93 500	17.1	2 200	—	2 600	6838	—	VV	—
	260	33	2	113 000	127 000	16.6	2 200	—	2 600	6938	—	—	—
	290	31	2	149 000	168 000	16.4	2 000	—	2 400	16038	—	—	—
	290	46	2.1	188 000	201 000	15.8	2 000	—	2 400	6038	ZZS	—	—
	340	55	4	255 000	282 000	15.0	1 600	—	2 000	6238	ZZS	—	—
	400	78	5	355 000	415 000	14.1	1 400	—	1 700	6338	—	—	—
200	250	24	1.5	74 000	98 000	17.2	2 200	—	2 600	6840	—	—	—
	280	38	2.1	143 000	158 000	16.4	2 000	—	2 400	6940	ZZS	—	—
	310	34	2	161 000	180 000	16.4	1 900	—	2 200	16040	—	—	—
	310	51	2.1	207 000	226 000	15.6	1 900	—	2 200	6040	ZZS	—	—
	360	58	4	269 000	310 000	15.2	1 500	—	1 800	6240	ZZS	—	—
	420	80	5	380 000	445 000	13.8	1 300	—	1 600	6340	—	—	—
220	270	24	1.5	76 500	107 000	17.4	1 900	—	2 400	6844	ZZS	—	—
	300	38	2.1	146 000	169 000	16.6	1 800	—	2 200	6944	ZZS	—	—
	340	37	2.1	180 000	217 000	16.5	1 600	—	2 000	16044	—	—	—
	340	56	3	235 000	271 000	15.6	1 700	—	2 000	6044	ZZS	—	—
	400	65	4	310 000	375 000	15.1	1 300	—	1 600	6244	—	—	—
	460	88	5	410 000	520 000	14.3	1 200	—	1 500	6344	—	—	—
240	300	28	2	98 500	137 000	17.3	1 700	—	2 000	6848	—	—	—
	320	38	2.1	154 000	190 000	16.8	1 700	—	2 000	6948	ZZS	—	—
	360	37	2.1	196 000	243 000	16.5	1 500	—	1 900	16048	—	—	—
	360	56	3	244 000	296 000	15.9	1 500	—	1 900	6048	—	—	—
	440	72	4	340 000	430 000	15.2	1 200	—	1 500	6248	—	—	—
	500	95	5	470 000	625 000	14.2	1 100	—	1 300	6348	—	—	—

**Note** <sup>(1)</sup> When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

**Remark** When using bearings with rotating outer rings, contact NSK if they are sealed or shielded.



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		$X$	$Y$	$X$	$Y$
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

## Static Equivalent Load

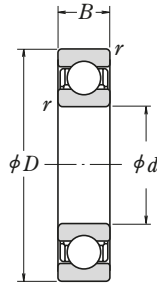
$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

Abutment and Fillet Dimensions (mm)				Mass (kg)
$d_a^{(1)}$	$D_a^{(1)}$	$r_a$		
min.	max.	max.	max.	approx.
176.5	182	208.5	1	1.86
179	186	221	2	3.34
178	—	252	1.5	5.71
181	194.5	249	2	6.89
186	215	294	3	15.8
186	—	344	3	36.6
186.5	192	218.5	1	1.98
189	198.5	241	2	4.16
189	—	271	2	7.5
191	208	269	2	8.88
196	223	304	3	15.9
196	—	364	3	43.1
198	202.5	232	1.5	2.53
199	—	251	2	5.18
199	—	281	2	7.78
201	218	279	2	9.39
206	236	324	3	22.3
210	—	380	4	49.7
208	—	242	1.5	2.67
211	222	269	2	7.28
209	—	301	2	10
211	231.5	299	2	12
216	252	344	3	26.7
220	—	400	4	55.3
228	233.5	262	1.5	2.9
231	242	289	2	7.88
231	—	329	2	13.1
233	254.5	327	2.5	18.6
236	—	384	3	37.4
240	—	440	4	73.9
249	—	291	2	4.48
251	262	309	2	8.49
251	—	349	2	13.9
253	—	347	2.5	19.9
256	—	424	3	50.5
260	—	480	4	94.4

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

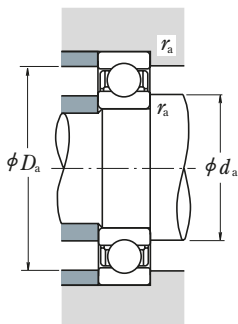
Bore Diameter 260 – 360 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )		Bearing Designations
$d$	$D$	$B$	$r$ min.	$C_r$	$C_{0r}$	$f_0$	Grease	Oil	Open
260	320	28	2	101 000	148 000	17.4	1 600	1 900	6852
	360	46	2.1	204 000	255 000	16.5	1 500	1 800	6952
	400	44	3	237 000	310 000	16.4	1 400	1 700	16052
	400	65	4	291 000	375 000	15.8	1 400	1 700	6052
	480	80	5	400 000	540 000	15.1	1 100	1 300	6252
	540	102	6	505 000	710 000	14.6	1 000	1 200	6352
280	350	33	2	133 000	191 000	17.3	1 500	1 700	6856
	380	46	2.1	209 000	272 000	16.6	1 400	1 700	6956
	420	44	3	243 000	330 000	16.5	1 300	1 600	16056
	420	65	4	300 000	410 000	16.0	1 300	1 600	6056
	500	80	5	400 000	550 000	15.2	1 000	1 300	6256
	580	108	6	570 000	840 000	14.5	900	1 100	6356
300	380	38	2.1	166 000	233 000	17.1	1 300	1 600	6860
	420	56	3	269 000	370 000	16.4	1 300	1 500	6960
	460	50	4	285 000	405 000	16.4	1 200	1 400	16060
	460	74	4	355 000	500 000	15.8	1 200	1 400	6060
	540	85	5	465 000	670 000	15.1	950	1 200	6260
320	400	38	2.1	168 000	244 000	17.2	1 300	1 500	6864
	440	56	3	266 000	375 000	16.5	1 200	1 400	6964
	480	50	4	293 000	430 000	16.5	1 100	1 300	16064
	480	74	4	390 000	570 000	15.7	1 100	1 300	6064
	580	92	5	530 000	805 000	15.0	850	1 100	6264
340	420	38	2.1	175 000	265 000	17.3	1 200	1 400	6868
	460	56	3	273 000	400 000	16.6	1 100	1 300	6968
	520	82	5	440 000	660 000	15.6	1 000	1 200	6068
	620	92	6	530 000	820 000	15.3	800	1 000	6268
360	440	38	2.1	192 000	290 000	17.3	1 100	1 300	6872
	480	56	3	280 000	425 000	16.7	1 100	1 300	6972
	540	82	5	460 000	720 000	15.7	950	1 200	6072
	650	95	6	555 000	905 000	15.4	750	950	6272

**Note** (1) When heavy axial loads are applied,  $d_a$  and  $D_a$  can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		$X$	$Y$	$X$	$Y$
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

**Static Equivalent Load**

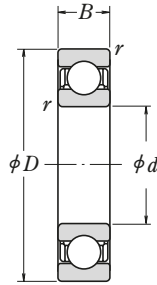
$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a^{(1)}$ min.	$D_a^{(1)}$ max.	$r_a$ max.	approx.
269	311	2	4.84
271	349	2	14
273	387	2.5	21.1
276	384	3	29.4
280	460	4	67
286	514	5	118
289	341	2	7.2
291	369	2	15.1
293	407	2.5	22.7
296	404	3	31.2
300	480	4	70.4
306	554	5	144
311	369	2	10.3
313	407	2.5	23.9
316	444	3	31.5
316	444	3	44.2
320	520	4	87.8
331	389	2	10.8
333	427	2.5	25.3
336	464	3	33.2
336	464	3	46.5
340	560	4	111
351	409	2	11.5
353	447	2.5	26.6
360	500	4	62.3
366	594	5	129
371	429	2	11.8
373	467	2.5	27.9
380	520	4	65.3
386	624	5	145

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

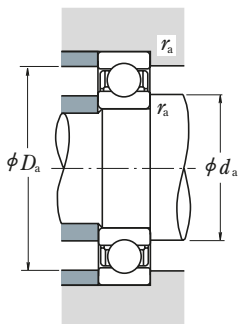
Bore Diameter 380 – 600 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )		Bearing Designations
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f<sub>0</sub></i>	Grease	Oil	Open
<b>380</b>	480	46	2.1	238 000	375 000	17.1	1 000	1 200	<b>6876</b>
	520	65	4	325 000	510 000	16.6	950	1 200	<b>6976</b>
	560	82	5	455 000	725 000	15.9	900	1 100	<b>6076</b>
<b>400</b>	500	46	2.1	241 000	390 000	17.2	950	1 200	<b>6880</b>
	540	65	4	335 000	540 000	16.7	900	1 100	<b>6980</b>
	600	90	5	510 000	825 000	15.7	850	1 000	<b>6080</b>
<b>420</b>	520	46	2.1	245 000	410 000	17.3	900	1 100	<b>6884</b>
	560	65	4	340 000	570 000	16.8	900	1 100	<b>6984</b>
	620	90	5	530 000	895 000	15.8	800	1 000	<b>6084</b>
<b>440</b>	540	46	2.1	248 000	425 000	17.4	900	1 100	<b>6888</b>
	600	74	4	395 000	680 000	16.6	800	1 000	<b>6988</b>
	650	94	6	550 000	965 000	16.0	750	900	<b>6088</b>
<b>460</b>	580	56	3	310 000	550 000	17.1	800	1 000	<b>6892</b>
	620	74	4	405 000	720 000	16.7	800	950	<b>6992</b>
	680	100	6	605 000	1 080 000	15.8	710	850	<b>6092</b>
<b>480</b>	600	56	3	315 000	575 000	17.2	800	950	<b>6896</b>
	650	78	5	450 000	815 000	16.6	750	900	<b>6996</b>
	700	100	6	605 000	1 090 000	15.9	710	850	<b>6096</b>
<b>500</b>	620	56	3	320 000	600 000	17.3	750	900	<b>68/500</b>
	670	78	5	460 000	865 000	16.7	710	850	<b>69/500</b>
	720	100	6	630 000	1 170 000	16.0	670	800	<b>60/500</b>
<b>530</b>	650	56	3	325 000	625 000	17.4	710	850	<b>68/530</b>
	710	82	5	455 000	870 000	16.8	670	800	<b>69/530</b>
	780	112	6	680 000	1 300 000	16.0	600	750	<b>60/530</b>
<b>560</b>	680	56	3	330 000	650 000	17.4	670	800	<b>68/560</b>
	750	85	5	525 000	1 040 000	16.7	600	750	<b>69/560</b>
	820	115	6	735 000	1 500 000	16.2	560	670	<b>60/560</b>
<b>600</b>	730	60	3	355 000	735 000	17.5	600	710	<b>68/600</b>
	800	90	5	550 000	1 160 000	16.9	560	670	<b>69/600</b>
	870	118	6	790 000	1 640 000	16.1	530	630	<b>60/600</b>

**Note** (1) When heavy axial loads are applied,  $d_a$  and  $D_a$  can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

**Static Equivalent Load**

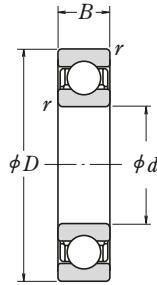
$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a^{(1)}$ min.	$D_a^{(1)}$ max.	$r_a$ max.	approx.
391	469	2	19.5
396	504	3	40
400	540	4	68
411	489	2	20.5
416	524	3	42
420	580	4	88.4
431	509	2	21.4
436	544	3	43.6
440	600	4	92.2
451	529	2	22.3
456	584	3	60.2
466	624	5	106
473	567	2.5	34.3
476	604	3	62.6
486	654	5	123
493	587	2.5	35.4
500	630	4	73.5
506	674	5	127
513	607	2.5	37.2
520	650	4	82
526	694	5	131
543	637	2.5	39.8
550	690	4	89.8
556	754	5	184
573	667	2.5	41.5
580	730	4	105
586	793.5	5	203
613	717	2.5	50.9
620	780	4	120
626	844	5	236

# SINGLE-ROW DEEP GROOVE BALL BEARINGS

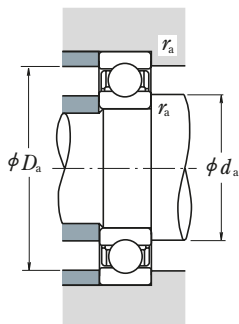
Bore Diameter 630 – 800 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min <sup>-1</sup> )		Bearing Designations
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>f<sub>0</sub></i>	Grease	Oil	Open
<b>630</b>	780	69	4	420 000	890 000	17.3	560	670	<b>68/630</b>
	850	100	6	625 000	1 350 000	16.7	530	630	<b>69/630</b>
	920	128	7.5	750 000	1 620 000	16.4	480	600	<b>60/630</b>
<b>670</b>	820	69	4	435 000	965 000	17.4	500	630	<b>68/670</b>
	900	103	6	675 000	1 460 000	16.7	480	560	<b>69/670</b>
	980	136	7.5	765 000	1 730 000	16.6	450	530	<b>60/670</b>
<b>710</b>	870	74	4	480 000	1 100 000	17.4	480	560	<b>68/710</b>
	950	106	6	715 000	1 640 000	16.8	450	530	<b>69/710</b>
<b>750</b>	920	78	5	525 000	1 260 000	17.4	430	530	<b>68/750</b>
	1 000	112	6	785 000	1 840 000	16.7	400	500	<b>69/750</b>
<b>800</b>	980	82	5	530 000	1 310 000	17.5	400	480	<b>68/800</b>
	1 060	115	6	825 000	2 050 000	16.8	380	450	<b>69/800</b>

**Note** <sup>(1)</sup> When heavy axial loads are applied, *d<sub>a</sub>* and *D<sub>a</sub>* can be adjusted up to the shoulder diameter of the races. Please consult NSK for details.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$\frac{f_0 F_a}{C_{0r}}$	$e$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		$X$	$Y$	$X$	$Y$
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00


**Static Equivalent Load**

$$\frac{F_a}{F_r} > 0.8, P_0 = 0.6F_r + 0.5F_a$$

$$\frac{F_a}{F_r} \leq 0.8, P_0 = F_r$$

Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a^{(1)}$ min.	$D_a^{(1)}$ max.	$r_a$ max.	approx.
646	764	3	71.3
656	824	5	163
662	888	6	285
686	804	3	75.4
696	874	5	181
702	948	6	351
726	854	3	92.6
736	924	5	208
770	900	4	110
776	974	5	245
820	960	4	132
826	1 034	5	275



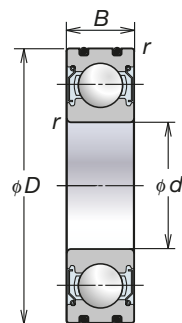
**Bore Diameter 10 – 100 mm**


Boundary Dimensions (mm)			Basic Load Ratings (N)		Recommended Fits <sup>(1)</sup>
<i>d</i>	<i>D</i>	<i>B</i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	
<b>10</b>	26	8	4 550	1 970	H7 or G6
	30	9	5 100	2 390	
	35	11	8 100	3 450	
<b>12</b>	28	8	5 100	2 370	
	32	10	6 800	3 050	
	37	12	9 700	4 200	
<b>15</b>	32	9	5 600	2 830	
	35	11	7 650	3 750	
	42	13	11 400	5 450	
<b>17</b>	35	10	6 000	3 250	
	40	12	9 550	4 800	
	47	14	13 600	6 650	
<b>20</b>	42	12	9 400	5 000	
	47	14	12 800	6 600	
	52	15	15 900	7 900	
<b>25</b>	47	12	10 100	5 850	
	52	15	14 000	7 850	
	62	17	20 600	11 200	
<b>30</b>	55	13	13 200	8 300	
	62	16	19 500	11 300	
	72	19	26 700	15 000	
<b>35</b>	62	14	16 000	10 300	
	72	17	25 700	15 300	
	80	21	33 500	19 200	
<b>40</b>	68	15	16 800	11 500	
	80	18	29 100	17 900	
	90	23	40 500	24 000	
<b>45</b>	75	16	20 900	15 200	
	85	19	31 500	20 400	
	100	25	53 000	32 000	
<b>50</b>	80	16	21 800	16 600	
	90	20	35 000	23 200	
	110	27	62 000	38 500	
<b>55</b>	90	18	28 300	21 200	
	100	21	43 500	29 300	
	120	29	71 500	44 500	
<b>60</b>	95	18	29 500	23 200	
	110	22	52 500	36 000	
	130	31	82 000	52 000	
<b>65</b>	100	18	30 500	25 200	
	120	23	57 500	40 000	
	140	33	92 500	60 000	
<b>70</b>	110	20	38 000	31 000	
	125	24	62 000	44 000	
	150	35	104 000	68 000	
<b>75</b>	115	20	39 500	33 500	
	130	25	66 000	49 500	
<b>80</b>	125	22	47 500	40 000	
	140	26	72 500	53 000	
<b>85</b>	130	22	49 500	43 000	
	150	28	84 000	62 000	
<b>90</b>	140	24	58 000	50 000	
<b>95</b>	145	24	60 500	54 000	
<b>100</b>	150	24	60 000	54 000	

**Notes** <sup>(1)</sup> Although recommended fits are H7 or G6, G6 is recommended when used under conditions that prioritize insertion under light preload.

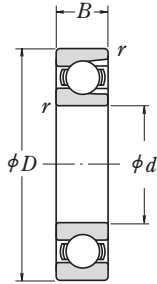
<sup>(2)</sup> Low-contact seals are available for sealed bearings; contact NSK for details.

Bearing Designations				
Basic Designation (Open)	Shields	Contact Seal <sup>(2)</sup>	Non-Contact Seal	
6000	ZZ	DDU	VV	
6200	ZZ	DDU	VV	
6300	ZZ	DDU	VV	
6001	ZZ	DDU	VV	
6201	ZZ	DDU	VV	
6301	ZZ	DDU	VV	
6002	ZZ	DDU	VV	
6202	ZZ	DDU	VV	
6302	ZZ	DDU	VV	
6003	ZZ	DDU	VV	
6203	ZZ	DDU	VV	
6303	ZZ	DDU	VV	
6004	ZZ	DDU	VV	
6204	ZZ	DDU	VV	
6304	ZZ	DDU	VV	
6005	ZZ	DDU	VV	
6205	ZZ	DDU	VV	
6305	ZZ	DDU	VV	
6006	ZZ	DDU	VV	
6206	ZZ	DDU	VV	
6306	ZZ	DDU	VV	
6007	ZZ	DDU	VV	
6207	ZZ	DDU	VV	
6307	ZZ	DDU	VV	
6008	ZZ	DDU	VV	
6208	ZZ	DDU	VV	
6308	ZZ	DDU	VV	
6009	ZZ	DDU	VV	
6209	ZZ	DDU	VV	
6309	ZZ	DDU	VV	
6010	ZZ	DDU	VV	
6210	ZZ	DDU	VV	
6310	ZZ	DDU	VV	
6011	ZZ	DDU	VV	
6211	ZZ	DDU	VV	
6311	ZZ	DDU	VV	
6012	ZZ	DDU	VV	
6212	ZZ	DDU	VV	
6312	ZZ	DDU	VV	
6013	ZZ	DDU	VV	
6213	ZZ	DDU	VV	
6313	ZZ	DDU	VV	
6014	ZZ	DDU	VV	
6214	ZZ	DDU	VV	
6314	ZZ	DDU	VV	
6015	ZZ	DDU	VV	
6215	ZZ	DDU	VV	
6016	ZZ	DDU	VV	
6216	ZZ	DDU	VV	
6017	ZZ	DDU	VV	
6217	ZZ	DDU	VV	
6018	ZZ	DDU	VV	
6019	ZZ	DDU	VV	
6020	ZZ	DDU	VV	



# MAXIMUM BALL BEARINGS

Bore Diameter 25 – 110 mm



Open



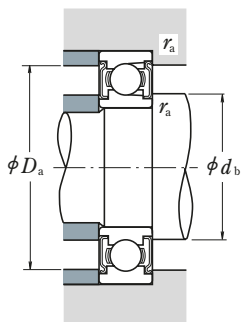
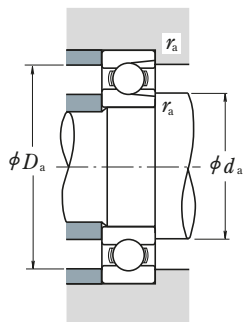
Shielded  
(One Shield) Z



Shielded  
(Two Shields) ZZ

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Open
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease Open Z · ZZ	Oil Open Z	
25	52	15	1	14 400	10 500	12 000	15 000	BL 205
	62	17	1.1	21 500	15 500	11 000	13 000	BL 305
30	62	16	1	21 000	16 300	10 000	12 000	BL 206
	72	19	1.1	27 900	20 700	9 000	11 000	BL 306
35	72	17	1.1	27 800	22 100	9 000	11 000	BL 207
	80	21	1.5	37 000	29 100	8 000	9 500	BL 307
40	80	18	1.1	35 500	28 800	8 000	9 500	BL 208
	90	23	1.5	46 500	36 000	7 500	9 000	BL 308
45	85	19	1.1	37 000	32 000	7 500	9 000	BL 209
	100	25	1.5	55 500	44 000	6 300	8 000	BL 309
50	90	20	1.1	39 000	35 000	6 700	8 500	BL 210
	110	27	2	65 000	52 500	6 000	7 100	BL 310
55	100	21	1.5	48 000	44 000	6 300	7 500	BL 211
	120	29	2	75 000	61 500	5 600	6 700	BL 311
60	110	22	1.5	58 000	54 000	5 600	6 700	BL 212
	130	31	2.1	85 500	71 500	5 000	6 000	BL 312
65	120	23	1.5	63 500	60 000	5 300	6 300	BL 213
	140	33	2.1	103 000	89 500	4 800	5 600	BL 313
70	125	24	1.5	69 000	66 000	5 000	6 000	BL 214
	150	35	2.1	115 000	102 000	4 300	5 300	BL 314
75	130	25	1.5	72 000	72 000	4 500	5 600	BL 215
	160	37	2.1	126 000	116 000	4 000	5 000	BL 315
80	140	26	2	84 000	85 000	4 300	5 300	BL 216
	170	39	2.1	136 000	130 000	3 800	4 500	BL 316
85	150	28	2	93 000	93 000	4 000	5 000	BL 217
	180	41	3	147 000	145 000	3 600	4 300	BL 317
90	160	30	2	107 000	107 000	3 800	4 500	BL 218
	190	43	3	158 000	161 000	3 400	4 000	BL 318
95	170	32	2.1	121 000	123 000	3 600	4 300	BL 219
	200	45	3	169 000	178 000	2 800	3 600	BL 319
100	180	34	2.1	136 000	140 000	3 400	4 000	BL 220
105	190	36	2.1	148 000	157 000	3 200	3 800	BL 221
110	200	38	2.1	160 000	176 000	2 800	3 400	BL 222

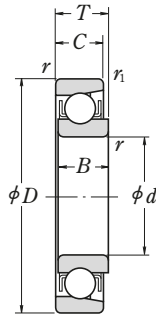
**Remark** When using maximum ball bearings, please contact NSK.



Bearing Designations		Abutment and Fillet Dimensions (mm)				Mass (kg)
With One Shield	With Two Shields	$d_a$ min.	$d_b$ max.	$D_a$ max.	$r_a$ max.	approx.
BL 205 Z	BL 205 ZZ	30	32	47	1	0.133
BL 305 Z	BL 305 ZZ	31.5	36	55.5	1	0.246
BL 206 Z	BL 206 ZZ	35	38.5	57	1	0.215
BL 306 Z	BL 306 ZZ	36.5	42	65.5	1	0.364
BL 207 Z	BL 207 ZZ	41.5	44.5	65.5	1	0.307
BL 307 Z	BL 307 ZZ	43	44.5	72	1.5	0.486
BL 208 Z	BL 208 ZZ	46.5	50	73.5	1	0.394
BL 308 Z	BL 308 ZZ	48	52.5	82	1.5	0.685
BL 209 Z	BL 209 ZZ	51.5	55.5	78.5	1	0.449
BL 309 Z	BL 309 ZZ	53	61.5	92	1.5	0.883
BL 210 Z	BL 210 ZZ	56.5	60	83.5	1	0.504
BL 310 Z	BL 310 ZZ	59	68	101	2	1.16
BL 211 Z	BL 211 ZZ	63	66.5	92	1.5	0.667
BL 311 Z	BL 311 ZZ	64	72.5	111	2	1.49
BL 212 Z	BL 212 ZZ	68	74.5	102	1.5	0.856
BL 312 Z	BL 312 ZZ	71	79	119	2	1.88
BL 213 Z	BL 213 ZZ	73	80	112	1.5	1.09
BL 313 Z	BL 313 ZZ	76	85.5	129	2	2.36
BL 214 Z	BL 214 ZZ	78	84	117	1.5	1.19
BL 314 Z	BL 314 ZZ	81	92	139	2	2.87
BL 215 Z	BL 215 ZZ	83	90	122	1.5	1.29
BL 315 Z	BL 315 ZZ	86	98.5	149	2	3.43
BL 216 Z	BL 216 ZZ	89	95.5	131	2	1.61
BL 316 Z	BL 316 ZZ	91	104.5	159	2	4.08
BL 217 Z	BL 217 ZZ	94	102	141	2	1.97
BL 317 Z	BL 317 ZZ	98	110.5	167	2.5	4.77
BL 218 Z	BL 218 ZZ	99	107.5	151	2	2.43
BL 318 Z	BL 318 ZZ	103	117	177	2.5	5.45
BL 219 Z	BL 219 ZZ	106	114	159	2	2.95
BL 319 Z	BL 319 ZZ	108	124	187	2.5	6.4
BL 220 Z	BL 220 ZZ	111	121.5	169	2	3.54
BL 221 Z	BL 221 ZZ	116	127.5	179	2	4.23
—	—	121	—	189	2	4.84

# MAGNETO BEARINGS

Bore Diameter 4 – 20 mm



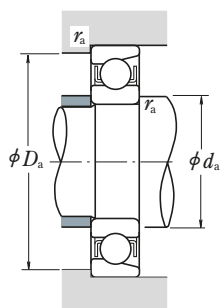
## Outside Diameter Tolerance (Class N)

Units :  $\mu\text{m}$

Nominal Outside Diameter $D$ (mm)		Single Plane Mean Outside Diameter $\Delta D_{mp}$			
		E Series		EN Series	
Over	Incl.	High	Low	High	Low
—	10	+ 8	0	0	– 8
10	18	+ 8	0	0	– 8
18	30	+ 9	0	0	– 9
30	50	+11	0	0	–11

Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds ( $\text{min}^{-1}$ )		Bearing Designations	
$d$	$D$	$B, C, T$	$r$ min.	$r_1$ min.	$C_r$	$C_{0r}$	Grease	Oil	E Series	EN Series
<b>4</b>	16	5	0.15	0.1	1 650	288	34 000	40 000	<b>E 4</b>	<b>EN 4</b>
<b>5</b>	16	5	0.15	0.1	1 650	288	34 000	40 000	<b>E 5</b>	<b>EN 5</b>
<b>6</b>	21	7	0.3	0.15	2 490	445	30 000	36 000	<b>E 6</b>	<b>EN 6</b>
<b>7</b>	22	7	0.3	0.15	2 490	445	30 000	36 000	<b>E 7</b>	<b>EN 7</b>
<b>8</b>	24	7	0.3	0.15	3 450	650	28 000	34 000	<b>E 8</b>	<b>EN 8</b>
<b>9</b>	28	8	0.3	0.15	4 550	880	24 000	30 000	<b>E 9</b>	<b>EN 9</b>
<b>10</b>	28	8	0.3	0.15	4 550	880	24 000	30 000	<b>E 10</b>	<b>EN 10</b>
<b>11</b>	32	7	0.3	0.15	4 400	845	22 000	26 000	<b>E 11</b>	<b>EN 11</b>
<b>12</b>	32	7	0.3	0.15	4 400	845	22 000	26 000	<b>E 12</b>	<b>EN 12</b>
<b>13</b>	30	7	0.3	0.15	4 400	845	22 000	26 000	<b>E 13</b>	<b>EN 13</b>
<b>14</b>	35	8	0.3	0.15	5 800	1 150	19 000	22 000	—	<b>EN 14</b>
<b>15</b>	35	8	0.3	0.15	5 800	1 150	19 000	22 000	<b>E 15</b>	<b>EN 15</b>
	40	10	0.6	0.3	7 400	1 500	17 000	20 000	<b>BO 15</b>	—
<b>16</b>	38	10	0.6	0.2	6 900	1 380	17 000	22 000	—	<b>EN 16</b>
<b>17</b>	40	10	0.6	0.3	7 400	1 500	17 000	20 000	<b>L 17</b>	—
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	—	<b>EN 17</b>
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	<b>BO 17</b>	—
<b>18</b>	40	9	0.6	0.2	5 050	1 030	17 000	20 000	—	<b>EN 18</b>
<b>19</b>	40	9	0.6	0.2	5 050	1 030	17 000	20 000	<b>E 19</b>	<b>EN 19</b>
<b>20</b>	47	12	1	0.6	11 000	2 380	14 000	17 000	<b>E 20</b>	<b>EN 20</b>
	47	14	1	0.6	11 000	2 380	14 000	17 000	<b>L 20</b>	—

- Remarks**
1. The outside diameters of Series E magneto bearings always have plus tolerances.
  2. Please contact NSK when using magneto bearings outside of the E Series.

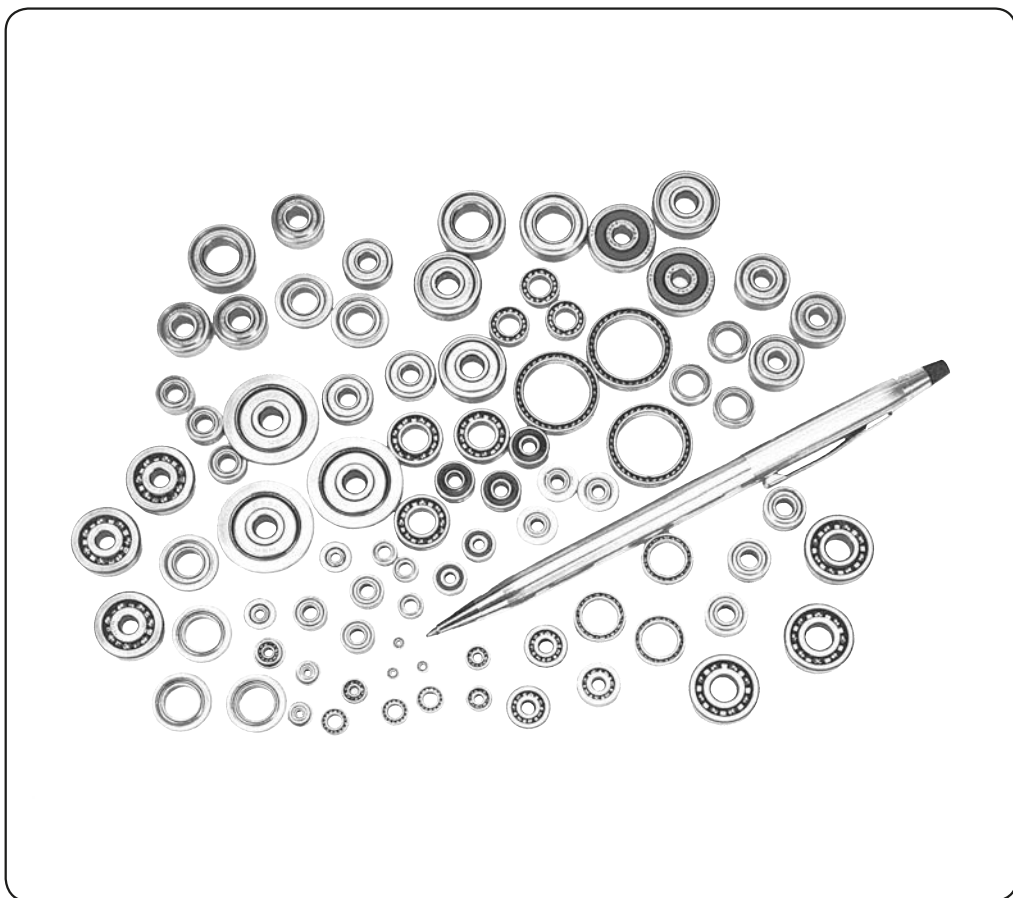


## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$		$e$
$X$	$Y$	$X$	$Y$	
1	0	0.5	2.5	0.2

Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a$ min.	$D_a$ max.	$r_a$ max.	approx.
5.2	14.8	0.15	0.005
6.2	14.8	0.15	0.004
8	19	0.3	0.011
9	20	0.3	0.013
10	22	0.3	0.014
11	26	0.3	0.022
12	26	0.3	0.021
13	30	0.3	0.029
14	30	0.3	0.028
15	28	0.3	0.021
16	33	0.3	0.035
17	33	0.3	0.034
19	36	0.6	0.055
20	34	0.6	0.049
21	36	0.6	0.051
21	40	0.6	0.080
21	40	0.6	0.080
22	36	0.6	0.051
23	36	0.6	0.049
25	42	1	0.089
25	42	1	0.101



## 2. EXTRA SMALL BALL BEARINGS AND MINIATURE BALL BEARINGS

INTRODUCTION ..... C 054

BEARING TABLES

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Series	Bore Diameter 1 – 9mm .....	C 058
With Flange	Bore Diameter 1 – 9mm .....	C 062
Inch Series	Bore Diameter 1.016 – 9.525mm .....	C 066
With Flange	Bore Diameter 1.191 – 9.525mm .....	C 068



## DESIGN AND TYPES

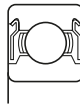
The size ranges of extra small and miniature ball bearings are shown in Table 1, and design/types and type designations are shown in Table 2. Types listed in the bearing tables are indicated by shading  in Table 2.

**Table 1 Size Ranges of Bearings**

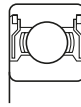
Units : mm

Series	Extra Small Ball Bearings	Miniature Ball Bearings
Metric	Outside diameter $D \geq 9$ Bore diameter $d < 10$	Outside diameter $D < 9$
Inch	Outside diameter $D \geq 9.525$ Bore diameter $d < 10$	Outside diameter $D < 9.525$

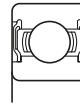
Please refer to NSK Miniature Ball Bearings (CAT. No. E126) for details.



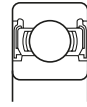
ZZ



ZZS











DD



VV

**Table 2 Design/Types and Type Designations of Miniature and Extra Small Bearings**

Design/Types		Type Designations				Remarks
		Metric	Inch	Special		
				Metric	Inch	
Single-Row Deep Groove Ball Bearings		6 ○ ○	R	MR	—	Shielded and sealed bearings are available.
	 Thin section	—	—	SMT	—	
	 With flange	F6 ○ ○	FR	MF	—	Shielded and sealed bearings are available.
	 Extended inner ring	—	—	—	RW	Shielded bearings are available.
	 With flange and extended inner ring	—	—	—	FRW	Shielded bearings are available.
	 For synchro motors	—	—	—	SR00X00	Shielded bearings are available.
Pivot Ball Bearings		—	—	BCF	—	
Thrust Ball Bearings		—	—	F	—	

**Remark** Other bearings, such as single-row angular contact ball bearings, are available.

## TOLERANCES AND RUNNING ACCURACY

**METRIC SERIES BEARINGS** ..... Table 7.2 (Pages A128 to A131)

The flange tolerances for metric series bearings are listed in Table 3.

**Table 3 Flange Tolerances for Metric Flanged Bearings**

(1) Tolerances of Flange Outside Diameter

Units :  $\mu\text{m}$

Nominal Outer Ring Flange Outside Diameter $D_1(\text{mm})$		Deviation of a Single Outside Diameter of Outer Ring Flange $\Delta D_{1S}$			
		Position Flange		Non-Position Flange	
over	incl.	high	low	high	low
—	6	+220	−36	0	−36
6	10	+220	−36	0	−36
10	18	+270	−43	0	−43
18	30	+330	−52	0	−52

(2) Flange Width Tolerances and Running Accuracies

Units :  $\mu\text{m}$

Nominal Outside Diameter $D$ (mm)		Deviation of a Single Outer Ring Flange Width $\Delta C_{1S}$	Variation of Outer Ring Flange Width $VC_{1S}$				Perpendicularity of Outer Ring Outside Surface With Respect to the Flange Back Face $S_{D1}$			Axial Runout of Outer Ring Flange Back Face of Assembled Bearing $S_{ea1}$						
			Normal and Classes 6,5,4,2	Normal and Class 6	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2			
over	incl.	high	low	max.				max.			max.					
2.5 <sup>(1)</sup>	6	Use the $\Delta B_S$ tolerance for $d$ of the same bearing in the same class		Use the $\Delta VB_S$ tolerance for $d$ of the same bearing in the same class				5	2.5	1.5	8	4	1.5	11	7	3
6	18			5	2.5	1.5	8	4	1.5	11	7	3				
18	30			5	2.5	1.5	8	4	1.5	11	7	3				

**Notes** (1) Including 2.5 mm

**INCH SERIES BEARINGS** ..... Table 7.2 (Pages A128 to A131)

The flange tolerances for inch design flanged bearings are listed in Table 7.9(2) (Pages A146 and A147).

**INSTRUMENT BALL BEARINGS** ..... Table 7.9 (Pages A146 and A147)

## RECOMMENDED FITS

Please refer to NSK Miniature Ball Bearings (CAT.No.E126).

**INTERNAL CLEARANCES** ..... Table 8.11 (Page A169)

## LIMITING SPEEDS

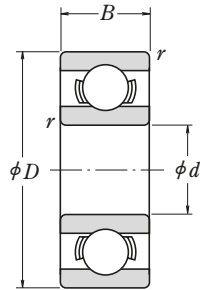
The limiting speeds listed in the bearing tables should be adjusted depending on bearing load conditions. In addition, higher speeds can be attained by making changes in the lubrication method, cage design, etc. Refer to Page A098 for detailed information.



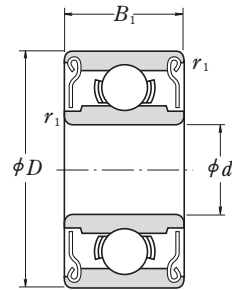
# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Series

Bore Diameter 1 – 4 mm



Open

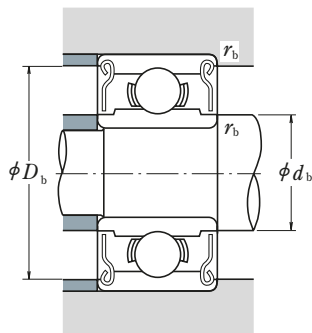
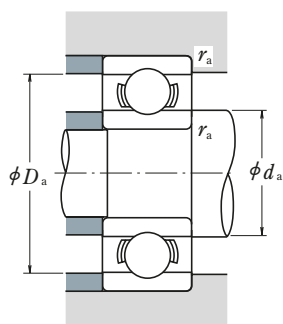


Shielded  
ZZ · ZZ1

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Open
<i>d</i>	<i>D</i>	<i>B</i>	<i>B</i> <sub>1</sub>	<i>r</i> <sup>(1)</sup> min.	<i>r</i> <sub>1</sub> <sup>(1)</sup> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease Open Z · ZZ	Oil Open Z	
<b>1</b>	3	1	—	0.05	—	80	23	130 000	150 000	<b>681</b>
	3	1.5	—	0.05	—	80	23	130 000	150 000	<b>MR 31</b>
	4	1.6	—	0.1	—	138	35	100 000	120 000	<b>691</b>
<b>1.2</b>	4	1.8	2.5	0.1	0.1	138	35	110 000	130 000	<b>MR 41 X</b>
<b>1.5</b>	4	1.2	2	0.05	0.05	112	33	100 000	120 000	<b>681 X</b>
	5	2	2.6	0.15	0.15	237	69	85 000	100 000	<b>691 X</b>
	6	2.5	3	0.15	0.15	330	98	75 000	90 000	<b>601 X</b>
<b>2</b>	5	1.5	2.3	0.08	0.08	169	50	85 000	100 000	<b>682</b>
	5	2	2.5	0.1	0.1	187	58	85 000	100 000	<b>MR 52 B</b>
	6	2.3	3	0.15	0.15	330	98	75 000	90 000	<b>692</b>
	6	2.5	2.5	0.15	0.15	330	98	75 000	90 000	<b>MR 62</b>
	7	2.5	3	0.15	0.15	385	127	63 000	75 000	<b>MR 72</b>
	7	2.8	3.5	0.15	0.15	385	127	63 000	75 000	<b>602</b>
<b>2.5</b>	6	1.8	2.6	0.08	0.08	208	74	71 000	80 000	<b>682 X</b>
	7	2.5	3.5	0.15	0.15	385	127	63 000	75 000	<b>692 X</b>
	8	2.5	—	0.2	—	560	179	60 000	67 000	<b>MR 82 X</b>
	8	2.8	4	0.15	0.15	550	175	60 000	71 000	<b>602 X</b>
	8	3	4	0.15	0.15	560	179	60 000	67 000	<b>693</b>
<b>3</b>	6	2	2.5	0.1	0.1	208	74	71 000	80 000	<b>MR 63</b>
	7	2	3	0.1	0.1	390	130	63 000	75 000	<b>683 A</b>
	8	2.5	—	0.15	—	560	179	60 000	67 000	<b>MR 83</b>
	8	3	4	0.15	0.15	560	179	60 000	67 000	<b>693</b>
	9	2.5	4	0.2	0.15	570	187	56 000	67 000	<b>MR 93</b>
	9	3	5	0.15	0.15	570	187	56 000	67 000	<b>603</b>
<b>4</b>	10	4	4	0.15	0.15	630	218	50 000	60 000	<b>623</b>
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	<b>633</b>
	7	2	—	0.1	—	310	115	60 000	67 000	<b>MR 74</b>
	7	—	2.5	—	0.1	255	107	60 000	71 000	<b>—</b>
	8	2	3	0.15	0.1	395	139	56 000	67 000	<b>MR 84</b>
	9	2.5	4	(0.15)	(0.15)	640	225	53 000	63 000	<b>684 A</b>
	10	3	4	0.2	0.15	710	270	50 000	60 000	<b>MR 104 B</b>
	11	4	4	0.15	0.15	960	345	48 000	56 000	<b>694</b>
	12	4	4	0.2	0.2	960	345	48 000	56 000	<b>604</b>
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	<b>624</b>
	16	5	5	0.3	0.3	1 730	670	36 000	43 000	<b>634</b>

**Note** <sup>(1)</sup> Values in parentheses are not based on ISO 15.

**Remark** When using shielded bearings with a rotating outer ring, please contact NSK.

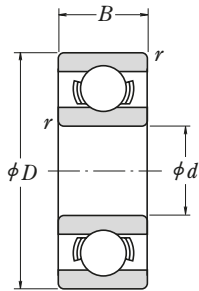


Bearing Designations			Abutment and Fillet Dimensions (mm)						Mass (g)	
Shielded	Sealed		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx. Open	Shielded
—	—	—	1.4	—	2.6	—	0.05	—	0.03	—
—	—	—	1.4	—	2.6	—	0.05	—	0.04	—
—	—	—	1.8	—	3.2	—	0.1	—	0.09	—
MR 41	XZZ	—	2.0	1.9	3.2	3.5	0.1	0.1	0.10	0.14
681	XZZ	—	1.9	2.1	3.6	3.6	0.05	0.05	0.07	0.11
691	XZZ	—	2.7	2.5	3.8	4.3	0.15	0.15	0.17	0.20
601	XZZ	—	2.7	3.0	4.8	5.4	0.15	0.15	0.33	0.38
682	ZZ	—	2.6	2.7	4.4	4.2	0.08	0.08	0.12	0.17
MR 52	BZZ	—	2.8	2.7	4.2	4.4	0.1	0.1	0.16	0.23
692	ZZ	—	3.2	3.0	4.8	5.4	0.15	0.15	0.28	0.38
MR 62	ZZ	—	3.2	3.0	4.8	5.2	0.15	0.15	0.30	0.29
MR 72	ZZ	—	3.2	3.8	5.8	6.2	0.15	0.15	0.45	0.49
602	ZZ	—	3.2	3.8	5.8	6.2	0.15	0.15	0.51	0.58
682	XZZ	—	3.1	3.7	5.4	5.4	0.08	0.08	0.23	0.29
692	XZZ	—	3.7	3.8	5.8	6.2	0.15	0.15	0.41	0.55
—	—	—	4.1	—	6.4	—	0.2	—	0.56	—
602	XZZ	—	3.7	4.1	6.8	7.0	0.15	0.15	0.63	0.83
MR 63	ZZ	—	3.8	3.7	5.2	5.4	0.1	0.1	0.20	0.27
683	AZZ	—	3.8	4.0	6.2	6.4	0.1	0.1	0.32	0.45
—	—	—	4.2	—	6.8	—	0.15	—	0.54	—
693	ZZ	—	4.2	4.3	6.8	7.3	0.15	0.15	0.61	0.83
MR 93	ZZ	—	4.6	4.3	7.4	7.9	0.2	0.15	0.73	1.18
603	ZZ	—	4.2	4.3	7.8	7.9	0.15	0.15	0.87	1.45
623	ZZ	—	4.2	4.3	8.8	8.0	0.15	0.15	1.65	1.66
633	ZZ	—	4.6	6.0	11.4	11.3	0.2	0.2	3.38	3.33
—	—	—	4.8	—	6.2	—	0.1	—	0.22	—
MR 74	ZZ	—	—	4.8	—	6.3	—	0.1	—	0.29
MR 84	ZZ	—	5.2	5.0	6.8	7.4	0.15	0.1	0.36	0.56
684	AZZ	—	4.8	5.2	8.2	8.1	0.1	0.1	0.63	1.01
MR 104	BZZ	—	5.6	5.9	8.4	8.8	0.2	0.15	1.04	1.42
694	ZZ	—	5.2	5.6	9.8	9.9	0.15	0.15	1.7	1.75
604	ZZ	—	5.6	5.6	10.4	9.9	0.2	0.2	2.25	2.29
624	ZZ	—	5.6	6.0	11.4	11.3	0.2	0.2	3.03	3.04
634	ZZ1	—	6.0	7.5	14.0	13.8	0.3	0.3	5.24	5.21

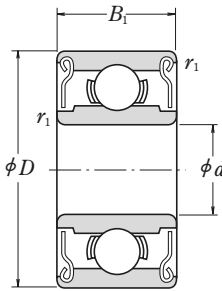
# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Series

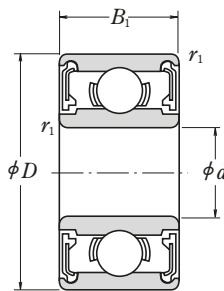
Bore Diameter 5 – 9 mm



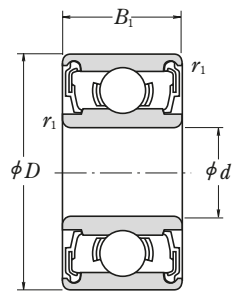
Open



Shielded  
ZZ · ZZ1



Non-Contact  
Sealed  
VW

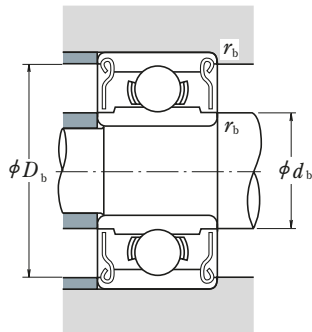
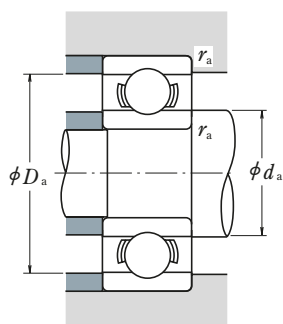


Contact  
Sealed  
DD

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )			Open
<i>d</i>	<i>D</i>	<i>B</i>	<i>B</i> <sub>1</sub>	<i>r</i> <sup>(1)</sup> min.	<i>r</i> <sub>1</sub> <sup>(1)</sup> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Open Z · ZZ V · VW	Grease D · DD	Oil Open Z	
5	8	2	—	0.1	—	310	120	53 000	—	63 000	MR 85
	8	—	2.5	—	0.1	278	131	53 000	—	63 000	—
	9	2.5	3	0.15	0.15	430	168	50 000	—	60 000	MR 95
	10	3	4	0.15	0.15	430	168	50 000	—	60 000	MR 105
	11	—	4	—	0.15	715	276	48 000	—	56 000	—
	11	3	5	0.15	0.15	715	281	45 000	—	53 000	685
	13	4	4	0.2	0.2	1 080	430	43 000	40 000	50 000	695
	14	5	5	0.2	0.2	1 330	505	40 000	38 000	50 000	605
	16	5	5	0.3	0.3	1 730	670	36 000	32 000	43 000	625
	19	6	6	0.3	0.3	2 340	885	32 000	30 000	40 000	635
6	10	2.5	3	0.15	0.1	495	218	45 000	—	53 000	MR 106
	12	3	4	0.2	0.15	715	292	43 000	40 000	50 000	MR 126
	13	3.5	5	0.15	0.15	1 080	440	40 000	38 000	50 000	686 A
	15	5	5	0.2	0.2	1 730	670	40 000	36 000	45 000	696
	17	6	6	0.3	0.3	2 260	835	38 000	34 000	45 000	606
	19	6	6	0.3	0.3	2 340	885	32 000	30 000	40 000	626
	22	7	7	0.3	0.3	3 300	1 370	30 000	28 000	36 000	636
	11	2.5	3	0.15	0.1	455	201	43 000	—	50 000	MR 117
	13	3	4	0.2	0.15	540	276	40 000	—	48 000	MR 137
	14	3.5	5	0.15	0.15	1 170	510	40 000	34 000	45 000	687
7	17	5	5	0.3	0.3	1 610	710	36 000	28 000	43 000	697
	19	6	6	0.3	0.3	2 340	885	36 000	32 000	43 000	607
	22	7	7	0.3	0.3	3 300	1 370	30 000	28 000	36 000	627
	26	9	9	0.3	0.3	4 550	1 970	28 000	22 000	34 000	637
	12	2.5	3.5	0.15	0.1	545	274	40 000	—	48 000	MR 128
	14	3.5	4	0.2	0.15	820	385	38 000	32 000	45 000	MR 148
	16	4	5	0.2	0.2	1 610	710	36 000	28 000	43 000	688 A
	19	6	6	0.3	0.3	2 240	910	36 000	28 000	43 000	698
	22	7	7	0.3	0.3	3 300	1 370	34 000	28 000	40 000	608
	24	8	8	0.3	0.3	3 350	1 430	28 000	24 000	34 000	628
8	28	9	9	0.3	0.3	4 550	1 970	28 000	22 000	34 000	638
	17	4	5	0.2	0.2	1 330	665	36 000	24 000	43 000	689
	20	6	6	0.3	0.3	1 720	840	34 000	24 000	40 000	699
	24	7	7	0.3	0.3	3 350	1 430	32 000	24 000	38 000	609
	26	8	8	(0.6)	(0.6)	4 550	1 970	28 000	22 000	34 000	629
	30	10	10	0.6	0.6	5 100	2 390	24 000	—	30 000	639

**Note** <sup>(1)</sup> Values in parentheses are not based on ISO 15.

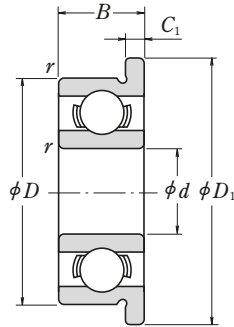
**Remarks** 1. When using sealed or shielded bearings with a rotating outer ring, please contact NSK.  
2. Bearings with snap rings are also available, please contact NSK for details.



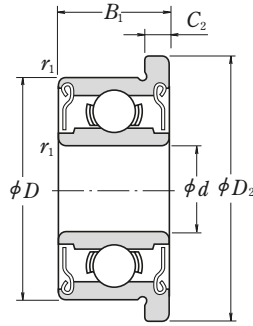
Bearing Designations			Abutment and Fillet Dimensions (mm)						Mass (g)	
Shielded	Sealed		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx. Open	Shielded
—	—	—	5.8	—	7.2	—	0.1	—	0.26	—
MR 85 ZZ	—	—	—	5.8	—	7.4	—	0.1	—	0.34
MR 95 ZZ1	—	—	6.2	6.0	7.8	8.2	0.15	0.15	0.50	0.58
MR 105 ZZ	—	—	6.2	6.0	8.8	8.4	0.15	0.15	0.95	1.29
MR 115 ZZ	VV	—	—	6.3	—	9.8	—	0.15	—	1.49
685 ZZ	—	—	6.2	6.2	9.8	9.9	0.15	0.15	1.2	1.96
695 ZZ	VV	DD	6.6	6.6	11.4	11.2	0.2	0.2	2.45	2.5
605 ZZ	—	DD	6.6	6.9	12.4	12.2	0.2	0.2	3.54	3.48
625 ZZ1	VV	DD	7.0	7.5	14.0	13.8	0.3	0.3	4.95	4.86
635 ZZ1	VV	DD	7.0	8.5	17.0	16.5	0.3	0.3	8.56	8.34
MR 106 ZZ1	—	—	7.2	7.0	8.8	9.3	0.15	0.1	0.56	0.68
MR 126 ZZ	—	DD	7.6	7.2	10.4	10.9	0.2	0.15	1.27	1.74
686 AZZ	VV	DD	7.2	7.4	11.8	11.7	0.15	0.15	1.91	2.69
696 ZZ1	VV	DD	7.6	7.9	13.4	13.3	0.2	0.2	3.88	3.72
606 ZZ	VV	DD	8.0	8.2	15.0	14.8	0.3	0.3	5.97	6.08
626 ZZ1	VV	DD	8.0	8.5	17.0	16.5	0.3	0.3	8.15	7.94
636 ZZ	VV	DD	8.0	10.5	20.0	19.0	0.3	0.3	14	14
MR 117 ZZ	—	—	8.2	8.0	9.8	10.5	0.15	0.1	0.62	0.72
MR 137 ZZ	—	—	8.6	9.0	11.4	11.6	0.2	0.15	1.58	2.02
687 ZZ1	VV	DD	8.2	8.5	12.8	12.7	0.15	0.15	2.13	2.97
697 ZZ1	VV	DD	9.0	10.2	15.0	14.8	0.3	0.3	5.26	5.12
607 ZZ1	VV	DD	9.0	9.1	17.0	16.5	0.3	0.3	7.67	7.51
627 ZZ	VV	DD	9.0	10.5	20.0	19.0	0.3	0.3	12.7	12.9
637 ZZ1	VV	DD	9.0	12.8	24.0	22.8	0.3	0.3	24	25
MR 128 ZZ1	—	—	9.2	9.0	10.8	11.3	0.15	0.1	0.71	0.97
MR 148 ZZ	VV	DD	9.6	9.2	12.4	12.8	0.2	0.15	1.86	2.16
688 AZZ1	VV	DD	9.6	10.2	14.4	14.2	0.2	0.2	3.12	4.02
698 ZZ	VV	DD	10.0	10.0	17.0	16.5	0.3	0.3	7.23	7.18
608 ZZ	VV	DD	10.0	10.5	20.0	19.0	0.3	0.3	12.1	12.2
628 ZZ	VV	DD	10.0	12.0	22.0	20.5	0.3	0.3	17.2	17.4
638 ZZ1	VV	DD	10.0	12.8	26.0	22.8	0.3	0.3	28.3	28.6
689 ZZ1	VV	DD	10.6	11.5	15.4	15.2	0.2	0.2	3.53	4.43
699 ZZ1	VV	DD	11.0	12.0	18.0	17.2	0.3	0.3	8.45	8.33
609 ZZ	VV	DD	11.0	12.0	22.8	20.5	0.3	0.3	14.5	14.7
629 ZZ	VV	DD	11.0	12.8	24.0	22.8	0.3	0.3	19.5	19.3
639 ZZ	VV	—	13.0	16.1	26.0	25.6	0.6	0.6	36.5	36

# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Series With Flange  
Bore Diameter 1 – 4 mm



Open

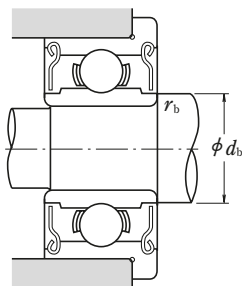
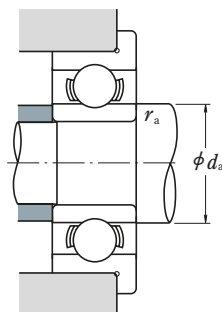


Shielded  
ZZ · ZZ1

Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>D</i> <sub>1</sub>	<i>D</i> <sub>2</sub>	<i>B</i>	<i>B</i> <sub>1</sub>	<i>C</i> <sub>1</sub>	<i>C</i> <sub>2</sub>	<i>r</i> <sup>(1)</sup> min.	<i>r</i> <sub>1</sub> <sup>(1)</sup> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease Open Z · ZZ	Oil Open Z
<b>1</b>	3	3.8	—	1	—	0.3	—	0.05	—	80	23	130 000	150 000
	4	5	—	1.6	—	0.5	—	0.1	—	140	36	100 000	120 000
<b>1.2</b>	4	4.8	—	1.8	—	0.4	—	0.1	—	138	35	110 000	130 000
<b>1.5</b>	4	5	5	1.2	2	0.4	0.6	0.05	0.05	112	33	100 000	120 000
	5	6.5	6.5	2	2.6	0.6	0.8	0.15	0.15	237	69	85 000	100 000
	6	7.5	7.5	2.5	3	0.6	0.8	0.15	0.15	330	98	75 000	90 000
<b>2</b>	5	6.1	6.1	1.5	2.3	0.5	0.6	0.08	0.08	169	50	85 000	100 000
	5	6.2	6.2	2	2.5	0.6	0.6	0.1	0.1	187	58	85 000	100 000
	6	7.5	7.5	2.3	3	0.6	0.8	0.15	0.15	330	98	75 000	90 000
	6	7.2	—	2.5	—	0.6	—	0.15	—	330	98	75 000	90 000
	7	8.2	8.2	2.5	3	0.6	0.6	0.15	0.15	385	127	63 000	75 000
	7	8.5	8.5	2.8	3.5	0.7	0.9	0.15	0.15	385	127	63 000	75 000
	7	8.5	8.5	2.5	3.5	0.7	0.9	0.15	0.15	385	127	63 000	75 000
<b>2.5</b>	6	7.1	7.1	1.8	2.6	0.5	0.8	0.08	0.08	208	74	71 000	80 000
	7	8.5	8.5	2.5	3.5	0.7	0.9	0.15	0.15	385	127	63 000	75 000
	8	9.2	—	2.5	—	0.6	—	0.2	—	560	179	60 000	67 000
	8	9.5	9.5	2.8	4	0.7	0.9	0.15	0.15	550	175	60 000	71 000
<b>3</b>	6	7.2	7.2	2	2.5	0.6	0.6	0.1	0.1	208	74	71 000	80 000
	7	8.1	8.1	2	3	0.5	0.8	0.1	0.1	390	130	63 000	75 000
	8	9.2	—	2.5	—	0.6	—	0.15	—	560	179	60 000	67 000
	8	9.5	9.5	3	4	0.7	0.9	0.15	0.15	560	179	60 000	67 000
	9	10.2	10.6	2.5	4	0.6	0.8	0.2	0.15	570	187	56 000	67 000
	9	10.5	10.5	3	5	0.7	1	0.15	0.15	570	187	56 000	67 000
	10	11.5	11.5	4	4	1	1	0.15	0.15	630	218	50 000	60 000
	13	15	15	5	5	1	1	0.2	0.2	1 300	485	36 000	43 000
<b>4</b>	7	8.2	—	2	—	0.6	—	0.1	—	310	115	60 000	67 000
	7	—	8.2	—	2.5	—	0.6	—	0.1	255	107	60 000	71 000
	8	9.2	9.2	2	3	0.6	0.6	0.15	0.1	395	139	56 000	67 000
	9	10.3	10.3	2.5	4	0.6	1	(0.15)	(0.15)	640	225	53 000	63 000
	10	11.2	11.6	3	4	0.6	0.8	0.2	0.15	710	270	50 000	60 000
	11	12.5	12.5	4	4	1	1	0.15	0.15	960	345	48 000	56 000
	12	13.5	13.5	4	4	1	1	0.2	0.2	960	345	48 000	56 000
	13	15	15	5	5	1	1	0.2	0.2	1 300	485	40 000	48 000
	16	18	18	5	5	1	1	0.3	0.3	1 730	670	36 000	43 000

**Note** <sup>(1)</sup> Values in parentheses are not based on ISO 15.

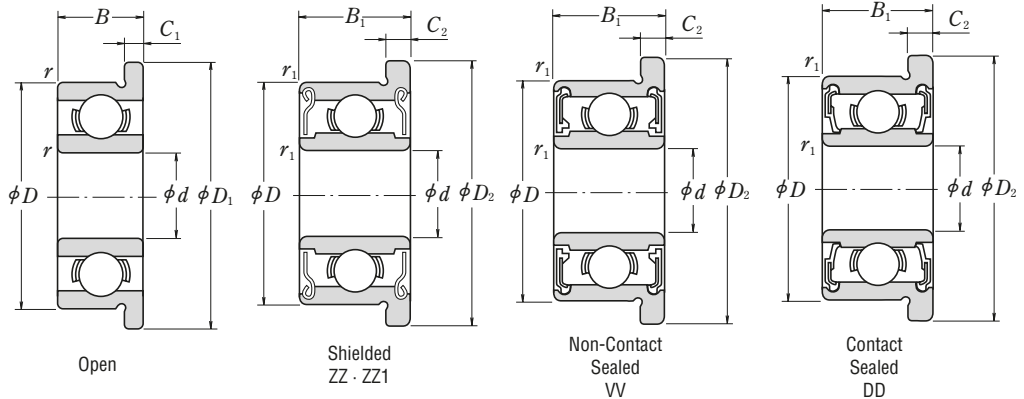
**Remark** When using shielded bearings with a rotating outer ring, please contact NSK.



Bearing Designations				Abutment and Fillet Dimensions (mm)				Mass (g)	
Open	Shielded	Sealed		$d_a$ min.	$d_b$ max.	$r_a$ max.	$r_b$ max.	approx. Open	Shielded
F 681	—	—	—	1.4	—	0.05	—	0.04	—
F 691	—	—	—	1.8	—	0.1	—	0.14	—
MF 41 X	—	—	—	2.0	—	0.1	—	0.12	—
F 681 X	F 681 XZZ	—	—	1.9	2.1	0.05	0.05	0.09	0.14
F 691 X	F 691 XZZ	—	—	2.7	2.5	0.15	0.15	0.23	0.28
F 601 X	F 601 XZZ	—	—	2.7	3.0	0.15	0.15	0.42	0.52
F 682	F 682 ZZ	—	—	2.6	2.7	0.08	0.08	0.16	0.22
MF 52 B	MF 52 BZZ	—	—	2.8	2.7	0.1	0.1	0.21	0.27
F 692	F 692 ZZ	—	—	3.2	3.0	0.15	0.15	0.35	0.48
MF 62	—	—	—	3.2	—	0.15	—	0.36	—
MF 72	MF 72 ZZ	—	—	3.2	3.8	0.15	0.15	0.52	0.56
F 602	F 602 ZZ	—	—	3.2	3.1	0.15	0.15	0.60	0.71
F 682 X	F 682 XZZ	—	—	3.1	3.7	0.08	0.08	0.25	0.36
F 692 X	F 692 XZZ	—	—	3.7	3.8	0.15	0.15	0.51	0.68
MF 82 X	—	—	—	4.1	—	0.2	—	0.62	—
F 602 X	F 602 XZZ	—	—	3.7	3.5	0.15	0.15	0.74	0.98
MF 63	MF 63 ZZ	—	—	3.8	3.7	0.1	0.1	0.27	0.33
F 683 A	F 683 AZZ	—	—	3.8	4.0	0.1	0.1	0.37	0.53
MF 83	—	—	—	4.2	—	0.15	—	0.56	—
F 693	F 693 ZZ	—	—	4.2	4.3	0.15	0.15	0.70	0.97
MF 93	MF 93 ZZ	—	—	4.6	4.3	0.2	0.15	0.81	1.34
F 603	F 603 ZZ	—	—	4.2	4.3	0.15	0.15	1.0	1.63
F 623	F 623 ZZ	—	—	4.2	4.3	0.15	0.15	1.85	1.86
F 633	F 633 ZZ	—	—	4.6	6.0	0.2	0.2	3.73	3.59
MF 74	—	—	—	4.8	—	0.1	—	0.29	—
—	MF 74 ZZ	—	—	—	4.8	—	0.1	—	0.35
MF 84	MF 84 ZZ	—	—	5.2	5.0	0.15	0.1	0.44	0.63
F 684	F 684 ZZ	—	—	4.8	5.2	0.1	0.1	0.70	1.14
MF 104 B	MF 104 BZZ	—	—	5.6	5.9	0.2	0.15	1.13	1.59
F 694	F 694 ZZ	—	—	5.2	5.6	0.15	0.15	1.91	1.96
F 604	F 604 ZZ	—	—	5.6	5.6	0.2	0.2	2.53	2.53
F 624	F 624 ZZ	—	—	5.6	6.0	0.2	0.2	3.38	3.53
F 634	F 634 ZZ1	—	—	6.0	7.5	0.3	0.3	5.73	5.62

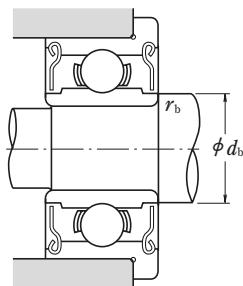
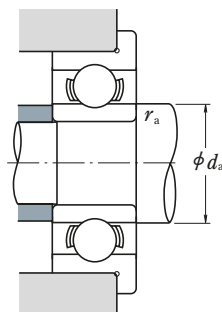
# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

## Metric Series With Flange Bore Diameter 5 – 9 mm



Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> ) GreaseOil			
<i>d</i>	<i>D</i>	<i>D</i> <sub>1</sub>	<i>D</i> <sub>2</sub>	<i>B</i>	<i>B</i> <sub>1</sub>	<i>C</i> <sub>1</sub>	<i>C</i> <sub>2</sub>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Open Z · ZZ V · VV	D · DD	Open Z	
5	8	9.2	—	2	—	0.6	—	0.1	—	310	120	53 000	—	63 000	
	8	—	9.2	—	2.5	—	0.6	—	0.1	278	131	53 000	—	63 000	
	9	10.2	10.2	2.5	3	0.6	0.6	0.15	0.15	430	168	50 000	—	60 000	
	10	11.2	11.6	3	4	0.6	0.8	0.15	0.15	430	168	50 000	—	60 000	
	11	12.5	12.5	3	5	0.8	1	0.15	0.15	715	281	45 000	—	53 000	
	13	15	15	4	4	1	1	0.2	0.2	1 080	430	43 000	40 000	50 000	
	14	16	16	5	5	1	1	0.2	0.2	1 330	505	40 000	38 000	50 000	
	16	18	18	5	5	1	1	0.3	0.3	1 730	670	36 000	32 000	43 000	
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	32 000	30 000	40 000	
	6	10	11.2	11.2	2.5	3	0.6	0.6	0.15	0.1	495	218	45 000	—	53 000
		12	13.2	13.6	3	4	0.6	0.8	0.2	0.15	715	292	43 000	40 000	50 000
		13	15	15	3.5	5	1	1.1	0.15	0.15	1 080	440	40 000	38 000	50 000
15		17	17	5	5	1.2	1.2	0.2	0.2	1 730	670	40 000	36 000	45 000	
17		19	19	6	6	1.2	1.2	0.3	0.3	2 260	835	38 000	34 000	45 000	
19		22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	32 000	30 000	40 000	
22		25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	30 000	28 000	36 000	
7		11	12.2	12.2	2.5	3	0.6	0.6	0.15	0.1	455	201	43 000	—	50 000
	13	14.2	14.6	3	4	0.6	0.8	0.2	0.15	540	276	40 000	—	48 000	
	14	16	16	3.5	5	1	1.1	0.15	0.15	1 170	510	40 000	34 000	45 000	
	17	19	19	5	5	1.2	1.2	0.3	0.3	1 610	715	36 000	28 000	43 000	
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	36 000	32 000	43 000	
	22	25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	30 000	28 000	36 000	
	8	12	13.2	13.6	2.5	3.5	0.6	0.8	0.15	0.1	545	274	40 000	—	48 000
		14	15.6	15.6	3.5	4	0.8	0.8	0.2	0.15	820	385	38 000	32 000	45 000
16		18	18	4	5	1	1.1	0.2	0.2	1 610	710	36 000	30 000	43 000	
19		22	22	6	6	1.5	1.5	0.3	0.3	2 240	910	36 000	28 000	43 000	
22	25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	34 000	28 000	40 000		
9	17	19	19	4	5	1	1.1	0.2	0.2	1 330	665	36 000	24 000	43 000	
	20	23	23	6	6	1.5	1.5	0.3	0.3	1 720	840	34 000	24 000	40 000	

**Remark** When using shielded bearings with a rotating outer ring, please contact NSK.

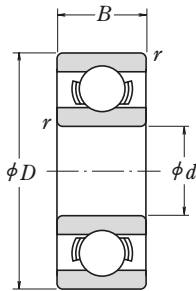


Bearing Designations				Abutment and Fillet Dimensions (mm)				Mass (g)	
Open	Shielded	Sealed		$d_a$ min.	$d_b$ max.	$r_a$ max.	$r_b$ max.	approx. Open	Shielded
<b>MF 85</b>	—	—	—	5.8	—	0.1	—	0.33	—
—	<b>MF 85 ZZ</b>	—	—	—	5.8	—	0.1	—	0.41
<b>MF 95</b>	<b>MF 95 ZZ1</b>	—	—	6.2	6.0	0.15	0.15	0.59	0.66
<b>MF 105</b>	<b>MF 105 ZZ</b>	—	—	6.2	6.0	0.15	0.15	1.05	1.46
<b>F 685</b>	<b>F 685 ZZ</b>	—	—	6.2	6.2	0.15	0.15	1.37	2.18
<b>F 695</b>	<b>F 695 ZZ</b>	<b>VV</b>	<b>DD</b>	6.6	6.6	0.2	0.2	2.79	2.84
<b>F 605</b>	<b>F 605 ZZ</b>	—	<b>DD</b>	6.6	6.9	0.2	0.2	3.9	3.85
<b>F 625</b>	<b>F 625 ZZ1</b>	<b>VV</b>	<b>DD</b>	7.0	7.5	0.3	0.3	5.37	5.27
<b>F 635</b>	<b>F 635 ZZ1</b>	<b>VV</b>	<b>DD</b>	7.0	8.5	0.3	0.3	9.49	9.49
<b>MF 106</b>	<b>MF 106 ZZ1</b>	—	—	7.2	7.0	0.15	0.1	0.65	0.77
<b>MF 126</b>	<b>MF 126 ZZ</b>	—	<b>DD</b>	7.6	7.2	0.2	0.15	1.38	1.94
<b>F 686 A</b>	<b>F 686 AZZ</b>	<b>VV</b>	<b>DD</b>	7.2	7.4	0.15	0.15	2.25	3.04
<b>F 696</b>	<b>F 696 ZZ1</b>	<b>VV</b>	<b>DD</b>	7.6	7.9	0.2	0.2	4.34	4.26
<b>F 606</b>	<b>F 606 ZZ</b>	<b>VV</b>	<b>DD</b>	8.0	8.2	0.3	0.3	6.58	6.61
<b>F 626</b>	<b>F 626 ZZ1</b>	<b>VV</b>	<b>DD</b>	8.0	8.5	0.3	0.3	9.09	9.09
<b>F 636</b>	<b>F 636 ZZ</b>	<b>VV</b>	<b>DD</b>	8.0	10.5	0.3	0.3	14.6	14.7
<b>MF 117</b>	<b>MF 117 ZZ</b>	—	—	8.2	8.0	0.15	0.1	0.72	0.82
<b>MF 137</b>	<b>MF 137 ZZ</b>	—	—	8.6	9.0	0.2	0.15	1.7	2.23
<b>F 687</b>	<b>F 687 ZZ1</b>	<b>VV</b>	<b>DD</b>	8.2	8.5	0.15	0.15	2.48	3.37
<b>F 697</b>	<b>F 697 ZZ1</b>	<b>VV</b>	<b>DD</b>	9.0	10.2	0.3	0.3	5.65	5.65
<b>F 607</b>	<b>F 607 ZZ1</b>	<b>VV</b>	<b>DD</b>	9.0	9.1	0.3	0.3	8.66	8.66
<b>F 627</b>	<b>F 627 ZZ</b>	<b>VV</b>	<b>DD</b>	9.0	10.5	0.3	0.3	14.2	14.2
<b>MF 128</b>	<b>MF 128 ZZ1</b>	—	—	9.2	9.0	0.15	0.1	0.82	1.15
<b>MF 148</b>	<b>MF 148 ZZ</b>	<b>VV</b>	<b>DD</b>	9.6	9.2	0.2	0.15	2.09	2.39
<b>F 688 A</b>	<b>F 688 AZZ</b>	<b>VV</b>	<b>DD</b>	9.6	10.2	0.2	0.2	3.54	4.47
<b>F 698</b>	<b>F 698 ZZ</b>	<b>VV</b>	<b>DD</b>	10.0	10.0	0.3	0.3	8.35	8.3
<b>F 608</b>	<b>F 608 ZZ</b>	<b>VV</b>	<b>DD</b>	10.0	10.5	0.3	0.3	13.4	13.5
<b>F 689</b>	<b>F 689 ZZ1</b>	<b>VV</b>	<b>DD</b>	10.6	11.5	0.2	0.2	3.97	4.91
<b>F 699</b>	<b>F 699 ZZ1</b>	<b>VV</b>	<b>DD</b>	11.0	12.0	0.3	0.3	9.51	9.51

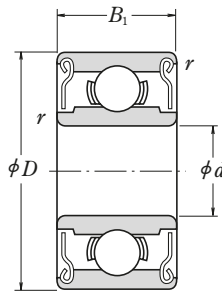
# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Inch Series

Bore Diameter 1.016 – 9.525 mm



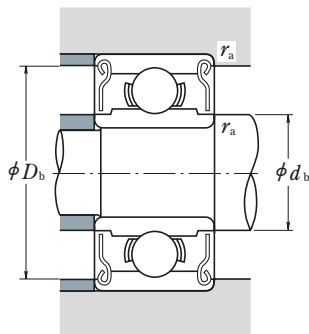
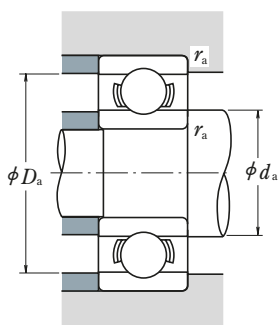
Open



Shielded  
ZZ · ZS

Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>B</i> <sub>1</sub>	<i>r</i> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease Open Z · ZZ	Oil Open Z	Open
<b>1.016</b>	3.175	1.191	—	0.1	80	23	130 000	150 000	<b>R 09</b>
<b>1.191</b>	3.967	1.588	2.380	0.1	138	35	110 000	130 000	<b>R 0</b>
<b>1.397</b>	4.762	1.984	2.779	0.1	231	66	90 000	110 000	<b>R 1</b>
<b>1.984</b>	6.350	2.380	3.571	0.1	310	108	67 000	80 000	<b>R 1-4</b>
<b>2.380</b>	4.762	1.588	—	0.1	188	60	80 000	95 000	<b>R 133</b>
	4.762	—	2.380	0.1	143	52	80 000	95 000	<b>—</b>
	7.938	2.779	3.571	0.15	550	175	60 000	71 000	<b>R 1-5</b>
<b>3.175</b>	6.350	2.380	2.779	0.1	283	95	67 000	80 000	<b>R 144</b>
	7.938	2.779	3.571	0.1	560	179	60 000	67 000	<b>R 2-5</b>
	9.525	2.779	3.571	0.15	640	225	53 000	63 000	<b>R 2-6</b>
	9.525	3.967	3.967	0.3	630	218	56 000	67 000	<b>R 2</b>
	12.700	4.366	4.366	0.3	640	225	53 000	63 000	<b>R 2A</b>
<b>3.967</b>	7.938	2.779	3.175	0.1	360	149	53 000	63 000	<b>R 155</b>
<b>4.762</b>	7.938	2.779	3.175	0.1	360	149	53 000	63 000	<b>R 156</b>
	9.525	3.175	3.175	0.1	710	270	50 000	60 000	<b>R 166</b>
	12.700	3.967	4.978	0.3	1 300	485	43 000	53 000	<b>R 3</b>
	12.700	3.175	3.175	0.1	420	204	48 000	56 000	<b>R 168B</b>
<b>6.350</b>	12.700	3.175	4.762	0.15	1 080	440	40 000	50 000	<b>R 188</b>
	15.875	4.978	4.978	0.3	1 610	660	38 000	45 000	<b>R 4B</b>
	19.050	5.558	7.142	0.4	2 620	1 060	36 000	43 000	<b>R 4AA</b>
	12.700	3.967	3.967	0.15	540	276	40 000	48 000	<b>R 1810</b>
<b>9.525</b>	22.225	5.558	7.142	0.4	3 350	1 410	32 000	38 000	<b>R 6</b>

- Remarks**
1. When using shielded bearings with a rotating outer ring, please contact NSK.
  2. Bearings with double shields (ZZ, ZS) are also available with single shields (Z, ZS).

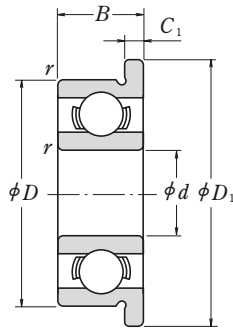


Designations	Abutment and Fillet Dimensions (mm)					Mass (g)	
	$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$r_a$ max.	approx. Open	approx. Shielded
—	1.9	—	2.3	—	0.1	0.04	—
<b>R 0 ZZ</b>	2.0	1.9	3.1	3.5	0.1	0.09	0.11
<b>R 1 ZZ</b>	2.2	2.3	3.9	4.1	0.1	0.15	0.19
<b>R 1-4 ZZ</b>	2.8	3.9	5.5	5.9	0.1	0.35	0.50
—	3.2	—	3.9	—	0.1	0.10	—
<b>R 133 ZZS</b>	—	3.0	—	4.2	0.1	—	0.13
<b>R 1-5 ZZ</b>	3.6	4.1	6.7	7.0	0.15	0.60	0.72
<b>R 144 ZZ</b>	4.0	3.9	5.5	5.9	0.1	0.25	0.27
<b>R 2-5 ZZ</b>	4.0	4.3	7.1	7.3	0.1	0.55	0.72
<b>R 2-6 ZZS</b>	4.4	4.6	8.3	8.2	0.15	0.96	1.13
<b>R 2 ZZ</b>	5.2	4.8	7.5	8.0	0.3	1.36	1.39
<b>R 2A ZZ</b>	5.2	4.6	10.7	8.2	0.3	3.3	3.23
<b>R 155 ZZS</b>	4.8	5.5	7.1	7.3	0.1	0.51	0.56
<b>R 156 ZZS</b>	5.6	5.5	7.1	7.3	0.1	0.39	0.42
<b>R 166 ZZ</b>	5.6	5.9	8.7	8.8	0.1	0.81	0.85
<b>R 3 ZZ</b>	6.8	6.5	10.7	11.2	0.3	2.21	2.79
<b>R 168 BZZ</b>	7.2	7.0	8.7	8.9	0.1	0.58	0.62
<b>R 188 ZZ</b>	7.6	7.4	11.5	11.6	0.15	1.53	2.21
<b>R 4B ZZ</b>	8.4	8.4	13.8	13.8	0.3	4.5	4.43
<b>R 4AA ZZ</b>	9.4	9.0	16.0	16.6	0.4	7.48	9.17
<b>R 1810 ZZ</b>	9.2	9.0	11.5	11.6	0.15	1.56	1.48
<b>R 6 ZZ</b>	12.6	11.9	19.2	20.0	0.4	9.02	11

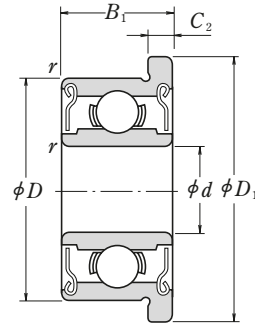
# ■ EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Inch Series With Flange

Bore Diameter 1.191 – 9.525 mm



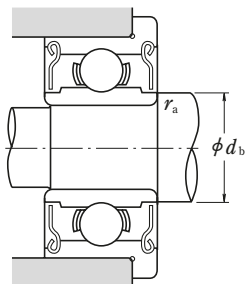
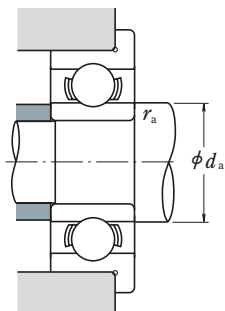
Open



Shielded  
ZZ · ZS

<i>d</i>	<i>D</i>	<i>D</i> <sub>1</sub>	Boundary Dimensions (mm)					Basic Load Ratings (N)	
			<i>B</i>	<i>B</i> <sub>1</sub>	<i>C</i> <sub>1</sub>	<i>C</i> <sub>2</sub>	<i>r</i> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>1.191</b>	3.967	5.156	1.588	2.380	0.330	0.790	0.1	138	35
<b>1.397</b>	4.762	5.944	1.984	2.779	0.580	0.790	0.1	231	66
<b>1.984</b>	6.350	7.518	2.380	3.571	0.580	0.790	0.1	310	108
<b>2.380</b>	4.762	5.944	1.588	—	0.460	—	0.1	188	60
	4.762	5.944	—	2.380	—	0.790	0.1	143	52
	7.938	9.119	2.779	3.571	0.580	0.790	0.15	550	175
<b>3.175</b>	6.350	7.518	2.380	2.779	0.580	0.790	0.1	283	95
	7.938	9.119	2.779	3.571	0.580	0.790	0.1	560	179
	9.525	10.719	2.779	3.571	0.580	0.790	0.15	640	225
	9.525	11.176	3.967	3.967	0.760	0.760	0.3	630	218
<b>3.967</b>	7.938	9.119	2.779	3.175	0.580	0.910	0.1	360	149
<b>4.762</b>	7.938	9.119	2.779	3.175	0.580	0.910	0.1	360	149
	9.525	10.719	3.175	3.175	0.580	0.790	0.1	710	270
	12.700	14.351	4.978	4.978	1.070	1.070	0.3	1 300	485
<b>6.350</b>	9.525	10.719	3.175	3.175	0.580	0.910	0.1	420	204
	12.700	13.894	3.175	4.762	0.580	1.140	0.15	1 080	440
	15.875	17.526	4.978	4.978	1.070	1.070	0.3	1 610	660
<b>7.938</b>	12.700	13.894	3.967	3.967	0.790	0.790	0.15	540	276
<b>9.525</b>	22.225	24.613	7.142	7.142	1.570	1.570	0.4	3 350	1 410

- Remarks**
1. When using shielded bearings with a rotating outer ring, please contact NSK.
  2. Bearings with double shields (ZZ, ZS) are also available with single shields (Z, ZS).



Limiting Speeds ( $\text{min}^{-1}$ )		Bearing Designations		Abutment and Fillet Dimensions (mm)			Mass (g)	
Grease Open Z · ZZ	Oil Open Z	Open	Shielded	$d_a$ min.	$d_b$ max.	$r_a$ max.	approx. Open	Shielded
110 000	130 000	<b>FR 0</b>	<b>FR 0 ZZ</b>	2.0	1.9	0.1	0.11	0.16
90 000	110 000	<b>FR 1</b>	<b>FR 1 ZZ</b>	2.2	2.3	0.1	0.20	0.25
67 000	80 000	<b>FR 1-4</b>	<b>FR 1-4 ZZ</b>	2.8	3.9	0.1	0.41	0.58
80 000	95 000	<b>FR 133</b>	—	3.2	—	0.1	0.13	—
80 000	95 000	—	<b>FR 133 ZZS</b>	—	3.0	0.1	—	0.19
60 000	71 000	<b>FR 1-5</b>	<b>FR 1-5 ZZ</b>	3.6	4.1	0.15	0.68	0.82
67 000	80 000	<b>FR 144</b>	<b>FR 144 ZZ</b>	4.0	3.9	0.1	0.31	0.35
60 000	67 000	<b>FR 2-5</b>	<b>FR 2-5 ZZ</b>	4.0	4.3	0.1	0.62	0.81
53 000	63 000	<b>FR 2-6</b>	<b>FR 2-6 ZZS</b>	4.4	4.6	0.15	1.04	1.25
56 000	67 000	<b>FR 2</b>	<b>FR 2 ZZ</b>	5.2	4.8	0.3	1.51	1.55
53 000	63 000	<b>FR 155</b>	<b>FR 155 ZZS</b>	4.8	5.5	0.1	0.59	0.67
53 000	63 000	<b>FR 156</b>	<b>FR 156 ZZS</b>	5.6	5.5	0.1	0.47	0.53
50 000	60 000	<b>FR 166</b>	<b>FR 166 ZZ</b>	5.6	5.9	0.1	0.90	0.98
43 000	53 000	<b>FR 3</b>	<b>FR 3 ZZ</b>	6.8	6.5	0.3	2.97	3.09
48 000	56 000	<b>FR 168B</b>	<b>FR 168 BZZ</b>	7.2	7.0	0.1	0.66	0.75
40 000	50 000	<b>FR 188</b>	<b>FR 188 ZZ</b>	7.6	7.4	0.15	1.64	2.49
38 000	45 000	<b>FR 4B</b>	<b>FR 4B ZZ</b>	8.4	8.4	0.3	4.78	4.78
40 000	48 000	<b>FR 1810</b>	<b>FR 1810 ZZ</b>	9.2	9.0	0.15	1.71	1.63
32 000	38 000	<b>FR 6</b>	<b>FR 6 ZZ</b>	12.6	11.9	0.4	10.1	12.1



### 3. ANGULAR CONTACT BALL BEARINGS

**INTRODUCTION** ..... C 072

**TECHNICAL DATA**

**Free Space of Angular Contact Ball Bearings**..... C 078

**Dynamic Equivalent Load of  
Triplex Angular Contact Ball Bearings**..... C 080

**Angular Clearances in Double-Row  
Angular Contact Ball Bearings**..... C 082

**Relationship Between Radial  
and Axial Clearances in Double-Row  
Angular Contact Ball Bearings**..... C 084



**BEARING TABLES**

**Single-Row and Matched Angular Contact Ball Bearings**

Bore Diameter 10 – 200 mm..... C 086

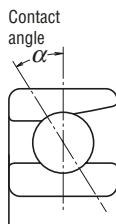
**Double-Row Angular Contact Ball Bearings  
Open, Shielded, and Sealed Types**

Bore Diameter 10 – 85 mm ..... C 106

**Four-Point-Contact Ball Bearings**

Bore Diameter 30 – 200 mm..... C 110

## DESIGN, TYPES, AND FEATURES



### SINGLE-ROW ANGULAR CONTACT BALL BEARINGS

Single-row angular contact ball bearings have a contact angle allowing them to sustain significant axial loads in one direction together with radial loads. Because of their design, when a radial load is applied, an axial force component is produced; therefore, two or more opposed bearings must be used.

Since the rigidity of single-row angular contact ball bearings can be increased by preloading, they are often used in the main spindles of machine tools where high running accuracy is required (refer to Chapter 9 Preload on Page A192 for more information).

Usually, the cages for angular contact ball bearings with a contact angle of  $30^\circ$  (designation **A**) or  $40^\circ$  (designation **B**) are made in accordance with Table 1, but depending on the application, machined synthetic-resin cages or molded polyamide-resin cages may also be used. The basic load ratings given in the bearing tables are based on standard cages.

Though the figures in the bearing tables on Pages C086 to C101 for bearing bore diameters of 10 to 120 show bearings with single-shoulder inner rings, dual-shoulder bearings are also available. Please consult NSK for more detailed information.

**Table 1 Features of Single-Row Angular Contact Ball Bearings**

Cage Spec.	Material	Steel	Nylon 46		L-PPS resin	Brass	
	Method	Pressed	Molded		Molded	Machined	
	Designation	W	TYN	T85	T7	Omitted	MR
Features	High Load Capacity	◎	○	◎	◎	○	◎
	High-Speed	△	◎	○	○	△	○
	High-Temperature	◎	△	△	◎	◎	◎
	Vibration	△	△	△	△	◎	◎

◎ Excellent ○ Good △ Fair

In addition, bearings with the same serial number will have different load ratings if the type of cage or number of balls are different.

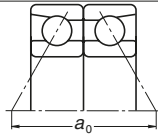
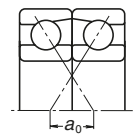
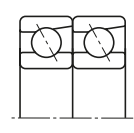
Angular contact ball bearings with contact angles of 15° (designation **C**) and 25° (designation **A5**) are primarily for high precision or high-speed applications, and molded polyamide cages (designation TYN) or machined-brass cages or synthetic resin cages (designation T) are used.

The maximum operating temperature of molded polyamide cages is 150°C.

### MATCHED ANGULAR CONTACT BALL BEARINGS

The types and features of matched angular contact ball bearings are shown in Table 2.

**Table 2 Types and Features of Matched Angular Contact Ball Bearings**

Figure	Arrangement	Features
	Back-to-Back (DB) (Example) 7208 A DB	Radial loads and axial loads in both directions can be sustained. Since the distance between the effective load centers $a_0$ is large, this type is suitable if moments are applied.
	Face-to-Face (DF) (Example) 7208 B DF	Radial loads and axial loads in both directions can be sustained. Compared with the DB Type, the distance between the effective load centers is small, so the capacity to sustain moments is inferior.
	Tandem (DT) (Example) 7208 A DT	Radial loads and axial loads in one direction can be sustained. Since two bearings share the axial load, this arrangement is used when the load in one direction is heavy.

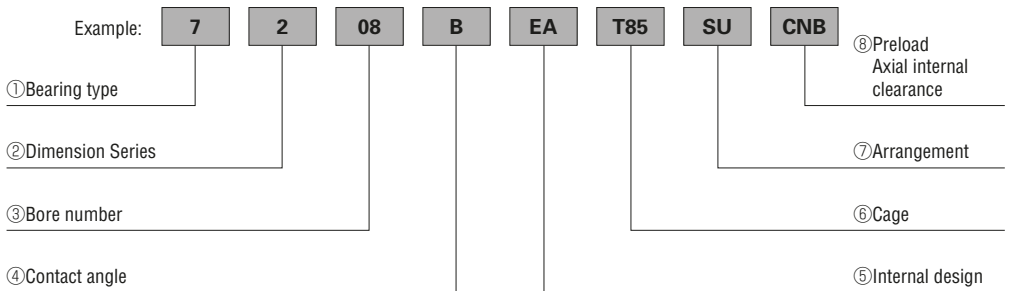
### NSKHPS™ ANGULAR CONTACT BALL BEARINGS

NSKHPS bearings feature high capacity, high limiting speed, and highly accurate universal matching. Molded polyamide cages are standard for the NSKHPS type.

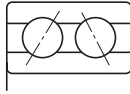


## Formulation of Bearing Designations

Single-Row Matched Angular Contact Ball Bearings



① Bearing type	7 : Single-row angular contact ball bearings, matched angular contact ball bearings
② Dimension Series	2 : 02 Series, 3 : 03 Series, 9 : 19 Series, 0 : 10 Series
③ Bore number	Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore Bore number $\times 5$ (mm)
④ Contact angle	C : 15°, A5 : 25°, A : 30°, B : 40°
⑤ Internal design	EA : High Load Capacity
⑥ Cage	W : Pressed steel Cage, T85 : Machined brass cage (ball-guided), No designation : Machined brass cage (inner ring guided), TYN : Polyamide resin cage, T85 : Polyamide 46 resin cage, T7 : L-PPS resin cage
⑦ Arrangement	SU : Universal arrangement (single-row), DU : Universal arrangement (double-row), DB : Back-to-back arrangement, DF : Face-to-face arrangement, DT : Tandem arrangement
⑧ Preload / Axial internal clearance	EL : Extra light preload, L : Light preload, M : Medium preload, H : Heavy preload Omitted : CN clearance, C3 : Clearance greater than CN, C4 : Clearance greater than C3, CNB : CN Clearance equivalent (universal arrangement)

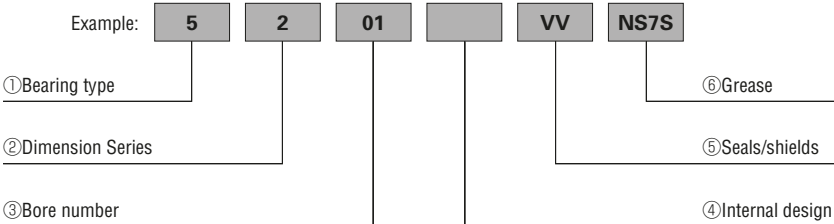


## DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

Double-row angular contact ball bearings are essentially a back-to-back mounting of two single-row angular contact ball bearings, but their inner and outer rings are each integrated into one. These bearings can sustain axial loads in both directions and offer good capacity for sustaining moment loads. They are often used as fixed-end bearings and contain cages made of pressed steel.

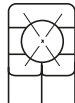
### Formulation of Bearing Designations

Double-Row Angular Contact Ball Bearings



- ①Bearing type      5 : Double-row angular contact ball bearings
- ②Dimension Series      2 : 02 Series    3 : 03 Series
- ③Bore number      03 and under: 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm  
04 and over: Bore diameter bore number  $\times 5$  (mm)
- ④Internal design      ZZ: Steel shield on both sides, DDU: Rubber contact seal on both sides VV: Rubber noncontact seal on both sides
- ⑤Seals/shields      Z: Steel shield on one sides, DU: Rubber contact seal on one side, V: Rubber non-contact seal on one side
- ⑥Grease\*      NS7: NS HI-LUBE

\*A grease code is required when using shields or seals on both sides.



## Four-Point-Contact Ball Bearings

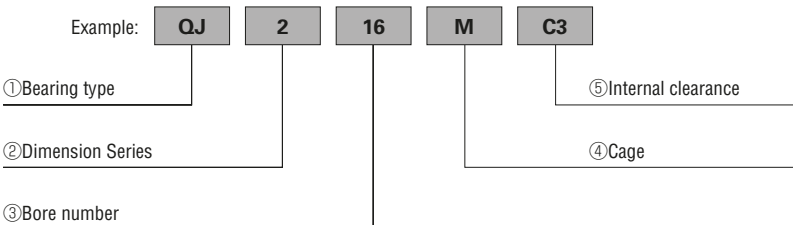
The inner ring is split radially into two pieces. This design allows one bearing to sustain significant axial loads in either direction.

The contact angle is  $35^\circ$ , so axial load capacity is high. These bearings are suitable for carrying pure axial loads or combined loads where axial loads are high.

The cages are made of machined brass.

### Formulation of Bearing Designations

Four-Point-Contact Ball Bearings



- ①Bearing type      QJ : Four-point contact ball bearings
- ②Dimension Series      10 : 10 Series, 2 : 02 Series, 3 : 03 Series
- ③Bore number      Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm  
Over 04, Bearing bore Bore number  $\times 5$  (mm)
- ④Cage      M : Machined-brass Cage (outer ring guided)
- ⑤Internal clearance      Omitted : CN clearance,  
C3 : Clearance greater than CN, C4 : Clearance greater than C3

## PRECAUTIONS FOR USE OF ANGULAR CONTACT BALL BEARINGS

Under severe operating conditions where speed and temperature are close to bearing limits, lubrication is marginal, and vibration and moment loads are heavy, angular contact ball bearings may not be suitable, particularly when using certain types of cages. In such cases, please consult with NSK beforehand.

If the load on angular contact ball bearings becomes too small, or if the ratio of the axial and radial loads for matched bearings exceeds 'e' (listed in the bearing tables) during operation, slippage occurs between the balls and raceways, which may result in smearing. This is especially true with large bearings since the weight of the balls and cage is high. If such load conditions are expected, please consult with NSK for bearing selection.



## TOLERANCES AND RUNNING ACCURACY

### SINGLE-ROW ANGULAR CONTACT

**BALL BEARINGS** ..... Table 7.2 (Pages A128 to A131)

### NSKHPS ANGULAR CONTACT BALL BEARINGS

**Tolerances: Class 6,**

**Running Accuracy: Class 5** ..... Table 7.2 (Pages A128 to A131)

### MATCHED ANGULAR CONTACT

**BALL BEARINGS** ..... Table 7.2 (Pages A128 to A131)

### DOUBLE-ROW ANGULAR CONTACT

**BALL BEARINGS** ..... Table 7.2 (Pages A128 to A131)

### FOUR-POINT-CONTACT BALL

**BEARINGS** ..... Table 7.2 (Pages A128 to A131)

## RECOMMENDED FITS

### SINGLE-ROW ANGULAR CONTACT BALL

### BEARINGS AND NSKHPS ANGULAR CONTACT

**BALL BEARINGS** ..... Table 8.3 (Page A164)

Table 8.5 (Page A165)

**MATCHED ANGULAR CONTACT BALL BEARINGS** .. Table 8.3 (Page A164)

Table 8.5 (Page A165)

### DOUBLE-ROW ANGULAR CONTACT BALL

**BEARINGS** ..... Table 8.3 (Page A164)

Table 8.5 (Page A165)

**FOUR-POINT-CONTACT BALL BEARINGS** ..... Table 8.3 (Page A164)

Table 8.5 (Page A165)

## INTERNAL CLEARANCES

### MATCHED ANGULAR CONTACT BALL BEARINGS..... Table 8.18 (Page A174)

Matched angular contact ball bearings with precision classes over P5 are primarily used in the main spindles of machine tools; as such, they are used with a preload for rigidity. For ease of selection, internal clearances are adjusted to produce Very Light, Light, Medium, and Heavy preloads. These bearings also use a special fitting; please refer to Tables 9.1 and 9.5 (Pages A194 and A197) for more information.

The clearance (or preload) of matched bearings is obtained by axially tightening a pair of bearings till the side faces of their inner or outer rings are pressed against each other.

### NSKHPS ANGULAR CONTACT BALL BEARINGS

**Axial Internal Clearance** (Measured Clearances) Units :  $\mu\text{m}$

Nominal Bore Diameter $d$ (mm)		Axial Internal Clearance			
		CNB		GA	
over	incl.	min.	max.	min.	max.
<b>12</b>	<b>18</b>	17	25	-2	6
<b>18</b>	<b>30</b>	20	28		
<b>30</b>	<b>50</b>	24	32		
<b>50</b>	<b>80</b>	29	41	-3	9



### DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

For the clearance in double-row angular contact ball bearings, please consult with NSK.

### FOUR-POINT CONTACT BALL BEARINGS.....Table 8.19 (Page A174)

## LIMITING SPEEDS (Grease/Oil)

Limiting speeds (grease/oil) listed in the bearing tables are for matched angular contact ball bearings with standard cages. Please consult NSK regarding bearings with optional cages, as limiting speeds (grease/oil) may differ from those listed. For example, limiting speeds (grease/oil) of machined cages (no designation) are 1.25 times higher than pressed cages.

The limiting speeds of bearings with contact angles of 15° (designation **C**) and 25° (designation **A5**) are for bearings with a precision class of P5 or better with machined synthetic resin cages (T) or molded polyamide cages (TYN).

The limiting speeds listed in the bearing tables should be adjusted depending on bearing load conditions. In addition, higher speeds are attainable by making changes in the lubrication method, cage design, etc; refer to Page A098 for detailed information.

TECHNICAL DATA

Free Space of Angular Contact Ball Bearings

Angular contact ball bearings are used in various components, such as spindles of machine tools, vertical pump motors, and worm gear reducers. Grease lubrication is usually used with these bearings; however, such grease lubrication may affect the bearing in terms of temperature rise or durability. To allow a bearing to demonstrate its full performance, the bearing must be filled with the proper amount of a suitable grease. To do so, knowledge of the bearing's free space is critical.

Various angular contact ball bearings are available independent of the numerous combinations of bearing series, contact angle, and cage type. The free space of frequently used bearings are listed below. Table 1 shows the free space of a bearing with a pressed cage for general use and Table 2 shows that of bearings with a high-tension brass machined cage. The contact angle designations A, B, and C in each table refer to the nominal contact angles of 30°, 40°, and 15° for each bearing.



Table 1 Free Space of Angular Contact Ball Bearings (1)  
(With Pressed Steel Cages)

Units: cm<sup>3</sup>

Bearing Bore No.	Bearing Free Space			
	Bearing Series — Contact Angle Designation			
	72-A	72-B	73-A	73-B
00	1.5	1.4	2.9	2.8
01	2.1	2.0	3.7	3.5
02	2.8	2.7	4.8	4.6
03	3.7	3.6	6.2	5.9
04	6.2	5.9	8.4	8.0
05	7.8	7.4	13	12
06	12	11	20	19
07	16	15	26	24
08	20	19	36	34
09	25	24	48	45
10	28	27	63	60

**Table 2 Free Space of Angular Contact Ball Bearings (2)**  
**(With High-Tension Brass Machined Cages)**

Units: cm<sup>3</sup>

Bearing Bore No.	Bearing Free Space				
	Bearing Series — Contact Angle Designation				
	70-C	72-A 72-C	72-B	73-A 73-C	73-B
00	0.9	1.0	1.0	2.2	2.1
01	0.9	1.6	1.6	2.5	2.5
02	1.2	1.9	1.9	3.4	3.3
03	1.6	2.7	2.7	4.6	4.4
04	3.0	4.7	4.2	6.1	5.9
05	3.5	6.0	5.3	9.2	9.0
06	4.3	8.5	8.1	14	13
07	6.5	12	11	18	17
08	8.3	14	14	25	24
09	10	18	17	34	33
10	11	20	20	45	44
11	16	26	25	57	55
12	17	33	31	71	69
13	18	38	37	87	83
14	24	43	42	107	103
15	24	47	45	129	123
16	34	58	57	152	146
17	37	71	70	179	172
18	44	88	85	207	201
19	44	105	105	261	244
20	47	127	127	282	278



## Dynamic Equivalent Load of Triplex Angular Contact Ball Bearings

Three separate single-row bearings may be used side by side as shown in the figure when angular contact ball bearings are used to carry a large axial load. There are three combination patterns, which are expressed by combination designations DBD, DFD, and DTD.

As in the case of single-row and double-row bearings, the dynamic equivalent load, which is determined from the radial and axial loads acting on a bearing, is used to calculate the fatigue life for these combined bearings.

Assuming the dynamic equivalent radial load as  $P_r$ , the radial load as  $F_r$ , and axial load as  $F_a$ , the relationship between the dynamic equivalent radial load and bearing load may be approximated as follows:

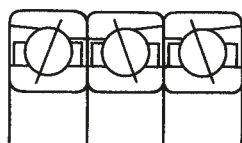
$$P_r = XF_r + YF_a \quad (1)$$

where  $X$ : Radial load factor  
 $Y$ : Axial load factor } See Table 1

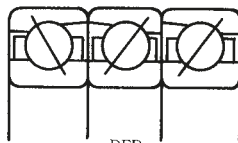
The axial load factor varies with contact angle. A small contact angle in an angular contact ball bearing varies substantially when axial load increases.

A change in the contact angle can be expressed by the ratio between the basic static load rating  $C_{0r}$  and axial load  $F_a$ . Axial load factors corresponding to this ratio at a contact angle of  $15^\circ$  are shown in Table 1. If angular contact ball bearings have contact angles of  $25^\circ$ ,  $30^\circ$  and  $40^\circ$ , the effect of change in the contact angle on the axial load factor may be ignored and thus the axial load factor is assumed as constant.

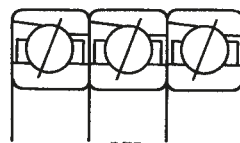
Arrangement	Load Direction
3-row matched stack, axial load is supported by 2 rows.  ( Symbol DBD or DFD )	
3-row matched stack, axial load is supported by 1 row.  ( Symbol DBD or DFD )	
3-row tandem matched stack  ( Symbol DTD )	



DBD



DFD



DTD

Table 1 Factors  $X$  and  $Y$  for Triplex Angular Contact Ball Bearing

Contact Angle $\alpha$	$j$	$\frac{C_{0r}}{jF_a}$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$e$	Basic Load Rating of 3-Row Ball Bearings	
			$X$	$Y$	$X$	$Y$		$C_r$	$C_{0r}$
15°	1.5	5	1	0.64	0.58	1.46	0.51	2.16 times that of a single bearing	3 times that of a single bearing
		10		0.70		1.61	0.47		
		15		0.74		1.70	0.44		
		20		0.76		1.75	0.42		
		25		0.78		1.81	0.41		
		30		0.80		1.83	0.40		
	50	0.83		1.91	0.39				
25°	—	—	1	0.48	0.54	1.16	0.68		
30°	—	—	1	0.41	0.52	1.01	0.80		
40°	—	—	1	0.29	0.46	0.76	1.14		
15°	3	5	1	2.28	0.95	2.37	0.51	2.16 times that of a single bearing	3 times that of a single bearing
		10		2.51		2.61	0.47		
		15		2.64		2.76	0.44		
		20		2.73		2.85	0.42		
		25		2.80		2.93	0.41		
		30		2.85		2.98	0.40		
	50	2.98		3.11	0.39				
25°	—	—	1	1.70	0.88	1.88	0.68		
30°	—	—	1	1.45	0.84	1.64	0.80		
40°	—	—	1	1.02	0.76	1.23	1.14		
15°	1	5	1	0	0.44	1.10	0.51	2.16 times that of a single bearing	3 times that of a single bearing
		10				1.21	0.47		
		15				1.28	0.44		
		20				1.32	0.42		
		25				1.36	0.41		
		30				1.38	0.40		
	50	1.44	0.39						
25°	—	—	1	0	0.41	0.87	0.68		
30°	—	—	1	0	0.39	0.76	0.80		
40°	—	—	1	0	0.35	0.57	1.14		



## Angular Clearances in Double-Row Angular Contact Ball Bearings

The angular clearance for double-row bearings is defined in exactly the same way as for single-row bearings; i.e., with one of the bearing rings fixed, the angular clearance refers to the greatest possible angular displacement of the axis of the other ring.

Since the angular clearance is the greatest total relative displacement of the two ring axes, it is twice the possible angle of inner and outer ring movement (the maximum angular displacement in one direction from the center without creating a moment).

The relationship between axial and angular clearance for double-row angular contact ball bearings is given by Equation (1) below:

$$\Delta_a = 2m_0 \left\{ \sin \alpha_0 + \frac{\theta R_i}{2m_0} - \sqrt{1 - \left( \cos \alpha_0 + \frac{\theta l}{4m_0} \right)^2} \right\} \quad (1)$$

where  $\Delta_a$  : Axial clearance (mm)

$m_0$  : Distance between inner and outer ring groove curvature centers

$m_0 = r_c + r_i - D_w$  (mm)

$r_c$  : Outer ring groove radius (mm)

$r_i$  : Inner ring groove radius (mm)

$\alpha_0$  : Initial contact angle (°)

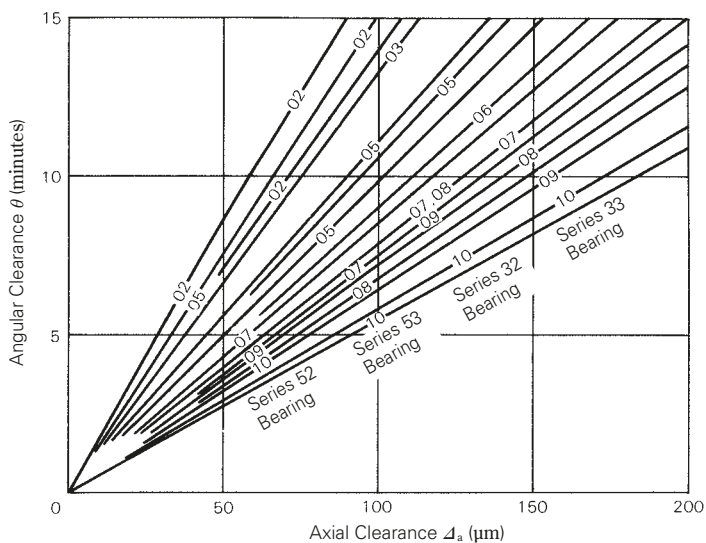
$\theta$  : Angular clearance (rad)

$R_i$  : Distance between shaft center and inner ring groove curvature center (mm)

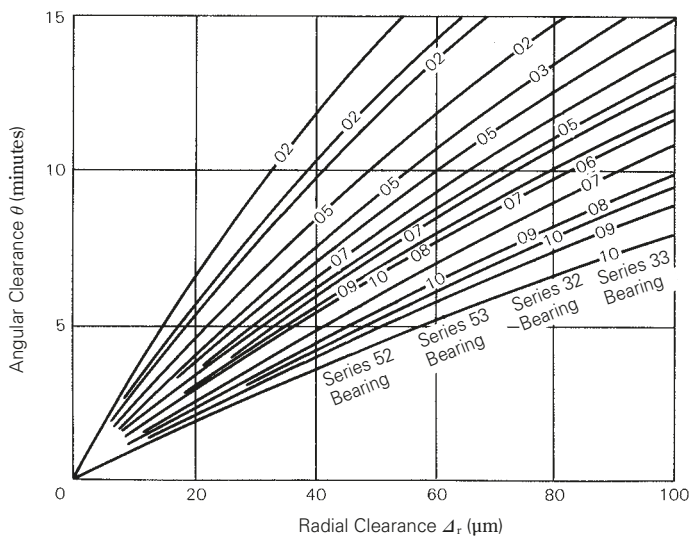
$l$  : Distance between left and right groove centers of inner ring (mm)

The above equation is shown plotted in Fig. 1 for Series 52, 53, 32, and 33 double-row angular contact ball bearings.

The relationship between radial clearance  $\Delta_r$  and axial clearance  $\Delta_a$  for double-row angular contact ball bearings is listed on pages C086 and C087. Fig. 2 shows the relationship between angular clearance  $\theta$  and radial clearance  $\Delta_r$  based on equations from those pages.



**Fig. 1 Relationship Between Axial and Angular Clearances**



**Fig. 2 Relationship Between Radial and Angular Clearances**

## Relationship Between Radial and Axial Clearances in Double-Row Angular Contact Ball Bearings

The relationship between the radial and axial internal clearances in double-row angular contact ball bearings can be determined geometrically as shown in Fig. 1 below.

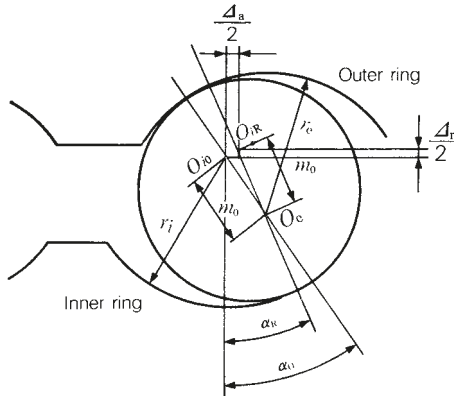


Fig. 1

- where  $\Delta_r$  : Radial clearance (mm)  
 $\Delta_a$  : Axial clearance (mm)  
 $\alpha_0$  : Initial contact angle, inner or outer ring displaced axially  
 $\alpha_R$  : Initial contact angle, inner or outer ring displaced radially  
 $O_{io}$  : Center of inner ring groove curvature (inner ring displaced axially)  
 $O_e$  : Center of outer ring groove curvature (outer ring fixed)  
 $O_{ir}$  : Center of inner ring groove curvature (inner ring displaced radially)  
 $m_0$  : Distance between inner and outer ring groove-curvature centers  
 $m_0 = r_i + r_e - D_w$   
 $D_w$  : Ball diameter (mm)  
 $r_i$  : Radius of inner ring groove (mm)  
 $r_e$  : Radius of outer ring groove (mm)

The following relations can be derived from Fig. 1:

$$m_0 \sin \alpha_0 = m_0 \sin \alpha_R + \frac{\Delta_a}{2} \quad (1)$$

$$m_0 \cos \alpha_0 = m_0 \cos \alpha_R - \frac{\Delta_r}{2} \quad (2)$$

$$\text{since } \sin^2 \alpha_0 = 1 - \cos^2 \alpha_0, \\ (m_0 \sin \alpha_0)^2 = m_0^2 - (m_0 \cos \alpha_0)^2 \quad (3)$$

By combining Equations (1), (2), and (3), we obtain the following:

$$\left( m_0 \sin \alpha_R + \frac{\Delta_a}{2} \right)^2 = m_0^2 - \left( m_0 \cos \alpha_R - \frac{\Delta_r}{2} \right)^2 \quad (4)$$

$$\therefore \Delta_a = 2 \sqrt{m_0^2 - \left( m_0 \cos \alpha_R - \frac{\Delta_r}{2} \right)^2} - 2 m_0 \sin \alpha_R \quad (5)$$

$\alpha_R$  is  $25^\circ$  for Series 52 and 53 bearings and  $32^\circ$  for Series 32 and 33 bearings. If we set  $\alpha_R$  equal to  $0^\circ$ , Equation (5) becomes:

$$\Delta_a = 2 \sqrt{m_0^2 - \left( m_0 - \frac{\Delta_r}{2} \right)^2} \\ = 2 \sqrt{m_0 \Delta_r - \frac{\Delta_r^2}{4}}$$

However,  $\frac{\Delta_r^2}{4}$  is negligible.

$$\therefore \Delta_a \approx 2 m_0^{1/2} \Delta_r^{1/2} \quad (6)$$

This is identical to the relationship between the radial and axial clearances in single-row deep groove ball bearings.

The value of  $m_0$  is dependent on the inner and outer ring groove radii. The relation between  $\Delta_r$  and  $\Delta_a$ , as given by Equation (5), is shown in Figs. 2 and 3 for Series 52, 53, 32, and 33 double-row angular contact ball bearings. When the clearance range is small, axial clearance is given approximately by the following:

$$\Delta_a \approx \Delta_r \cot \alpha_R \quad (7)$$

However, when the clearance is relatively large, (when  $\Delta_r/D_w > 0.002$ ) the error in Equation (7) can be quite large.

The contact angle  $\alpha_R$  is independent of the radial

clearance; however, the initial contact angle  $\alpha_0$  varies with the radial clearance when the inner or outer ring is displaced axially. This relationship is given by Equation (2).

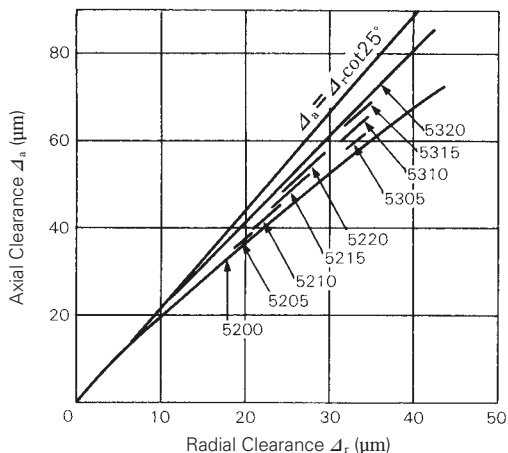


Fig. 2 Radial and Axial Clearances of Series 52 and 53 Bearings

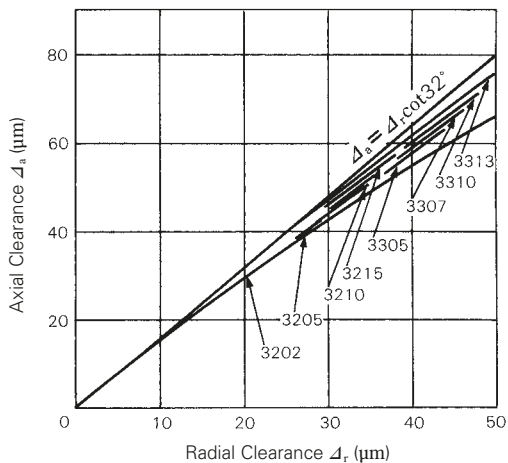
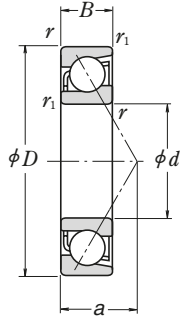


Fig. 3 Radial and Axial Clearances of Series 32 and 33 Bearings

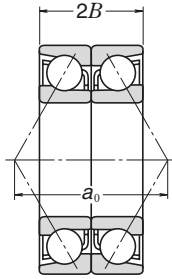
# ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

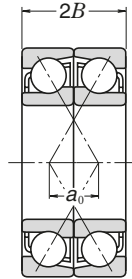
Bore Diameter 10 – 15 mm



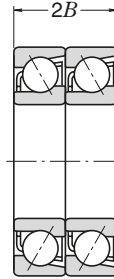
Single



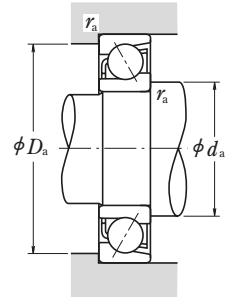
Back-to-Back  
DB



Face-to-Face  
DF

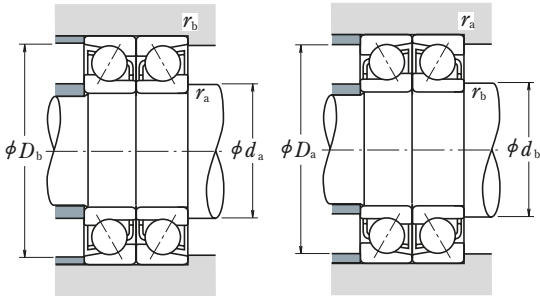


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) <i>a</i>	Abutment and Fillet Dimensions (mm)			Mass (kg)
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	<i>f</i> <sub>0</sub>	Grease	Oil		<i>d</i> <sub>a</sub> min.	<i>D</i> <sub>a</sub> max.	<i>r</i> <sub>a</sub> max.	approx.
10	22	6	0.3	0.15	2 880	1 450	—	40 000	56 000	6.7	12.5	19.5	0.3	0.010
	22	6	0.3	0.15	3 000	1 520	14.1	48 000	63 000	5.1	12.5	19.5	0.3	0.010
	26	8	0.3	0.15	5 350	2 600	—	24 000	34 000	9.2	12.5	23.5	0.3	0.019
	26	8	0.3	0.15	5 300	2 490	12.6	45 000	63 000	6.4	12.5	23.5	0.3	0.019
	30	9	0.6	0.3	5 400	2 710	—	22 000	30 000	10.3	15	25	0.6	0.032
	30	9	0.6	0.3	5 000	2 500	—	16 000	22 000	12.9	15	25	0.6	0.032
	30	9	0.6	0.3	5 400	2 610	13.2	40 000	56 000	7.2	15	25	0.6	0.032
	35	11	0.6	0.3	9 300	4 300	—	16 000	22 000	12.0	15	30	0.6	0.053
	35	11	0.6	0.3	8 750	4 050	—	14 000	20 000	14.9	15	30	0.6	0.054
	24	6	0.3	0.15	3 200	1 770	—	38 000	53 000	7.2	14.5	21.5	0.3	0.011
	24	6	0.3	0.15	3 350	1 860	14.7	45 000	63 000	5.4	14.5	21.5	0.3	0.011
	28	8	0.3	0.15	5 800	2 980	—	22 000	30 000	9.8	14.5	25.5	0.3	0.021
12	28	8	0.3	0.15	5 800	2 900	13.2	40 000	56 000	6.7	14.5	25.5	0.3	0.021
	32	10	0.6	0.3	8 000	4 050	—	20 000	28 000	11.4	17	27	0.6	0.037
	32	10	0.6	0.3	7 450	3 750	—	15 000	20 000	14.2	17	27	0.6	0.038
	32	10	0.6	0.3	8 150	3 750	—	20 000	30 000	14.2	17	27	0.6	0.036
	32	10	0.6	0.3	7 900	3 850	12.5	36 000	50 000	7.9	17	27	0.6	0.036
	37	12	1	0.6	9 450	4 500	—	15 000	20 000	13.1	18	31	1	0.060
	37	12	1	0.6	8 850	4 200	—	13 000	18 000	16.3	18	31	1	0.062
	37	12	1	0.6	11 100	4 950	—	18 000	26 000	16.3	18	31	1	0.061
	28	7	0.3	0.15	4 550	2 530	—	32 000	43 000	8.5	17.5	25.5	0.3	0.016
	28	7	0.3	0.15	4 750	2 640	14.5	38 000	53 000	6.4	17.5	25.5	0.3	0.016
	32	9	0.3	0.15	6 100	3 450	—	19 000	26 000	11.3	17.5	29.5	0.3	0.030
	32	9	0.3	0.15	6 250	3 400	14.1	34 000	48 000	7.6	17.5	29.5	0.3	0.030
15	35	11	0.6	0.3	8 650	4 650	—	18 000	24 000	12.7	20	30	0.6	0.045
	35	11	0.6	0.3	7 950	4 300	—	13 000	18 000	16.0	20	30	0.6	0.046
	35	11	0.6	0.3	9 800	4 800	—	18 000	26 000	16.0	20	30	0.6	0.044
	35	11	0.6	0.3	8 650	4 550	13.2	32 000	45 000	8.8	20	30	0.6	0.045
	42	13	1	0.6	13 400	7 100	—	13 000	17 000	14.7	21	36	1	0.084
	42	13	1	0.6	12 500	6 600	—	11 000	15 000	18.5	21	36	1	0.086
	42	13	1	0.6	14 300	6 900	—	16 000	22 000	18.5	21	36	1	0.084

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of *d*<sub>a</sub> (min) and *r*<sub>a</sub> (max) for bearings with “—” in the *d*<sub>b</sub> column.

Dynamic Equivalent Load  $P = X F_r + Y F_a$ 

Contact Angle	$i f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	1.63
	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
25°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
30°	—	1.14	1	0	0.35	0.57	1	0.55	0.57	0.93
40°	—	—	—	—	—	—	—	—	—	—

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7900 A5	TYN	(M)	DB DF DT	4 700	2 900	32 000	43 000	13.5	1.5	—	20.8	0.15
7900 C	TYN	(M), T	DB DF DT	4 900	3 050	38 000	53 000	10.3	1.7	—	20.8	0.15
7000 A	W	(M), T, TYN	DB DF DT	8 750	5 200	20 000	28 000	18.4	2.4	11.2	24.8	0.15
7000 C	TYN	W, (M), T	DB DF DT	8 650	5 000	36 000	50 000	12.8	3.2	—	24.8	0.15
7200 A	W	(M), TYN	DB DF DT	8 800	5 400	18 000	24 000	20.5	2.5	12.5	27.5	0.3
7200 B	W	(M), T	DB DF DT	8 100	5 000	13 000	18 000	25.8	7.8	12.5	27.5	0.3
7200 C	TYN	W, (M), T	DB DF DT	8 800	5 200	32 000	45 000	14.4	3.6	—	27.5	0.3
7300 A	W	(M), T	DB DF DT	15 100	8 600	13 000	17 000	24.0	2.0	12.5	32.5	0.3
7300 B	W	(M), T	DB DF DT	14 200	8 100	11 000	16 000	29.9	7.9	12.5	32.5	0.3
7901 A5	TYN	(M), T	DB DF DT	5 200	3 550	30 000	43 000	14.4	2.4	—	22.8	0.15
7901 C	TYN	(M), T	DB DF DT	5 450	3 700	36 000	50 000	10.8	1.2	—	22.8	0.15
7001 A	W	(M), T, TYN	DB DF DT	9 400	5 950	18 000	24 000	19.5	3.5	13.2	26.8	0.15
7001 C	TYN	W, (M), T	DB DF DT	9 400	5 800	32 000	45 000	13.4	2.6	—	26.8	0.15
7201 A	W	(M), T, TYN	DB DF DT	13 000	8 050	16 000	22 000	22.7	2.7	14.5	29.5	0.3
7201 B	W	(M), T	DB DF DT	12 100	7 500	12 000	16 000	28.5	8.5	14.5	29.5	0.3
* 7201 BEA	T85	—	—	—	—	16 000	24 000	28.5	8.5	14.5	29.5	0.3
7201 C	TYN	W, (M), T	DB DF DT	12 800	7 700	30 000	40 000	15.9	4.1	—	29.5	0.3
7301 A	W	(M), T	DB DF DT	15 400	9 000	12 000	16 000	26.1	2.1	17	32	0.6
7301 B	W	(M), T	DB DF DT	14 400	8 400	10 000	14 000	32.6	8.6	17	32	0.6
* 7301 BEA	T85	—	—	—	—	15 000	22 000	32.6	8.6	17	32	0.6
7902 A5	TYN	(M), T	DB DF DT	7 400	5 050	26 000	34 000	17.0	3.0	—	26.8	0.15
7902 C	TYN	(M), T	DB DF DT	7 750	5 300	30 000	43 000	12.8	1.2	—	26.8	0.15
7002 A	W	(M), T, TYN	DB DF DT	9 950	6 850	15 000	22 000	22.6	4.6	16.2	30.8	0.15
7002 C	TYN	W, (M), T	DB DF DT	10 100	6 750	28 000	38 000	15.3	2.7	—	30.8	0.15
7202 A	W	(M), T, TYN	DB DF DT	14 000	9 300	14 000	20 000	25.4	3.4	17.5	32.5	0.3
7202 B	W	(M), T	DB DF DT	12 900	8 600	10 000	14 000	32.0	10.0	17.5	32.5	0.3
* 7202 BEA	T85	—	—	—	—	14 000	20 000	32.0	10.0	17.5	32.5	0.3
7202 C	TYN	W, (M), T	DB DF DT	14 100	9 050	26 000	36 000	17.7	4.3	—	32.5	0.3
7302 A	W	(M), T	DB DF DT	21 800	14 200	10 000	13 000	29.5	3.5	20	37	0.6
7302 B	W	(M), T	DB DF DT	20 200	13 200	9 000	12 000	36.9	10.9	20	37	0.6
* 7302 BEA	T85	—	—	—	—	13 000	18 000	36.9	10.9	20	37	0.6

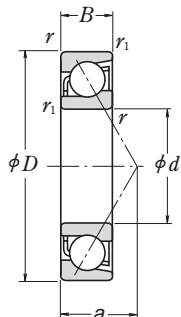
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSKHPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

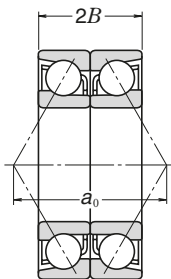
# ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

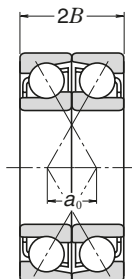
Bore Diameter 17 – 25 mm



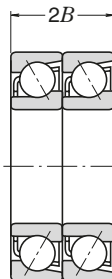
Single



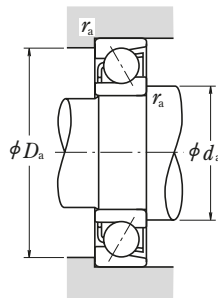
Back-to-Back  
DB



Face-to-Face  
DF



Tandem  
DT

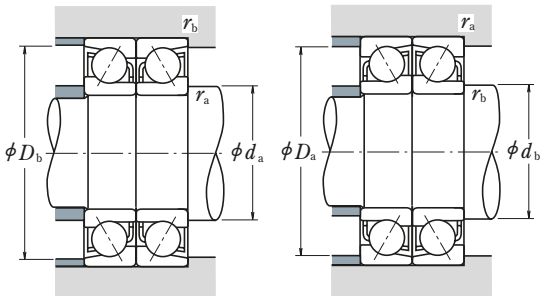


Boundary Dimensions (mm)					Basic Load Ratings (Single)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) <i>a</i>	Abutment and Fillet Dimensions (mm)			Mass (kg)
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	<i>f</i> <sub>0</sub>	Grease	Oil		<i>d</i> <sub>a</sub> min.	<i>D</i> <sub>a</sub> max.	<i>r</i> <sub>a</sub> max.	approx.
17	30	7	0.3	0.15	4 750	2 800	—	30 000	40 000	9.0	19.5	27.5	0.3	0.017
	30	7	0.3	0.15	5 000	2 940	14.8	34 000	48 000	6.6	19.5	27.5	0.3	0.017
	35	10	0.3	0.15	6 400	3 800	—	17 000	24 000	12.5	19.5	32.5	0.3	0.040
	35	10	0.3	0.15	6 600	3 800	14.5	32 000	43 000	8.5	19.5	32.5	0.3	0.040
	40	12	0.6	0.3	10 800	6 000	—	16 000	22 000	14.2	22	35	0.6	0.067
	40	12	0.6	0.3	9 950	5 500	—	11 000	15 000	18.0	22	35	0.6	0.068
	40	12	0.6	0.3	11 600	6 100	—	16 000	22 000	18.2	22	35	0.6	0.065
	40	12	0.6	0.3	10 900	5 850	13.3	28 000	38 000	9.8	22	35	0.6	0.065
	47	14	1	0.6	15 900	8 650	—	11 000	15 000	16.2	23	41	1	0.116
	47	14	1	0.6	14 800	8 000	—	10 000	14 000	20.4	23	41	1	0.118
	47	14	1	0.6	16 800	8 300	—	14 000	20 000	20.4	23	41	1	0.113
	37	9	0.3	0.15	6 600	4 050	—	24 000	32 000	11.1	22.5	34.5	0.3	0.037
	37	9	0.3	0.15	6 950	4 250	14.9	28 000	38 000	8.3	22.5	34.5	0.3	0.036
	42	12	0.6	0.3	10 800	6 600	—	14 000	20 000	14.9	25	37	0.6	0.068
20	42	12	0.6	0.3	11 100	6 550	14.0	26 000	36 000	10.1	25	37	0.6	0.068
	47	14	1	0.6	14 500	8 300	—	13 000	18 000	16.7	26	41	1	0.106
	47	14	1	0.6	13 300	7 650	—	9 500	13 000	21.1	26	41	1	0.109
	47	14	1	0.6	15 600	8 150	—	13 000	19 000	21.1	26	41	1	0.103
	47	14	1	0.6	14 600	8 050	13.3	24 000	34 000	11.5	26	41	1	0.104
	52	15	1.1	0.6	18 700	10 400	—	10 000	13 000	17.9	27	45	1	0.146
	52	15	1.1	0.6	17 300	9 650	—	9 000	12 000	22.6	27	45	1	0.150
	52	15	1.1	0.6	19 800	10 500	—	13 000	18 000	22.6	27	45	1	0.149
	42	9	0.3	0.15	7 450	5 150	—	20 000	28 000	12.3	27.5	39.5	0.3	0.043
	42	9	0.3	0.15	7 850	5 400	15.5	24 000	34 000	9.0	27.5	39.5	0.3	0.043
	47	12	0.6	0.3	11 300	7 400	—	12 000	17 000	16.4	30	42	0.6	0.079
	47	12	0.6	0.3	11 700	7 400	14.7	22 000	30 000	10.8	30	42	0.6	0.078
	52	15	1	0.6	16 200	10 300	—	12 000	16 000	18.6	31	46	1	0.130
	52	15	1	0.6	14 800	9 400	—	8 500	11 000	23.7	31	46	1	0.133
25	52	15	1	0.6	17 600	10 200	—	12 000	17 000	23.7	31	46	1	0.127
	52	15	1	0.6	16 600	10 200	14.0	22 000	28 000	12.7	31	46	1	0.129
	62	17	1.1	0.6	26 400	15 800	—	8 500	11 000	21.1	32	55	1	0.235

Notes <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.

<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.

<sup>(3)</sup> Use the values of *d*<sub>a</sub> (min) and *r*<sub>a</sub> (max) for bearings with “—” in the *d*<sub>b</sub> column.

Dynamic Equivalent Load  $P = X F_r + Y F_a$ 

Contact Angle	$i f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			$X$	$Y$	$X$	$Y$	$X$	$Y$	$X$	$Y$
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7903 A5	TYN	(M), T	DB DF DT	7 750	5 600	24 000	32 000	18.0	4.0	—	28.8	0.15
7903 C	TYN	(M), T	DB DF DT	8 150	5 850	28 000	38 000	13.3	0.7	—	28.8	0.15
7003 A	W	(M), T, TYN	DB DF DT	10 400	7 650	14 000	19 000	25.0	5.0	18.2	33.8	0.15
7003 C	TYN	W, (M), T	DB DF DT	10 700	7 600	26 000	34 000	17.0	3.0	—	33.8	0.15
7203 A	W	(M), T, TYN	DB DF DT	17 600	12 000	13 000	17 000	28.5	4.5	19.5	37.5	0.3
7203 B	W	(M), T	DB DF DT	16 100	11 000	9 000	12 000	35.9	11.9	19.5	37.5	0.3
*7203 BEA	T85	T7	— — —	—	—	13 000	18 000	36.3	12.3	19.5	37.5	0.3
7203 C	TYN	W, (M), T	DB DF DT	17 600	11 700	22 000	32 000	19.6	4.4	—	37.5	0.3
7303 A	W	(M), T	DB DF DT	25 900	17 300	9 000	12 000	32.5	4.5	22	42	0.6
7303 B	W	(M), T	DB DF DT	24 000	16 000	8 000	11 000	40.9	12.9	22	42	0.6
*7303 BEA	T85	—	— — —	—	—	11 000	16 000	40.9	12.9	22	42	0.6
7904 A5	TYN	(M), T	DB DF DT	10 700	8 100	19 000	26 000	22.3	4.3	—	35.8	0.15
7904 C	TYN	(M), T	DB DF DT	11 300	8 500	22 000	32 000	16.6	1.4	—	35.8	0.15
7004 A	W	(M), T, TYN	DB DF DT	17 600	13 200	12 000	16 000	29.9	5.9	22.5	39.5	0.3
7004 C	TYN	W, (M), T	DB DF DT	18 000	13 100	20 000	30 000	20.3	3.7	—	39.5	0.3
7204 A	W	(M), T, TYN	DB DF DT	23 500	16 600	11 000	15 000	33.3	5.3	25	42	0.6
7204 B	W	(M), T	DB DF DT	21 600	15 300	7 500	11 000	42.1	14.1	25	42	0.6
*7204 BEA	T85	T7	— — —	—	—	11 000	16 000	42.1	14.1	25	42	0.6
7204 C	TYN	W, (M), T	DB DF DT	23 600	16 100	19 000	26 000	23.0	5.0	—	42	0.6
7304 A	W	(M), T	DB DF DT	30 500	20 800	8 000	11 000	35.8	5.8	25	47	0.6
7304 B	W	(M), T	DB DF DT	28 200	19 300	7 100	10 000	45.2	15.2	25	47	0.6
*7304 BEA	T85	MR, T7	— — —	—	—	10 000	14 000	45.2	15.2	25	47	0.6
7905 A5	TYN	(M), T	DB DF DT	12 100	10 300	16 000	22 000	24.6	6.6	—	40.8	0.15
7905 C	TYN	(M), T	DB DF DT	12 700	10 800	19 000	26 000	18.0	0.0	—	40.8	0.15
7005 A	W	(M), T, TYN	DB DF DT	18 300	14 800	10 000	14 000	32.8	8.8	27.5	44.5	0.3
7005 C	TYN	W, (M), T	DB DF DT	19 000	14 800	18 000	26 000	21.6	2.4	—	44.5	0.3
7205 A	W	(M), T, TYN	DB DF DT	26 300	20 500	9 500	13 000	37.2	7.2	30	47	0.6
7205 B	W	(M), T	DB DF DT	24 000	18 800	6 700	9 000	47.3	17.3	30	47	0.6
*7205 BEA	T85	T7	— — —	—	—	9 500	14 000	47.3	17.3	30	47	0.6
7205 C	TYN	W, (M), T	DB DF DT	27 000	20 400	17 000	24 000	25.3	4.7	—	47	0.6
7305 A	W	(M), T	DB DF DT	43 000	31 500	6 700	9 000	42.1	8.1	30	57	0.6

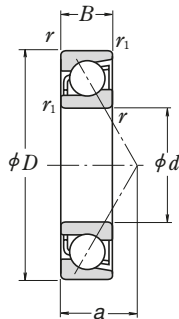
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSKHPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

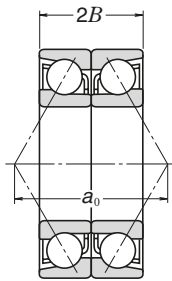
# **ANGULAR CONTACT BALL BEARINGS**

## **SINGLE/MATCHED MOUNTINGS**

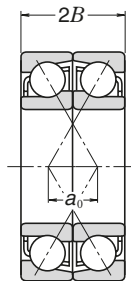
**Bore Diameter 25 – 40 mm**



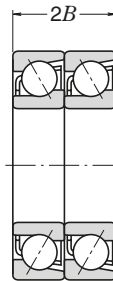
Single



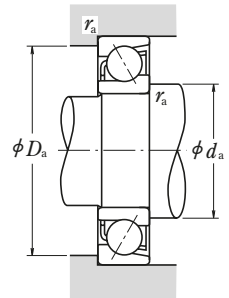
Back-to-Back  
DB



Face-to-Face  
DF

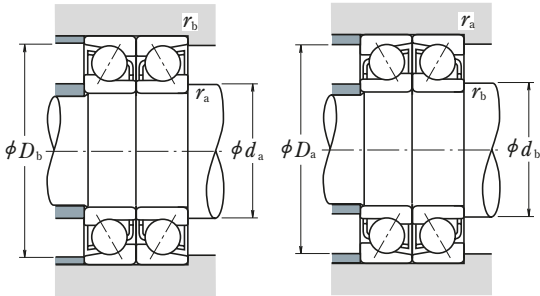


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single)		Factor $f_0$	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) $a$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
$d$	$D$	$B$	$r_{\min.}$	$r_{1\min.}$	$C_r$	$C_{0r}$		Grease	Oil		$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>25</b>	62	17	1.1	0.6	24 400	14 600	—	7 500	10 000	26.7	32	55	1	0.241
	62	17	1.1	0.6	27 200	14 900	—	10 000	15 000	26.8	32	55	1	0.229
<b>30</b>	47	9	0.3	0.15	7 850	5 950	—	18 000	24 000	13.5	32.5	44.5	0.3	0.050
	47	9	0.3	0.15	8 300	6 250	15.9	22 000	28 000	9.7	32.5	44.5	0.3	0.049
	55	13	1	0.6	14 500	10 100	—	11 000	14 000	18.8	36	49	1	0.116
	55	13	1	0.6	15 100	10 300	14.9	19 000	26 000	12.2	36	49	1	0.115
	62	16	1	0.6	22 500	14 800	—	9 500	13 000	21.3	36	56	1	0.197
	62	16	1	0.6	20 500	13 500	—	7 100	9 500	27.3	36	56	1	0.202
	62	16	1	0.6	23 700	14 300	—	10 000	14 000	27.3	36	56	1	0.194
	62	16	1	0.6	23 000	14 700	13.9	18 000	24 000	14.2	36	56	1	0.197
	72	19	1.1	0.6	33 500	20 900	—	7 100	9 500	24.2	37	65	1	0.346
	72	19	1.1	0.6	31 000	19 300	—	6 300	8 500	30.9	37	65	1	0.354
	72	19	1.1	0.6	36 500	20 600	—	9 000	13 000	30.9	37	65	1	0.336
	55	10	0.6	0.3	11 400	8 700	—	15 000	20 000	15.5	40	50	0.6	0.075
	55	10	0.6	0.3	12 100	9 150	15.7	18 000	24 000	11.0	40	50	0.6	0.075
	62	14	1	0.6	18 300	13 400	—	9 000	13 000	21.0	41	56	1	0.153
	62	14	1	0.6	19 100	13 700	15.0	17 000	22 000	13.5	41	56	1	0.153
	72	17	1.1	0.6	29 700	20 100	—	8 500	12 000	23.9	42	65	1	0.287
	72	17	1.1	0.6	27 100	18 400	—	6 000	8 000	30.9	42	65	1	0.294
<b>35</b>	72	17	1.1	0.6	32 500	19 600	—	8 500	12 000	30.9	42	65	1	0.271
	72	17	1.1	0.6	30 500	19 900	13.9	15 000	20 000	15.7	42	65	1	0.320
	80	21	1.5	1	40 000	26 300	—	6 300	8 500	27.1	44	71	1.5	0.464
	80	21	1.5	1	40 500	24 400	—	8 000	11 000	34.6	44	71	1.5	0.451
	80	21	1.5	1	40 500	24 400	—	5 600	7 500	34.6	44	71	1.5	0.469
	62	12	0.6	0.3	14 300	11 200	—	14 000	18 000	17.9	45	57	0.6	0.110
	62	12	0.6	0.3	15 100	11 700	15.7	16 000	22 000	12.8	45	57	0.6	0.109
	68	15	1	0.6	19 500	15 400	—	8 500	11 000	23.1	46	62	1	0.190
	68	15	1	0.6	20 600	15 900	15.4	15 000	20 000	14.7	46	62	1	0.213
	80	18	1.1	0.6	35 500	25 100	—	7 500	10 000	26.3	47	73	1	0.375
	80	18	1.1	0.6	32 000	23 000	—	5 300	7 500	34.2	47	73	1	0.383

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of  $d_a$  (min) and  $r_a$  (max) for bearings with “—” in the  $d_b$  column.

Dynamic Equivalent Load  $P = XF_r + YF_a$ 

Contact Angle	$i/f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	1.63
	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
25°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
30°	—	1.14	1	0	0.35	0.57	1	0.55	0.57	0.93
40°	—	—	—	—	—	—	—	—	—	—

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b^{(3)}$ min.	$D_b$ max.	$r_b^{(3)}$ max.
7305 B	W	(M), T	DB DF DT	39 500	29 300	6 000	8 000	53.5	19.5	30	57	0.6
*7305 BEA	T85	MR, T7	— — —	—	—	8 500	12 000	53.5	19.5	30	57	0.6
7906 A5	TYN	(M), T	DB DF DT	12 800	11 900	14 000	19 000	27.0	9.0	—	45.8	0.15
7906 C	TYN	(M), T	DB DF DT	13 500	12 500	17 000	24 000	19.3	1.3	—	45.8	0.15
7006 A	W	(M), T, TYN	DB DF DT	23 600	20 200	8 500	12 000	37.5	11.5	35	50	0.6
7006 C	TYN	W, (M), T	DB DF DT	24 600	20 500	15 000	22 000	24.4	1.6	—	50	0.6
7206 A	W	(M), T, TYN	DB DF DT	36 500	29 500	8 000	11 000	42.6	10.6	35	57	0.6
7206 B	W	(M), T	DB DF DT	33 500	27 000	5 600	7 500	54.6	22.6	35	57	0.6
*7206 BEA	T85	MR, T7	— — —	—	—	8 000	11 000	54.6	22.6	35	57	0.6
7206 C	TYN	W, (M), T	DB DF DT	37 500	29 300	14 000	20 000	28.3	3.7	—	57	0.6
7306 A	W	(M), T	DB DF DT	54 500	41 500	5 600	7 500	48.4	10.4	35	67	0.6
7306 B	W	(M), T	DB DF DT	50 500	38 500	5 000	7 100	61.8	23.8	35	67	0.6
*7306 BEA	T85	MR, T7	— — —	—	—	7 100	10 000	61.8	23.8	35	67	0.6
7907 A5	TYN	(M), T	DB DF DT	18 600	17 400	12 000	17 000	31.0	11.0	—	52.5	0.3
7907 C	TYN	(M), T	DB DF DT	19 600	18 300	14 000	20 000	22.1	2.1	—	52.5	0.3
7007 A	W	(M), T, TYN	DB DF DT	29 700	26 800	7 500	10 000	42.0	14.0	40	57	0.6
7007 C	TYN	W, (M), T	DB DF DT	31 000	27 300	13 000	19 000	27.0	1.0	—	57	0.6
7207 A	W	(M), T, TYN	DB DF DT	48 500	40 000	6 700	9 500	47.9	13.9	40	67	0.6
7207 B	W	(M), T	DB DF DT	44 000	36 500	4 800	6 700	61.9	27.9	40	67	0.6
*7207 BEA	T85	MR, T7	— — —	—	—	6 700	9 500	61.9	27.9	40	67	0.6
7207 C	(M)	W, T, TYN	DB DF DT	49 500	40 000	12 000	17 000	31.3	2.7	—	67	0.6
7307 A	W	(M), T	DB DF DT	65 000	52 500	5 000	6 700	54.2	12.2	41	74	1
*7307 BEA	T85	MR, T7	— — —	—	—	6 300	9 000	69.2	27.2	41	74	1
7307 BEA	W	MR, T7	DB DF DT	65 500	49 000	4 500	6 000	69.2	27.2	41	74	1
7908 A5	TYN	(M), T	DB DF DT	23 300	22 300	11 000	15 000	35.8	11.8	—	59.5	0.3
7908 C	TYN	(M), T	DB DF DT	24 600	23 500	13 000	18 000	25.7	1.7	—	59.5	0.3
7008 A	W	(M), T, TYN	DB DF DT	31 500	31 000	6 700	9 000	46.2	16.2	45	63	0.6
7008 C	(M)	W, T, TYN	DB DF DT	33 500	32 000	12 000	17 000	29.5	0.5	—	63	0.6
7208 A	W	(M), T, TYN	DB DF DT	57 500	50 500	6 000	8 500	52.6	16.6	45	75	0.6
7208 B	W	(M), T	DB DF DT	52 000	46 000	4 300	6 000	68.3	32.3	45	75	0.6

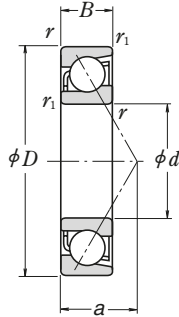
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSKHPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

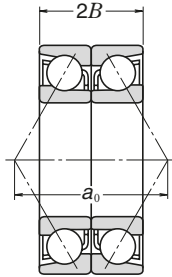
# **ANGULAR CONTACT BALL BEARINGS**

## **SINGLE/MATCHED MOUNTINGS**

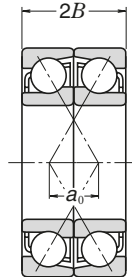
**Bore Diameter 40 – 55 mm**



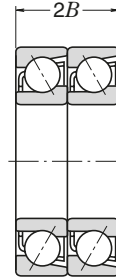
Single



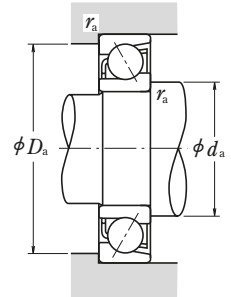
Back-to-Back  
DB



Face-to-Face  
DF

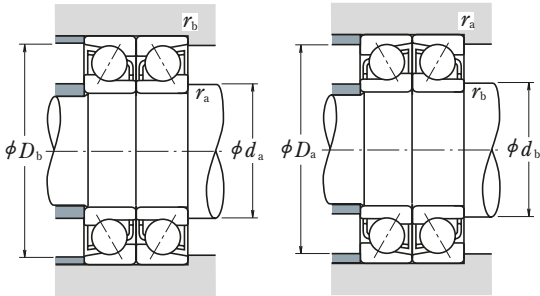


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) <i>a</i>	Abutment and Fillet Dimensions (mm)			Mass (kg)
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	<i>f</i> <sub>0</sub>	Grease	Oil		<i>d</i> <sub>a</sub> min.	<i>D</i> <sub>a</sub> max.	<i>r</i> <sub>a</sub> max.	approx.
<b>40</b>	80	18	1.1	0.6	38 500	24 500	—	7 500	11 000	34.2	47	73	1	0.357
	80	18	1.1	0.6	36 500	25 200	14.1	14 000	19 000	17.0	47	73	1	0.418
	90	23	1.5	1	49 000	33 000	—	5 600	7 500	30.3	49	81	1.5	0.633
	90	23	1.5	1	53 000	33 000	—	7 100	10 000	38.8	49	81	1.5	0.619
	90	23	1.5	1	53 000	33 000	—	5 000	6 700	38.8	49	81	1.5	0.644
	<b>45</b>	68	12	0.6	15 100	12 700	—	12 000	17 000	19.2	50	63	0.6	0.130
		68	12	0.6	16 000	13 400	16.0	14 000	20 000	13.6	50	63	0.6	0.129
		75	16	1	23 100	18 700	—	7 500	10 000	25.3	51	69	1	0.250
		75	16	1	24 400	19 300	15.4	14 000	19 000	16.0	51	69	1	0.274
		85	19	1.1	39 500	28 700	—	6 700	9 500	28.3	52	78	1	0.411
		85	19	1.1	36 000	26 200	—	5 000	6 700	36.8	52	78	1	0.421
	<b>50</b>	85	19	1.1	40 500	27 100	—	7 100	10 000	36.8	52	78	1	0.400
		85	19	1.1	41 000	28 800	14.2	12 000	17 000	18.2	52	78	1	0.468
		100	25	1.5	63 500	43 500	—	5 000	6 700	33.4	54	91	1.5	0.848
		100	25	1.5	62 500	39 500	—	6 300	9 000	42.9	54	91	1.5	0.823
		100	25	1.5	62 500	39 500	—	4 500	6 000	42.9	54	91	1.5	0.860
		110	27	2	78 000	50 500	—	5 600	8 000	47.1	60	100	2	1.07
		110	27	2	78 000	50 500	—	4 000	5 600	47.1	60	100	2	1.11
<b>55</b>	80	13	1	0.6	18 100	16 800	—	10 000	14 000	22.2	61	74	1	0.184
	80	13	1	0.6	19 100	17 700	16.3	12 000	16 000	15.5	61	74	1	0.182
	90	18	1.1	0.6	32 500	27 700	—	6 300	8 500	29.9	62	83	1	0.391
	90	18	1.1	0.6	32 500	27 700	—	6 300	8 500	29.9	62	83	1	0.391
	90	18	1.1	0.6	32 500	27 700	—	6 300	8 500	29.9	62	83	1	0.391
	90	18	1.1	0.6	32 500	27 700	—	6 300	8 500	29.9	62	83	1	0.391

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of *d*<sub>a</sub> (min) and *r*<sub>a</sub> (max) for bearings with “—” in the *d*<sub>a</sub> column.

Dynamic Equivalent Load  $P = XF_r + YF_a$ 

Contact Angle	$i f_0 F_a^{*e}$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			$X$	$Y$	$X$	$Y$	$X$	$Y$	$X$	$Y$
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
*7208 BEA	T85	MR, T7	— — —	—	—	6 000	8 500	68.3	32.3	45	75	0.6
7208 C	(M)	W, T, TYN	DB DF DT	59 000	50 500	11 000	15 000	34.1	1.9	—	75	0.6
7308 A	W	(M), T	DB DF DT	79 500	66 000	4 500	6 000	60.5	14.5	46	84	1
*7308 BEA	T85	MR, T7	— — —	—	—	5 600	8 000	77.5	31.5	46	84	1
7308 BEA	W	MR, T7	DB DF DT	86 500	65 500	4 000	5 300	77.5	31.5	46	84	1
7909 A5	(M)	T, TYN	DB DF DT	24 600	25 400	9 500	13 000	38.4	14.4	—	65.5	0.3
7909 C	(M)	T, TYN	DB DF DT	26 000	26 800	12 000	16 000	27.1	3.1	—	65.5	0.3
7009 A	W	(M), TYN	DB DF DT	37 500	37 500	6 000	8 500	50.6	18.6	50	70	0.6
7009 C	(M)	W, TYN	DB DF DT	39 500	38 500	11 000	15 000	32.1	0.1	—	70	0.6
7209 A	W	(M), T, TYN	DB DF DT	64 500	57 500	5 600	7 500	56.5	18.5	50	80	0.6
7209 B	W	(M), T	DB DF DT	58 500	52 500	4 000	5 300	73.5	35.5	50	80	0.6
*7209 BEA	T85	MR, T7	— — —	—	—	5 600	8 000	73.5	35.5	50	80	0.6
7209 C	(M)	W, T, TYN	DB DF DT	66 500	57 500	10 000	14 000	36.4	1.6	—	80	0.6
7309 A	W	(M), T	DB DF DT	103 000	87 000	4 000	5 300	66.9	16.9	51	94	1
*7309 BEA	T85	MR, T7	— — —	—	—	5 000	7 100	85.8	35.8	51	94	1
7309 BEA	W	MR, T7	DB DF DT	102 000	79 500	3 600	4 800	85.8	35.8	51	94	1
7910 A5	(M)	T, TYN	DB DF DT	25 900	28 400	9 000	12 000	40.5	16.5	—	69.5	0.3
7910 C	(M)	T, TYN	DB DF DT	27 400	30 000	11 000	15 000	28.3	4.3	—	69.5	0.3
7010 A	W	(M), T, TYN	DB DF DT	40 000	42 000	5 600	7 500	53.5	21.5	55	75	0.6
7010 C	(M)	W, T, TYN	DB DF DT	42 000	44 000	10 000	14 000	33.4	1.4	—	75	0.6
7210 A	W	(M), T, TYN	DB DF DT	67 000	63 000	5 000	7 100	60.4	20.4	55	85	0.6
7210 B	W	(M), T	DB DF DT	60 500	57 000	3 600	5 000	78.7	38.7	55	85	0.6
*7210 BEA	T85	MR, T7	— — —	—	—	5 000	7 500	78.7	38.7	55	85	0.6
7210 C	(M)	W, T, TYN	DB DF DT	69 500	63 500	9 500	13 000	38.7	1.3	—	85	0.6
7310 A	W	(M), T	DB DF DT	121 000	104 000	3 600	4 800	73.2	19.2	56	104	1
*7310 BEA	T85	MR, T7	— — —	—	—	4 500	6 700	94.1	40.1	56	104	1
7310 BEA	W	MR, T7	DB DF DT	127 000	101 000	3 200	4 500	94.1	40.1	56	104	1
7911 A5	(M)	T, TYN	DB DF DT	29 300	33 500	8 000	11 000	44.5	18.5	—	75	0.6
7911 C	(M)	T, TYN	DB DF DT	31 000	35 500	9 500	13 000	31.1	5.1	—	75	0.6
7011 A	W	(M), T, TYN	DB DF DT	52 500	55 500	5 000	6 700	59.9	23.9	60	85	0.6

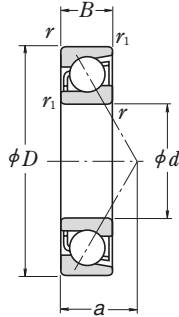
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSKHPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

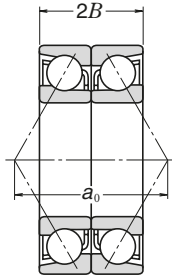
# **ANGULAR CONTACT BALL BEARINGS**

## **SINGLE/MATCHED MOUNTINGS**

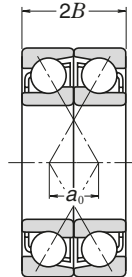
**Bore Diameter 55 – 65 mm**



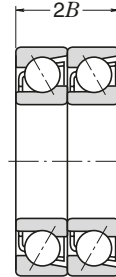
Single



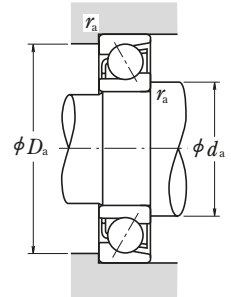
Back-to-Back  
DB



Face-to-Face  
DF



Tandem  
DT

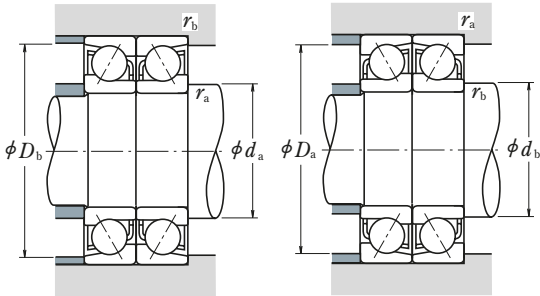


Boundary Dimensions (mm)					Basic Load Ratings (Single)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	<i>f</i> <sub>0</sub>	Grease	Oil	<i>a</i>	<i>d</i> <sub>a</sub> min.	<i>D</i> <sub>a</sub> max.	<i>r</i> <sub>a</sub> max.	approx.
<b>55</b>	90	18	1.1	0.6	34 000	28 600	15.5	11 000	15 000	18.7	62	83	1	0.430
	100	21	1.5	1	51 000	39 500	—	5 600	8 000	32.9	64	91	1.5	0.613
	100	21	1.5	1	46 500	36 000	—	4 000	5 600	43.0	64	91	1.5	0.627
	100	21	1.5	1	51 500	37 000	—	6 000	8 500	43.0	64	91	1.5	0.596
	100	21	1.5	1	53 000	40 000	14.5	10 000	14 000	20.9	64	91	1.5	0.688
	120	29	2	1	86 000	61 500	—	4 000	5 600	39.8	65	110	2	1.41
	120	29	2	1	89 000	58 500	—	5 000	7 500	51.2	65	110	2	1.36
	120	29	2	1	89 000	58 500	—	3 600	5 000	51.2	65	110	2	1.42
	85	13	1	0.6	18 300	17 700	—	9 500	13 000	23.4	66	79	1	0.197
	85	13	1	0.6	19 400	18 700	16.5	11 000	15 000	16.2	66	79	1	0.194
	95	18	1.1	0.6	33 000	29 500	—	5 600	8 000	31.4	67	88	1	0.417
	95	18	1.1	0.6	35 000	30 500	15.7	10 000	14 000	19.4	67	88	1	0.460
<b>60</b>	110	22	1.5	1	62 000	48 500	—	5 300	7 100	35.5	69	101	1.5	0.798
	110	22	1.5	1	56 000	44 500	—	3 800	5 300	46.7	69	101	1.5	0.815
	110	22	1.5	1	61 500	45 000	—	5 300	7 500	46.7	69	101	1.5	0.791
	110	22	1.5	1	64 000	49 000	14.4	9 500	13 000	22.4	69	101	1.5	0.889
	130	31	2.1	1.1	98 000	71 500	—	3 800	5 000	42.9	72	118	2	1.74
	130	31	2.1	1.1	102 000	68 500	—	4 800	6 700	55.4	72	118	2	1.70
	130	31	2.1	1.1	102 000	68 500	—	3 400	4 500	55.4	72	118	2	1.77
	90	13	1	0.6	19 100	19 400	—	9 000	12 000	24.6	71	84	1	0.211
	90	13	1	0.6	20 200	20 500	16.7	10 000	14 000	16.9	71	84	1	0.208
	100	18	1.1	0.6	35 000	33 000	—	5 300	7 500	32.8	72	93	1	0.455
	100	18	1.1	0.6	37 000	34 500	15.9	10 000	13 000	20.0	72	93	1	0.493
	120	23	1.5	1	70 500	58 000	—	4 800	6 700	38.2	74	111	1.5	1.03
<b>65</b>	120	23	1.5	1	63 500	52 500	—	3 400	4 800	50.3	74	111	1.5	1.05
	120	23	1.5	1	70 000	53 500	—	4 800	7 100	50.3	74	111	1.5	1.01
	120	23	1.5	1	73 000	58 500	14.6	9 000	12 000	23.9	74	111	1.5	1.14
	140	33	2.1	1.1	111 000	82 000	—	3 600	4 800	46.1	77	128	2	2.12
	140	33	2.1	1.1	114 000	77 000	—	4 300	6 300	59.5	77	128	2	2.09
	140	33	2.1	1.1	114 000	77 000	—	3 200	4 300	59.5	77	128	2	2.17

**Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.

<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.

<sup>(3)</sup> Use the values of *d*<sub>a</sub> (min) and *r*<sub>a</sub> (max) for bearings with “—” in the *d*<sub>b</sub> column.

Dynamic Equivalent Load  $P = X F_r + Y F_a$ 

Contact Angle	$\frac{if_0 F_a}{C_{or}}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7011 C	(M)	W, T, TYN	DB DF DT	55 500	57 500	9 000	12 000	37.4	1.4	—	85	0.6
7211 C	W	(M), T, TYN	DB DF DT	83 000	79 000	4 500	6 300	65.7	23.7	61	94	1
7211 B	W	(M), T	DB DF DT	75 000	72 000	3 400	4 500	86.0	44.0	61	94	1
* 7211 BEA	T85	MR, T7	— — —	—	—	4 500	6 700	86.0	44.0	61	94	1
7211 C	(M)	W, T, TYN	DB DF DT	86 000	80 000	8 500	12 000	41.7	0.3	—	94	1
7311 A	W	(M), T	DB DF DT	139 000	123 000	3 200	4 300	79.5	21.5	61	114	1
* 7311 BEA	T85	MR, T7	— — —	—	—	4 000	6 000	102.4	44.4	61	114	1
7311 BEA	W	MR, T7	DB DF DT	145 000	117 000	3 000	4 000	102.4	44.4	61	114	1
7912 A5	(M)	T, TYN	DB DF DT	29 800	35 500	7 500	10 000	46.8	20.8	—	80	0.6
7912 C	(M)	T, TYN	DB DF DT	31 500	37 500	9 000	12 000	32.4	6.4	—	80	0.6
7012 A	W	(M), T, TYN	DB DF DT	53 500	59 000	4 500	6 300	62.7	26.7	65	90	0.6
7012 C	(M)	W, T, TYN	DB DF DT	57 000	61 500	8 500	12 000	38.8	2.8	—	90	0.6
7212 A	W	(M), T, TYN	DB DF DT	100 000	97 500	4 300	6 000	71.1	27.1	66	104	1
7212 B	W	(M), T	DB DF DT	91 000	89 000	3 000	4 000	93.3	49.3	66	104	1
* 7212 BEA	T85	MR, T7	— — —	—	—	4 300	6 000	93.3	49.3	66	104	1
7212 C	(M)	W, T, TYN	DB DF DT	104 000	98 500	7 500	11 000	44.8	0.8	—	104	1
7312 A	W	(M), T	DB DF DT	159 000	143 000	3 000	4 000	85.9	23.9	67	123	1
* 7312 BEA	T85	MR, T7	— — —	—	—	3 800	5 600	110.7	48.7	67	123	1
7312 BEA	W	MR, T7	DB DF DT	166 000	137 000	2 600	3 800	110.7	48.7	67	123	1
7913 A5	(M)	T, TYN	DB DF DT	31 000	39 000	7 100	9 500	49.1	23.1	—	85	0.6
7913 C	(M)	T, TYN	DB DF DT	33 000	41 000	8 500	12 000	33.8	7.8	—	85	0.6
7013 A	W	(M), T, TYN	DB DF DT	56 500	65 500	4 300	6 000	65.6	29.6	70	95	0.6
7013 C	(M)	W, T, TYN	DB DF DT	60 500	68 500	8 000	11 000	40.1	4.1	—	95	0.6
7213 A	W	(M), T, TYN	DB DF DT	114 000	116 000	3 800	5 300	76.4	30.4	71	114	1
7213 B	W	(M), T	DB DF DT	103 000	105 000	2 800	3 800	100.6	54.6	71	114	1
* 7213 BEA	T85	MR, T7	— — —	—	—	3 800	5 600	100.6	54.6	71	114	1
7213 C	(M)	W, T, TYN	DB DF DT	119 000	117 000	7 100	9 500	47.8	1.8	—	114	1
7313 A	W	(M), T	DB DF DT	180 000	164 000	2 800	3 800	92.2	26.2	72	133	1
* 7313 BEA	T85	MR, T7	— — —	—	—	3 600	5 000	119.0	53.0	72	133	1
7313 BEA	W	MR, T7	DB DF DT	184 000	154 000	2 400	3 400	119.0	53.0	72	133	1

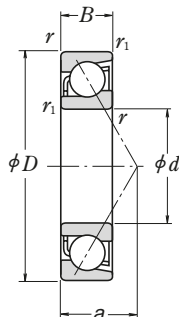
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSKHPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

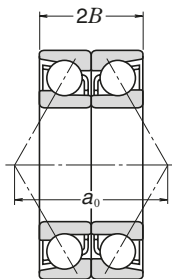
# **ANGULAR CONTACT BALL BEARINGS**

## **SINGLE/MATCHED MOUNTINGS**

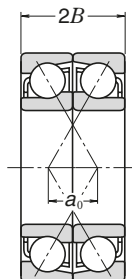
**Bore Diameter 70 – 80 mm**



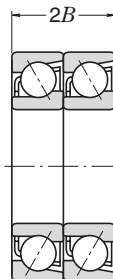
Single



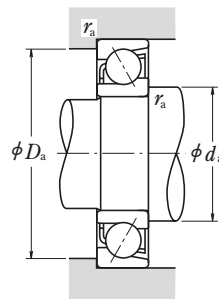
Back-to-Back  
DB



Face-to-Face  
DF

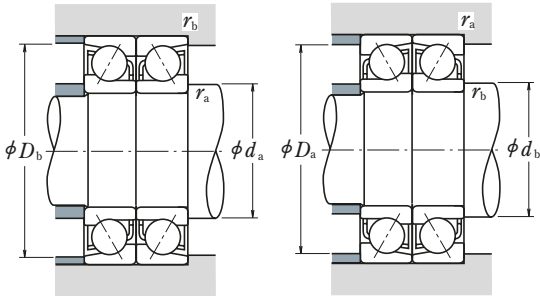


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single)		Factor $f_0$	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) $a$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
$d$	$D$	$B$	$r$ min.	$r_1$ min.	$C_r$	$C_{0r}$		Grease	Oil		$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>70</b>	100	16	1	0.6	26 500	26 300	—	8 000	11 000	27.8	76	94	1	0.341
	100	16	1	0.6	28 100	27 800	16.4	9 500	13 000	19.4	76	94	1	0.338
	110	20	1.1	0.6	44 000	41 500	—	5 000	6 700	36.0	77	103	1	0.625
	110	20	1.1	0.6	47 000	43 000	15.7	9 000	12 000	22.1	77	103	1	0.698
	125	24	1.5	1	76 500	63 500	—	4 500	6 300	40.1	79	116	1.5	1.11
	125	24	1.5	1	69 000	58 000	—	3 200	4 500	52.9	79	116	1.5	1.14
	125	24	1.5	1	75 500	58 500	—	4 500	6 700	52.9	79	116	1.5	1.08
	125	24	1.5	1	79 500	64 500	14.6	8 500	11 000	25.1	79	116	1.5	1.24
	150	35	2.1	1.1	125 000	93 500	—	3 200	4 300	49.3	82	138	2	2.60
	150	35	2.1	1.1	124 000	87 500	—	4 000	6 000	63.7	82	138	2	2.53
	150	35	2.1	1.1	124 000	87 500	—	2 800	4 000	63.6	82	138	2	2.62
	<b>75</b>	105	16	1	26 900	27 700	—	7 500	10 000	29.0	81	99	1	0.355
		105	16	1	28 600	29 300	16.6	9 000	12 000	20.1	81	99	1	0.357
		115	20	1.1	45 000	43 500	—	4 800	6 300	37.4	82	108	1	0.661
	115	20	1.1	0.6	48 000	45 500	15.9	8 500	12 000	22.7	82	108	1	0.748
	130	25	1.5	1	76 000	64 500	—	4 300	6 000	42.1	84	121	1.5	1.19
	130	25	1.5	1	68 500	58 500	—	3 200	4 300	55.5	84	121	1.5	1.22
	130	25	1.5	1	78 500	63 500	—	4 300	6 300	55.5	84	121	1.5	1.18
	130	25	1.5	1	83 000	70 000	14.8	8 000	11 000	26.2	84	121	1.5	1.36
	160	37	2.1	1.1	136 000	106 000	—	3 000	4 000	52.4	87	148	2	3.13
	160	37	2.1	1.1	134 000	98 500	—	3 800	5 600	67.8	87	148	2	3.03
	160	37	2.1	1.1	134 000	98 500	—	2 800	3 800	67.8	87	148	2	3.13
	<b>80</b>	110	16	1	27 300	29 000	—	7 100	10 000	30.2	86	104	1	0.380
		110	16	1	29 000	30 500	16.7	8 500	12 000	20.7	86	104	1	0.376
		125	22	1.1	55 000	53 000	—	4 300	6 000	40.6	87	118	1	0.880
		125	22	1.1	58 500	55 500	15.7	8 000	11 000	24.7	87	118	1	0.966
		140	26	2	89 000	76 000	—	4 000	5 600	44.8	90	130	2	1.46
		140	26	2	80 500	69 500	—	2 800	4 000	59.1	90	130	2	1.49
		140	26	2	87 500	70 000	—	4 000	6 000	59.2	90	130	2	1.42
		140	26	2	93 000	77 500	14.7	7 500	10 000	27.7	90	130	2	1.63
		170	39	2.1	147 000	119 000	—	2 800	3 800	55.6	92	158	2	3.71
		170	39	2.1	144 000	110 000	—	3 600	5 300	71.9	92	158	2	3.59
		170	39	2.1	144 000	110 000	—	2 600	3 400	71.9	92	158	2	3.84

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of  $d_a$  (min) and  $r_a$  (max) for bearings with “—” in the  $d_b$  column.

Dynamic Equivalent Load  $P = X F_r + Y F_a$ 

Contact Angle	$i f_0 F_a^{*e}$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			$X$	$Y$	$X$	$Y$	$X$	$Y$	$X$	$Y$
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	



Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b^{(3)}$ min.	$D_b$ max.	$r_b^{(3)}$ max.
7914 A5	(M)	T, TYN	DB DF DT	43 000	52 500	6 300	9 000	55.6	23.6	—	95	0.6
7914 C	(M)	T, TYN, T85	DB DF DT	45 500	55 500	7 500	11 000	38.8	6.8	—	95	0.6
7014 A	W	(M), T, TYN	DB DF DT	71 500	82 500	4 000	5 600	72.0	32.0	75	105	0.6
7014 C	(M)	W, T, TYN	DB DF DT	76 000	86 000	7 100	10 000	44.1	4.1	—	105	0.6
7214 A	W	(M), T, TYN	DB DF DT	124 000	127 000	3 600	5 000	80.3	32.3	76	119	1
7214 B	W	(M), T	DB DF DT	112 000	116 000	2 600	3 600	105.8	57.8	76	119	1
*7214 BEA	T85	MR, T7	— — —	—	—	3 600	5 300	105.8	57.8	76	119	1
7214 C	(M)	W, T, TYN, T7	DB DF DT	129 000	129 000	6 700	9 000	50.1	2.1	—	119	1
7314 A	W	(M), T	DB DF DT	203 000	187 000	2 600	3 400	98.5	28.5	77	143	1
*7314 BEA	T85	MR, T7	— — —	—	—	3 200	4 800	127.3	57.3	77	143	1
7314 BEA	W	MR, T7	DB DF DT	201 000	175 000	2 400	3 200	127.3	57.3	77	143	1
7915 A5	(M)	TYN	DB DF DT	44 000	55 500	6 000	8 500	58.0	26.0	—	100	0.6
7915 C	(M)	T, TYN	DB DF DT	46 500	58 500	7 100	10 000	40.1	8.1	—	100	0.6
7015 A	W	(M), T, TYN	DB DF DT	73 000	87 500	3 800	5 300	74.8	34.8	80	110	0.6
7015 C	(M)	W, T, TYN	DB DF DT	78 000	91 500	6 700	9 500	45.4	5.4	—	110	0.6
7215 A	W	(M), T, TYN	DB DF DT	123 000	129 000	3 600	4 800	84.2	34.2	81	124	1
7215 B	W	(M), T	DB DF DT	112 000	117 000	2 400	3 400	111.0	61.0	81	124	1
*7215 BEA	T85	MR	— — —	—	—	3 600	5 000	111.0	61.0	81	124	1
7215 C	(M)	W, T, TYN, T7	DB DF DT	134 000	140 000	6 300	9 000	52.4	2.4	—	124	1
7315 A	W	(M), T	DB DF DT	221 000	212 000	2 400	3 200	104.8	30.8	82	153	1
*7315 BEA	T85	MR	— — —	—	—	3 000	4 500	135.6	61.6	82	153	1
7315 BEA	W	MR, T7	DB DF DT	217 000	197 000	2 200	3 000	135.6	61.6	82	153	1
7916 A5	(M)	T, TYN	DB DF DT	44 500	58 000	5 600	8 000	60.3	28.3	—	105	0.6
7916 C	(M)	T, TYN	DB DF DT	47 000	61 500	6 700	9 500	41.5	9.5	—	105	0.6
7016 A	W	(M), T, TYN	DB DF DT	89 500	106 000	3 600	4 800	81.2	37.2	85	120	0.6
7016 C	(M)	W, T, TYN	DB DF DT	95 500	111 000	6 300	9 000	49.4	5.4	—	120	0.6
7216 A	W	(M), T, TYN	DB DF DT	145 000	152 000	3 200	4 500	89.5	37.5	86	134	1
7216 B	W	(M), T	DB DF DT	131 000	139 000	2 400	3 200	118.3	66.3	86	134	1
*7216 BEA	T85	MR, T7	— — —	—	—	3 200	4 800	118.3	66.3	86	134	1
7216 C	(M)	W, T, TYN	DB DF DT	151 000	155 000	6 000	8 000	55.5	3.5	—	134	1
7316 A	W	(M), T	DB DF DT	239 000	238 000	2 200	3 000	111.2	33.2	87	163	1
*7316 BEA	T85	MR, T7	— — —	—	—	2 800	4 300	143.9	65.9	87	163	1
7316 BEA	W	MR, T7	DB DF DT	235 000	220 000	2 000	2 800	143.9	65.9	87	163	1

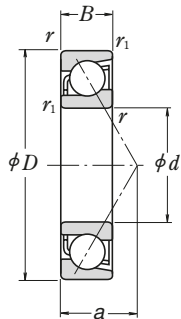
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

Remark Bearings with an asterisk (\*) are NSK HPS angular contact ball bearings. In arrangements, they are limited to SU universal matching types. See Page C073 for details.

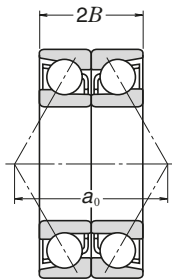
# ■ ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

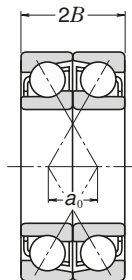
Bore Diameter 85 – 100 mm



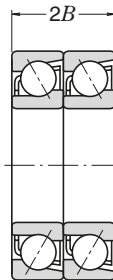
Single



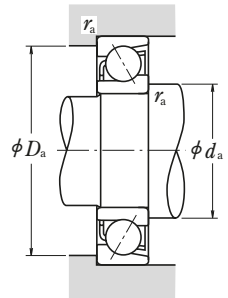
Back-to-Back  
DB



Face-to-Face  
DF

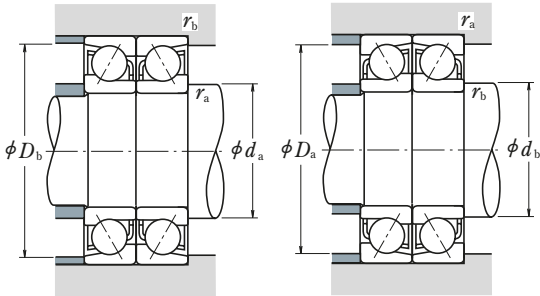


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) a	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r <sub>1</sub> min.	C <sub>r</sub>	C <sub>0r</sub>	f <sub>0</sub>	Grease	Oil		d <sub>a</sub> min.	D <sub>a</sub> max.	r <sub>a</sub> max.	approx.
85	120	18	1.1	0.6	36 500	38 500	—	6 700	9 000	32.9	92	113	1	0.541
	120	18	1.1	0.6	39 000	40 500	16.5	8 000	11 000	22.7	92	113	1	0.534
	130	22	1.1	0.6	56 500	56 000	—	4 300	5 600	42.0	92	123	1	0.913
	130	22	1.1	0.6	60 000	58 500	15.9	7 500	10 000	25.4	92	123	1	1.01
	150	28	2	1	103 000	89 000	—	3 800	5 300	47.9	95	140	2	1.83
	150	28	2	1	93 000	81 000	—	2 800	3 800	63.3	95	140	2	1.87
	150	28	2	1	96 000	81 500	—	3 800	5 600	63.3	95	140	2	1.75
	150	28	2	1	107 000	90 500	14.7	6 700	9 500	29.7	95	140	2	2.04
	180	41	3	1.1	159 000	133 000	—	2 600	3 600	58.8	99	166	2.5	4.33
	180	41	3	1.1	146 000	122 000	—	2 400	3 200	76.1	99	166	2.5	4.42
	180	41	3	1.1	157 000	133 000	—	3 400	5 000	76.1	99	166	2.5	4.34
	125	18	1.1	0.6	39 500	43 500	—	6 300	8 500	34.1	97	118	1	0.560
	125	18	1.1	0.6	41 500	46 000	16.6	7 500	10 000	23.4	97	118	1	0.563
	140	24	1.5	1	67 500	66 500	—	3 800	5 300	45.2	99	131	1.5	1.19
	140	24	1.5	1	71 500	69 000	15.7	7 100	9 500	27.4	99	131	1.5	1.34
	160	30	2	1	118 000	103 000	—	3 600	4 800	51.1	100	150	2	2.25
90	160	30	2	1	107 000	94 000	—	2 600	3 400	67.4	100	150	2	2.29
	160	30	2	1	109 000	93 500	—	3 600	5 300	67.4	100	150	2	2.19
	160	30	2	1	123 000	105 000	14.6	6 300	9 000	31.7	100	150	2	2.51
	190	43	3	1.1	171 000	147 000	—	2 600	3 400	61.9	104	176	2.5	5.06
	190	43	3	1.1	156 000	135 000	—	2 200	3 000	80.2	104	176	2.5	5.17
	190	43	3	1.1	169 000	146 000	—	3 200	4 500	80.2	104	176	2.5	4.97
	130	18	1.1	0.6	40 000	45 500	—	6 000	8 500	35.2	102	123	1	0.597
	130	18	1.1	0.6	42 500	48 000	16.7	7 100	10 000	24.1	102	123	1	0.591
	145	24	1.5	1	67 000	67 000	—	4 500	6 300	46.6	104	136	1.5	1.43
	145	24	1.5	1	73 500	73 000	15.9	6 700	9 000	28.1	104	136	1.5	1.42
	170	32	2.1	1.1	128 000	111 000	—	3 400	4 500	54.2	107	158	2	2.68
	170	32	2.1	1.1	116 000	101 000	—	2 400	3 200	71.6	107	158	2	2.74
	170	32	2.1	1.1	123 000	107 000	—	3 400	5 000	71.6	107	158	2	2.67
	170	32	2.1	1.1	133 000	112 000	14.6	6 000	8 500	33.7	107	158	2	3.05
	200	45	3	1.1	183 000	162 000	—	2 400	3 200	65.1	109	186	2.5	5.83
	200	45	3	1.1	167 000	149 000	—	2 200	3 000	84.3	109	186	2.5	5.98
	200	45	3	1.1	180 000	160 000	—	3 000	4 500	84.3	109	186	2.5	5.82
100	140	20	1.1	0.6	47 500	51 500	—	5 600	8 000	38.0	107	133	1	0.804
	140	20	1.1	0.6	50 000	54 000	16.5	6 700	9 000	26.1	107	133	1	0.794
	150	24	1.5	1	68 500	70 500	—	4 500	6 000	48.1	109	141	1.5	1.48

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of d<sub>a</sub> (min) and r<sub>a</sub> (max) for bearings with “—” in the d<sub>a</sub> column.

Dynamic Equivalent Load  $P = XF_r + YF_a$ 

Contact Angle	$i f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	1.63
	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
25°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
30°	—	1.14	1	0	0.35	0.57	1	0.55	0.57	0.93
40°	—	—	—	—	—	—	—	—	—	—

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

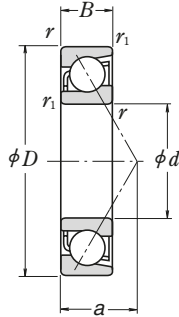
Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7917 A5	(M)	T, TYN	DB DF DT	59 500	77 000	5 300	7 500	65.8	29.8	—	115	0.6
7917 C	(M)	T, TYN	DB DF DT	63 000	81 500	6 300	9 000	45.5	9.5	—	115	0.6
7017 A	W	(M), T, TYN	DB DF DT	91 500	112 000	3 400	4 500	84.1	40.1	90	125	0.6
7017 C	(M)	W, T, TYN	DB DF DT	98 000	117 000	6 000	8 500	50.8	6.8	—	125	0.6
7217 A	W	(M), T, TYN	DB DF DT	167 000	178 000	3 000	4 300	95.8	39.8	91	144	1
7217 B	W	(M), T	DB DF DT	151 000	162 000	2 200	3 000	126.6	70.6	91	144	1
7217 BEA	T85	—	—	—	—	3 200	4 500	126.6	70.6	91	144	1
7217 C	(M)	W, T, TYN	DB DF DT	174 000	181 000	5 600	7 500	59.5	3.5	—	144	1
7317 A	W	(M), T	DB DF DT	258 000	265 000	2 200	2 800	117.5	35.5	92	173	1
7317 B	W	(M), T	DB DF DT	236 000	244 000	1 900	2 600	152.2	70.2	92	173	1
7317 BEA	T85	MR, T7	—	—	—	2 800	4 000	152.2	70.2	92	173	1
7918 A5	(M)	T, TYN	DB DF DT	64 000	87 000	5 000	7 100	68.1	32.1	—	120	0.6
7918 C	(M)	T, TYN	DB DF DT	67 500	92 000	6 000	8 500	46.8	10.8	—	120	0.6
7018 A	W	(M), T, TYN	DB DF DT	109 000	133 000	3 200	4 300	90.4	42.4	96	134	1
7018 C	(M)	W, T, TYN	DB DF DT	116 000	138 000	5 600	8 000	54.8	6.8	—	134	1
7218 A	W	(M), T, TYN	DB DF DT	191 000	206 000	2 800	4 000	102.2	42.2	96	154	1
7218 B	W	(M), T	DB DF DT	173 000	188 000	2 000	2 800	134.9	74.9	96	154	1
7218 BEA	T85	MR	—	—	—	3 000	4 300	134.9	74.9	96	154	1
7218 C	(M)	W, T, TYN	DB DF DT	199 000	209 000	5 300	7 100	63.5	3.5	—	154	1
7318 A	W	(M), T	DB DF DT	277 000	294 000	2 000	2 800	123.8	37.8	97	183	1
7318 B	W	(M), T	DB DF DT	254 000	270 000	1 800	2 400	160.5	74.5	97	183	1
7318 BEA	T85	MR	—	—	—	2 600	3 600	160.5	74.5	97	183	1
7919 A5	(M)	T, TYN	DB DF DT	64 500	91 000	4 800	6 700	70.5	34.5	—	125	0.6
7919 C	(M)	T, TYN	DB DF DT	68 500	96 000	5 600	8 000	48.1	12.1	—	125	0.6
7019 A	(M)	T, TYN	DB DF DT	109 000	134 000	3 800	5 000	93.3	45.3	—	139	1
7019 C	(M)	T, TYN	DB DF DT	119 000	146 000	5 300	7 500	56.1	8.1	—	139	1
7219 A	W	(M), T, TYN	DB DF DT	208 000	221 000	2 600	3 600	108.5	44.5	102	163	1
7219 B	W	(M), T	DB DF DT	188 000	202 000	1 900	2 600	143.2	79.2	102	163	1
7219 BEA	T85	MR, T7	—	—	—	2 800	4 000	143.2	79.2	102	163	1
7219 C	(M)	W, T, TYN	DB DF DT	216 000	224 000	4 800	6 700	67.5	3.5	—	163	1
7319 A	W	(M), T	DB DF DT	297 000	325 000	1 900	2 600	130.2	40.2	102	193	1
7319 B	W	(M), T	DB DF DT	272 000	298 000	1 700	2 400	168.7	78.7	102	193	1
7319 BEA	T85	MR	—	—	—	2 400	3 600	168.7	78.7	102	193	1
7920 A5	(M)	T, TYN	DB DF DT	77 000	103 000	4 500	6 300	76.0	36.0	—	135	0.6
7920 C	(M)	T, TYN	DB DF DT	81 500	108 000	5 300	7 500	52.2	12.2	—	135	0.6
7020 A	(M)	T, TYN	DB DF DT	111 000	141 000	3 600	5 000	96.2	48.2	—	144	1

Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

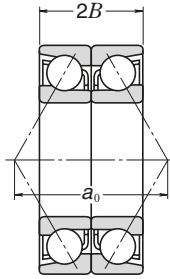
# ■ ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

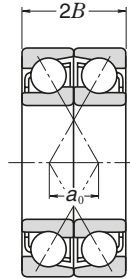
Bore Diameter 100 – 120 mm



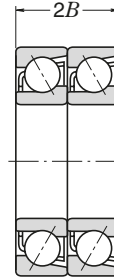
Single



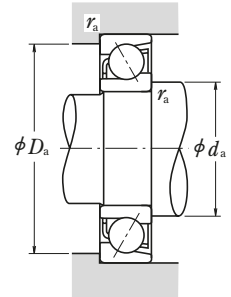
Back-to-Back  
DB



Face-to-Face  
DF

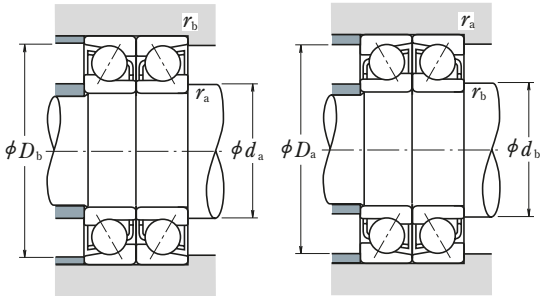


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) a	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r <sub>1</sub> min.	C <sub>r</sub>	C <sub>0r</sub>	f <sub>0</sub>	Grease	Oil		d <sub>a</sub> min.	D <sub>a</sub> max.	r <sub>a</sub> max.	approx.
100	150	24	1.5	1	75 000	77 000	16.0	6 300	9 000	28.7	109	141	1.5	1.46
	180	34	2.1	1.1	144 000	126 000	—	3 200	4 300	57.4	112	168	2	3.22
	180	34	2.1	1.1	130 000	114 000	—	2 200	3 000	75.7	112	168	2	3.28
	180	34	2.1	1.1	136 000	122 000	—	3 200	4 500	75.7	112	168	2	3.27
	180	34	2.1	1.1	149 000	127 000	14.5	5 600	8 000	35.7	112	168	2	3.65
	215	47	3	1.1	207 000	193 000	—	2 200	3 000	69.0	114	201	2.5	7.29
	215	47	3	1.1	190 000	178 000	—	2 000	2 800	89.6	114	201	2.5	7.43
	215	47	3	1.1	202 000	187 000	—	2 800	4 000	89.6	114	201	2.5	7.14
	145	20	1.1	0.6	48 000	54 000	—	5 600	7 500	39.2	112	138	1	0.820
	145	20	1.1	0.6	51 000	57 000	16.6	6 300	9 000	26.7	112	138	1	0.826
105	160	26	2	1	80 000	81 500	—	4 300	5 600	51.2	115	150	2	1.84
	160	26	2	1	88 000	89 500	15.9	6 000	8 500	30.7	115	150	2	1.82
	190	36	2.1	1.1	157 000	142 000	—	3 000	4 000	60.6	117	178	2	3.84
	190	36	2.1	1.1	142 000	129 000	—	2 200	3 000	79.9	117	178	2	3.92
	190	36	2.1	1.1	148 000	133 000	—	3 000	4 500	79.9	117	178	2	3.69
	190	36	2.1	1.1	162 000	143 000	14.5	5 300	7 500	37.7	117	178	2	4.33
	225	49	3	1.1	208 000	193 000	—	2 600	3 600	72.1	119	211	2.5	9.34
	225	49	3	1.1	191 000	177 000	—	2 400	3 200	93.7	119	211	2.5	9.43
	225	49	3	1.1	213 000	203 000	—	2 600	4 000	93.7	119	211	2.5	8.12
	150	20	1.1	0.6	49 000	56 000	—	5 300	7 100	40.3	117	143	1	0.877
110	150	20	1.1	0.6	52 000	59 500	16.7	6 300	8 500	27.4	117	143	1	0.867
	170	28	2	1	96 500	95 500	—	4 000	5 300	54.4	120	160	2	2.28
	170	28	2	1	106 000	104 000	15.6	5 600	8 000	32.7	120	160	2	2.26
	200	38	2.1	1.1	170 000	158 000	—	2 800	3 800	63.7	122	188	2	4.49
	200	38	2.1	1.1	154 000	144 000	—	2 000	2 800	84.0	122	188	2	4.58
	200	38	2.1	1.1	154 000	144 000	—	2 800	4 300	84.0	122	188	2	4.48
	200	38	2.1	1.1	176 000	160 000	14.5	5 000	7 100	39.8	122	188	2	5.10
	240	50	3	1.1	220 000	215 000	—	2 600	3 400	75.5	124	226	2.5	11.1
	240	50	3	1.1	201 000	197 000	—	2 200	3 000	98.4	124	226	2.5	11.2
	240	50	3	1.1	226 000	226 000	—	2 600	3 800	98.4	124	226	2.5	9.91
120	165	22	1.1	0.6	67 500	77 000	—	4 800	6 300	44.2	127	158	1	1.15
	165	22	1.1	0.6	72 000	81 000	16.5	5 600	7 500	30.1	127	158	1	1.15
	180	28	2	1	102 000	107 000	—	3 600	5 000	57.3	130	170	2	2.45
	215	40	2.1	1.1	183 000	177 000	—	3 200	4 500	68.3	132	203	2	6.22
	215	40	2.1	1.1	165 000	162 000	—	2 400	3 200	90.3	132	203	2	6.26
	215	40	2.1	1.1	179 000	177 000	—	2 600	3 800	90.3	132	203	2	5.37
	260	55	3	1.1	246 000	252 000	—	2 200	3 000	82.3	134	246	2.5	14.5
	260	55	3	1.1	225 000	231 000	—	2 000	2 800	107.2	134	246	2.5	14.4
	260	55	3	1.1	238 000	250 000	—	2 200	3 400	107.2	134	246	2.5	12.8
	260	55	3	1.1	238 000	250 000	—	2 200	3 400	107.2	134	246	2.5	12.8

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of d<sub>a</sub> (min) and r<sub>a</sub> (max) for bearings with “—” in the d<sub>b</sub> column.

Dynamic Equivalent Load  $P = XF_r + YF_a$ 

Contact Angle	$i f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

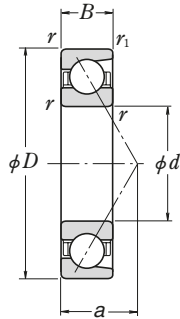
Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7020 C	(M)	T, TYN	DB DF DT	122 000	154 000	5 300	7 100	57.5	9.5	—	144	1
7220 A	W	(M), T, TYN	DB DF DT	233 000	251 000	2 600	3 400	114.8	46.8	107	173	1
7220 B	W	(M), T	DB DF DT	212 000	229 000	1 800	2 400	151.5	83.5	107	173	1
7220 BEA	T85	MR	—	—	—	2 600	3 600	151.5	83.5	107	173	1
7220 C	(M)	W, T, TYN	DB DF DT	242 000	254 000	4 500	6 300	71.5	3.5	—	173	1
7320 A	W	(M), T	DB DF DT	335 000	385 000	1 800	2 400	137.9	43.9	107	208	1
7320 B	W	(M), T	DB DF DT	310 000	355 000	1 600	2 200	179.2	85.2	107	208	1
7320 BEA	T85	MR, T7	—	—	—	2 200	3 200	179.2	85.2	107	208	1
7921 A5	(M)	T, TYN	DB DF DT	78 500	108 000	4 300	6 000	78.3	38.3	—	140	0.6
7921 C	(M)	T, TYN	DB DF DT	83 000	114 000	5 300	7 100	53.5	13.5	—	140	0.6
7021 A	(M)	T, TYN	DB DF DT	130 000	163 000	3 400	4 500	102.5	50.5	—	154	1
7021 C	(M)	T, TYN	DB DF DT	143 000	179 000	4 800	6 700	61.5	9.5	—	154	1
7221 A	W	(M), T	DB DF DT	254 000	283 000	2 400	3 400	121.2	49.2	112	183	1
7221 B	W	(M), T	DB DF DT	231 000	258 000	1 700	2 400	159.8	87.8	112	183	1
7221 BEA	T85	—	—	—	—	2 400	3 600	159.8	87.8	112	183	1
7221 C	(M)	W, T, TYN	DB DF DT	264 000	286 000	4 300	6 000	75.5	3.5	—	183	1
7321 A	(M)	T	DB DF DT	335 000	385 000	2 200	2 800	144.3	46.3	—	218	1
7321 B	(M)	T	DB DF DT	310 000	355 000	1 900	2 600	187.4	89.4	—	218	1
7321 BEA	T85	T7	—	—	—	2 200	3 200	187.4	89.4	—	218	1
7922 A5	(M)	T, TYN	DB DF DT	79 500	112 000	4 300	5 600	80.6	40.6	—	145	0.6
7922 C	(M)	T, TYN	DB DF DT	84 500	119 000	5 000	6 700	54.8	14.8	—	145	0.6
7022 A	(M)	T, TYN	DB DF DT	157 000	191 000	3 200	4 300	108.8	52.8	—	164	1
7022 C	(M)	T, TYN	DB DF DT	172 000	208 000	4 500	6 300	65.5	9.5	—	164	1
7222 A	W	(M), T, TYN	DB DF DT	276 000	315 000	2 200	3 200	127.5	51.5	117	193	1
7222 B	W	(M), T	DB DF DT	250 000	289 000	1 600	2 200	168.1	92.1	117	193	1
7222 BEA	T85	MR	—	—	—	2 400	3 400	168.1	92.1	117	193	1
7222 C	(M)	W, T, TYN	DB DF DT	286 000	320 000	4 000	5 600	79.5	3.5	—	193	1
7322 A	(M)	W, T	DB DF DT	360 000	430 000	2 000	2 600	151.0	51.0	—	233	1
7322 B	(M)	W, T	DB DF DT	325 000	395 000	1 800	2 400	196.8	96.8	—	233	1
7322 BEA	T85	MR	—	—	—	2 000	3 000	196.8	96.8	—	233	1
7924 A5	(M)	T, TYN	DB DF DT	110 000	154 000	3 800	5 300	88.5	44.5	—	160	0.6
7924 C	(M)	T, TYN	DB DF DT	117 000	162 000	4 500	6 300	60.2	16.2	—	160	0.6
7024 A	(M)	T, TYN	DB DF DT	166 000	213 000	3 000	4 000	114.6	58.6	—	174	1
7224 A	(M)	T	DB DF DT	297 000	355 000	2 600	3 600	136.7	56.7	—	208	1
7224 B	(M)	T	DB DF DT	269 000	325 000	1 900	2 600	180.5	100.5	—	208	1
7224 BEA	T85	MR, T7	—	—	—	2 200	3 000	180.5	100.5	—	208	1
7324 A	(M)	T	DB DF DT	400 000	505 000	1 800	2 400	164.7	54.7	—	253	1
7324 B	(M)	T	DB DF DT	365 000	460 000	1 600	2 200	214.4	104.4	—	253	1
7324 BEA	T85	MR	—	—	—	1 900	2 800	214.4	104.4	—	253	1

Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

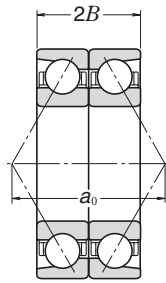
# ■ ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

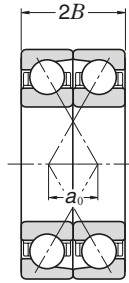
Bore Diameter 130 – 170 mm



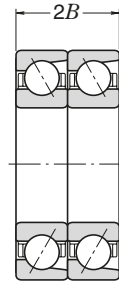
Single



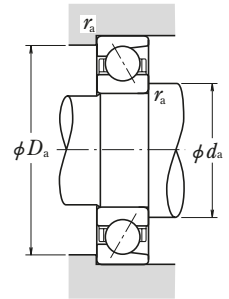
Back-to-Back  
DB



Face-to-Face  
DF

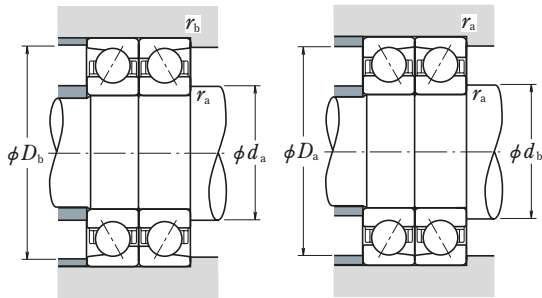


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single)		Factor $f_0$	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) $a$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
$d$	$D$	$B$	$r_{\min.}$	$r_{1\min.}$	$C_r$	$C_{0r}$		Grease	Oil		$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>130</b>	180	24	1.5	1	74 000	86 000	—	4 300	6 000	48.1	139	171	1.5	1.54
	180	24	1.5	1	78 500	91 000	16.5	5 000	7 100	32.8	139	171	1.5	1.50
	200	33	2	1	117 000	125 000	—	3 400	4 500	64.1	140	190	2	3.68
	230	40	3	1.1	189 000	193 000	—	2 400	3 200	72.0	144	216	2.5	7.06
	230	40	3	1.1	171 000	175 000	—	2 200	3 000	95.5	144	216	2.5	7.10
	280	58	4	1.5	273 000	293 000	—	2 200	2 800	88.2	148	262	3	17.5
	280	58	4	1.5	250 000	268 000	—	1 900	2 600	115.0	148	262	3	17.6
	280	58	4	1.5	250 000	268 000	—	1 900	2 600	115.0	148	262	3	17.6
<b>140</b>	190	24	1.5	1	75 000	90 000	—	4 000	5 600	50.5	149	181	1.5	1.63
	190	24	1.5	1	79 500	95 500	16.7	4 800	6 700	34.1	149	181	1.5	1.63
	210	33	2	1	120 000	133 000	—	3 200	4 300	67.0	150	200	2	3.90
	250	42	3	1.1	218 000	234 000	—	2 200	3 000	77.3	154	236	2.5	8.92
	250	42	3	1.1	197 000	213 000	—	2 000	2 800	102.8	154	236	2.5	8.94
	300	62	4	1.5	300 000	335 000	—	2 000	2 600	94.5	158	282	3	21.4
	300	62	4	1.5	275 000	310 000	—	1 700	2 400	123.3	158	282	3	21.6
	300	62	4	1.5	275 000	310 000	—	1 700	2 400	123.3	158	282	3	21.6
<b>150</b>	210	28	2	1	96 500	115 000	—	3 800	5 000	56.0	160	200	2	2.97
	210	28	2	1	102 000	122 000	16.6	4 300	6 000	38.1	160	200	2	2.96
	225	35	2.1	1.1	137 000	154 000	—	2 400	3 000	71.6	162	213	2	4.75
	270	45	3	1.1	248 000	280 000	—	2 000	2 800	83.1	164	256	2.5	11.2
	270	45	3	1.1	225 000	254 000	—	1 800	2 600	110.6	164	256	2.5	11.2
	320	65	4	1.5	315 000	370 000	—	1 800	2 400	100.3	168	302	3	26.0
	320	65	4	1.5	289 000	340 000	—	1 600	2 200	131.1	168	302	3	25.9
	320	65	4	1.5	289 000	340 000	—	1 600	2 200	131.1	168	302	3	25.9
<b>160</b>	220	28	2	1	106 000	133 000	16.7	3 800	5 000	39.4	170	210	2	3.10
	240	38	2.1	1.1	155 000	176 000	—	2 200	2 800	76.7	172	228	2	5.77
	290	48	3	1.1	263 000	305 000	—	1 900	2 600	89.0	174	276	2.5	14.1
	290	48	3	1.1	238 000	279 000	—	1 700	2 400	118.4	174	276	2.5	14.2
	340	68	4	1.5	345 000	420 000	—	1 700	2 200	106.2	178	322	3	30.7
	340	68	4	1.5	315 000	385 000	—	1 500	2 000	138.9	178	322	3	30.8
	340	68	4	1.5	315 000	385 000	—	1 500	2 000	138.9	178	322	3	30.8
	340	68	4	1.5	315 000	385 000	—	1 500	2 000	138.9	178	322	3	30.8
<b>170</b>	230	28	2	1	113 000	148 000	16.8	3 600	4 800	40.8	180	220	2	3.36
	260	42	2.1	1.1	186 000	214 000	—	2 000	2 600	83.1	182	248	2	7.90
	310	52	4	1.5	295 000	360 000	—	1 800	2 400	95.3	188	292	3	17.3
	310	52	4	1.5	266 000	325 000	—	1 600	2 200	126.7	188	292	3	17.6
	360	72	4	1.5	390 000	485 000	—	1 600	2 200	112.5	188	342	3	35.8
	360	72	4	1.5	355 000	445 000	—	1 400	2 000	147.2	188	342	3	35.6
	360	72	4	1.5	355 000	445 000	—	1 400	2 000	147.2	188	342	3	35.6
	360	72	4	1.5	355 000	445 000	—	1 400	2 000	147.2	188	342	3	35.6

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of  $d_a$  (min) and  $r_a$  (max) for bearings with “—” in the  $d_a$  column.

Dynamic Equivalent Load  $P = X F_r + Y F_a$ 

Contact Angle	$i f_0 F_a^*$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			$X$	$Y$	$X$	$Y$	$X$	$Y$	$X$	$Y$
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

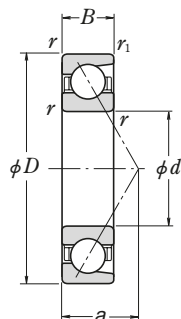
Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>			Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option		$C_r$	$C_{or}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7926 A5	(M)	T, TYN	DB DF DT	120 000	172 000	3 400	4 800	96.3	48.3	—	174	1
7926 C	(M)	T, TYN	DB DF DT	128 000	182 000	4 000	5 600	65.5	17.5	—	174	1
7026 A	(M)	T, TYN	DB DF DT	191 000	251 000	2 600	3 600	128.3	62.3	—	194	1
7226 A	(M)	T	DB DF DT	310 000	385 000	1 900	2 600	143.9	63.9	—	223	1
7226 B	(M)	T	DB DF DT	278 000	350 000	1 700	2 400	191.0	111.0	—	223	1
7326 A	(M)	T	DB DF DT	445 000	585 000	1 700	2 200	176.3	60.3	—	271	1.5
7326 B	(M)	T	DB DF DT	405 000	535 000	1 500	2 000	230.0	114.0	—	271	1.5
7928 A5	(M)	T, TYN	DB DF DT	122 000	180 000	3 200	4 500	100.9	52.9	—	184	1
7928 C	(M)	T, TYN	DB DF DT	129 000	191 000	3 800	5 300	68.2	20.2	—	184	1
7028 A	(M)	T	DB DF DT	194 000	265 000	2 600	3 400	134.0	68.0	—	204	1
7228 A	(M)	T	DB DF DT	355 000	470 000	1 800	2 400	154.6	70.6	—	243	1
7228 B	(M)	T	DB DF DT	320 000	425 000	1 600	2 200	205.6	121.6	—	243	1
7328 A	(M)	T	DB DF DT	490 000	670 000	1 600	2 000	189.0	65.0	—	291	1.5
7328 B	(M)	T	DB DF DT	445 000	615 000	1 400	1 900	246.6	122.6	—	291	1.5
7930 A5	(M)	—	DB DF DT	157 000	231 000	3 000	4 000	112.0	56.0	—	204	1
7930 C	(M)	—	DB DF DT	166 000	244 000	3 600	4 800	76.2	20.2	—	204	1
7030 A	(M)	T	DB DF DT	222 000	305 000	1 900	2 400	143.3	73.3	—	218	1
7230 A	(M)	—	DB DF DT	405 000	560 000	1 600	2 200	166.3	76.3	—	263	1
7230 B	(M)	—	DB DF DT	365 000	510 000	1 500	2 000	221.2	131.2	—	263	1
7330 A	(M)	T	DB DF DT	515 000	745 000	1 500	1 900	200.7	70.7	—	311	1.5
7330 B	(M)	T	DB DF DT	470 000	680 000	1 300	1 800	262.2	132.2	—	311	1.5
7932 C	(M)	TYN	DB DF DT	173 000	265 000	3 000	4 000	78.9	22.9	—	214	1
7032 A	(M)	T	DB DF DT	252 000	355 000	1 700	2 400	153.5	77.5	—	233	1
7232 A	(M)	T	DB DF DT	425 000	615 000	1 500	2 000	177.9	81.9	—	283	1
7232 B	(M)	—	DB DF DT	385 000	555 000	1 400	1 900	236.8	140.8	—	283	1
7332 A	(M)	T	DB DF DT	565 000	845 000	1 400	1 800	212.3	76.3	—	331	1.5
7332 B	(M)	T	DB DF DT	515 000	770 000	1 200	1 700	277.8	141.8	—	331	1.5
7934 C	(M)	—	DB DF DT	183 000	297 000	2 800	3 800	81.6	25.6	—	224	1
7034 A	(M)	—	DB DF DT	300 000	430 000	1 600	2 200	166.1	82.1	—	253	1
7234 A	(M)	—	DB DF DT	480 000	715 000	1 400	1 900	190.6	86.6	—	301	1.5
7234 B	(M)	—	DB DF DT	435 000	650 000	1 300	1 700	253.4	149.4	—	301	1.5
7334 A	(M)	—	DB DF DT	630 000	970 000	1 300	1 700	225.0	81.0	—	351	1.5
7334 B	(M)	T	DB DF DT	575 000	890 000	1 100	1 600	294.3	150.3	—	351	1.5

Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

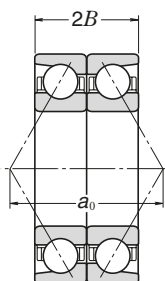
# ■ ANGULAR CONTACT BALL BEARINGS

## SINGLE/MATCHED MOUNTINGS

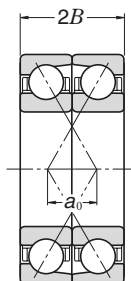
Bore Diameter 180 – 200 mm



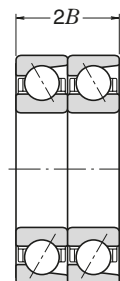
Single



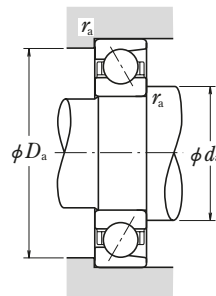
Back-to-Back  
DB



Face-to-Face  
DF

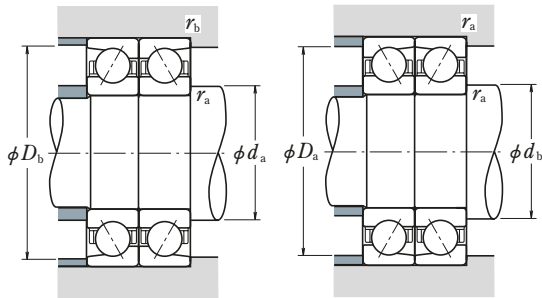


Tandem  
DT



Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds <sup>(1)</sup> (min <sup>-1</sup> )		Eff. Load Center (mm) <i>a</i>	Abutment and Fillet Dimensions (mm)			Mass (kg)
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	<i>f</i> <sub>0</sub>	Grease	Oil		<i>d</i> <sub>a</sub> min.	<i>D</i> <sub>a</sub> max.	<i>r</i> <sub>a</sub> max.	approx.
<b>180</b>	250	33	2	1	145 000	184 000	16.6	3 200	4 500	45.3	190	240	2	4.90
	280	46	2.1	1.1	207 000	252 000	—	1 900	2 400	89.4	192	268	2	10.5
	320	52	4	1.5	305 000	385 000	—	1 700	2 200	98.2	198	302	3	18.1
	320	52	4	1.5	276 000	350 000	—	1 500	2 000	130.9	198	302	3	18.4
	380	75	4	1.5	410 000	535 000	—	1 500	2 000	118.3	198	362	3	42.1
	380	75	4	1.5	375 000	490 000	—	1 300	1 800	155.0	198	362	3	42.6
<b>190</b>	260	33	2	1	147 000	192 000	16.7	3 000	4 300	46.6	200	250	2	4.98
	290	46	2.1	1.1	224 000	280 000	—	1 800	2 400	92.3	202	278	2	11.3
	340	55	4	1.5	315 000	410 000	—	1 600	2 200	104.0	208	322	3	22.4
	340	55	4	1.5	284 000	375 000	—	1 400	2 000	138.7	208	322	3	22.5
	400	78	5	2	450 000	600 000	—	1 400	1 900	124.2	212	378	4	47.5
	400	78	5	2	410 000	550 000	—	1 300	1 700	162.8	212	378	4	47.2
<b>200</b>	280	38	2.1	1.1	189 000	244 000	16.5	2 800	4 000	51.2	212	268	2	6.85
	310	51	2.1	1.1	240 000	310 000	—	1 700	2 200	99.1	212	298	2	13.7
	360	58	4	1.5	335 000	450 000	—	1 500	2 000	109.8	218	342	3	26.5
	360	58	4	1.5	305 000	410 000	—	1 300	1 800	146.5	218	342	3	26.6
	420	80	5	2	475 000	660 000	—	1 300	1 800	129.5	222	398	4	54.4
	420	80	5	2	430 000	600 000	—	1 200	1 600	170.1	222	398	4	55.3

- Notes** <sup>(1)</sup> For applications operating near the limiting speed, refer to Page C077.  
<sup>(2)</sup> Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.  
<sup>(3)</sup> Use the values of *d*<sub>a</sub> (min) and *r*<sub>a</sub> (max) for bearings with “—” in the *d*<sub>b</sub> column.

Dynamic Equivalent Load  $P = XF_r + YF_a$ 

Contact Angle	$i/f_0 F_a^{*e}$ $C_{or}$	$e$	Single, DT				DB or DF			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			$X$	$Y$	$X$	$Y$	$X$	$Y$	$X$	$Y$
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	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

\*For  $i$ , use 2 for DB and DF and 1 for DTStatic Equivalent Load  $P_0 = X_0 F_r + Y_0 F_a$ 

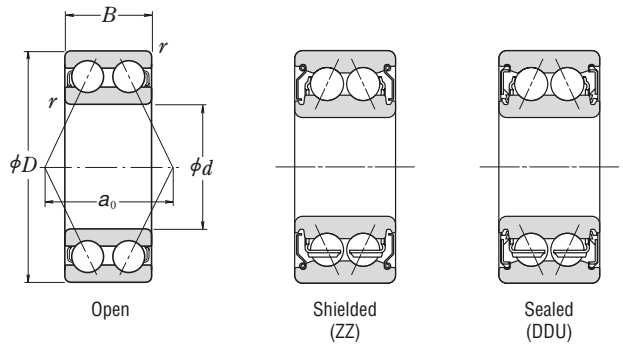
Contact Angle	Single, DT		DB or DF		Single or DT mounting When $F_r > 0.5 F_r + Y_0 F_a$ use $P_0 = F_r$
	$X_0$	$Y_0$	$X_0$	$Y_0$	
15°	0.5	0.46	1	0.92	
25°	0.5	0.38	1	0.76	
30°	0.5	0.33	1	0.66	
40°	0.5	0.26	1	0.52	

Bearing Designations <sup>(2)</sup> Cage Designation <sup>(4)</sup>				Arrangement	Basic Load Ratings (Matched) (N)		Limiting Speeds <sup>(1)</sup> (Matched) (min <sup>-1</sup> )		Load Center Spacings (mm)		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option			$C_r$	$C_{0r}$	Grease	Oil	DB	DF	$d_b$ <sup>(3)</sup> min.	$D_b$ max.	$r_b$ <sup>(3)</sup> max.
7936 C	(M)	—		DB DF DT	236 000	370 000	2 600	3 600	90.6	24.6	—	244	1
7036 A	(M)	—		DB DF DT	335 000	505 000	1 500	2 000	178.8	86.8	—	273	1
7236 A	(M)	—		DB DF DT	495 000	770 000	1 400	1 800	196.3	92.3	—	311	1.5
7236 B	(M)	—		DB DF DT	450 000	700 000	1 200	1 700	261.8	157.8	—	311	1.5
7336 A	(M)	—		DB DF DT	665 000	1 070 000	1 200	1 600	236.6	86.6	—	371	1.5
7336 B	(M)	—		DB DF DT	605 000	975 000	1 100	1 500	309.9	159.9	—	371	1.5
7938 C	(M)	TYN		DB DF DT	239 000	385 000	2 400	3 400	93.3	27.3	—	254	1
7038 A	(M)	—		DB DF DT	365 000	560 000	1 400	1 900	184.6	92.6	—	283	1
7238 A	(M)	—		DB DF DT	510 000	825 000	1 300	1 700	208.0	98.0	—	331	1.5
7238 B	(M)	—		DB DF DT	460 000	750 000	1 100	1 600	277.3	167.3	—	331	1.5
7338 A	(M)	T		DB DF DT	730 000	1 200 000	1 100	1 500	248.3	92.3	—	390	2
7338 B	(M)	—		DB DF DT	670 000	1 100 000	1 000	1 400	325.5	169.5	—	390	2
7940 C	(M)	—		DB DF DT	305 000	490 000	2 200	3 200	102.3	26.3	—	273	1
7040 A	(M)	T		DB DF DT	390 000	620 000	1 300	1 800	198.2	96.2	—	303	1
7240 A	(M)	—		DB DF DT	550 000	900 000	1 200	1 600	219.6	103.6	—	351	1.5
7240 B	(M)	—		DB DF DT	495 000	815 000	1 100	1 500	292.9	176.9	—	351	1.5
7340 A	(M)	T		DB DF DT	770 000	1 320 000	1 100	1 400	259.0	99.0	—	410	2
7340 B	(M)	—		DB DF DT	700 000	1 200 000	950	1 300	340.1	180.1	—	410	2

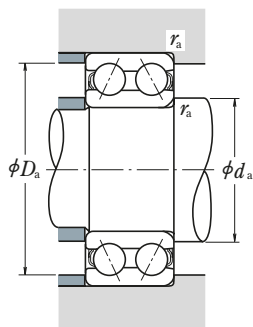
Note <sup>(4)</sup> Cage designation (M) is usually omitted from the bearing designation.

# DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

Bore Diameter 10 – 45 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )			Bearing Designations		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease		Oil	Open	Shielded	Sealed
						Open ZZ	DDU	Open			
<b>10</b>	30	14.3	0.6	7 150	3 900	17 000	—	22 000	<b>5200</b>	—	—
	30	14.3	0.6	7 150	3 900	17 000	15 000	—	—	<b>5200ZZ</b>	<b>5200DDU</b>
<b>12</b>	32	15.9	0.6	10 500	5 800	15 000	—	20 000	<b>5201</b>	—	—
	32	15.9	0.6	8 500	5 300	15 000	12 000	—	—	<b>5201BZZ</b>	<b>5201BDDU</b>
<b>15</b>	35	15.9	0.6	11 700	7 050	13 000	—	17 000	<b>5202</b>	—	—
	35	15.9	0.6	8 500	5 300	13 000	12 000	—	—	<b>5202BZZ</b>	<b>5202BDDU</b>
	42	19	1	17 600	10 200	11 000	—	15 000	<b>5302</b>	—	—
	42	19	1	14 700	9 100	11 000	10 000	—	—	<b>5302AZZ</b>	<b>5302ADDU</b>
<b>17</b>	40	17.5	0.6	14 600	9 050	11 000	—	15 000	<b>5203</b>	—	—
	40	17.5	0.6	12 700	8 300	11 000	10 000	—	—	<b>5203AZZ</b>	<b>5203ADDU</b>
	47	22.2	1	21 000	12 600	10 000	—	13 000	<b>5303</b>	—	—
	47	22.2	1	19 600	12 400	10 000	9 500	—	—	<b>5303AZZ</b>	<b>5303ADDU</b>
<b>20</b>	47	20.6	1	19 600	12 400	10 000	—	13 000	<b>5204</b>	—	—
	47	20.6	1	15 900	10 700	10 000	9 000	—	—	<b>5204AZZ</b>	<b>5204ADDU</b>
	52	22.2	1.1	24 600	15 000	9 000	—	12 000	<b>5304</b>	—	—
	52	22.2	1.1	19 700	12 800	9 000	8 500	—	—	<b>5304AZZ</b>	<b>5304ADDU</b>
<b>25</b>	52	20.6	1	21 300	14 700	8 500	—	11 000	<b>5205</b>	—	—
	52	20.6	1	16 900	12 300	8 500	7 500	—	—	<b>5205BZZ</b>	<b>5205BDDU</b>
	62	25.4	1.1	32 500	20 700	7 500	—	10 000	<b>5305</b>	—	—
	62	25.4	1.1	25 200	18 200	7 500	6 300	—	—	<b>5305AZZ</b>	<b>5305ADDU</b>
<b>30</b>	62	23.8	1	29 600	21 100	7 100	—	9 500	<b>5206</b>	—	—
	62	23.8	1	25 200	18 200	7 100	6 300	—	—	<b>5206BZZ</b>	<b>5206BDDU</b>
	72	30.2	1.1	40 500	28 100	6 300	—	8 500	<b>5306</b>	—	—
	72	30.2	1.1	39 000	28 700	6 300	5 300	—	—	<b>5306AZZ</b>	<b>5306ADDU</b>
<b>35</b>	72	27	1.1	39 000	28 700	6 300	—	8 000	<b>5207</b>	—	—
	72	27	1.1	34 000	25 300	6 300	5 300	—	—	<b>5207AZZ</b>	<b>5207ADDU</b>
	80	34.9	1.5	51 000	36 000	5 600	—	7 500	<b>5307</b>	—	—
	80	34.9	1.5	44 000	33 500	5 600	4 800	—	—	<b>5307AZZ</b>	<b>5307ADDU</b>
<b>40</b>	80	30.2	1.1	44 000	33 500	5 600	—	7 100	<b>5208</b>	—	—
	80	30.2	1.1	36 500	29 000	5 600	4 800	—	—	<b>5208AZZ</b>	<b>5208ADDU</b>
	90	36.5	1.5	56 500	41 000	5 300	—	6 700	<b>5308</b>	—	—
	90	36.5	1.5	49 500	38 000	5 300	4 500	—	—	<b>5308AZZ</b>	<b>5308ADDU</b>
<b>45</b>	85	30.2	1.1	49 500	38 000	5 000	—	6 700	<b>5209</b>	—	—
	85	30.2	1.1	41 500	33 500	5 000	4 300	—	—	<b>5209A1ZZ</b>	<b>5209A1DDU</b>
	100	39.7	1.5	68 500	51 000	4 500	—	6 000	<b>5309</b>	—	—

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$		$e$
$X$	$Y$	$X$	$Y$	
1	0.92	0.67	1.41	0.68

**Static Equivalent Load**

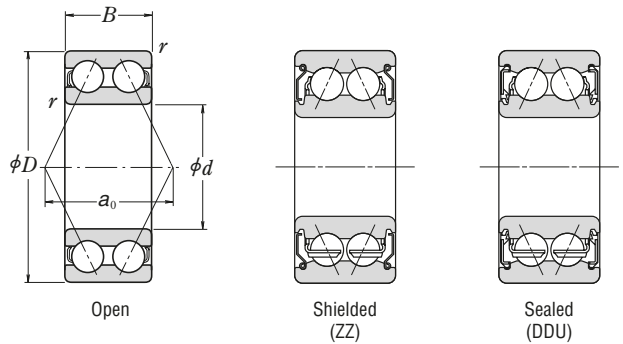
$$P_0 = F_r + 0.76 F_a$$



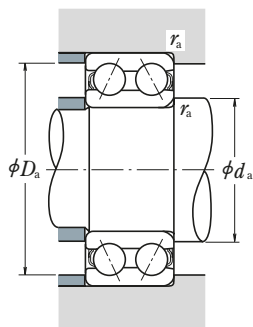
Load Center Spacings (mm) $a_0$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
	$d_a$ min.	$D_a$ max.	$r_a$ max.	
14.5	15	25	0.6	0.050
14.5	14	26	0.6	0.050
16.7	17	27	0.6	0.060
16.3	16	28	0.6	0.060
18.3	20	30	0.6	0.070
16.3	19	31	0.6	0.070
22	21	36	1	0.13
21	21	36	1	0.13
20.8	22	35	0.6	0.10
20.1	21	36	0.6	0.10
25	23	41	1	0.18
24.3	23	41	1	0.18
24.3	26	41	1	0.16
23	26	41	1	0.16
26.7	27	45	1	0.22
25.4	27	45	1	0.22
26.8	31	46	1	0.18
25.4	31	46	1	0.18
31.8	32	55	1	0.35
30.9	32	55	1	0.36
31.6	36	56	1	0.30
30.9	36	56	1	0.30
36.5	37	65	1	0.57
36.6	37	65	1	0.57
36.6	42	65	1	0.46
36.3	42	65	1	0.46
41.6	44	71	1.5	0.76
41.5	44	71	1.5	0.79
41.5	47	73	1	0.62
39.4	47	73	1	0.63
45.5	49	81	1.5	1.03
43.8	49	81	1.5	1.05
43.4	52	78	1	0.67
42.5	52	78	1	0.67
50.6	54	91	1.5	1.37

# DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

Bore Diameter 50 – 85 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )			Bearing Designations		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease		Oil	Open	Shielded	Sealed
						Open ZZ	DDU	Open			
<b>50</b>	90	30.2	1.1	53 000	43 500	4 800	—	6 000	<b>5210</b>	—	—
	90	30.2	1.1	40 500	36 000	4 800	4 000	—	—	<b>5210AZZ</b>	<b>5210ADDU</b>
	110	44.4	2	81 500	61 500	4 300	—	5 600	<b>5310</b>	—	—
<b>55</b>	100	33.3	1.5	56 000	49 000	4 300	—	5 600	<b>5211</b>	—	—
	100	33.3	1.5	49 500	43 500	4 300	3 600	—	—	<b>5211AZZ</b>	<b>5211ADDU</b>
	120	49.2	2	95 000	73 000	3 800	—	5 000	<b>5311</b>	—	—
<b>60</b>	110	36.5	1.5	69 000	62 000	3 800	—	5 000	<b>5212</b>	—	—
	130	54	2.1	125 000	98 500	3 400	—	4 500	<b>5312</b>	—	—
<b>65</b>	120	38.1	1.5	76 500	69 000	3 600	—	4 500	<b>5213</b>	—	—
	140	58.7	2.1	142 000	113 000	3 200	—	4 300	<b>5313</b>	—	—
<b>70</b>	125	39.7	1.5	94 000	82 000	3 400	—	4 500	<b>5214</b>	—	—
	150	63.5	2.1	159 000	128 000	3 000	—	3 800	<b>5314</b>	—	—
<b>75</b>	130	41.3	1.5	93 500	83 000	3 200	—	4 300	<b>5215</b>	—	—
<b>80</b>	140	44.4	2	99 000	93 000	3 000	—	3 800	<b>5216</b>	—	—
<b>85</b>	150	49.2	2	116 000	110 000	2 800	—	3 600	<b>5217</b>	—	—

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$		$e$
$X$	$Y$	$X$	$Y$	
1	0.92	0.67	1.41	0.68

**Static Equivalent Load**

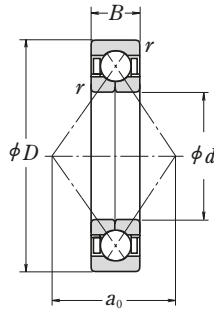
$$P_0 = F_r + 0.76 F_a$$

Load Center Spacings (mm) $a_0$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
	$d_a$ min.	$D_a$ max.	$r_a$ max.	
45.9	57	83	1	0.72
44	57	83	1	0.73
55.6	60	100	2	1.84
50.1	64	91	1.5	1.01
49.2	64	91	1.5	1.01
60.6	65	110	2	2.40
56.5	69	101	1.5	1.33
69.2	72	118	2	2.92
59.7	74	111	1.5	1.71
72.8	77	128	2	3.67
63.8	79	116	1.5	1.75
78.3	82	138	2	4.55
66.1	84	121	1.5	1.88
69.6	90	130	2	2.51
75.3	95	140	2	3.16



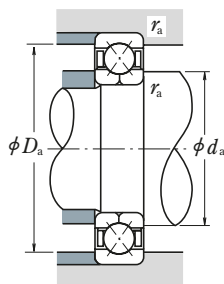
# ■ FOUR-POINT-CONTACT BALL BEARINGS

Bore Diameter 30 – 95 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>	Grease	Oil
<b>30</b>	62	16	1	31 000	45 000	8 500	12 000
	72	19	1.1	46 000	63 000	8 000	11 000
<b>35</b>	72	17	1.1	41 000	61 500	7 500	10 000
	80	21	1.5	55 000	80 000	7 100	9 500
<b>40</b>	80	18	1.1	49 000	77 500	6 700	9 000
	90	23	1.5	67 000	100 000	6 300	8 500
<b>45</b>	85	19	1.1	55 000	88 500	6 300	8 500
	100	25	1.5	87 500	133 000	5 600	7 500
<b>50</b>	90	20	1.1	57 000	97 000	5 600	8 000
	110	27	2	102 000	159 000	5 000	6 700
<b>55</b>	100	21	1.5	71 000	122 000	5 300	7 100
	120	29	2	118 000	187 000	4 500	6 300
<b>60</b>	110	22	1.5	85 500	150 000	4 800	6 300
	130	31	2.1	135 000	217 000	4 300	5 600
<b>65</b>	120	23	1.5	97 500	179 000	4 300	6 000
	140	33	2.1	153 000	250 000	3 800	5 300
<b>70</b>	125	24	1.5	106 000	197 000	4 000	5 600
	150	35	2.1	172 000	285 000	3 600	5 000
<b>75</b>	130	25	1.5	110 000	212 000	3 800	5 300
	160	37	2.1	187 000	320 000	3 400	4 800
<b>80</b>	125	22	1.1	77 000	167 000	3 800	5 300
	140	26	2	124 000	236 000	3 600	5 000
	170	39	2.1	202 000	360 000	3 200	4 300
<b>85</b>	130	22	1.1	79 000	176 000	3 800	5 000
	150	28	2	143 000	276 000	3 400	4 800
	180	41	3	218 000	405 000	3 000	4 000
<b>90</b>	140	24	1.5	94 000	208 000	3 400	4 800
	160	30	2	164 000	320 000	3 200	4 300
	190	43	3	235 000	450 000	2 800	3 800
<b>95</b>	145	24	1.5	96 500	220 000	3 400	4 500
	170	32	2.1	177 000	340 000	3 000	4 000
	200	45	3	251 000	495 000	2 600	3 600

**Remark** Please contact NSK when using four-point contact ball bearings.

**Dynamic Equivalent Load**

$$P_a = F_a$$

**Static Equivalent Load**

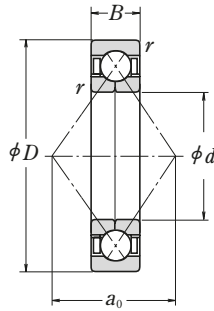
$$P_{0a} = F_a$$



Bearing Designation	Load Center Spacing (mm) $a_0$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
		$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>QJ 206</b>	32.2	36	56	1	0.24
<b>QJ 306</b>	35.7	37	65	1	0.42
<b>QJ 207</b>	37.5	42	65	1	0.35
<b>QJ 307</b>	40.3	44	71	1.5	0.57
<b>QJ 208</b>	42.0	47	73	1	0.45
<b>QJ 308</b>	45.5	49	81	1.5	0.78
<b>QJ 209</b>	45.5	52	78	1	0.52
<b>QJ 309</b>	50.8	54	91	1.5	1.05
<b>QJ 210</b>	49.0	57	83	1	0.59
<b>QJ 310</b>	56.0	60	100	2	1.35
<b>QJ 211</b>	54.3	64	91	1.5	0.77
<b>QJ 311</b>	61.3	65	110	2	1.75
<b>QJ 212</b>	59.5	69	101	1.5	0.98
<b>QJ 312</b>	66.5	72	118	2	2.15
<b>QJ 213</b>	64.8	74	111	1.5	1.2
<b>QJ 313</b>	71.8	77	128	2	2.7
<b>QJ 214</b>	68.3	79	116	1.5	1.3
<b>QJ 314</b>	77.0	82	138	2	3.18
<b>QJ 215</b>	71.8	84	121	1.5	1.5
<b>QJ 315</b>	82.3	87	148	2	3.9
<b>QJ 1016</b>	71.8	87	118	1	1.05
<b>QJ 216</b>	77.0	90	130	2	1.85
<b>QJ 316</b>	87.5	92	158	2	4.6
<b>QJ 1017</b>	75.3	92	123	1	1.1
<b>QJ 217</b>	82.3	95	140	2	2.2
<b>QJ 317</b>	92.8	99	166	2.5	5.34
<b>QJ 1018</b>	80.5	99	131	1.5	1.45
<b>QJ 218</b>	87.5	100	150	2	2.75
<b>QJ 318</b>	98.0	104	176	2.5	6.4
<b>QJ 1019</b>	84.0	104	136	1.5	1.5
<b>QJ 219</b>	92.8	107	158	2	3.35
<b>QJ 319</b>	103.3	109	186	2.5	7.4

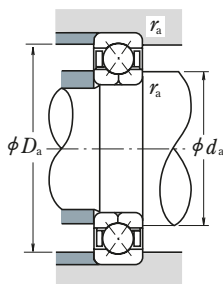
# ■ FOUR-POINT-CONTACT BALL BEARINGS

Bore Diameter 100 – 200 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
$d$	$D$	$B$	$r$ min.	$C_a$	$C_{0a}$	Grease	Oil
<b>100</b>	150	24	1.5	98 500	232 000	3 200	4 300
	180	34	2.1	199 000	390 000	2 800	3 800
	215	47	3	300 000	640 000	2 400	3 400
<b>105</b>	160	26	2	115 000	269 000	3 000	4 000
	190	36	2.1	217 000	435 000	2 600	3 600
	225	49	3	305 000	640 000	2 400	3 200
<b>110</b>	170	28	2	139 000	315 000	2 800	3 800
	200	38	2.1	235 000	490 000	2 600	3 400
	240	50	3	320 000	710 000	2 200	3 000
<b>120</b>	180	28	2	147 000	350 000	2 600	3 600
	215	40	2.1	265 000	585 000	2 400	3 200
	260	55	3	360 000	835 000	2 000	2 800
<b>130</b>	200	33	2	169 000	415 000	2 400	3 200
	230	40	3	274 000	635 000	2 200	3 000
	280	58	4	400 000	970 000	1 900	2 600
<b>140</b>	210	33	2	172 000	435 000	2 200	3 000
	250	42	3	315 000	775 000	2 000	2 800
	300	62	4	440 000	1 110 000	1 700	2 400
<b>150</b>	225	35	2.1	197 000	505 000	2 000	2 800
	270	45	3	360 000	925 000	1 800	2 600
	320	65	4	460 000	1 230 000	1 600	2 200
<b>160</b>	240	38	2.1	224 000	580 000	1 900	2 600
	290	48	3	380 000	1 010 000	1 700	2 400
	340	68	4	505 000	1 400 000	1 500	2 000
<b>170</b>	260	42	2.1	268 000	705 000	1 800	2 400
	310	52	4	425 000	1 180 000	1 600	2 200
	360	72	4	565 000	1 610 000	1 400	2 000
<b>180</b>	280	46	2.1	299 000	830 000	1 700	2 200
	320	52	4	440 000	1 270 000	1 500	2 000
	380	75	4	595 000	1 770 000	1 300	1 800
<b>190</b>	290	46	2.1	325 000	925 000	1 600	2 200
	340	55	4	440 000	1 290 000	1 400	2 000
	400	78	5	655 000	1 980 000	1 300	1 700
<b>200</b>	310	51	2.1	345 000	1 020 000	1 500	2 000
	360	58	4	490 000	1 480 000	1 300	1 800
	420	80	5	690 000	2 180 000	1 200	1 600

**Remark** Please contact NSK when using four-point contact ball bearings.

**Dynamic Equivalent Load**

$$P_a = F_a$$

**Static Equivalent Load**

$$P_{0a} = F_a$$



Bearing Designation	Load Center Spacing (mm) $a_0$	Abutment and Fillet Dimensions (mm)			Mass (kg) approx.
		$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>QJ 1020</b>	87.5	109	141	1.5	1.6
<b>QJ 220</b>	98.0	112	168	2	4.0
<b>QJ 320</b>	110.3	114	201	2.5	9.3
<b>QJ 1021</b>	92.8	115	150	2	2.0
<b>QJ 221</b>	103.3	117	178	2	4.7
<b>QJ 321</b>	115.5	119	211	2.5	10.5
<b>QJ 1022</b>	98.0	120	160	2	2.5
<b>QJ 222</b>	108.5	122	188	2	5.6
<b>QJ 322</b>	122.5	124	226	2.5	12.5
<b>QJ 1024</b>	105.0	130	170	2	2.65
<b>QJ 224</b>	117.3	132	203	2	6.9
<b>QJ 324</b>	133.0	134	246	2.5	15.4
<b>QJ 1026</b>	115.5	140	190	2	4.0
<b>QJ 226</b>	126.0	144	216	2.5	7.7
<b>QJ 326</b>	143.5	148	262	3	19
<b>QJ 1028</b>	122.5	150	200	2	4.3
<b>QJ 228</b>	136.5	154	236	2.5	9.8
<b>QJ 328</b>	154.0	158	282	3	24
<b>QJ 1030</b>	131.3	162	213	2	5.2
<b>QJ 230</b>	147.0	164	256	2.5	12
<b>QJ 330</b>	164.5	168	302	3	29
<b>QJ 1032</b>	140.0	172	228	2	6.4
<b>QJ 232</b>	157.5	174	276	2.5	15
<b>QJ 332</b>	175.1	178	322	3	31
<b>QJ 1034</b>	150.5	182	248	2	8.6
<b>QJ 234</b>	168.0	188	292	3	19.5
<b>QJ 334</b>	185.6	188	342	3	41
<b>QJ 1036</b>	161.0	192	268	2	11
<b>QJ 236</b>	175.1	198	302	3	20.5
<b>QJ 336</b>	196.1	198	362	3	48
<b>QJ 1038</b>	168.0	202	278	2	11.5
<b>QJ 238</b>	185.6	208	322	3	23
<b>QJ 338</b>	206.6	212	378	4	54.5
<b>QJ 1040</b>	178.6	212	298	2	15
<b>QJ 240</b>	196.1	218	342	3	27
<b>QJ 340</b>	217.1	222	398	4	61.5



4. SELF-ALIGNING BALL BEARINGS

INTRODUCTION ..... C 116

BEARING TABLES

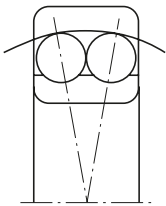
SELF-ALIGNING BALL BEARINGS

Bore Diameter 5 – 110 mm ..... C 118



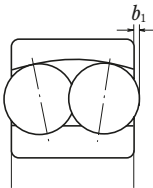
DESIGN, TYPES, AND FEATURES

The outer ring of a self-aligning ball bearing has a spherical raceway and its center of curvature coincides with that of the bearing; therefore, the axis of the inner ring, balls and cage can deflect to some extent around the bearing center. This type is recommended when the alignment of the shaft and housing is difficult and when the shaft may bend. Since the contact angle is small, axial load capacity is low. Pressed-steel cages are usually used.



PROTRUSION AMOUNT

Some self-aligning ball bearings have balls that protrude from the side face as shown below. This protrusion amount  $b_1$  is listed in the following table.



Bearing Designation	$b_1$ (mm)
2222(K), 2316(K)	0.5
2319(K), 2320(K) 2321 , 2322(K)	0.5
1318(K)	1.5
1319(K)	2
1320(K), 1321 1322(K)	3

TOLERANCES AND RUNNING

ACCURACY ..... Table 7.2 (Pages A128 to A131)

RECOMMENDED FITS ..... Table 8.3 (Page A164)  
Table 8.5 (Page A165)

INTERNAL CLEARANCE ..... Table 8.13 (Page A170)

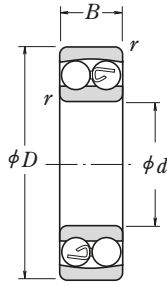
PERMISSIBLE MISALIGNMENT

The permissible misalignment of self-aligning ball bearings is approximately 0.07 to 0.12 radian ( $4^\circ$  to  $7^\circ$ ) under normal loads. However, depending on the surrounding structure, such an angle may not be possible. Take care in the design of the bearing surroundings.

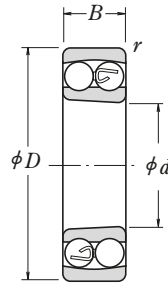


# **SELF-ALIGNING BALL BEARINGS**

**Bore Diameter 5 – 30 mm**



Cylindrical Bore

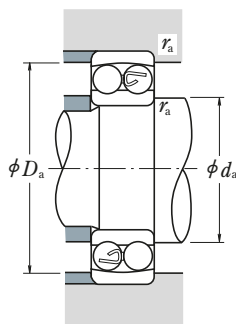


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil	Cylindrical Bore
<b>5</b>	19	6	0.3	2 530	475	30 000	36 000	<b>135</b>
<b>6</b>	19	6	0.3	2 530	475	30 000	36 000	<b>126</b>
<b>7</b>	22	7	0.3	2 750	600	26 000	32 000	<b>127</b>
<b>8</b>	22	7	0.3	2 750	600	26 000	32 000	<b>108</b>
<b>9</b>	26	8	0.6	4 150	895	26 000	30 000	<b>129</b>
<b>10</b>	30	9	0.6	5 550	1 190	22 000	28 000	<b>1200</b>
	30	14	0.6	7 450	1 590	24 000	28 000	<b>2200</b>
	35	11	0.6	7 350	1 620	20 000	24 000	<b>1300</b>
	35	17	0.6	9 200	2 010	18 000	22 000	<b>2300</b>
<b>12</b>	32	10	0.6	5 700	1 270	22 000	26 000	<b>1201</b>
	32	14	0.6	7 750	1 730	22 000	26 000	<b>2201</b>
	37	12	1	9 650	2 160	18 000	22 000	<b>1301</b>
	37	17	1	12 100	2 730	17 000	22 000	<b>2301</b>
<b>15</b>	35	11	0.6	7 600	1 750	18 000	22 000	<b>1202</b>
	35	14	0.6	7 800	1 850	18 000	22 000	<b>2202</b>
	42	13	1	9 700	2 290	16 000	20 000	<b>1302</b>
	42	17	1	12 300	2 910	14 000	18 000	<b>2302</b>
<b>17</b>	40	12	0.6	8 000	2 010	16 000	20 000	<b>1203</b>
	40	16	0.6	9 950	2 420	16 000	20 000	<b>2203</b>
	47	14	1	12 700	3 200	14 000	17 000	<b>1303</b>
	47	19	1	14 700	3 550	13 000	16 000	<b>2303</b>
<b>20</b>	47	14	1	10 000	2 610	14 000	17 000	<b>1204</b>
	47	18	1	12 800	3 300	14 000	17 000	<b>2204</b>
	52	15	1.1	12 600	3 350	12 000	15 000	<b>1304</b>
	52	21	1.1	18 500	4 700	11 000	14 000	<b>2304</b>
<b>25</b>	52	15	1	12 200	3 300	12 000	14 000	<b>1205</b>
	52	18	1	12 400	3 450	12 000	14 000	<b>2205</b>
	62	17	1.1	18 200	5 000	10 000	13 000	<b>1305</b>
	62	24	1.1	24 900	6 600	9 500	12 000	<b>2305</b>
<b>30</b>	62	16	1	15 800	4 650	10 000	12 000	<b>1206</b>
	62	20	1	15 300	4 550	10 000	12 000	<b>2206</b>
	72	19	1.1	21 400	6 300	8 500	11 000	<b>1306</b>
	72	27	1.1	32 000	8 750	8 000	10 000	<b>2306</b>

**Note** <sup>(1)</sup> Suffix K represents bearings with tapered bores (1 : 12).

**Remark** For dimensions related to adapters, refer to Page C348.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.65	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

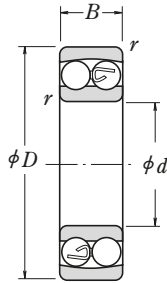
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are listed in the table below.

Designations	Abutment and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg)  approx.
	$d_a$ min.	$D_a$ max.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
—	7	17	0.3	0.34	2.9	1.9	1.9	0.009
—	8	17	0.3	0.34	2.9	1.9	1.9	0.008
—	9	20	0.3	0.31	3.1	2.0	2.1	0.013
—	10	20	0.3	0.31	3.1	2.0	2.1	0.016
—	13	22	0.6	0.32	3.1	2.0	2.1	0.021
—	14	26	0.6	0.32	3.1	2.0	2.1	0.034
—	14	26	0.6	0.64	1.5	0.98	1.0	0.046
—	14	31	0.6	0.35	2.8	1.8	1.9	0.059
—	14	31	0.6	0.71	1.4	0.89	0.93	0.080
—	16	28	0.6	0.36	2.7	1.8	1.8	0.041
—	16	28	0.6	0.58	1.7	1.1	1.1	0.051
—	17	32	1	0.33	2.9	1.9	2.0	0.068
—	17	32	1	0.60	1.6	1.1	1.1	0.089
—	19	31	0.6	0.32	3.1	2.0	2.1	0.050
—	19	31	0.6	0.50	1.9	1.3	1.3	0.058
—	20	37	1	0.33	2.9	1.9	2.0	0.101
—	20	37	1	0.51	1.9	1.2	1.3	0.116
—	21	36	0.6	0.31	3.1	2.0	2.1	0.074
—	21	36	0.6	0.50	1.9	1.3	1.3	0.089
—	22	42	1	0.32	3.1	2.0	2.1	0.13
—	22	42	1	0.51	1.9	1.2	1.3	0.16
<b>1204 K</b>	25	42	1	0.29	3.4	2.2	2.3	0.12
<b>2204 K</b>	25	42	1	0.47	2.1	1.3	1.4	0.142
<b>1304 K</b>	26.5	45.5	1	0.29	3.4	2.2	2.3	0.164
<b>2304 K</b>	26.5	45.5	1	0.50	1.9	1.2	1.3	0.210
<b>1205 K</b>	30	47	1	0.28	3.5	2.3	2.4	0.14
<b>2205 K</b>	30	47	1	0.41	2.4	1.5	1.6	0.16
<b>1305 K</b>	31.5	55.5	1	0.28	3.5	2.3	2.4	0.261
<b>2305 K</b>	31.5	55.5	1	0.47	2.1	1.4	1.4	0.340
<b>1206 K</b>	35	57	1	0.25	3.9	2.5	2.6	0.22
<b>2206 K</b>	35	57	1	0.38	2.5	1.6	1.7	0.262
<b>1306 K</b>	36.5	65.5	1	0.26	3.7	2.4	2.5	0.391
<b>2306 K</b>	36.5	65.5	1	0.44	2.2	1.4	1.5	0.51

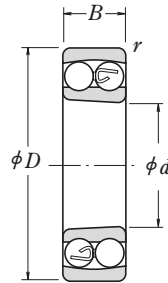


# **SELF-ALIGNING BALL BEARINGS**

**Bore Diameter 35 – 70 mm**



Cylindrical Bore

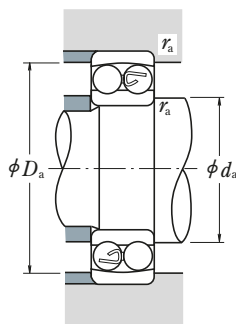


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds ( $\text{min}^{-1}$ )		Bearing
$d$	$D$	$B$	$r$ min.	$C_r$	$C_{0r}$	Grease	Oil	Cylindrical Bore
<b>35</b>	72	17	1.1	15 900	5 100	8 500	10 000	<b>1207</b>
	72	23	1.1	21 700	6 600	8 500	10 000	<b>2207</b>
	80	21	1.5	25 300	7 850	7 500	9 500	<b>1307</b>
	80	31	1.5	40 000	11 300	7 100	9 000	<b>2307</b>
<b>40</b>	80	18	1.1	19 300	6 500	7 500	9 000	<b>1208</b>
	80	23	1.1	22 400	7 350	7 500	9 000	<b>2208</b>
	90	23	1.5	29 800	9 700	6 700	8 500	<b>1308</b>
	90	33	1.5	45 500	13 500	6 300	8 000	<b>2308</b>
<b>45</b>	85	19	1.1	22 000	7 350	7 100	8 500	<b>1209</b>
	85	23	1.1	23 300	8 150	7 100	8 500	<b>2209</b>
	100	25	1.5	38 500	12 700	6 000	7 500	<b>1309</b>
	100	36	1.5	55 000	16 700	5 600	7 100	<b>2309</b>
<b>50</b>	90	20	1.1	22 800	8 100	6 300	8 000	<b>1210</b>
	90	23	1.1	23 300	8 450	6 300	8 000	<b>2210</b>
	110	27	2	43 500	14 100	5 600	6 700	<b>1310</b>
	110	40	2	65 000	20 200	5 000	6 300	<b>2310</b>
<b>55</b>	100	21	1.5	26 900	10 000	6 000	7 100	<b>1211</b>
	100	25	1.5	26 700	9 900	6 000	7 100	<b>2211</b>
	120	29	2	51 500	17 900	5 000	6 300	<b>1311</b>
	120	43	2	76 500	24 000	4 800	6 000	<b>2311</b>
<b>60</b>	110	22	1.5	30 500	11 500	5 300	6 300	<b>1212</b>
	110	28	1.5	34 000	12 600	5 300	6 300	<b>2212</b>
	130	31	2.1	57 500	20 800	4 500	5 600	<b>1312</b>
	130	46	2.1	88 500	28 300	4 300	5 300	<b>2312</b>
<b>65</b>	120	23	1.5	31 000	12 500	4 800	6 000	<b>1213</b>
	120	31	1.5	43 500	16 400	4 800	6 000	<b>2213</b>
	140	33	2.1	62 500	22 900	4 300	5 300	<b>1313</b>
	140	48	2.1	97 000	32 500	3 800	4 800	<b>2313</b>
<b>70</b>	125	24	1.5	35 000	13 800	4 800	5 600	<b>1214</b>
	125	31	1.5	44 000	17 100	4 500	5 600	<b>2214</b>
	150	35	2.1	75 000	27 700	4 000	5 000	<b>1314</b>
	150	51	2.1	111 000	37 500	3 600	4 500	<b>2314</b>

**Note** <sup>(1)</sup> Suffix K represents bearings with tapered bores (1 : 12).

**Remark** For dimensions related to adapters, refer to Pages C348 and C349.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.65	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

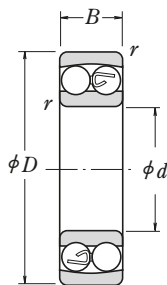
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are listed in the table below.

Designations	Abutment and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg)  approx.
	Tapered Bore <sup>(1)</sup> $d_a$ min.	$D_a$ max.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>1207 K</b>	41.5	65.5	1	0.23	4.2	2.7	2.8	0.33
<b>2207 K</b>	41.5	65.5	1	0.37	2.6	1.7	1.8	0.403
<b>1307 K</b>	43	72	1.5	0.26	3.8	2.5	2.6	0.52
<b>2307 K</b>	43	72	1.5	0.46	2.1	1.4	1.4	0.687
<b>1208 K</b>	46.5	73.5	1	0.22	4.3	2.8	2.9	0.42
<b>2208 K</b>	46.5	73.5	1	0.33	3.0	1.9	2.0	0.506
<b>1308 K</b>	48	82	1.5	0.24	4.0	2.6	2.7	0.727
<b>2308 K</b>	48	82	1.5	0.43	2.3	1.5	1.5	0.940
<b>1209 K</b>	51.5	78.5	1	0.21	4.7	3.0	3.1	0.47
<b>2209 K</b>	51.5	78.5	1	0.30	3.2	2.1	2.2	0.556
<b>1309 K</b>	53	92	1.5	0.25	4.0	2.6	2.7	0.971
<b>2309 K</b>	53	92	1.5	0.41	2.4	1.5	1.6	1.3
<b>1210 K</b>	56.5	83.5	1	0.21	4.7	3.1	3.2	0.535
<b>2210 K</b>	56.5	83.5	1	0.28	3.4	2.2	2.3	0.598
<b>1310 K</b>	59	101	2	0.23	4.2	2.7	2.8	1.23
<b>2310 K</b>	59	101	2	0.42	2.3	1.5	1.6	1.66
<b>1211 K</b>	63	92	1.5	0.20	4.9	3.2	3.3	0.708
<b>2211 K</b>	63	92	1.5	0.28	3.5	2.3	2.4	0.807
<b>1311 K</b>	64	111	2	0.23	4.2	2.7	2.8	1.6
<b>2311 K</b>	64	111	2	0.41	2.4	1.5	1.6	2.12
<b>1212 K</b>	68	102	1.5	0.18	5.3	3.4	3.6	0.91
<b>2212 K</b>	68	102	1.5	0.28	3.5	2.3	2.4	1.1
<b>1312 K</b>	71	119	2	0.23	4.3	2.8	2.9	2.0
<b>2312 K</b>	71	119	2	0.40	2.4	1.6	1.6	2.63
<b>1213 K</b>	73	112	1.5	0.17	5.7	3.7	3.8	1.16
<b>2213 K</b>	73	112	1.5	0.28	3.5	2.3	2.4	1.5
<b>1313 K</b>	76	129	2	0.23	4.2	2.7	2.9	2.47
<b>2313 K</b>	76	129	2	0.39	2.5	1.6	1.7	3.3
—	78	117	1.5	0.18	5.3	3.4	3.6	1.3
—	78	117	1.5	0.26	3.7	2.4	2.5	1.55
—	81	139	2	0.22	4.4	2.8	3.0	3.03
—	81	139	2	0.38	2.6	1.7	1.8	4.0

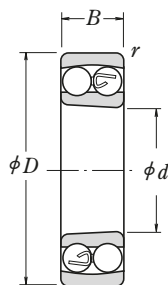


# SELF-ALIGNING BALL BEARINGS

Bore Diameter 75 – 110 mm



Cylindrical Bore



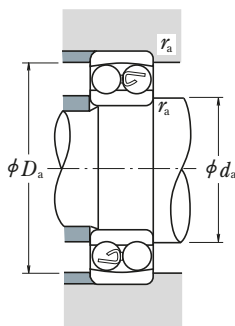
Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil	Cylindrical Bore
<b>75</b>	130	25	1.5	39 000	15 700	4 300	5 300	<b>1215</b>
	130	31	1.5	44 500	17 800	4 300	5 300	<b>2215</b>
	160	37	2.1	80 000	30 000	3 800	4 500	<b>1315</b>
	160	55	2.1	125 000	43 000	3 400	4 300	<b>2315</b>
<b>80</b>	140	26	2	40 000	17 000	4 000	5 000	<b>1216</b>
	140	33	2	49 000	19 900	4 000	5 000	<b>2216</b>
	170	39	2.1	89 000	33 000	3 600	4 300	<b>1316</b>
	170	58	2.1	130 000	45 000	3 200	4 000	<b>* 2316</b>
<b>85</b>	150	28	2	49 500	20 800	3 800	4 500	<b>1217</b>
	150	36	2	58 500	23 600	3 800	4 800	<b>2217</b>
	180	41	3	98 500	38 000	3 400	4 000	<b>1317</b>
	180	60	3	142 000	51 500	3 000	3 800	<b>2317</b>
<b>90</b>	160	30	2	57 500	23 500	3 600	4 300	<b>1218</b>
	160	40	2	70 500	28 700	3 600	4 300	<b>2218</b>
	190	43	3	117 000	44 500	3 200	3 800	<b>* 1318</b>
	190	64	3	154 000	57 500	2 800	3 600	<b>2318</b>
<b>95</b>	170	32	2.1	64 000	27 100	3 400	4 000	<b>1219</b>
	170	43	2.1	84 000	34 500	3 400	4 000	<b>2219</b>
	200	45	3	129 000	51 000	3 000	3 600	<b>* 1319</b>
	200	67	3	161 000	64 500	2 800	3 400	<b>* 2319</b>
<b>100</b>	180	34	2.1	69 500	29 700	3 200	3 800	<b>1220</b>
	180	46	2.1	94 500	38 500	3 200	3 800	<b>2220</b>
	215	47	3	140 000	57 500	2 800	3 400	<b>* 1320</b>
	215	73	3	187 000	79 000	2 400	3 200	<b>* 2320</b>
<b>105</b>	190	36	2.1	75 000	32 500	3 000	3 600	<b>1221</b>
	190	50	2.1	109 000	45 000	3 000	3 600	<b>2221</b>
	225	49	3	154 000	64 500	2 600	3 200	<b>* 1321</b>
	225	77	3	200 000	87 000	2 400	3 000	<b>* 2321</b>
<b>110</b>	200	38	2.1	87 000	38 500	2 800	3 400	<b>1222</b>
	200	53	2.1	122 000	51 500	2 800	3 400	<b>* 2222</b>
	240	50	3	161 000	72 000	2 400	3 000	<b>* 1322</b>
	240	80	3	211 000	94 500	2 200	2 800	<b>* 2322</b>

**Notes** <sup>(1)</sup> Suffix K represents bearings with tapered bores (1 : 12).

(\*) The balls of the bearings marked \* protrude slightly from the bearing face. The protrusion amounts are shown on Page C114.

**Remark** For dimensions related to adapters, refer to Pages C350 and C351.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.65	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$

are listed in the table below.

Designations	Abutment and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_a$ max.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>1215 K</b>	83	122	1.5	0.17	5.6	3.6	3.8	1.36
<b>2215 K</b>	83	122	1.5	0.25	3.9	2.5	2.6	1.6
<b>1315 K</b>	86	149	2	0.22	4.4	2.8	2.9	3.63
<b>2315 K</b>	86	149	2	0.38	2.5	1.6	1.7	4.84
<b>1216 K</b>	89	131	2	0.16	6.0	3.9	4.1	1.68
<b>2216 K</b>	89	131	2	0.25	3.9	2.5	2.7	2.02
<b>1316 K</b>	91	159	2	0.22	4.5	2.9	3.1	4.24
<b>* 2316 K</b>	91	159	2	0.39	2.5	1.6	1.7	5.75
<b>1217 K</b>	94	141	2	0.17	5.7	3.7	3.8	2.1
<b>2217 K</b>	94	141	2	0.25	3.9	2.5	2.6	2.56
<b>1317 K</b>	98	167	2.5	0.21	4.6	2.9	3.1	5.03
<b>2317 K</b>	98	167	2.5	0.37	2.6	1.7	1.8	6.68
<b>1218 K</b>	99	151	2	0.17	5.8	3.8	3.9	2.56
<b>2218 K</b>	99	151	2	0.27	3.7	2.4	2.5	3.22
<b>* 1318 K</b>	103	177	2.5	0.22	4.3	2.8	2.9	5.83
<b>2318 K</b>	103	177	2.5	0.38	2.6	1.7	1.7	7.87
<b>1219 K</b>	106	159	2	0.17	5.8	3.7	3.9	3.12
<b>2219 K</b>	106	159	2	0.27	3.7	2.4	2.5	3.96
<b>* 1319 K</b>	108	187	2.5	0.23	4.3	2.8	2.9	6.79
<b>* 2319 K</b>	108	187	2.5	0.38	2.6	1.7	1.8	9.09
<b>1220 K</b>	111	169	2	0.17	5.6	3.6	3.8	3.74
<b>2220 K</b>	111	169	2	0.27	3.7	2.4	2.5	4.71
<b>* 1320 K</b>	113	202	2.5	0.24	4.1	2.7	2.8	8.4
<b>* 2320 K</b>	113	202	2.5	0.38	2.6	1.7	1.8	11.7
—	116	179	2	0.18	5.5	3.6	3.7	4.43
—	116	179	2	0.28	3.5	2.3	2.4	5.73
—	118	212	2.5	0.23	4.2	2.7	2.9	9.58
—	118	212	2.5	0.38	2.6	1.7	1.7	14.5
<b>1222 K</b>	121	189	2	0.17	5.7	3.7	3.9	5.21
<b>* 2222 K</b>	121	189	2	0.28	3.5	2.2	2.3	6.75
<b>* 1322 K</b>	123	227	2.5	0.22	4.4	2.8	3.0	11.5
<b>* 2322 K</b>	123	227	2.5	0.37	2.6	1.7	1.8	17.5





## 5. CYLINDRICAL ROLLER BEARINGS

### SINGLE-ROW AND DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

**INTRODUCTION** ..... C 126

#### TECHNICAL DATA

**Free Space of Cylindrical Roller Bearings** ..... C 130

#### BEARING TABLES

##### Single-Row Cylindrical Roller Bearings

Bore Diameter 20 – 500 mm ..... C 132

##### L-Shaped Thrust Collars For Cylindrical Roller Bearings

Bore Diameter 20 – 320 mm ..... C 156

##### Double-Row Cylindrical Roller Bearings

Bore Diameter 25 – 360 mm ..... C 158

### FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS

#### SINGLE-ROW(NCF), DOUBLE-ROW(NNCF) AND FOR SHEAVES

**INTRODUCTION** ..... C 162

#### BEARING TABLES

**Single-Row(NCF)** Bore Diameter 100 – 800 mm ..... C 166

**Double-Row(NNCF)** Bore Diameter 100 – 500 mm ..... C 170

#### For Sheaves: Open Fixed-End Bearings RS-48E4, RS-49E4

##### Free-End Bearings RSF-48E4, RSF-49E4

Bore Diameter 50 – 560 mm ..... C 174

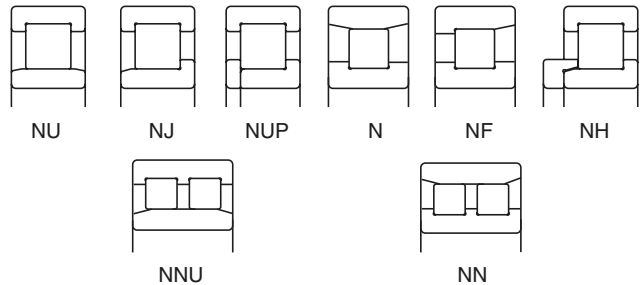
#### For Sheaves: Prelubricated Type RS-50, RS-50NR

Bore Diameter 40 – 400 mm ..... C 178



## DESIGN, TYPES, AND FEATURES

Cylindrical roller bearings are classified into the following types depending on whether or not they have ribs on their rings:



Types NU, N, NNU, and NN are suitable as free-end bearings. Types NJ and NF can sustain limited axial loads in one direction. Types NH and NUP can be used as fixed-end bearings.

The NH type consists of NJ-type cylindrical roller bearings and HJ-type L-shaped thrust collars (see Pages C156 and C157).

The inner ring loose rib of the NUP type should be mounted so that the marked side is on the outside.

### Features of Single-Row Cylindrical Roller Bearings

Cage Spec.	Material	Steel	Steel	Polyamide 66 resin	L-PPS resin	Brass	
		Pressed		Molded		Machined	
	Method						
	Designation	W	EW	ET	ET7	M	EM
Features	High Load Capacity	○	◎	◎	◎	△	◎
	High-Speed	△	○	○	○	○	◎
	High-Temperature	○	○	△	○	○	○
	Vibration	×	×	×	×	△	○

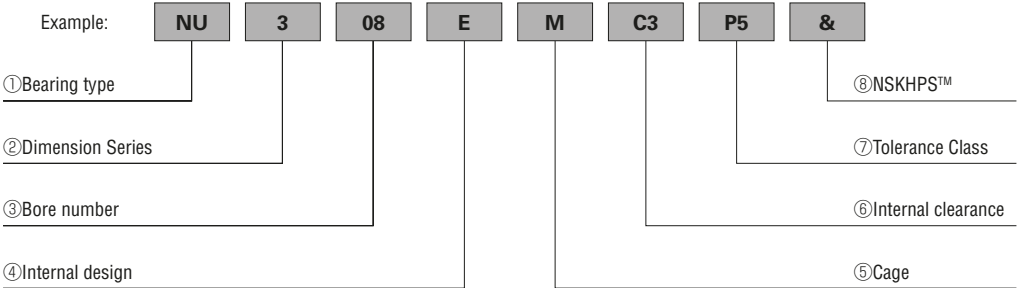
◎ Excellent ○ Good △ Fair × Poor

If a cage is nonstandard for a given bearing number the number of rollers may vary; in such a case, the load rating will differ from that listed in the bearing tables.

Many NN double-row bearings have tapered bores, and they are primarily used in the main spindles of machine tools. Cages are made of either molded polyphenylenesulfide (PPS) or machined brass.

## Formulation of Bearing Designations

### Single-Row Cylindrical Roller Bearing



- ① Bearing type  
NU : Single-row cylindrical roller bearings  
(Outer ring with both ribs + Inner ring without rib)  
Please refer to page C124 for detailed information.
- ② Dimension Series  
10 : 10 Series, 2 : 02 Series, 22 : 22 Series, 3 : 03 Series, 23 : 23 Series, 4 : 04 Series,
- ③ Bore number  
Less than 03, Bearing bore 01 : 12mm, 02 : 15mm, 03 : 17mm  
Over 04, Bearing bore Bore number X 5 (mm)
- ④ Internal design  
E : High load capacity
- ⑤ Cage  
W : Pressed-steel Cage, M : Machined Brass Cage, No designation : Machined-brass cage (in Series 10)  
T : Polyamide 66 resin cage, T7 : L-PPS resin cage
- ⑥ Internal clearance  
For All Radial Brgs.  
Omitted : CN clearance, C3 : Clearance greater than CN, C4 : Clearance greater than C3, CG : Special Clearance  
For Non-Interchangeable Cylindrical Roller Bearings  
CC : Normal Clearance, CC3 : Clearance greater than CC, CC4 : Clearance greater than CC3, CCG : Special Clearance
- ⑦ Tolerance class  
Omitted : ISO Normal, P6 : ISO Class 6,  
P5 : ISO Class 5, P4 : ISO Class 4
- ⑧ NSKHPS™  
& : NSKHPS™ Designation  
Tolerance Class : ISO Normal



## NSKHPS™ Cylindrical Roller Bearings

### Features

Compared with conventional bearings ...

Maximum  
Bearing Life  
**60%**  
longer

New Product  
Wide product  
lineup

#### 1. Improved reliability

Up to 60% longer life than that of conventional bearings by optimization of the bearing's internal design and improvement of processing technology.

#### 2. Wide product lineup

NSK offers a wide lineup of NSKHPS bearings with four types of cages for wide range of sizes, offering a high degree of versatility for various general-purpose applications.

- Pressed-steel cage with high cost performance
- Highly reliable machined-brass cage
- Polyamide-resin cage that excels in heat and chemical resistance

## PRECAUTIONS FOR USE OF CYLINDRICAL ROLLER BEARINGS

If the load on cylindrical roller bearings becomes too small during operation, slippage occurs between the rollers and raceways, which may result in smearing. This tendency is prevalent especially with large bearings since the weight of the rollers and cage is high.

In case of strong shock loads or vibration, pressed-steel cages are sometimes inadequate.

If very small bearing loads, strong shock loads, or vibration are expected, please consult with NSK for selection of the bearings.

Bearings with molded polyamide cages (ET type) can be used continuously at temperatures between  $-40$  and  $120^{\circ}\text{C}$ . If the bearings are to be used in gear oil, nonflammable hydraulic oil, or ester oil at a temperature over  $100^{\circ}\text{C}$ , please contact NSK beforehand.

## TOLERANCES AND RUNNING ACCURACY

**CYLINDRICAL ROLLER BEARINGS** ..... Table 7.2 (Pages A128 to A131)

**NSKHPS CYLINDRICAL ROLLER BEARINGS**

Tolerance for Dimensions : ISO Normal

Running Accuracy : ISO Normal

**DOUBLE-ROW CYLINDRICAL ROLLER**

**BEARINGS** ..... Table 7.2 (Pages A128 to A131)

**Table 2 Tolerances for Roller Inscribed Circle Diameter  $F_w$  and Roller Circumscribed Circle Diameter  $E_w$  of Cylindrical Roller Bearings With Interchangeable Rings**

Units : m

Nominal Bore Diameter $d$ (mm)		Tolerances for $F_w$ of Types NU, NJ, NUP, NH, and NNU $\Delta F_w$		Tolerances for $E_w$ of Types N, NF, and NN $\Delta E_w$	
over	incl.	high	low	high	low
—	20	+10	0	0	−10
20	50	+15	0	0	−15
50	120	+20	0	0	−20
120	200	+25	0	0	−25
200	250	+30	0	0	−30
250	315	+35	0	0	−35
315	400	+40	0	0	−40
400	500	+45	0	—	—

## RECOMMENDED FITS

<b>CYLINDRICAL ROLLER BEARINGS</b> .....	Table 8.3 (Page A164)
	Table 8.5 (Page A165)
<b>DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS</b> .....	Table 8.3 (Page A164)
	Table 8.5 (Page A165)

## INTERNAL CLEARANCES

<b>CYLINDRICAL ROLLER BEARINGS</b> .....	Table 8.15 (Page A171)
<b>NSKHPS CYLINDRICAL ROLLER BEARINGS</b>	
<b>INTERNAL CLEARANCE DESIGNATION : CN, C3, C4</b>	
<b>DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS</b> .....	Table 8.15 (Page A171)

## PERMISSIBLE MISALIGNMENT

The permissible misalignment of cylindrical roller bearings varies depending on the type and internal specifications, but under normal loads, the angles are approximately as follows:

Cylindrical roller bearings of Width Series 0 or 1 .....	0.0012 radian (4')
Cylindrical roller bearings of Width Series 2 .....	0.0006 radian (2')
For double-row cylindrical roller bearings, nearly no misalignment is allowed.	



## LIMITING SPEEDS (Mechanical)

In some single-row cylindrical roller bearings, optional cage types are available for special purposes or customer requests. The limiting speeds (mechanical) in the bearing tables reflect values for the standard cage type. Please consult with NSK regarding limiting speeds (mechanical) for optional cages.

## LIMITING SPEEDS (Grease/Oil)

The limiting speeds (grease) and limiting speeds (oil) listed in the bearing tables should be adjusted depending on bearing load. Furthermore, higher speeds are attainable by making changes in the lubrication method, cage design, etc. Refer to Page A098 for more detailed information.

## TECHNICAL DATA

### Free Space of Cylindrical Roller Bearings

Cylindrical roller bearings often employ grease lubrication because it makes maintenance easier and simplifies the peripheral construction of the housing. Select a grease brand appropriate for the operating conditions while noting the grease fill amount and position of the bearing and housing.

Cylindrical roller bearings can be divided into types NU, NJ, N, NF, NH, and NUP according to the collar, collar ring, and position of the inner or outer ring ribs. Even if bearings belong to the same Dimension Series, they may have different amounts of free space depending on whether the cage

provided is made from pressed-steel or from machined high-tension brass. When determining the grease filling amount, please refer to Tables 1 and 2 for the free space of NU type bearings.

For other types, the free space can be determined from a free space ratio based on the NU type, as shown in Table 3. For example, the free space of an NJ310 bearing with a pressed steel cage may be calculated approximately as 47 cm<sup>3</sup>. This result was obtained by multiplying the free space of the bearing (52 cm<sup>3</sup>) in Table 1 by the space ratio 0.90 for the NJ type (Table 3).

**Table 1 Free Space of Cylindrical Roller Bearings  
(NU Type) (1) (With Pressed Cage)**

Units: cm<sup>3</sup>

Bearing Bore No.	Bearing Free Space			
	Bearing Series			
	NU2	NU3	NU22	NU23
05	6.6	11	7.8	16
06	9.6	17	12	24
07	14	22	18	35
08	18	31	22	44
09	20	42	23	62
10	23	52	26	80
11	30	68	35	102
12	37	85	45	130
13	44	107	57	156
14	51	124	62	179
15	58	155	70	226
16	71	177	85	260
17	85	210	104	300
18	103	244	134	365
19	132	283	164	415
20	151	335	200	540

**Table 2 Free Space of Cylindrical Roller Bearings  
(NU Type) (2) (With High-Tension Brass  
Machined Cage)**

Units: cm<sup>3</sup>

Bearing Bore No.	Bearing Free Space			
	Bearing Series			
	NU2	NU3	NU22	NU23
05	5.0	7.6	5.7	10
06	7.4	12	7.9	16
07	9.6	16	12	27
08	12	21	15	32
09	15	29	16	45
10	18	38	17	58
11	22	52	24	77
12	26	62	31	88
13	31	74	43	104
14	37	92	44	129
15	42	102	50	149
16	51	122	60	181
17	64	164	74	200
18	79	193	96	279
19	94	218	116	280
20	115	221	137	355

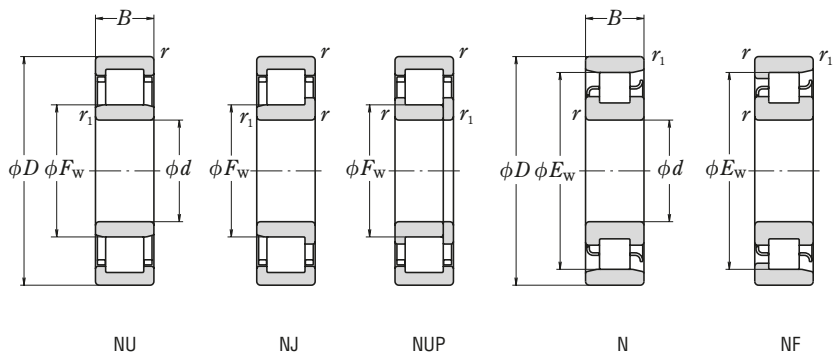
**Table 3 Ratio of Free Space in Cylindrical  
Roller Bearing Types**

NU Type	NJ Type	N Type	NF Type
1	0.90	1.05	0.95



# SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

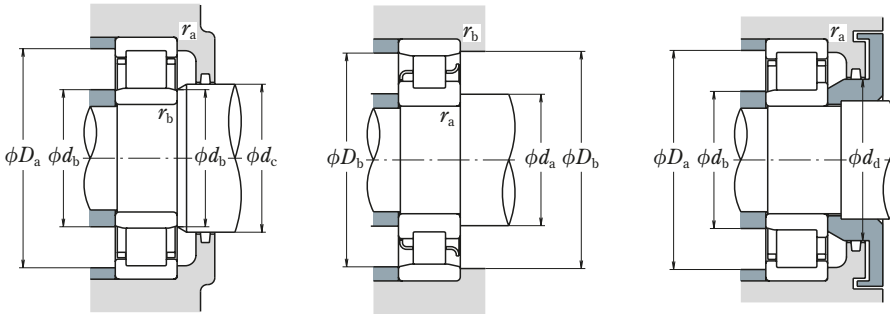
Bore Diameter 20 – 30 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )		
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Thermal Reference Speed	Limiting Speeds	
										<sup>(5)</sup> Mechanical	Grease
20	47	14	1	0.6	—	40	15 400	12 700	18 000	—	12 000
	47	14	1	0.6	26.5	—	25 700	22 600	16 000	—	13 000
	47	18	1	0.6	27	—	20 700	18 400	19 000	—	11 000
	52	15	1.1	0.6	—	44.5	21 400	17 300	14 000	—	10 000
	52	15	1.1	0.6	27.5	—	31 500	26 900	13 000	—	12 000
	52	21	1.1	0.6	28.5	—	30 500	27 200	14 000	—	11 000
	52	21	1.1	0.6	27.5	—	42 000	39 000	13 000	—	11 000
25	47	12	0.6	0.3	30.5	—	14 300	13 100	15 000	—	15 000
	52	15	1	0.6	—	45	17 700	15 700	16 000	—	10 000
	52	15	1	0.6	31.5	—	33 500	27 700	14 000	17 000	12 000
	52	15	1	0.6	31.5	—	29 300	27 700	14 000	17 000	12 000
	52	18	1	0.6	31.5	—	40 000	34 500	14 000	20 000	12 000
	52	18	1	0.6	31.5	—	35 000	34 500	14 000	20 000	12 000
	62	17	1.1	1.1	—	53	29 300	25 200	12 000	—	8 000
	62	17	1.1	1.1	34	—	48 000	37 500	11 000	15 000	10 000
	62	17	1.1	1.1	34	—	41 500	37 500	11 000	15 000	10 000
	62	24	1.1	1.1	34	—	65 500	56 000	11 000	18 000	9 000
	62	24	1.1	1.1	34	—	57 000	56 000	11 000	18 000	9 000
	80	21	1.5	1.5	38.8	62.8	46 500	40 000	9 500	—	7 100
30	55	13	1	0.6	36.5	48.5	19 700	19 600	13 000	—	12 000
	62	16	1	0.6	—	53.5	24 900	23 300	13 000	—	8 500
	62	16	1	0.6	37.5	—	45 000	37 500	12 000	14 000	9 500
	62	16	1	0.6	37.5	—	39 000	37 500	12 000	14 000	9 500
	62	20	1	0.6	37.5	—	56 500	50 000	12 000	17 000	9 500
	62	20	1	0.6	37.5	—	49 000	50 000	12 000	17 000	9 500
	72	19	1.1	1.1	—	62	38 500	35 000	10 000	—	7 100
	72	19	1.1	1.1	40.5	—	61 000	50 000	9 500	13 000	8 500
	72	19	1.1	1.1	40.5	—	53 000	50 000	9 500	13 000	8 500
	72	27	1.1	1.1	40.5	—	86 000	77 500	9 500	16 000	8 000
	72	27	1.1	1.1	40.5	—	74 500	77 500	9 500	16 000	8 000
	90	23	1.5	1.5	45	73	62 500	55 000	8 500	—	6 000

Notes (1) Cage designation (M) is usually omitted from the bearing designation.

(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)
							Cage <sup>(1)</sup>	<sup>(2)</sup>					$d_a^{(3)}$	$d_b$	$d_b^{(4)}$	$d_c$	
Standard Option							min.	min.	max.	min.	min.	max.	max.	min.	max.	max.	approx.
N 204	W	—	—	—	—	N NF	25	—	—	—	—	—	43	42	1	0.6	0.107
NU204E	T	T7	NU NJ	NUP	—	—	25	24	25	29	32	42	—	—	1	0.6	0.107
NU2204	W	M	NU NJ	—	—	—	25	24	25	29	32	42	—	—	1	0.6	0.144
N 304	W	—	—	—	—	N NF	26.5	—	—	—	—	—	48	46	1	0.6	0.148
NU304E	T	T7	NU NJ	NUP	—	—	26.5	24	26	30	33	45.5	—	—	1	0.6	0.145
NU2304	M	—	NU NJ	NUP	—	—	26.5	24	27	30	33	45.5	—	—	1	0.6	0.217
NU2304E	T7	—	NU NJ	NUP	—	—	26.5	24	26	30	33	45.5	—	—	1	0.6	0.209
NU1005	(M)	—	NU	—	—	—	—	27	30	32	—	43	—	—	0.6	0.3	0.094
N 205	W	M	—	—	—	N NF	30	—	—	—	—	—	48	46	1	0.6	0.135
*NU205E	W	M, T, T7	NU NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.136
NU205E	W	M, T, T7	NU NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.136
*NU2205E	M	T, T7	NU NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.16
NU2205E	M	T, T7	NU NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.16
N 305	W	M	—	—	—	N NF	31.5	—	—	—	—	—	55.5	50	1	1	0.233
*NU305E	W	M, T, T7	NU NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.269
NU305E	W	M, T, T7	NU NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.269
*NU2305E	M	T, T7	NU NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.338
NU2305E	M	T, T7	NU NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.338
NU405	W	—	NU NJ	—	N NF	—	33	33	37	41	46	72	72	64	1.5	1.5	0.57
NU1006	(M)	—	NU	—	—	N	35	34	36	38	—	50	51	49	1	0.5	0.136
N 206	W	M	—	—	—	N NF	35	—	—	—	—	—	58	56	1	0.6	0.208
*NU206E	W	M, T, T7	NU NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.205
NU206E	W	M, T, T7	NU NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.205
*NU2206E	M	T, T7	NU NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.255
NU2206E	M	T, T7	NU NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.255
N 306	W	M	—	—	—	N NF	36.5	—	—	—	—	—	65.5	64	1	1	0.353
*NU306E	W	M, T, T7	NU NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.409
NU306E	W	M, T, T7	NU NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.409
*NU2306E	M	T, T7	NU NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.518
NU2306E	M	T, T7	NU NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.518
NU406	W	M	NU NJ	—	N NF	—	38	38	43	47	52	82	82	75	1.5	1.5	0.758

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

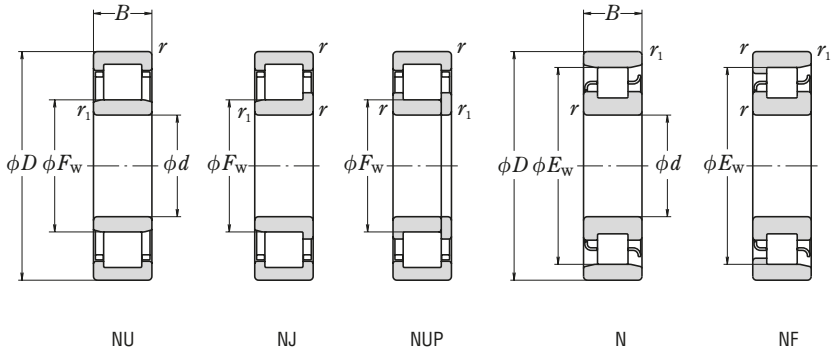
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

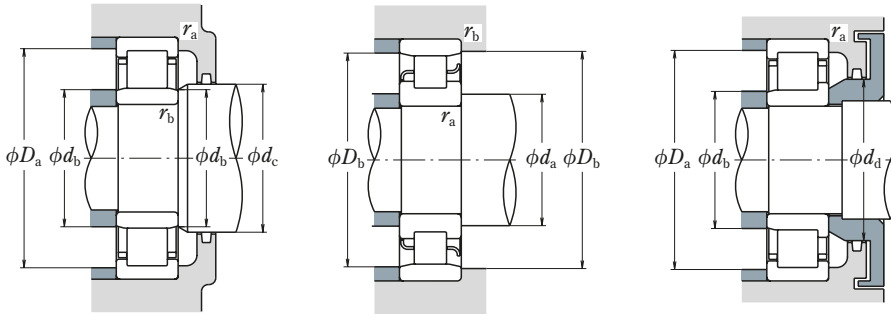
Bore Diameter 35 – 40 mm



<i>d</i>	Boundary Dimensions (mm)						Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
<b>35</b>	62	14	1	0.6	42	55	22 600	23 200	11 000	—	11 000
	72	17	1.1	0.6	—	61.8	35 500	34 000	11 000	—	7 500
	72	17	1.1	0.6	44	—	58 000	50 000	10 000	12 000	8 500
	72	17	1.1	0.6	44	—	50 500	50 000	10 000	12 000	8 500
	72	23	1.1	0.6	44	—	71 000	65 500	11 000	15 000	8 500
	72	23	1.1	0.6	44	—	61 500	65 500	11 000	15 000	8 500
	80	21	1.5	1.1	—	68.2	49 500	47 000	9 500	—	6 300
	80	21	1.5	1.1	46.2	—	76 500	65 500	8 500	11 000	7 500
	80	21	1.5	1.1	46.2	—	66 500	65 500	8 500	11 000	7 500
	80	31	1.5	1.1	46.2	—	107 000	101 000	9 000	14 000	6 700
	80	31	1.5	1.1	46.2	—	93 000	101 000	9 000	14 000	6 700
	100	25	1.5	1.5	53	83	75 500	69 000	7 500	—	5 300
	68	15	1	0.6	47	61	27 300	29 000	10 000	—	10 000
	80	18	1.1	1.1	—	70	43 500	43 000	9 500	—	6 700
	80	18	1.1	1.1	49.5	—	64 000	55 500	9 000	11 000	7 500
<b>40</b>	80	18	1.1	1.1	49.5	—	55 500	55 500	9 000	11 000	7 500
	80	23	1.1	1.1	49.5	—	83 000	77 500	9 000	13 000	7 500
	80	23	1.1	1.1	49.5	—	72 500	77 500	9 000	13 000	7 500
	90	23	1.5	1.5	—	77.5	58 500	57 000	8 500	—	5 600
	90	23	1.5	1.5	52	—	95 500	81 500	7 500	10 000	6 700
	90	23	1.5	1.5	52	—	83 000	81 500	7 500	10 000	6 700
	90	33	1.5	1.5	52	—	131 000	122 000	8 000	12 000	6 000
	90	33	1.5	1.5	52	—	114 000	122 000	8 000	12 000	6 000
	110	27	2	2	58	92	95 500	89 000	6 700	—	4 800

**Notes** (<sup>1</sup>) Cage designation (M) is usually omitted from the bearing designation.

(<sup>2</sup>) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)	
							Cage <sup>(1)</sup>		(2)			$d_a^{(3)}$	$d_b$	$d_b^{(4)}$	$d_c$	$d_d$	$D_a^{(3)}$	$D_b$
Standard Option							min.	min.	max.	min.	min.	max.	max.	min.	max.	max.		
NU 1007	(M)	—	NU	NJ	—	N	—	40	39	41	44	—	57	58	56	1	0.5	0.18
N 207	W	M	—	—	—	N	NF	41.5	—	—	—	—	68	64	1	0.6	0.301	
*NU207E	W	M, T, T7	NU	NJ	NUP	—	—	41.5	39	42	46	50	65.5	—	—	1	0.6	0.304
NU207E	W	M, T, T7	NU	NJ	NUP	—	—	41.5	39	42	46	50	65.5	—	—	1	0.6	0.304
*NU2207E	M	T, T7	NU	NJ	NUP	—	—	41.5	39	42	46	50	65.5	—	—	1	0.6	0.40
NU2207E	M	T, T7	NU	NJ	NUP	—	—	41.5	39	42	46	50	65.5	—	—	1	0.6	0.40
N 307	W	M	—	—	—	N	NF	43	—	—	—	—	73.5	70	1.5	1	0.476	
*NU307E	W	M, T, T7	NU	NJ	NUP	—	—	41.5	41.5	44	48	53	72	—	—	1.5	1	0.545
NU307E	W	M, T, T7	NU	NJ	NUP	—	—	41.5	41.5	44	48	53	72	—	—	1.5	1	0.545
*NU2307E	M	T, T7	NU	NJ	NUP	—	—	43	41.5	44	48	53	72	—	—	1.5	1	0.711
NU2307E	M	T, T7	NU	NJ	NUP	—	—	43	41.5	44	48	53	72	—	—	1.5	1	0.711
NU407	W	—	NU	NJ	—	N	NF	43	43	51	55	61	92	92	85	1.5	1.5	1.01
NU1008	(M)	—	NU	NJ	NUP	N	—	45	44	46	49	—	63	64	62	1	0.6	0.223
N 208	W	M	—	—	—	N	NF	46.5	—	—	—	—	73.5	72	1	1	0.375	
*NU208E	W	M, T, T7	NU	NJ	NUP	—	—	46.5	46.5	48	52	56	73.5	—	—	1	1	0.379
NU208E	W	M, T, T7	NU	NJ	NUP	—	—	46.5	46.5	48	52	56	73.5	—	—	1	1	0.379
*NU2208E	M	T, T7	NU	NJ	NUP	—	—	46.5	46.5	48	52	56	73.5	—	—	1	1	0.480
NU2208E	M	T, T7	NU	NJ	NUP	—	—	46.5	46.5	48	52	56	73.5	—	—	1	1	0.480
N 308	W	M	—	—	—	N	NF	48	—	—	—	—	82	79	1.5	1.5	0.649	
*NU308E	W	M, T, T7	NU	NJ	NUP	—	—	48	48	50	55	60	82	—	—	1.5	1.5	0.747
NU308E	W	M, T, T7	NU	NJ	NUP	—	—	48	48	50	55	60	82	—	—	1.5	1.5	0.747
*NU2308E	M	T, T7	NU	NJ	NUP	—	—	48	48	50	55	60	82	—	—	1.5	1.5	0.933
NU2308E	M	T, T7	NU	NJ	NUP	—	—	48	48	50	55	60	82	—	—	1.5	1.5	0.933
NU408	W	—	NU	NJ	NUP	N	NF	49	49	56	60	67	101	101	94	2	2	1.28

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

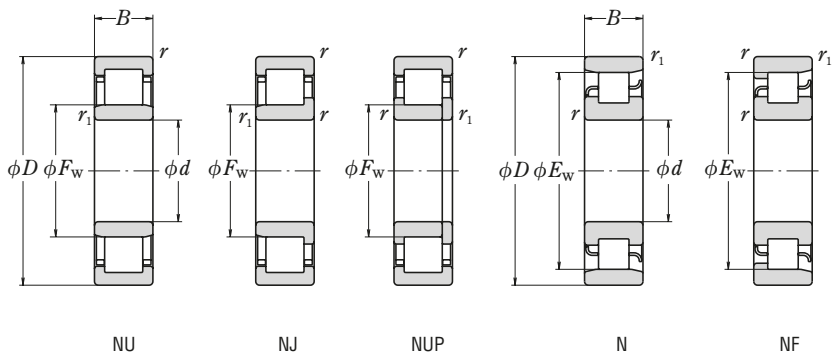
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

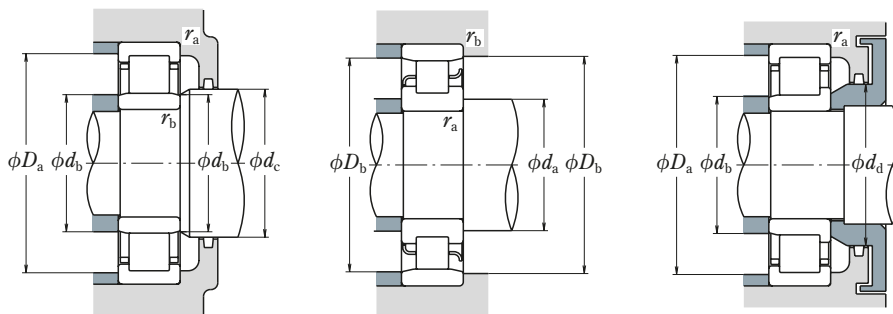
Bore Diameter 45 – 50 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>2</sup> ) Mechanical	Grease
45	75	16	1	0.6	52.5	67.5	32 500	35 500	9 500	—	9 000
	85	19	1.1	1.1	—	75	46 000	47 000	9 000	—	6 300
	85	19	1.1	1.1	54.5	—	72 500	66 500	8 500	10 000	6 700
	85	19	1.1	1.1	54.5	—	63 000	66 500	8 500	10 000	6 700
	85	23	1.1	1.1	54.5	—	87 500	84 500	8 500	12 000	6 700
	85	23	1.1	1.1	54.5	—	76 000	84 500	8 500	12 000	6 700
	100	25	1.5	1.5	—	86.5	79 000	77 500	7 500	—	5 000
	100	25	1.5	1.5	58.5	—	112 000	98 500	7 100	9 000	6 000
	100	25	1.5	1.5	58.5	—	97 500	98 500	7 100	9 000	6 000
	100	36	1.5	1.5	58.5	—	158 000	153 000	7 100	11 000	5 300
	100	36	1.5	1.5	58.5	—	137 000	153 000	7 100	11 000	5 300
	120	29	2	2	64.5	100.5	107 000	102 000	6 300	—	4 300
	80	16	1	0.6	57.5	72.5	32 000	36 000	8 500	—	8 000
	90	20	1.1	1.1	—	80.4	48 000	51 000	8 500	—	5 600
	90	20	1.1	1.1	59.5	—	79 500	76 500	8 000	9 000	6 300
50	90	20	1.1	1.1	59.5	—	69 000	76 500	8 000	9 000	6 300
	90	23	1.1	1.1	59.5	—	96 000	97 000	7 500	11 000	6 300
	90	23	1.1	1.1	59.5	—	83 500	97 000	7 500	11 000	6 300
	110	27	2	2	—	95	87 000	86 000	7 100	—	4 500
	110	27	2	2	65	—	127 000	113 000	6 700	8 000	5 000
	110	27	2	2	65	—	110 000	113 000	6 700	8 000	5 000
	110	40	2	2	65	—	187 000	187 000	6 700	10 000	5 000
	110	40	2	2	65	—	163 000	187 000	6 700	10 000	5 000
	130	31	2.1	2.1	—	110.8	139 000	136 000	5 600	—	4 000
	130	31	2.1	2.1	70.8	—	129 000	124 000	5 600	—	4 000

Notes (1) Cage designation (M) is usually omitted from the bearing designation.

(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)
							Cage <sup>(1)</sup>	(2)				$d_a^{(3)}$	$d_b$	$d_b^{(4)}$	$d_c$	$d_d$	$D_a^{(3)}$
Standard Option							min.	min.	max.	min.	min.	max.	max.	min.	max.	max.	approx.
NU 1009	(M)	—	NU	—	—	N	50	49	51	54	—	70	71	68	1	0.6	0.279
N 209	W	M	—	—	—	N	51.5	—	—	—	—	—	78.5	77	1	1	0.429
*NU209E	W	M, T, T7	NU	NJ	NUP	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.438
NU209E	W	M, T, T7	NU	NJ	NUP	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.438
*NU2209E	M	T, T7	NU	NJ	NUP	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.521
NU2209E	M	T, T7	NU	NJ	NUP	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.521
N 309	W	M	—	—	—	N	53	—	—	—	—	92	92	77	1.5	1.5	0.869
*NU309E	W	M, T, T7	NU	NJ	NUP	—	53	53	56	60	66	92	—	—	1.5	1.5	1.01
NU309E	W	M, T, T7	NU	NJ	NUP	—	53	53	56	60	66	92	—	—	1.5	1.5	1.01
*NU2309E	M	T, T7	NU	NJ	NUP	—	53	53	56	60	66	92	—	—	1.5	1.5	1.28
NU2309E	M	T, T7	NU	NJ	NUP	—	53	53	56	60	66	92	—	—	1.5	1.5	1.28
NU409	W	—	NU	NJ	NUP	N	54	54	62	66	74	111	111	103	2	2	1.62
NU1010	(M)	—	NU	NJ	NUP	N	55	54	56	59	—	75	76	73	1	0.6	0.301
N 210	W	M	—	—	—	N	56.5	—	—	—	—	—	83.5	82	1	1	0.483
*NU210E	W	M, T, T7	NU	NJ	NUP	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.50
NU210E	W	M, T, T7	NU	NJ	NUP	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.50
*NU2210E	M	T, T7	NU	NJ	NUP	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.562
NU2210E	M	T, T7	NU	NJ	NUP	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.562
N 310	W	M	—	—	—	N	59	—	—	—	—	101	97	2	2	1.11	
*NU310E	W	M, T, T7	NU	NJ	NUP	—	59	59	63	67	73	101	—	—	2	2	1.3
NU310E	W	M, T, T7	NU	NJ	NUP	—	59	59	63	67	73	101	—	—	2	2	1.3
*NU2310E	M	T, T7	NU	NJ	NUP	—	59	59	63	67	73	101	—	—	2	2	1.7
NU2310E	M	T, T7	NU	NJ	NUP	—	59	59	63	67	73	101	—	—	2	2	1.7
N 410	W	M	—	—	—	N	65	—	—	—	—	117	113	2	2	2	
NU410	W	M	NU	NJ	NUP	—	61	61	68	73	81	119	119	113.3	2	2	1.99

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

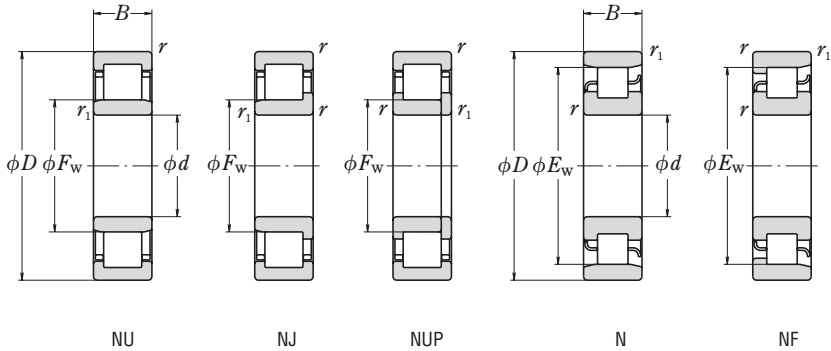
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

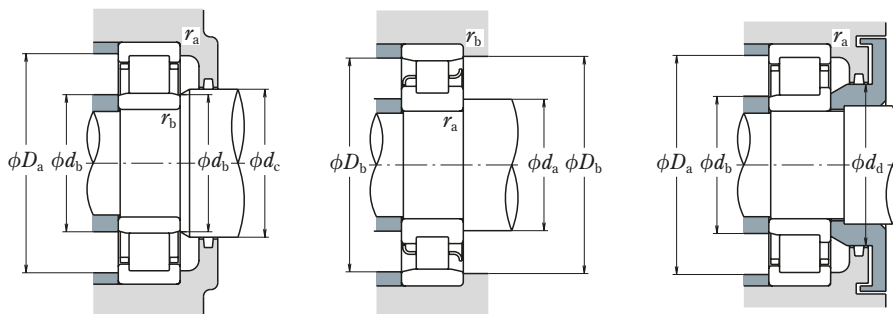
Bore Diameter 55 – 60 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>1</sup> ) Mechanical	Grease
55	90	18	1.1	1	64.5	80.5	37 500	44 000	8 000	—	7 500
	100	21	1.5	1.1	—	88.5	58 000	62 500	7 500	—	5 300
	100	21	1.5	1.1	66	—	99 000	98 500	6 700	8 500	5 600
	100	21	1.5	1.1	66	—	86 500	98 500	6 700	8 500	5 600
	100	25	1.5	1.1	66	—	117 000	122 000	6 700	10 000	5 600
	100	25	1.5	1.1	66	—	101 000	122 000	6 700	10 000	5 600
	120	29	2	2	—	104.5	111 000	111 000	6 300	—	4 000
	120	29	2	2	70.5	—	158 000	143 000	6 000	7 500	4 500
	120	29	2	2	70.5	—	137 000	143 000	6 000	7 500	4 500
	120	43	2	2	70.5	—	231 000	233 000	6 000	9 000	4 500
	120	43	2	2	70.5	—	201 000	233 000	6 000	9 000	4 500
	140	33	2.1	2.1	77.2	117.2	139 000	138 000	5 300	—	3 800
	95	18	1.1	1	69.5	85.5	40 000	48 500	7 500	—	6 700
	110	22	1.5	1.5	—	97.5	68 500	75 000	7 100	—	4 800
	110	22	1.5	1.5	72	—	112 000	107 000	6 300	7 500	5 300
60	110	22	1.5	1.5	72	—	97 500	107 000	6 300	7 500	5 300
	110	28	1.5	1.5	72	—	151 000	157 000	6 300	9 500	5 300
	110	28	1.5	1.5	72	—	131 000	157 000	6 300	9 500	5 300
	130	31	2.1	2.1	—	113	124 000	126 000	6 000	—	3 800
	130	31	2.1	2.1	77	—	124 000	126 000	6 000	—	3 800
	130	31	2.1	2.1	77	—	169 000	157 000	5 600	9 500	4 800
	130	31	2.1	2.1	77	—	150 000	157 000	5 600	9 500	4 800
	130	46	2.1	2.1	77	—	251 000	262 000	5 600	8 500	4 300
	130	46	2.1	2.1	77	—	222 000	262 000	5 600	8 500	4 300
	150	35	2.1	2.1	83	127	167 000	168 000	5 000	—	3 400

**Notes** (<sup>1</sup>) Cage designation (M) is usually omitted from the bearing designation.

(<sup>2</sup>) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)											Mass (kg)
		Cage <sup>(1)</sup>	(2)				$d_a^{(3)}$	$d_b$	$d_b^{(4)}$	$d_c$	$d_d$	$D_a^{(3)}$	$D_b$	$D_b$	$r_a$	$r_b$		
		Standard	Option	NU	NJ	NUP	N	NF	min.	min.	max.	min.	min.	max.	max.	min.	max.	approx.
NU1011	(M)	—	NU NJ	—	N	—	61.5	60	63	66	—	83.5	85	82	1	1	0.445	
N 211	W	M	—	—	—	N NF	63	—	—	—	—	—	93.5	91	1.5	1	0.634	
*NU211E	W	M, T, T7	NU NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.669	
NU211E	W	M, T, T7	NU NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.669	
*NU2211E	M	T, T7	NU NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.783	
NU2211E	M	T, T7	NU NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.783	
N 311	W	M	—	—	—	N NF	64	—	—	—	—	—	111	107	2	2	1.42	
*NU311E	W	M, T, T7	NU NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	1.64	
NU311E	W	M, T, T7	NU NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	1.64	
*NU2311E	M	T, T7	NU NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	2.18	
NU2311E	M	T, T7	NU NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	2.18	
NU411	W	—	NU NJ	NUP	N	NF	66	66	75	79	87	129	129	119	2	2	2.5	
NU1012	(M)	—	NU NJ	—	N	NF	66.5	65	68	71	—	88.5	90	87	1	1	0.474	
N 212	W	M	—	—	—	N NF	68	—	—	—	—	—	102	100	1.5	1.5	0.823	
*NU212E	W	M, T, T7	NU NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	0.824	
NU212E	W	M, T, T7	NU NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	0.824	
*NU2212E	M	T, T7	NU NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	1.06	
NU2212E	M	T, T7	NU NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	1.06	
N 312	W	M	—	—	—	N NF	71	—	—	—	—	—	119	115	2	2	1.78	
NU312	W	M	NU NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	1.82	
*NU312E	M	T, T7	NU NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.06	
NU312E	M	T, T7	NU NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.06	
*NU2312E	M	T, T7	NU NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.7	
NU2312E	M	T, T7	NU NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.7	
NU412	W	M	NU NJ	NUP	N	NF	71	71	80	85	94	139	139	130	2	2	3.04	

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

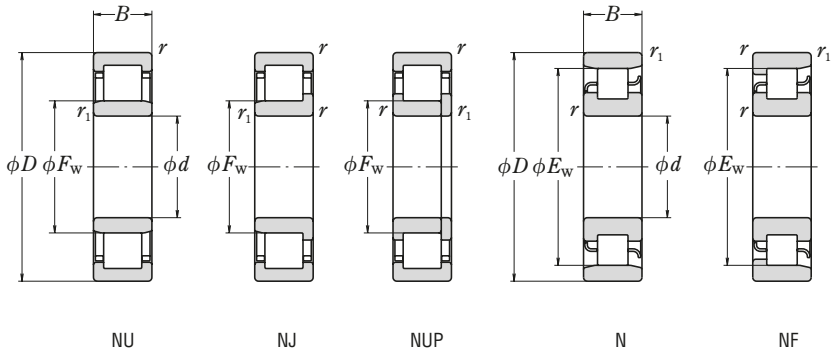
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPST<sup>TM</sup> cylindrical roller bearings.



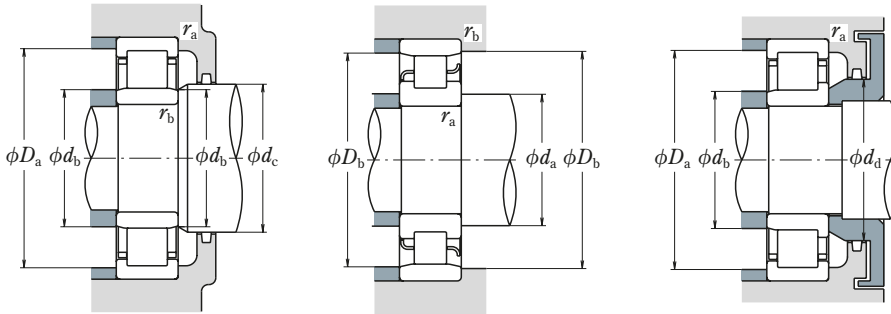
# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 65 – 70 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		<sup>(5)</sup> Mechanical	Grease
65	100	18	1.1	1	74.5	90.5	41 000	51 000	6 700	—	6 300
	120	23	1.5	1.5	—	105.6	84 000	94 500	6 300	—	4 300
	120	23	1.5	1.5	78.5	—	124 000	119 000	6 000	7 100	4 800
	120	23	1.5	1.5	78.5	—	108 000	119 000	6 000	7 100	4 800
	120	31	1.5	1.5	78.5	—	171 000	181 000	6 000	8 500	4 800
	120	31	1.5	1.5	78.5	—	149 000	181 000	6 000	8 500	4 800
	140	33	2.1	2.1	—	121.5	135 000	139 000	5 600	—	3 600
	140	33	2.1	2.1	83.5	—	135 000	139 000	5 600	—	3 600
	140	33	2.1	2.1	82.5	—	204 000	191 000	5 300	8 500	4 300
	140	33	2.1	2.1	82.5	—	181 000	191 000	5 300	8 500	4 300
	140	48	2.1	2.1	82.5	—	263 000	265 000	5 600	7 500	3 800
	140	48	2.1	2.1	82.5	—	233 000	265 000	5 600	7 500	3 800
	160	37	2.1	2.1	—	135.3	195 000	203 000	4 500	—	4 000
	160	37	2.1	2.1	89.3	—	182 000	186 000	4 800	—	3 200
	70	110	20	1.1	1	80	100	58 500	70 500	6 300	—
125		24	1.5	1.5	—	110.5	83 500	95 000	6 300	—	4 000
125		24	1.5	1.5	83.5	—	136 000	137 000	5 600	9 000	5 000
125		24	1.5	1.5	83.5	—	119 000	137 000	5 600	9 000	5 000
125		31	1.5	1.5	83.5	—	179 000	194 000	5 600	8 000	4 500
125		31	1.5	1.5	83.5	—	156 000	194 000	5 600	8 000	4 500
150		35	2.1	2.1	—	130	149 000	156 000	5 600	—	3 200
150		35	2.1	2.1	90	—	158 000	168 000	5 300	—	3 200
150		35	2.1	2.1	89	—	231 000	222 000	4 800	8 000	4 000
150		35	2.1	2.1	89	—	205 000	222 000	4 800	8 000	4 000
150		51	2.1	2.1	89	—	310 000	325 000	5 000	7 100	3 600
150		51	2.1	2.1	89	—	274 000	325 000	5 000	7 100	3 600
180		42	3	3	100	152	228 000	236 000	4 500	—	2 800

- Notes** (1) Cage designation (M) is usually omitted from the bearing designation.  
 (2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations								Abutment and Fillet Dimensions (mm)										Mass (kg)
Cage <sup>(1)</sup> Standard Option		<sup>(2)</sup> NU NJ NUP N NF						<sup>(3)</sup> <i>d</i> <sub>a</sub> min.	<i>d</i> <sub>b</sub> min.	<sup>(4)</sup> <i>d</i> <sub>b</sub> max.	<i>d</i> <sub>c</sub> min.	<i>d</i> <sub>d</sub> min.	<sup>(3)</sup> <i>D</i> <sub>a</sub> max.	<i>D</i> <sub>b</sub> max.	<i>D</i> <sub>b</sub> min.	<i>r</i> <sub>a</sub> max.	<i>r</i> <sub>b</sub> max.	approx.
NU1013	(M)	—	NU	NJ	—	N	NF	71.5	70	73	76	—	93.5	95	92	1	1	0.504
N 213	W	M	—	—	—	N	NF	73	—	—	—	—	—	112	108	1.5	1.5	1.05
*NU213E	W	M, T, T7	NU	NJ	NUP	—	—	73	73	76	81	87	112	—	—	1.5	1.5	1.05
NU213E	W	M, T, T7	NU	NJ	NUP	—	—	73	73	76	81	87	112	—	—	1.5	1.5	1.05
*NU2213E	M	T, T7	NU	NJ	NUP	—	—	73	73	76	81	87	112	—	—	1.5	1.5	1.41
NU2213E	M	T, T7	NU	NJ	NUP	—	—	73	73	76	81	87	112	—	—	1.5	1.5	1.41
N 313	W	M	—	—	—	N	NF	76	—	—	—	—	—	129	125	2	2	2.17
NU313	W	M	NU	NJ	NUP	—	—	76	76	81	85	93	129	—	—	2	2	2.23
*NU313E	M	T, T7	NU	NJ	NUP	—	—	76	76	80	85	93	129	—	—	2	2	2.56
NU313E	M	T, T7	NU	NJ	NUP	—	—	76	76	80	85	93	129	—	—	2	2	2.56
*NU2313E	M	T, T7	NU	NJ	NUP	—	—	76	76	80	85	93	129	—	—	2	2	3.16
NU2313E	M	T, T7	NU	NJ	NUP	—	—	76	76	80	85	93	129	—	—	2	2	3.16
N 413	M	—	—	—	—	N	NF	76	—	—	—	—	—	149	138.8	2	2	3.63
NU413	W	M	NU	NJ	—	—	—	76	76	86	91	100	149	—	—	2	2	3.63
NU1014	(M)	—	NU	NJ	NUP	N	NF	76.5	75	79	82	—	103.5	105	101	1	1	0.693
N 214	W	M	—	—	—	N	NF	78	—	—	—	—	—	117	113	1.5	1.5	1.14
*NU214E	M	T, T7	NU	NJ	NUP	—	—	78	78	81	86	92	117	—	—	1.5	1.5	1.29
NU214E	M	T, T7	NU	NJ	NUP	—	—	78	78	81	86	92	117	—	—	1.5	1.5	1.29
*NU2214E	M	T, T7	NU	NJ	NUP	—	—	78	78	81	86	92	117	—	—	1.5	1.5	1.49
NU2214E	M	T, T7	NU	NJ	NUP	—	—	78	78	81	86	92	117	—	—	1.5	1.5	1.49
N 314	W	M	—	—	—	N	NF	81	—	—	—	—	—	139	133.5	2	2	2.67
NU314	W	M	NU	NJ	NUP	—	—	81	81	87	92	100	139	—	—	2	2	2.75
*NU314E	M	T, T7	NU	NJ	NUP	—	—	81	81	86	92	100	139	—	—	2	2	3.09
NU314E	M	T, T7	NU	NJ	NUP	—	—	81	81	86	92	100	139	—	—	2	2	3.09
*NU2314E	M	T, T7	NU	NJ	NUP	—	—	81	81	86	92	100	139	—	—	2	2	3.92
NU2314E	M	T, T7	NU	NJ	NUP	—	—	81	81	86	92	100	139	—	—	2	2	3.92
NU414	W	M	NU	NJ	NUP	N	NF	83	83	97	102	112	167	167	155	2.5	2.5	5.28

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

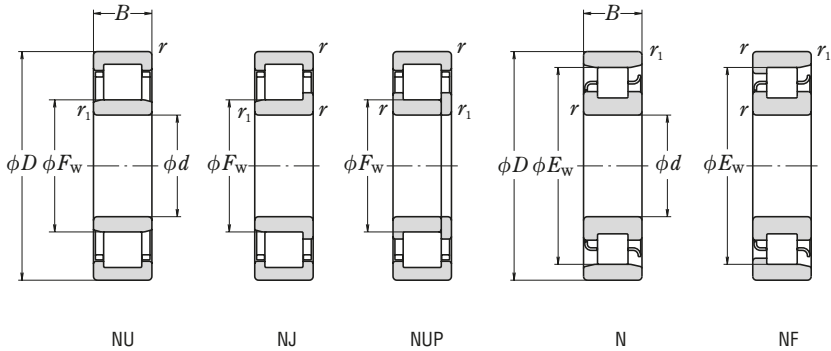
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSK HPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

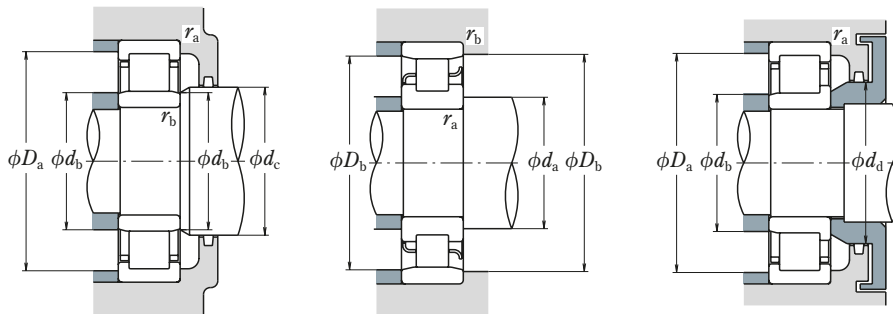
Bore Diameter 75 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>w</sub>	<i>E</i> <sub>w</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>2</sup> ) Mechanical	Grease
<b>75</b>	115	20	1.1	1	85	105	60 000	74 500	6 000	—	5 600
	130	25	1.5	1.5	—	116.5	96 500	111 000	6 000	—	3 800
	130	25	1.5	1.5	88.5	—	150 000	156 000	5 300	8 500	4 800
	130	25	1.5	1.5	88.5	—	130 000	156 000	5 300	8 500	4 800
	130	31	1.5	1.5	88.5	—	186 000	207 000	5 300	7 500	4 300
	130	31	1.5	1.5	88.5	—	162 000	207 000	5 300	7 500	4 300
	160	37	2.1	2.1	—	139.5	179 000	189 000	5 000	—	3 000
	160	37	2.1	2.1	95.5	—	179 000	189 000	5 000	—	3 000
	160	37	2.1	2.1	95	—	271 000	263 000	4 500	7 500	3 800
	160	37	2.1	2.1	95	—	240 000	263 000	4 500	7 500	3 800
	160	55	2.1	2.1	95	—	370 000	395 000	4 800	6 700	3 400
	160	55	2.1	2.1	95	—	330 000	395 000	4 800	6 700	3 400
	190	45	3	3	104.5	160.5	262 000	274 000	4 300	—	2 600

**Notes** (<sup>1</sup>) Cage designation (M) is usually omitted from the bearing designation.

(<sup>2</sup>) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)
	Cage <sup>(1)</sup> Standard Option			<sup>(2)</sup>			$d_a^{(3)}$ min.	$d_b$ min.	$d_b^{(4)}$ max.	$d_c$ min.	$d_d$ min.	$D_a^{(3)}$ max.	$D_b$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx.
				NU	NJ	NUP											
NU 1015	(M)	—	NU	—	—	N NF	81.5	80	83	87	—	108.5	110	106	1	1	0.731
N 215	W	M	—	—	—	N NF	83	—	—	—	—	—	122	119	1.5	1.5	1.23
*NU215E	M	T, T7	NU	NJ	NUP	—	83	83	86	90	96	122	—	—	1.5	1.5	1.44
NU215E	M	T, T7	NU	NJ	NUP	—	83	83	86	90	96	122	—	—	1.5	1.5	1.44
*NU2215E	M	T, T7	NU	NJ	NUP	—	83	83	86	90	96	122	—	—	1.5	1.5	1.57
NU2215E	M	T, T7	NU	NJ	NUP	—	83	83	86	90	96	122	—	—	1.5	1.5	1.57
N 315	W	M	—	—	—	N NF	86	—	—	—	—	—	149	143	2	2	3.2
NU315	W	M	NU	NJ	NUP	—	86	86	93	97	106	149	—	—	2	2	3.26
*NU315E	M	T, T7	NU	NJ	NUP	—	86	86	92	97	106	149	—	—	2	2	3.73
NU315E	M	T, T7	NU	NJ	NUP	—	86	86	92	97	106	149	—	—	2	2	3.73
*NU2315E	M	T, T7	NU	NJ	NUP	—	86	86	92	97	106	149	—	—	2	2	4.86
NU2315E	M	T, T7	NU	NJ	NUP	—	86	86	92	97	106	149	—	—	2	2	4.86
NU415	W	M	NU	NJ	—	N NF	88	88	102	107	118	177	177	164	2.5	2.5	6.27

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

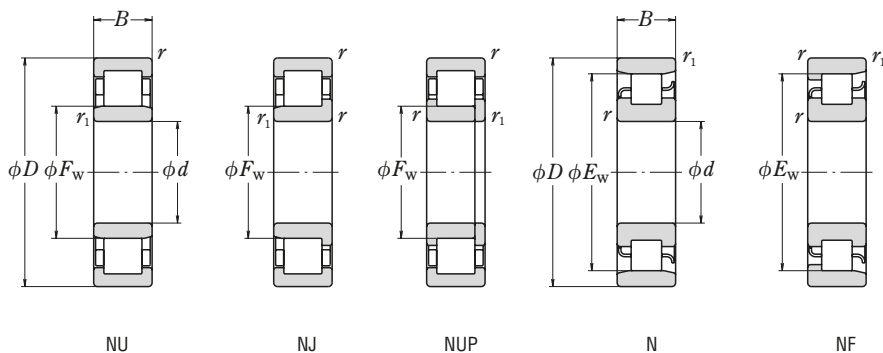
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKPS™ cylindrical roller bearings.



# SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

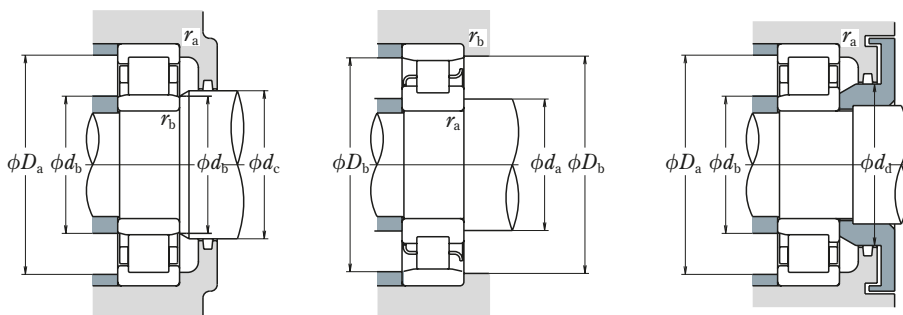
Bore Diameter 80 – 90 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
80	125	22	1.1	1	91.5	113.5	72 500	90 500	6 000	—	5 300
	140	26	2	2	—	125.3	106 000	122 000	5 600	—	3 600
	140	26	2	2	95.3	—	160 000	167 000	5 000	8 000	4 500
	140	26	2	2	95.3	—	139 000	167 000	5 000	8 000	4 500
	140	33	2	2	95.3	—	214 000	243 000	5 000	7 100	4 000
	140	33	2	2	95.3	—	186 000	243 000	5 000	7 100	4 000
	170	39	2.1	2.1	—	147	190 000	207 000	4 800	—	2 800
	170	39	2.1	2.1	101	—	289 000	282 000	4 300	7 100	3 600
	170	39	2.1	2.1	101	—	256 000	282 000	4 300	7 100	3 600
	170	58	2.1	2.1	101	—	400 000	430 000	4 500	6 300	3 200
	170	58	2.1	2.1	101	—	355 000	430 000	4 500	6 300	3 200
	200	48	3	3	110	170	299 000	315 000	4 000	—	2 600
	85	130	22	1.1	1	96.5	74 500	95 500	5 600	—	5 000
		150	28	2	2	—	120 000	140 000	5 300	—	3 400
		150	28	2	2	100.5	192 000	199 000	4 800	7 500	4 300
		150	28	2	2	100.5	167 000	199 000	4 800	7 500	4 300
		150	36	2	2	100.5	250 000	279 000	4 800	6 700	3 800
		150	36	2	2	100.5	217 000	279 000	4 800	6 700	3 800
		180	41	3	3	—	225 000	247 000	4 500	—	2 600
		180	41	3	3	108	212 000	228 000	4 800	—	2 600
		180	41	3	3	108	360 000	330 000	4 000	6 700	3 400
		180	41	3	3	108	291 000	330 000	4 000	6 700	3 400
		180	60	3	3	108	485 000	485 000	4 300	6 000	3 000
		180	60	3	3	108	395 000	485 000	4 300	6 000	3 000
		210	52	4	4	113	335 000	350 000	4 000	—	3 000
	90	140	24	1.5	1.1	103	88 000	114 000	5 300	—	4 500
		160	30	2	2	—	152 000	178 000	5 000	—	3 200
		160	30	2	2	107	205 000	217 000	4 800	7 100	4 000
		160	30	2	2	107	182 000	217 000	4 800	7 100	4 000
		160	40	2	2	107	274 000	315 000	4 800	6 300	3 600
		160	40	2	2	107	242 000	315 000	4 800	6 300	3 600
		190	43	3	3	—	240 000	265 000	4 500	—	2 600
		190	43	3	3	115	240 000	265 000	4 500	—	2 600
		190	43	3	3	113.5	390 000	355 000	4 000	6 300	3 200
		190	43	3	3	113.5	315 000	355 000	4 000	6 300	3 200
		190	64	3	3	113.5	535 000	535 000	4 000	5 600	2 800
		190	64	3	3	113.5	435 000	535 000	4 000	5 600	2 800
		225	54	4	4	123.5	375 000	400 000	3 600	—	2 800

**Notes** (<sup>1</sup>) Cage designation (M) is usually omitted from the bearing designation.

(<sup>2</sup>) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)											Mass (kg)
		Cage <sup>(1)</sup>	(2)				d <sub>a</sub> <sup>(3)</sup>	d <sub>b</sub>	d <sub>b</sub> <sup>(4)</sup>	d <sub>c</sub>	d <sub>d</sub>	D <sub>a</sub> <sup>(3)</sup>	D <sub>b</sub>	D <sub>b</sub>	r <sub>a</sub>	r <sub>b</sub>		
Standard Option			NU	NJ	NUP	N	min.	min.	max.	min.	min.	max.	max.	min.	max.	max.	approx.	
NU 1016	(M)	—	NU	—	NUP	N	86.5	85	90	94	—	118.5	120	115	1	1	0.969	
N 216	W	M	—	—	—	N NF	89	—	—	—	—	—	131	128	2	2	1.47	
*NU216E	M	T, T7	NU	NJ	NUP	—	89	89	92	97	104	131	—	—	2	2	1.7	
NU216E	M	T, T7	NU	NJ	NUP	—	89	89	92	97	104	131	—	—	2	2	1.7	
*NU2216E	M	T, T7	NU	NJ	NUP	—	89	89	92	97	104	131	—	—	2	2	1.96	
NU2216E	M	T, T7	NU	NJ	NUP	—	89	89	92	97	104	131	—	—	2	2	1.96	
N 316	W	M	—	—	—	N NF	91	—	—	—	—	—	159	150	2	2	3.85	
*NU316E	M	T, T7	NU	NJ	NUP	—	91	91	98	105	114	159	—	—	2	2	4.45	
NU316E	M	T, T7	NU	NJ	NUP	—	91	91	98	105	114	159	—	—	2	2	4.45	
*NU2316E	M	T, T7	NU	NJ	NUP	—	91	91	98	105	114	159	—	—	2	2	5.73	
NU2316E	M	T, T7	NU	NJ	NUP	—	91	91	98	105	114	159	—	—	2	2	5.73	
NU416	W	M	NU	NJ	—	N NF	93	93	107	112	124	187	187	173	2.5	2.5	7.36	
NU1017	(M)	—	NU	—	—	N	91.5	90	95	99	—	123.5	125	120	1	1	1.01	
N 217	W	M	—	—	—	N NF	94	—	—	—	—	—	141	137	2	2	1.87	
*NU217E	M	T, T7	NU	NJ	NUP	—	94	94	98	104	110	141	—	—	2	2	2.11	
NU217E	M	T, T7	NU	NJ	NUP	—	94	94	98	104	110	141	—	—	2	2	2.11	
*NU2217E	M	T, T7	NU	NJ	NUP	—	94	94	98	104	110	141	—	—	2	2	2.44	
NU2217E	M	T, T7	NU	NJ	NUP	—	94	94	98	104	110	141	—	—	2	2	2.44	
N 317	W	M	—	—	—	N NF	98	—	—	—	—	—	167	159	2.5	2.5	4.53	
NU317	W	N	NU	NJ	NUP	—	98	98	105	110	119	167	—	—	2.5	2.5	4.6	
*NU317E	M	—	NU	NJ	NUP	—	98	98	105	110	119	167	—	—	2.5	2.5	5.26	
NU317E	M	T, T7	NU	NJ	NUP	—	98	98	105	110	119	167	—	—	2.5	2.5	5.26	
*NU2317E	M	—	NU	NJ	NUP	—	98	98	105	110	119	167	—	—	2.5	2.5	6.77	
NU2317E	M	T, T7	NU	NJ	NUP	—	98	98	105	110	119	167	—	—	2.5	2.5	6.77	
NU417	M	—	NU	NJ	—	N NF	101	101	110	115	128	194	194	180	3	3	9.56	
NU1018	(M)	—	NU	—	NUP	N	98	96.5	101	106	—	132	133.5	129	1.5	1	1.35	
N 218	W	M	—	—	—	N NF	99	—	—	—	—	—	151	146	2	2	2.31	
*NU218E	M	T, T7	NU	NJ	NUP	—	99	99	104	109	116	151	—	—	2	2	2.6	
NU218E	M	T, T7	NU	NJ	NUP	—	99	99	104	109	116	151	—	—	2	2	2.6	
*NU2218E	M	T, T7	NU	NJ	NUP	—	99	99	104	109	116	151	—	—	2	2	3.11	
NU2218E	M	T, T7	NU	NJ	NUP	—	99	99	104	109	116	151	—	—	2	2	3.11	
N 318	W	M	—	—	—	N NF	103	—	—	—	—	—	177	168	2.5	2.5	5.31	
NU318	W	M	NU	NJ	NUP	—	103	103	112	117	127	177	—	—	2.5	2.5	5.38	
*NU318E	M	—	NU	NJ	NUP	—	103	103	111	117	127	177	—	—	2.5	2.5	6.1	
NU318E	M	T, T7	NU	NJ	NUP	—	103	103	111	117	127	177	—	—	2.5	2.5	6.1	
*NU2318E	M	—	NU	NJ	NUP	—	103	103	111	117	127	177	—	—	2.5	2.5	7.9	
NU2318E	M	T, T7	NU	NJ	NUP	—	103	103	111	117	127	177	—	—	2.5	2.5	7.9	
NU418	M	—	NU	NJ	—	N NF	106	106	120	125	139	209	209	196	3	3	11.5	

Notes (3) If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

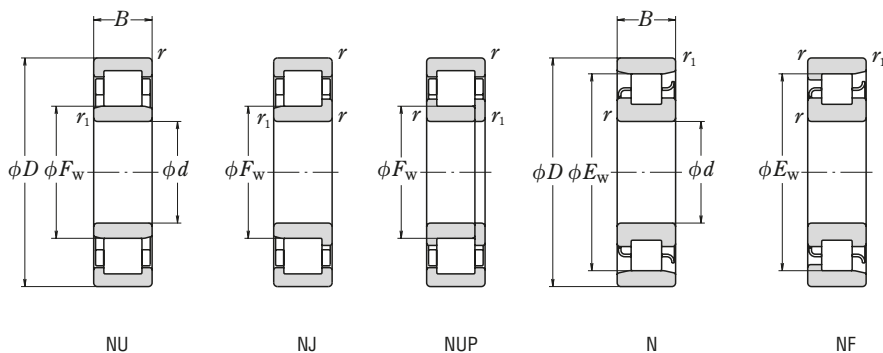
(4)  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

(5) The limiting speeds (mechanical) in the bearing tables are for standard cages.

Remark Bearings denoted by an asterisk (\*) are NSKPS™ cylindrical roller bearings.

# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

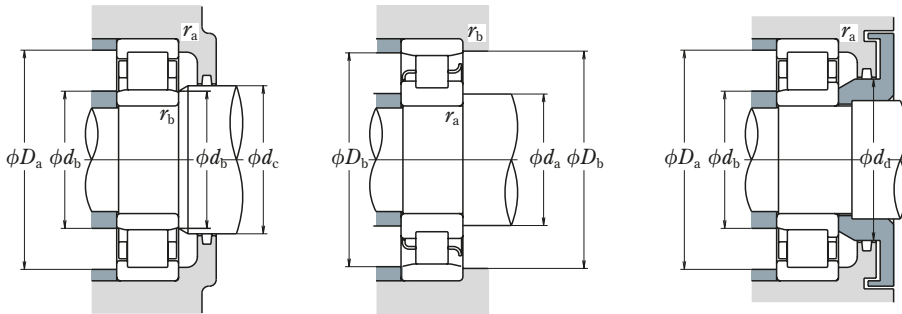
Bore Diameter 95 – 105 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
95	145	24	1.5	1.1	108	132	90 500	120 000	5 000	—	4 300
	170	32	2.1	2.1	—	151.5	166 000	196 000	4 800	—	3 000
	170	32	2.1	2.1	112.5	—	249 000	265 000	4 300	6 700	3 800
	170	32	2.1	2.1	112.5	—	220 000	265 000	4 300	6 700	3 800
	170	43	2.1	2.1	112.5	—	325 000	370 000	4 500	6 000	3 400
	170	43	2.1	2.1	112.5	—	286 000	370 000	4 500	6 000	3 400
	200	45	3	3	—	173.5	259 000	289 000	4 300	—	2 400
	200	45	3	3	121.5	—	259 000	289 000	4 300	—	2 400
	200	45	3	3	121.5	—	410 000	385 000	3 800	6 000	3 000
	200	45	3	3	121.5	—	335 000	385 000	3 800	6 000	3 000
	200	67	3	3	121.5	—	565 000	585 000	3 800	5 300	2 600
	200	67	3	3	121.5	—	460 000	585 000	3 800	5 300	2 600
	240	55	4	4	133.5	201.5	400 000	445 000	3 200	—	2 600
	150	24	1.5	1.1	113	137	93 000	126 000	4 800	—	4 300
	180	34	2.1	2.1	—	160	183 000	217 000	4 500	—	2 800
	180	34	2.1	2.1	119	—	305 000	305 000	4 300	6 300	3 600
	180	34	2.1	2.1	119	—	249 000	305 000	4 300	6 300	3 600
	180	46	2.1	2.1	119	—	410 000	445 000	4 300	5 600	3 200
	180	46	2.1	2.1	119	—	335 000	445 000	4 300	5 600	3 200
	215	47	3	3	—	185.5	299 000	335 000	4 000	—	2 200
	215	47	3	3	129.5	—	299 000	335 000	4 000	—	2 200
	215	47	3	3	127.5	—	465 000	425 000	3 600	5 600	2 800
100	215	47	3	3	127.5	—	380 000	425 000	3 600	5 600	2 800
	215	73	3	3	127.5	—	700 000	715 000	3 400	5 000	2 400
	215	73	3	3	127.5	—	570 000	715 000	3 400	5 000	2 400
	250	58	4	4	139	211	450 000	500 000	3 000	—	2 600
	160	26	2	1.1	119.5	145.5	109 000	149 000	4 500	—	4 000
	190	36	2.1	2.1	—	168.8	201 000	241 000	4 500	—	3 400
	190	36	2.1	2.1	125	—	320 000	310 000	4 300	6 000	3 400
	190	36	2.1	2.1	125	—	262 000	310 000	4 300	6 000	3 400
	225	49	3	3	—	195	340 000	390 000	3 800	—	2 200
	225	49	3	3	133	—	525 000	480 000	3 400	5 300	2 600
105	225	49	3	3	133	—	425 000	480 000	3 400	5 300	2 600
	260	60	4	4	144.5	220.5	495 000	555 000	2 800	—	2 400

Notes (1) Cage designation (M) is usually omitted from the bearing designation.

(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)											Mass (kg)
Cage <sup>(1)</sup> Standard Option			<sup>(2)</sup>				$d_a^{(3)}$ min.	$d_b$ min.	$d_b^{(4)}$ max.	$d_c$ min.	$d_d$ min.	$D_a^{(3)}$ max.	$D_b$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx.	
			NU	NJ	NUP	N												NF
NU1019	(M)	—	NU	NJ	—	N	—	103	101.5	106	111	—	137	138.5	134	1.5	1	1.41
N 219	W	M	—	—	—	N	NF	106	—	—	—	—	—	159	155	2	2	2.79
*NU219E	M	T, T7	NU	NJ	NUP	—	—	106	106	110	116	123	159	—	—	2	2	3.17
NU219E	M	T, T7	NU	NJ	NUP	—	—	106	106	110	116	123	159	—	—	2	2	3.17
*NU2219E	M	T, T7	NU	NJ	NUP	—	—	106	106	110	116	123	159	—	—	2	2	3.81
NU2219E	M	T, T7	NU	NJ	NUP	—	—	106	106	110	116	123	159	—	—	2	2	3.81
N 319	W	M	—	—	—	N	NF	108	—	—	—	—	—	187	177	2.5	2.5	6.09
NU319	W	M	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	6.23
*NU319E	M	—	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	7.13
NU319E	M	T, T7	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	7.13
*NU2319E	M	—	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	9.21
NU2319E	M	T, T7	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	9.21
NU419	M	—	NU	NJ	NUP	—	NF	111	111	130	136	149	224	224	206	3	3	13.6
NU1020	(M)	—	NU	NJ	NUP	N	—	108	106.5	111	116	—	142	143.5	139	1.5	1	1.47
N 220	W	M	—	—	—	N	NF	111	—	—	—	—	—	169	163	2	2	3.36
*NU220E	M	—	NU	NJ	NUP	—	—	111	111	116	122	130	169	—	—	2	2	3.81
NU220E	M	T, T7	NU	NJ	NUP	—	—	111	111	116	122	130	169	—	—	2	2	3.81
*NU2220E	M	—	NU	NJ	NUP	—	—	111	111	116	122	130	169	—	—	2	2	4.69
NU2220E	M	T, T7	NU	NJ	NUP	—	—	111	111	116	122	130	169	—	—	2	2	4.69
N 320	W	M	—	—	—	N	NF	113	—	—	—	—	—	202	190	2.5	2.5	7.59
NU320	W	M	NU	NJ	NUP	—	—	113	113	126	132	143	202	—	—	2.5	2.5	7.69
*NU320E	M	—	NU	NJ	NUP	—	—	113	113	124	132	143	202	—	—	2.5	2.5	8.63
NU320E	M	T, T7	NU	NJ	NUP	—	—	113	113	124	132	143	202	—	—	2.5	2.5	8.63
*NU2320E	M	—	NU	NJ	NUP	—	—	113	113	124	132	143	202	—	—	2.5	2.5	11.8
NU2320E	M	T, T7	NU	NJ	NUP	—	—	113	113	124	132	143	202	—	—	2.5	2.5	11.8
NU420	M	—	NU	NJ	—	N	NF	116	116	135	141	156	234	234	215	3	3	15.5
NU1021	(M)	—	NU	—	—	N	NF	114	111.5	118	122	—	151	153.5	147	2	1	1.83
N 221	W	M	—	—	—	N	NF	116	—	—	—	—	—	179	172	2	2	4.0
*NU221E	M	—	NU	NJ	NUP	—	—	116	116	121	129	137	179	—	—	2	2	4.58
NU221E	M	—	NU	NJ	NUP	—	—	116	116	121	129	137	179	—	—	2	2	4.58
N 321	W	M	—	—	—	N	NF	118	—	—	—	—	—	212	199	2.5	2.5	8.69
*NU321E	M	—	NU	NJ	NUP	—	—	118	118	131	137	149	212	—	—	2.5	2.5	9.84
NU321E	M	—	NU	NJ	NUP	—	—	118	118	131	137	149	212	—	—	2.5	2.5	9.84
NU421	M	—	NU	NJ	—	N	NF	121	121	141	147	162	244	244	225	3	3	17.3

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

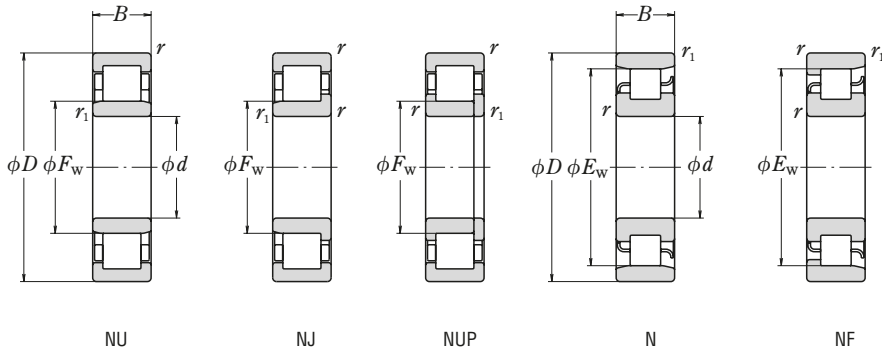
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

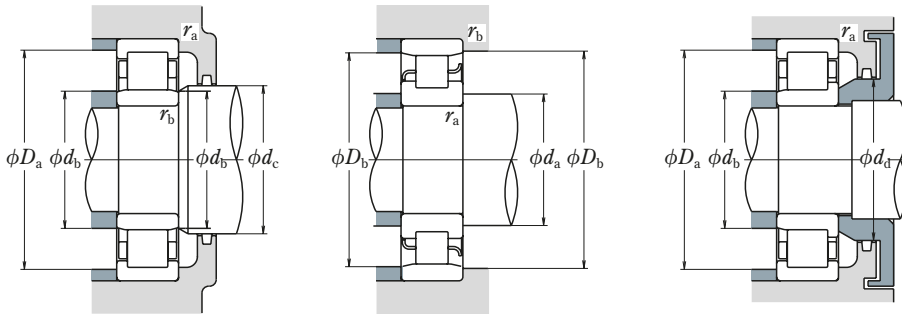
Bores Diameter 110 – 130 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
<b>110</b>	170	28	2	1.1	125	155	131 000	174 000	4 500	—	3 800
	200	38	2.1	2.1	—	178.5	229 000	272 000	4 300	—	2 600
	200	38	2.1	2.1	132.5	—	360 000	365 000	4 000	5 600	3 200
	200	38	2.1	2.1	132.5	—	293 000	365 000	4 000	5 600	3 200
	200	53	2.1	2.1	132.5	—	470 000	515 000	4 000	5 000	2 800
	200	53	2.1	2.1	132.5	—	385 000	515 000	4 000	5 000	2 800
	240	50	3	3	—	207	380 000	435 000	3 400	—	2 000
	240	50	3	3	143	—	555 000	525 000	3 200	5 000	2 600
	240	50	3	3	143	—	450 000	525 000	3 200	5 000	2 600
	240	80	3	3	143	—	830 000	880 000	3 000	4 500	2 200
	240	80	3	3	143	—	675 000	880 000	3 000	4 500	2 200
	280	65	4	4	155	—	550 000	620 000	2 600	—	2 200
	<b>120</b>	180	28	2	1.1	135	139 000	191 000	4 000	—	3 400
		215	40	2.1	2.1	—	260 000	320 000	4 000	—	2 400
		215	40	2.1	2.1	143.5	410 000	420 000	3 600	5 300	3 000
		215	40	2.1	2.1	143.5	335 000	420 000	3 600	5 300	3 000
		215	58	2.1	2.1	143.5	555 000	620 000	3 600	4 800	2 600
		215	58	2.1	2.1	143.5	450 000	620 000	3 600	4 800	2 600
		260	55	3	3	—	450 000	510 000	3 000	—	2 200
		260	55	3	3	154	650 000	610 000	2 800	4 800	2 200
		260	55	3	3	154	530 000	610 000	2 800	4 800	2 200
		260	86	3	3	154	975 000	1 030 000	2 600	4 300	2 000
		260	86	3	3	154	795 000	1 030 000	2 600	4 300	2 000
		310	72	5	5	170	675 000	770 000	2 400	—	2 000
	<b>130</b>	200	33	2	1.1	148	172 000	238 000	4 000	—	3 200
		230	40	3	3	—	270 000	340 000	3 800	—	2 200
		230	40	3	3	153.5	445 000	455 000	3 400	5 000	2 600
		230	40	3	3	153.5	365 000	455 000	3 400	5 000	2 600
		230	64	3	3	153.5	650 000	735 000	3 400	4 500	2 400
		230	64	3	3	153.5	530 000	735 000	3 400	4 500	2 400
		280	58	4	4	—	500 000	570 000	2 800	—	2 200
		280	58	4	4	167	760 000	735 000	2 600	4 300	2 200
		280	58	4	4	167	615 000	735 000	2 600	4 300	2 200
		280	93	4	4	167	1 130 000	1 230 000	2 400	3 800	1 900
		280	93	4	4	167	920 000	1 230 000	2 400	3 800	1 900
		340	78	5	5	185	825 000	955 000	2 000	—	1 800

Notes (<sup>1</sup>) Cage designation (M) is usually omitted from the bearing designation.

(<sup>2</sup>) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)	
Cage <sup>(1)</sup> Standard Option		<sup>(2)</sup>					<sup>(3)</sup>	<sup>(4)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	<sup>(3)</sup>	approx.
		NU	NJ	NUP	N	NF	<i>d</i> <sub>a</sub> min.	<i>d</i> <sub>b</sub> min.	<i>d</i> <sub>b</sub> max.	<i>d</i> <sub>c</sub> min.	<i>d</i> <sub>d</sub> min.	<i>D</i> <sub>a</sub> max.	<i>D</i> <sub>b</sub> max.	<i>D</i> <sub>b</sub> min.	<i>r</i> <sub>a</sub> max.	<i>r</i> <sub>b</sub> max.		
NU1022	(M)	—	NU	NJ	—	N	NF	119	116.5	123	128	—	161	163.5	157	2	1	2.27
N 222	W	M	—	—	—	N	NF	121	—	—	—	—	—	189	182	2	2	4.64
*NU222E	M	—	NU	NJ	NUP	—	—	121	121	129	135	144	189	—	—	2	2	5.37
NU222E	M	T, T7	NU	NJ	NUP	—	—	121	121	129	135	144	189	—	—	2	2	5.37
*NU2222E	M	—	NU	NJ	NUP	—	—	121	121	129	135	144	189	—	—	2	2	7.65
NU2222E	M	—	NU	NJ	NUP	—	—	121	121	129	135	144	189	—	—	2	2	7.65
N 322	W	M	—	—	—	N	NF	123	—	—	—	—	—	227	211	2.5	2.5	10.3
*NU322E	M	—	NU	NJ	NUP	—	—	123	123	139	145	158	227	—	—	2.5	2.5	11.8
NU322E	M	—	NU	NJ	NUP	—	—	123	123	139	145	158	227	—	—	2.5	2.5	11.8
*NU2322E	M	—	NU	NJ	NUP	—	—	123	123	139	145	158	227	—	—	2.5	2.5	18.8
NU2322E	M	—	NU	NJ	NUP	—	—	123	123	139	145	158	227	—	—	2.5	2.5	18.8
NU422	M	—	NU	NJ	—	—	—	126	126	151	157	173	264	—	—	3	3	22.1
NU1024	(M)	—	NU	NJ	NUP	N	—	129	126.5	133	138	—	171	173.5	167	2	1	2.43
N 224	W	M	—	—	—	N	NF	131	—	—	—	—	—	204	196	2	2	5.63
*NU224E	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	6.43
NU224E	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	6.43
*NU2224E	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	9.51
NU2224E	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	9.51
N 324	W	M	—	—	—	N	NF	133	—	—	—	—	—	247	230	2.5	2.5	12.9
*NU324E	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	15
NU324E	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	15
*NU2324E	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	25
NU2324E	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	25
NU424	M	—	NU	NJ	NUP	N	—	140	140	166	172	190	290	290	266	4	4	30.2
NU1026	(M)	—	NU	NJ	—	N	NF	139	136.5	146	151	—	191	193.5	184	2	1	3.66
N 226	W	M	—	—	—	N	NF	143	—	—	—	—	—	217	208	2.5	2.5	6.48
*NU226E	M	—	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	8.03
NU226E	M	T, T7	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	8.03
*NU2226E	M	—	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	9.44
NU2226E	M	—	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	9.44
N 326	M	—	—	—	—	N	NF	146	—	—	—	—	—	264	247.5	3	3	17.7
*NU326E	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	18.7
NU326E	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	18.7
*NU2326E	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	30
NU2326E	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	30
NU426	M	—	NU	NJ	—	—	NF	150	150	180	187	208	320	320	291	4	4	39.6

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

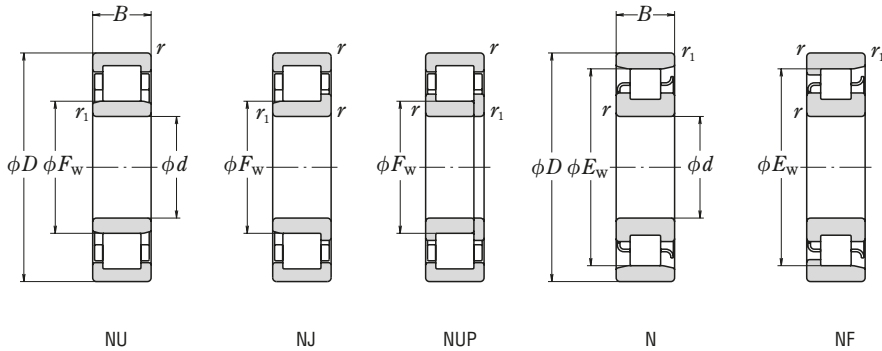
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

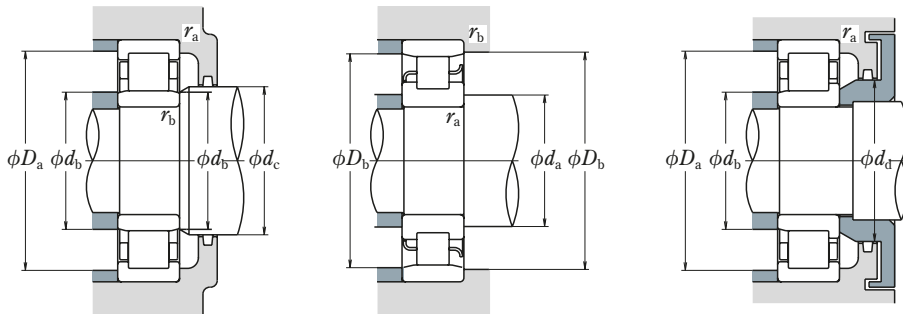
Bore Diameter 140 – 160 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
<b>140</b>	210	33	2	1.1	158	192	176 000	250 000	3 800	—	3 000
	250	42	3	3	—	221	297 000	375 000	3 400	—	2 000
	250	42	3	3	169	—	485 000	515 000	3 200	4 500	2 400
	250	42	3	3	169	—	395 000	515 000	3 200	4 500	2 400
	250	68	3	3	169	—	675 000	790 000	3 200	4 000	2 200
	250	68	3	3	169	—	550 000	790 000	3 200	4 000	2 200
	300	62	4	4	—	260	550 000	640 000	2 600	—	2 000
	300	62	4	4	180	—	815 000	795 000	2 400	4 000	2 000
	300	62	4	4	180	—	665 000	795 000	2 400	4 000	2 000
	300	102	4	4	180	—	1 250 000	1 380 000	2 200	2 600	1 700
	300	102	4	4	180	—	1 020 000	1 380 000	2 200	2 600	1 700
	360	82	5	5	198	302	875 000	1 020 000	1 900	—	1 700
	<b>150</b>	225	35	2.1	169.5	205.5	202 000	294 000	3 600	—	2 800
		270	45	3	—	238	360 000	465 000	3 000	—	1 800
		270	45	3	182	—	550 000	595 000	2 800	4 300	2 200
		270	45	3	182	—	450 000	595 000	2 800	4 300	2 200
		270	73	3	182	—	780 000	930 000	2 800	3 800	2 000
		270	73	3	182	—	635 000	930 000	2 800	3 800	2 000
		320	65	4	—	277	665 000	805 000	2 200	—	1 800
		320	65	4	193	—	930 000	920 000	2 200	3 800	1 800
		320	65	4	193	—	760 000	920 000	2 200	3 800	1 800
		320	108	4	193	—	1 430 000	1 600 000	2 000	2 400	1 600
		320	108	4	193	—	1 160 000	1 600 000	2 000	2 400	1 600
		380	85	5	213	—	930 000	1 120 000	1 700	—	1 600
	<b>160</b>	240	38	2.1	180	220	238 000	340 000	3 400	—	2 600
		290	48	3	—	255	430 000	570 000	2 800	—	2 200
		290	48	3	195	—	615 000	665 000	2 600	4 000	2 200
		290	48	3	195	—	500 000	665 000	2 600	4 000	2 200
		290	80	3	193	—	995 000	1 190 000	2 400	3 600	1 900
		290	80	3	193	—	810 000	1 190 000	2 400	3 600	1 900
		340	68	4	—	292	700 000	875 000	2 000	—	1 700
		340	68	4	204	—	1 060 000	1 050 000	1 900	3 600	1 700
		340	68	4	204	—	860 000	1 050 000	1 900	3 600	1 700
		340	114	4	204	—	1 310 000	1 820 000	1 800	2 400	1 500

Notes (1) Cage designation (M) is usually omitted from the bearing designation.

(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations								Abutment and Fillet Dimensions (mm)										Mass (kg)
Cage <sup>(1)</sup> Standard Option			<sup>(2)</sup> NU NJ NUP N NF					$d_a^{(3)}$ min.	$d_b$ min.	$d_b^{(4)}$ max.	$d_c$ min.	$d_d$ min.	$D_a^{(3)}$ max.	$D_b$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx.
NU1028	(M)	—	NU	NJ	NUP	N	—	149	146.5	156	161	—	201	203.5	194	2	1	3.87
N 228	W	M	—	—	—	N	NF	153	—	—	—	—	—	237	225	2.5	2.5	8.08
*NU228E	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	9.38
NU228E	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	9.38
*NU2228E	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	15.2
NU2228E	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	15.2
N 328	M	—	—	—	—	N	NF	156	—	—	—	—	—	284	266	3	3	21.7
*NU328E	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	22.8
NU328E	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	22.8
*NU2328E	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	37.7
NU2328E	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	37.7
NU428	M	—	NU	NJ	—	N	—	160	160	193	200	222	340	308	4	4	46.4	
NU1030	(M)	—	NU	NJ	—	N	NF	161	158	167	173	—	214	217	208	2	1.5	4.77
N 230	W	M	—	—	—	N	NF	163	—	—	—	—	—	257	242	2.5	2.5	10.4
*NU230E	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	11.9
NU230E	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	11.9
*NU2230E	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	19.3
NU2230E	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	19.3
N 330	M	—	—	—	—	N	NF	166	—	—	—	—	—	304	283	3	3	25.8
*NU330E	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	27.1
NU330E	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	27.1
*NU2330E	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	45.1
NU2330E	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	45.1
NU430	M	—	NU	NJ	—	—	—	170	170	208	216	237	360	—	—	4	4	55.8
NU1032	(M)	—	NU	NJ	—	N	NF	171	168	178	184	—	229	232	222	2	1.5	5.81
N 232	M	—	—	—	—	N	NF	173	—	—	—	—	—	277	261	2.5	2.5	14.1
*NU232E	M	—	NU	NJ	NUP	—	—	173	173	190	197	210	277	—	—	2.5	2.5	14.7
NU232E	M	—	NU	NJ	NUP	—	—	173	173	190	197	210	277	—	—	2.5	2.5	14.7
*NU2232E	M	—	NU	NJ	NUP	—	—	173	173	188	197	210	277	—	—	2.5	2.5	24.5
NU2232E	M	—	NU	NJ	NUP	—	—	173	173	188	197	210	277	—	—	2.5	2.5	24.5
N 332	M	—	—	—	—	N	—	176	—	—	—	—	—	324	298	3	3	30.8
*NU332E	M	—	NU	NJ	NUP	—	—	176	176	199	211	228	324	—	—	3	3	32.1
NU332E	M	—	NU	NJ	NUP	—	—	176	176	199	211	228	324	—	—	3	3	32.1
NU2332E	M	—	NU	NJ	NUP	—	—	176	176	199	211	228	324	—	—	3	3	53.9

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

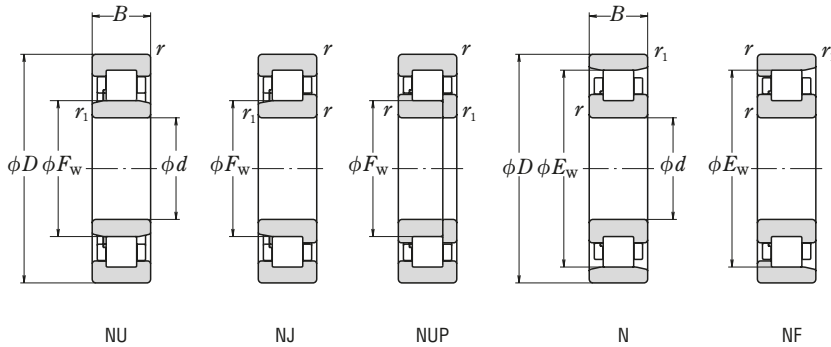
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPST<sup>™</sup> cylindrical roller bearings.



# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

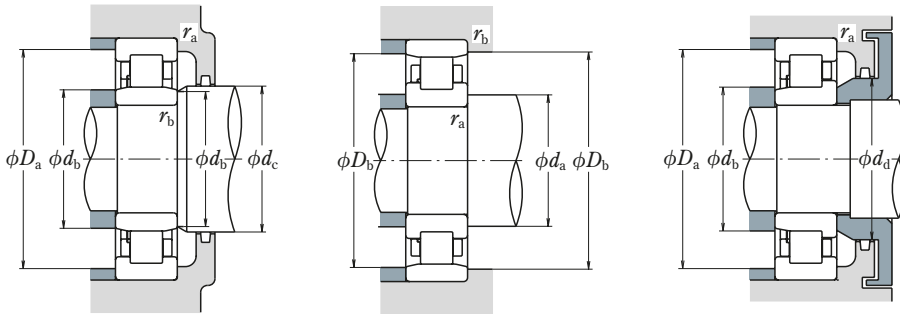
Bore Diameter 170 – 200 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										( <sup>s</sup> ) Mechanical	Grease
<b>170</b>	260	42	2.1	2.1	193	237	287 000	415 000	3 200	—	2 400
	310	52	4	4	—	272	475 000	635 000	2 600	—	2 000
	310	52	4	4	207	—	740 000	800 000	2 400	3 800	2 000
	310	52	4	4	207	—	605 000	800 000	2 400	3 800	2 000
	310	86	4	4	205	—	1 140 000	1 330 000	2 200	3 200	1 800
	310	86	4	4	205	—	925 000	1 330 000	2 200	3 200	1 800
	360	72	4	4	—	310	795 000	1 010 000	1 900	—	1 600
	360	72	4	4	218	—	930 000	1 150 000	1 800	3 400	1 600
	360	120	4	4	216	—	1 490 000	2 070 000	1 600	2 200	1 400
	<b>180</b>	280	46	2.1	2.1	205	355 000	510 000	3 000	—	2 200
		320	52	4	4	—	495 000	675 000	2 400	—	1 900
		320	52	4	4	217	770 000	850 000	2 200	3 600	1 900
		320	52	4	4	217	625 000	850 000	2 200	3 600	1 900
		320	86	4	4	215	1 240 000	1 510 000	2 000	3 200	1 700
		320	86	4	4	215	1 010 000	1 510 000	2 000	3 200	1 700
	<b>190</b>	380	75	4	4	—	905 000	1 150 000	1 700	—	1 500
		380	75	4	4	231	985 000	1 230 000	1 700	2 800	1 500
		380	126	4	4	227	1 560 000	2 220 000	1 500	2 000	1 300
		290	46	2.1	2.1	215	365 000	535 000	2 800	—	2 000
<b>190</b>	340	55	4	4	—	299	555 000	770 000	2 200	—	1 800
	340	55	4	4	230	—	855 000	955 000	2 000	3 400	1 800
	340	55	4	4	230	—	695 000	955 000	2 000	3 400	1 800
	340	92	4	4	228	—	1 360 000	1 670 000	1 900	3 000	1 600
	340	92	4	4	228	—	1 100 000	1 670 000	1 900	3 000	1 600
	400	78	5	5	—	345	975 000	1 260 000	1 600	—	1 400
	400	78	5	5	245	—	1 060 000	1 340 000	1 600	2 600	1 400
	400	132	5	5	240	—	1 770 000	2 520 000	1 400	2 000	1 300
	<b>200</b>	310	51	2.1	2.1	229	390 000	580 000	2 600	—	2 000
		360	58	4	4	—	620 000	865 000	2 000	—	1 700
		360	58	4	4	243	945 000	1 060 000	1 900	3 200	1 700
		360	58	4	4	243	765 000	1 060 000	1 900	3 200	1 700
		360	98	4	4	241	1 500 000	1 870 000	1 800	2 200	1 500
		360	98	4	4	241	1 220 000	1 870 000	1 800	2 200	1 500
		420	80	5	5	—	975 000	1 270 000	1 600	—	1 300
		420	80	5	5	258	1 140 000	1 450 000	1 500	2 600	1 300
	420	138	5	5	253	—	1 910 000	2 760 000	1 300	1 900	1 200

Notes (1) Cage designation (M) is usually omitted from the bearing designation.

(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)	
Cage <sup>(1)</sup> Standard Option		<sup>(2)</sup> NU NJ NUP N NF					$d_a^{(3)}$ min.	$d_b$ min.	$d_b^{(4)}$ max.	$d_c$ min.	$d_d$ min.	$D_a^{(3)}$ max.	$D_b$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx.	
NU1034	(M)	—	NU	NJ	—	N	—	181	181	190	197	—	249	249	239	2	2	7.91
N 234	M	—	—	—	—	N	NF	186	—	—	—	—	—	294	278	3	3	17.4
*NU234E	M	—	NU	NJ	NUP	—	—	186	186	202	211	223	294	—	—	3	3	18.3
NU234E	M	—	NU	NJ	NUP	—	—	186	186	202	211	223	294	—	—	3	3	18.3
*NU2234E	M	—	NU	NJ	NUP	—	—	186	186	200	211	223	294	—	—	3	3	29.9
NU2234E	M	—	NU	NJ	NUP	—	—	186	186	200	211	223	294	—	—	3	3	29.9
N 334	M	—	—	—	—	N	NF	186	—	—	—	—	—	344	316	3	3	36.6
NU334E	M	—	NU	NJ	NUP	—	—	186	186	213	223	241	344	—	—	3	3	37.9
NU2334E	M	—	NU	NJ	NUP	—	—	186	186	210	223	241	344	—	—	3	3	63.4
NU1036	(M)	—	NU	NJ	—	N	NF	191	191	202	209	—	269	269	258	2	2	10.2
N 236	M	—	—	—	—	N	NF	196	—	—	—	—	—	304	288	3	3	18.1
*NU236E	M	—	NU	NJ	NUP	—	—	196	196	212	221	233	304	—	—	3	3	19
NU236E	M	—	NU	NJ	NUP	—	—	196	196	212	221	233	304	—	—	3	3	19
*NU2236E	M	—	NU	NJ	NUP	—	—	196	196	210	221	233	304	—	—	3	3	31.4
NU2236E	M	—	NU	NJ	NUP	—	—	196	196	210	221	233	304	—	—	3	3	31.4
N 336	M	—	—	—	—	N	NF	196	—	—	—	—	—	364	335	3	3	42.6
NU336E	M	—	NU	NJ	NUP	—	—	196	196	226	235	255	364	—	—	3	3	44
NU2336E	M	—	NU	NJ	NUP	—	—	196	196	222	235	255	364	—	—	3	3	74.6
NU1038	(M)	—	NU	NJ	—	N	—	201	201	212	219	—	279	279	268	2	2	10.7
N 238	M	—	—	—	—	N	NF	206	—	—	—	—	—	324	305	3	3	22
*NU238E	M	—	NU	NJ	NUP	—	—	206	206	225	234	247	324	—	—	3	3	23
NU238E	M	—	NU	NJ	NUP	—	—	206	206	225	234	247	324	—	—	3	3	23
*NU2238E	M	—	NU	NJ	NUP	—	—	206	206	223	234	247	324	—	—	3	3	38.3
NU2238E	M	—	NU	NJ	NUP	—	—	206	206	223	234	247	324	—	—	3	3	38.3
N 338	M	—	—	—	—	N	—	210	—	—	—	—	—	380	352	4	4	48.7
NU338E	M	—	NU	NJ	NUP	—	—	210	210	240	248	268	380	—	—	4	4	50.6
NU2338E	M	—	NU	NJ	NUP	—	—	210	210	235	248	268	380	—	—	4	4	86.2
NU1040	(M)	—	NU	NJ	—	N	NF	211	211	226	233	—	299	299	284	2	2	14
N 240	M	—	—	—	—	N	NF	216	—	—	—	—	—	344	323	3	3	26.2
*NU240E	M	—	NU	NJ	NUP	—	—	216	216	238	247	261	344	—	—	3	3	27.4
NU240E	M	—	NU	NJ	NUP	—	—	216	216	238	247	261	344	—	—	3	3	27.4
*NU2240E	M	—	NU	NJ	NUP	—	—	216	216	235	247	261	344	—	—	3	3	46.1
NU2240E	M	—	NU	NJ	NUP	—	—	216	216	235	247	261	344	—	—	3	3	46.1
N 340	M	—	—	—	—	N	NF	220	—	—	—	—	—	400	367	4	4	55.3
NU340E	M	—	NU	NJ	NUP	—	—	220	220	252	263	283	400	—	—	4	4	57.1
NU2340E	M	—	NU	NJ	NUP	—	—	220	220	247	263	283	400	—	—	4	4	99.3

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

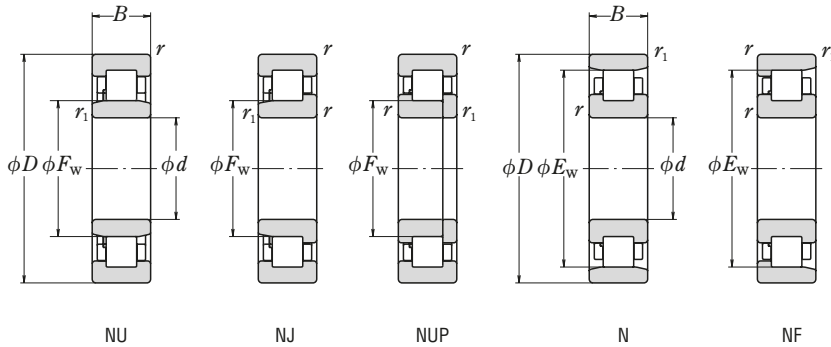
<sup>(5)</sup> The limiting speeds (mechanical) in the bearing tables are for standard cages.

**Remark** Bearings denoted by an asterisk (\*) are NSKHPS™ cylindrical roller bearings.



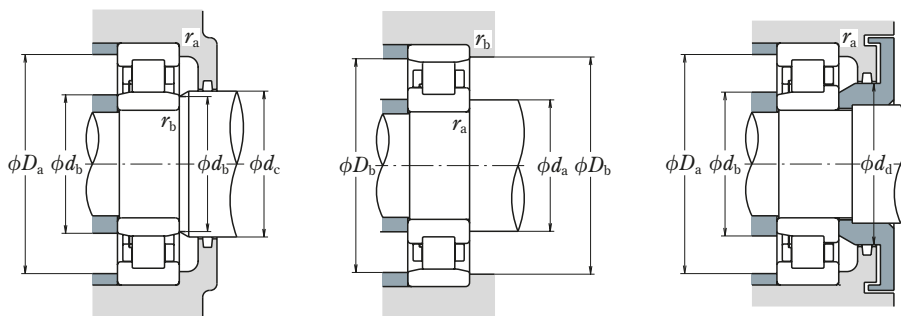
# ■ SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 220 – 500 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>F</i> <sub>W</sub>	<i>E</i> <sub>W</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>		Limiting Speeds	
										Mechanical	Grease
<b>220</b>	340	56	3	3	250	310	500 000	750 000	2 400	—	1 800
	400	65	4	4	—	350	760 000	1 080 000	1 800	—	1 500
	400	65	4	4	268	—	1 110 000	1 250 000	1 800	—	1 500
	400	65	4	4	268	—	905 000	1 250 000	1 800	—	1 500
	400	108	4	4	270	—	1 140 000	1 810 000	1 700	—	1 300
	460	88	5	5	—	396	1 190 000	1 570 000	1 400	—	1 200
	460	88	5	5	284	—	1 190 000	1 570 000	1 400	—	1 200
	460	88	5	5	284	—	1 190 000	1 570 000	1 400	—	1 200
<b>240</b>	360	56	3	3	270	330	530 000	820 000	2 200	—	1 600
	440	72	4	4	—	385	935 000	1 340 000	1 600	—	1 300
	440	72	4	4	295	—	935 000	1 340 000	1 600	—	1 300
	440	120	4	4	295	—	1 440 000	2 320 000	1 500	—	1 200
	500	95	5	5	—	430	1 360 000	1 820 000	1 200	—	1 100
	500	95	5	5	310	—	1 360 000	1 820 000	1 200	—	1 100
	500	95	5	5	310	—	1 360 000	1 820 000	1 200	—	1 100
	500	95	5	5	310	—	1 360 000	1 820 000	1 200	—	1 100
<b>260</b>	400	65	4	4	296	364	645 000	1 000 000	1 900	—	1 500
	480	80	5	5	—	420	1 100 000	1 580 000	1 500	—	1 200
	480	80	5	5	320	—	1 100 000	1 580 000	1 500	—	1 200
	480	130	5	5	320	—	1 710 000	2 770 000	1 300	—	1 100
	540	102	6	6	336	—	1 540 000	2 090 000	1 100	—	1 000
	540	102	6	6	336	—	1 540 000	2 090 000	1 100	—	1 000
<b>280</b>	420	65	4	4	316	384	660 000	1 050 000	1 800	—	1 400
	500	80	5	5	—	440	1 140 000	1 680 000	1 300	—	1 100
	500	80	5	5	340	—	1 140 000	1 680 000	1 300	—	1 100
<b>300</b>	460	74	4	4	340	420	885 000	1 400 000	1 600	—	1 300
	540	85	5	5	364	—	1 400 000	2 070 000	1 200	—	1 100
<b>320</b>	480	74	4	4	360	440	905 000	1 470 000	1 500	—	1 200
	580	92	5	5	—	510	1 540 000	2 270 000	1 100	—	950
	580	92	5	5	390	—	1 540 000	2 270 000	1 100	—	950
<b>340</b>	520	82	5	5	385	475	1 080 000	1 740 000	1 400	—	1 100
<b>360</b>	540	82	5	5	405	495	1 110 000	1 830 000	1 300	—	1 000
<b>380</b>	560	82	5	5	425	—	1 140 000	1 910 000	1 200	—	1 000
<b>400</b>	600	90	5	5	450	550	1 360 000	2 280 000	1 100	—	900
<b>420</b>	620	90	5	5	470	570	1 390 000	2 380 000	1 100	—	850
<b>440</b>	650	94	6	6	493	—	1 470 000	2 530 000	1 000	—	800
<b>460</b>	680	100	6	6	516	624	1 580 000	2 740 000	950	—	750
<b>480</b>	700	100	6	6	536	644	1 620 000	2 860 000	900	—	750
<b>500</b>	720	100	6	6	556	664	1 660 000	2 970 000	900	—	710

- Notes (1) Cage designation (M) is usually omitted from the bearing designation.  
(2) When L-shaped thrust collars (see Pages C156-C157) are used, the bearings are considered the NH type.



Bearing Designations							Abutment and Fillet Dimensions (mm)										Mass (kg)
Cage <sup>(1)</sup>		<sup>(2)</sup>				<sup>(3)</sup>		<sup>(4)</sup>		<sup>(3)</sup>							
Standard Option		NU	NJ	NUP	N	NF	$d_a$ min.	$d_b$ min.	$d_b$ max.	$d_c$ min.	$d_d$ min.	$D_a$ max.	$D_b$ max.	$D_b$ min.	$r_a$ max.	$r_b$ max.	approx.
NU 1044	(M)	—	NU NJ	—	N	—	233	233	247	254	—	327	327	313	2.5	2.5	18.2
N 244	M	—	—	—	N	NF	236	—	—	—	—	—	384	357	3	3	37
*NU244E	M	—	NU NJ	NUP	—	—	236	236	264	273	289	384	—	—	3	3	37.4
NU244E	M	—	NU NJ	NUP	—	—	236	236	264	273	289	384	—	—	3	3	37.4
NU2244	M	—	NU	—	—	—	—	236	264	273	289	384	—	—	3	3	61.8
N 344	M	—	—	—	N	NF	240	—	—	—	—	—	440	403	4	4	72.8
NU344	M	—	NU NJ	—	—	—	240	240	278	287	307	440	—	—	4	4	74.6
NU 1048	(M)	—	NU NJ	—	N	—	253	253	266	275	—	347	347	333	2.5	2.5	19.5
N 248	M	—	—	—	N	NF	256	—	—	—	—	—	424	392	3	3	49.6
NU248	M	—	NU NJ	NUP	—	—	256	256	289	298	316	424	—	—	3	3	50.4
NU2248	M	—	NU	—	—	—	—	256	289	298	316	424	—	—	3	3	84.9
N 348	M	—	—	—	N	NF	260	—	—	—	—	—	480	438	4	4	92.3
NU348	M	—	NU NJ	—	—	—	260	260	304	313	333	480	—	—	4	4	94.6
NU1052	(M)	—	NU NJ	—	N	NF	276	276	292	300	—	384	384	367	3	3	29.1
N 252	M	—	—	—	N	—	280	—	—	—	—	—	460	428	4	4	66.2
NU252	M	—	NU NJ	—	—	—	280	280	314	323	343	460	—	—	4	4	67.1
NU2252	M	—	NU	NUP	—	—	280	280	314	323	343	460	—	—	4	4	111
NU352	M	—	NU NJ	—	—	—	286	286	330	339	359	514	—	—	5	5	118
NU1056	(M)	—	NU NJ	NUP	N	NF	296	296	312	320	—	404	404	387	3	3	30.8
N 256	M	—	—	—	N	NF	300	—	—	—	—	—	480	448	4	4	69.6
NU256	M	—	NU NJ	—	—	—	300	300	334	344	364	480	—	—	4	4	70.7
NU1060	(M)	—	NU NJ	—	N	NF	316	316	336	344	—	444	444	424	3	3	43.7
NU260	M	—	NU NJ	—	—	—	320	320	358	368	391	520	—	—	4	4	89.2
NU1064	(M)	—	NU	—	N	NF	336	336	356	365	—	464	464	444	3	3	46.1
N 264	M	—	—	—	N	—	340	—	—	—	—	—	560	519	4	4	110
NU264	M	—	NU NJ	—	—	—	340	340	384	394	420	560	—	—	4	4	112
NU1068	(M)	—	NU NJ	—	N	NF	360	360	381	390	—	500	500	479	4	4	61.8
NU1072	(M)	—	NU	—	N	NF	380	380	400	410	—	520	520	499	4	4	64.6
NU1076	(M)	—	NU	—	—	—	—	400	420	430	—	540	—	—	4	4	67.5
NU1080	(M)	—	NU	NUP	N	—	420	420	445	455	—	580	580	554.5	4	4	88.2
NU1084	(M)	—	NU	—	N	—	440	440	465	475	—	600	600	574.5	4	4	91.7
NU1088	(M)	—	NU	—	—	—	—	466	488	498	—	624	—	—	5	5	105
NU1092	(M)	—	NU	NUP	N	—	486	486	511	521	—	654	654	628.5	5	5	123
NU1096	(M)	—	NU NJ	—	N	—	506	506	531	541	—	674	674	654	5	5	127
NU10/500	(M)	—	NU	—	N	—	526	526	551	558	—	694	694	674	5	5	131

**Notes** <sup>(3)</sup> If axial loads are applied, increase  $d_a$  and reduce  $D_a$  from the values listed above.

<sup>(4)</sup>  $d_b$  (max.) refers to values for adjusting rings for NU and NJ bearings.

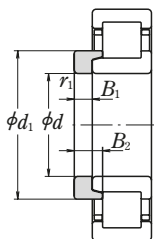
**Remark** Bearings denoted by an asterisk (\*) are NSKPS™ cylindrical roller bearings.



# ■ CYLINDRICAL ROLLER BEARINGS

## L-Shaped Thrust Collars

Bore Diameter 20 – 85 mm

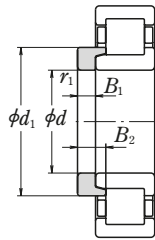


L-Shaped Thrust Collar

Boundary Dimensions (mm)					Bearing Designation	Mass (kg) approx.
$d$	$d_1$	$B_1$	$B_2$	$r_1$ min.		
20	30	3	6.75	0.6	<b>HJ 204</b>	0.012
	29.8	3	5.5	0.6	<b>HJ 204 E</b>	0.011
	30	3	7.5	0.6	<b>HJ 2204</b>	0.012
	29.8	3	6.5	0.6	<b>HJ 2204 E</b>	0.012
	31.7	4	7.5	0.6	<b>HJ 304</b>	0.017
	31.4	4	6.5	0.6	<b>HJ 304 E</b>	0.017
	31.8	4	8.5	0.6	<b>HJ 2304</b>	0.017
	31.4	4	7.5	0.6	<b>HJ 2304 E</b>	0.018
	34.8	3	6	0.6	<b>HJ 205 E</b>	0.014
	34.8	3	6.5	0.6	<b>HJ 2205 E</b>	0.014
25	38.2	4	7	1.1	<b>HJ 305 E</b>	0.025
	38.2	4	8	1.1	<b>HJ 2305 E</b>	0.026
	43.6	6	10.5	1.5	<b>HJ 405</b>	0.057
	41.3	4	7	0.6	<b>HJ 206 E</b>	0.025
30	41.4	4	7.5	0.6	<b>HJ 2206 E</b>	0.025
	45.1	5	8.5	1.1	<b>HJ 306 E</b>	0.042
	45.1	5	9.5	1.1	<b>HJ 2306 E</b>	0.043
	50.5	7	11.5	1.5	<b>HJ 406</b>	0.080
35	48.2	4	7	0.6	<b>HJ 207 E</b>	0.033
	48.2	4	8.5	0.6	<b>HJ 2207 E</b>	0.035
	51.1	6	9.5	1.1	<b>HJ 307 E</b>	0.060
	51.1	6	11	1.1	<b>HJ 2307 E</b>	0.062
40	59	8	13	1.5	<b>HJ 407</b>	0.12
	54.1	5	8.5	1.1	<b>HJ 208 E</b>	0.049
	54.1	5	9	1.1	<b>HJ 2208 E</b>	0.050
	57.6	7	11	1.5	<b>HJ 308 E</b>	0.088
45	57.7	7	12.5	1.5	<b>HJ 2308 E</b>	0.091
	64.8	8	13	2	<b>HJ 408</b>	0.14
	59.1	5	8.5	1.1	<b>HJ 209 E</b>	0.055
	59.1	5	9	1.1	<b>HJ 2209 E</b>	0.055
50	64.5	7	11.5	1.5	<b>HJ 309 E</b>	0.11
	64.5	7	13	1.5	<b>HJ 2309 E</b>	0.113
	71.7	8	13.5	2	<b>HJ 409</b>	0.175
	64.1	5	9	1.1	<b>HJ 210 E</b>	0.061
55	64.1	5	9	1.1	<b>HJ 2210 E</b>	0.061
	71.4	8	13	2	<b>HJ 310 E</b>	0.151
	71.4	8	14.5	2	<b>HJ 2310 E</b>	0.155
	78.8	9	14.5	2.1	<b>HJ 410</b>	0.23

Boundary Dimensions (mm)					Bearing Designation	Mass (kg) approx.
$d$	$d_1$	$B_1$	$B_2$	$r_1$ min.		
55	70.9	6	9.5	1.1	<b>HJ 211 E</b>	0.087
	70.9	6	10	1.1	<b>HJ 2211 E</b>	0.088
	77.6	9	14	2	<b>HJ 311 E</b>	0.195
	77.6	9	15.5	2	<b>HJ 2311 E</b>	0.20
60	85.2	10	16.5	2.1	<b>HJ 411</b>	0.29
	77.7	6	10	1.5	<b>HJ 212 E</b>	0.108
	77.7	6	10	1.5	<b>HJ 2212 E</b>	0.108
	84.5	9	14.5	2.1	<b>HJ 312 E</b>	0.231
65	84.5	9	16	2.1	<b>HJ 2312 E</b>	0.237
	91.8	10	16.5	2.1	<b>HJ 412</b>	0.34
	84.5	6	10	1.5	<b>HJ 213 E</b>	0.129
	84.5	6	10.5	1.5	<b>HJ 2213 E</b>	0.131
70	90.6	10	15.5	2.1	<b>HJ 313 E</b>	0.288
	90.6	10	18	2.1	<b>HJ 2313 E</b>	0.298
	98.5	11	18	2.1	<b>HJ 413</b>	0.42
	89.5	7	11	1.5	<b>HJ 214 E</b>	0.157
75	89.5	7	11.5	1.5	<b>HJ 2214 E</b>	0.158
	97.5	10	15.5	2.1	<b>HJ 314 E</b>	0.33
	97.5	10	18.5	2.1	<b>HJ 2314 E</b>	0.345
	110.5	12	20	3	<b>HJ 414</b>	0.605
80	94.5	7	11	1.5	<b>HJ 215 E</b>	0.166
	94.5	7	11.5	1.5	<b>HJ 2215 E</b>	0.167
	104.2	11	16.5	2.1	<b>HJ 315 E</b>	0.41
	104.2	11	19.5	2.1	<b>HJ 2315 E</b>	0.43
85	116	13	21.5	3	<b>HJ 415</b>	0.71
	101.6	8	12.5	2	<b>HJ 216 E</b>	0.222
	101.6	8	12.5	2	<b>HJ 2216 E</b>	0.222
	110.6	11	17	2.1	<b>HJ 316 E</b>	0.46
90	111	11	20	2.1	<b>HJ 2316 E</b>	0.48
	122	13	22	3	<b>HJ 416</b>	0.78
95	107.6	8	12.5	2	<b>HJ 217 E</b>	0.25
	107.6	8	13	2	<b>HJ 2217 E</b>	0.252
	117.9	12	18.5	3	<b>HJ 317 E</b>	0.575
	117.9	12	22	3	<b>HJ 2317 E</b>	0.595
100	126	14	24	4	<b>HJ 417</b>	0.88

## Bore Diameter 90 – 320 mm



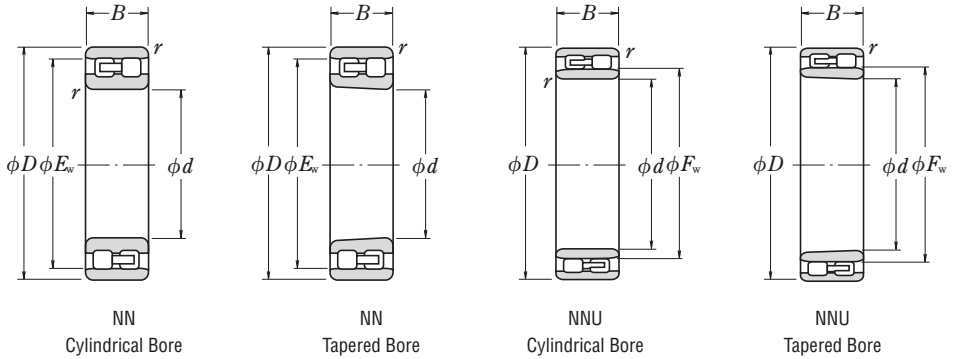
L-Shaped Thrust Collar

Boundary Dimensions (mm)						Bearing Designation	Mass (kg) approx.
$d$	$d_1$	$B_1$	$B_2$	$r_1$ min.			
90	114.3	9	14	2	HJ 218 E	0.32	
	114.3	9	15	2	HJ 2218 E	0.325	
	124.2	12	18.5	3	HJ 318 E	0.63	
	124.2	12	22	3	HJ 2318 E	0.66	
	137	14	24	4	<b>HJ 418</b>	1.05	
95	120.6	9	14	2.1	HJ 219 E	0.355	
	120.6	9	15.5	2.1	HJ 2219 E	0.365	
	132.2	13	20.5	3	HJ 319 E	0.785	
	132.2	13	24.5	3	HJ 2319 E	0.815	
	147	15	25.5	4	<b>HJ 419</b>	1.3	
100	127.5	10	15	2.1	HJ 220 E	0.44	
	127.5	10	16	2.1	HJ 2220 E	0.45	
	139.6	13	20.5	3	HJ 320 E	0.89	
	139.6	13	23.5	3	HJ 2320 E	0.92	
	153.5	16	27	4	<b>HJ 420</b>	1.5	
105	145	13	20.5	3	<b>HJ 321 E</b>	0.97	
	159.5	16	27	4	<b>HJ 421</b>	1.65	
110	141.7	11	17	2.1	HJ 222 E	0.62	
	141.7	11	19.5	2.1	HJ 2222 E	0.645	
	155.8	14	22	3	HJ 322 E	1.21	
	155.8	14	26.5	3	HJ 2322 E	1.27	
	171	17	29.5	4	<b>HJ 422</b>	2.1	
120	153.4	11	17	2.1	HJ 224 E	0.71	
	153.4	11	20	2.1	HJ 2224 E	0.745	
	168.6	14	22.5	3	HJ 324 E	1.41	
	168.6	14	26	3	HJ 2324 E	1.46	
	188	17	30.5	5	<b>HJ 424</b>	2.6	
130	164.2	11	17	3	HJ 226 E	0.79	
	164.2	11	21	3	HJ 2226 E	0.84	
	182.3	14	23	4	HJ 326 E	1.65	
	182.3	14	28	4	HJ 2326 E	1.73	
	205	18	32	5	<b>HJ 426</b>	3.3	
140	180	11	18	3	HJ 228 E	0.99	
	180	11	23	3	HJ 2228 E	1.07	
	196	15	25	4	HJ 328 E	2.04	
	196	15	31	4	HJ 2328 E	2.14	
	219	18	33	5	<b>HJ 428</b>	3.75	
Boundary Dimensions (mm)						Bearing Designation	Mass (kg) approx.
$d$	$d_1$	$B_1$	$B_2$	$r_1$ min.			
150	193.7	12	19.5	3	HJ 230 E	1.26	
	193.7	12	24.5	3	HJ 2230 E	1.35	
	210	15	25	4	HJ 330 E	2.35	
	210	15	31.5	4	HJ 2330 E	2.48	
	234	20	36.5	5	<b>HJ 430</b>	4.7	
160	207.3	12	20	3	HJ 232 E	1.48	
	206.1	12	24.5	3	HJ 2232 E	1.55	
	222	15	25	4	HJ 332 E	2.59	
	222.1	15	32	4	HJ 2332 E	2.76	
170	220.8	12	20	4	HJ 234 E	1.7	
	219.5	12	24	4	HJ 2234 E	1.79	
	238	16	33.5	4	<b>HJ 434 E</b>	3.25	
180	230.8	12	20	4	HJ 236 E	1.79	
	229.5	12	24	4	HJ 2236 E	1.88	
	252	17	35	4	<b>HJ 2336 E</b>	3.85	
190	244.5	13	21.5	4	HJ 238 E	2.19	
	243.2	13	26.5	4	HJ 2238 E	2.31	
	260.6	18	36.5	5	<b>HJ 2338 E</b>	4.45	
200	258.2	14	23	4	HJ 240 E	2.65	
	258	14	34	4	<b>HJ 2240</b>	2.6	
	256.9	14	28	4	HJ 2240 E	2.78	
	280	18	30	5	<b>HJ 340 E</b>	5.0	
220	286	15	27.5	4	<b>HJ 244</b>	3.55	
	286	15	36.5	4	<b>HJ 2244</b>	3.55	
	307	20	36	5	<b>HJ 344</b>	7.05	
240	313	16	29.5	4	<b>HJ 248</b>	4.65	
	313	16	38.5	4	<b>HJ 2248</b>	4.65	
	334	22	39.5	5	<b>HJ 348</b>	8.2	
260	340	18	33	5	<b>HJ 252</b>	6.2	
	340	18	40.5	5	<b>HJ 2252</b>	6.2	
	362	24	43	6	<b>HJ 352</b>	11.4	
280	360	18	33	5	<b>HJ 256</b>	7.4	
300	387	20	34.5	5	<b>HJ 260</b>	9.15	
320	415	21	37	5	<b>HJ 264</b>	11.3	



# DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

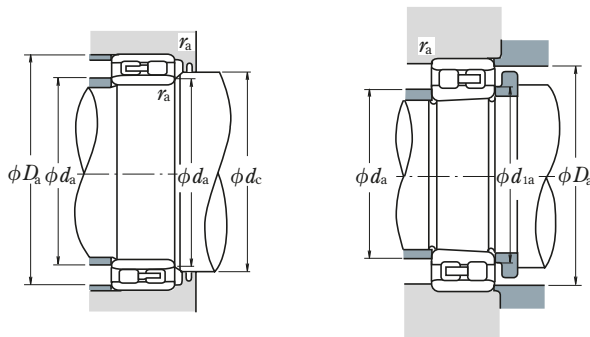
Bore Diameter 25 – 140 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>F<sub>W</sub></i>	<i>E<sub>W</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
25	47	16	0.6	—	41.3	25 800	30 000	14 000	17 000
30	55	19	1	—	48.5	31 000	37 000	12 000	14 000
35	62	20	1	—	55	39 500	50 000	10 000	12 000
40	68	21	1	—	61	43 500	55 500	9 000	11 000
45	75	23	1	—	67.5	52 000	68 500	8 500	10 000
50	80	23	1	—	72.5	53 000	72 500	7 500	9 000
55	90	26	1.1	—	81	69 500	96 500	6 700	8 000
60	95	26	1.1	—	86.1	73 500	106 000	6 300	7 500
65	100	26	1.1	—	91	77 000	116 000	6 000	7 100
70	110	30	1.1	—	100	97 500	148 000	5 600	6 700
75	115	30	1.1	—	105	96 500	149 000	5 300	6 300
80	125	34	1.1	—	113	119 000	186 000	4 800	6 000
85	130	34	1.1	—	118	125 000	201 000	4 500	5 600
90	140	37	1.5	—	127	143 000	228 000	4 300	5 000
95	145	37	1.5	—	132	150 000	246 000	4 000	5 000
100	140	40	1.1	112	—	155 000	295 000	4 000	5 000
	150	37	1.5	—	137	157 000	265 000	4 000	4 800
105	145	40	1.1	117	—	161 000	315 000	3 800	4 800
	160	41	2	—	146	198 000	320 000	3 800	4 500
110	150	40	1.1	122	—	167 000	335 000	3 600	4 500
	170	45	2	—	155	229 000	375 000	3 400	4 300
120	165	45	1.1	133.5	—	183 000	360 000	3 200	4 000
	180	46	2	—	165	239 000	405 000	3 200	3 800
130	180	50	1.5	144	—	274 000	545 000	3 000	3 800
	200	52	2	—	182	284 000	475 000	3 000	3 600
140	190	50	1.5	154	—	283 000	585 000	2 800	3 600
	210	53	2	—	192	298 000	515 000	2 800	3 400

**Note** (1) Suffix KR represents bearings with tapered bores (taper 1 : 12).

**Remark** Double-row cylindrical roller bearings are generally produced in high precision classes (Class 5 or better).



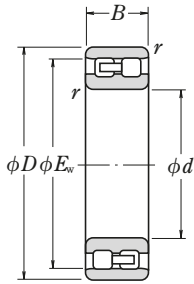
Bearing Designations		Abutment and Fillet Dimensions (mm)							Mass (kg)
Cylindrical Bore	Tapered Bore <sup>(1)</sup>	$d_a^{(2)}$		$d_{1a}$	$d_c$	$D_a$		$r_a$	approx.
		min.	max.	min.	min.	max.	min.	max.	
NN 3005	NN 3005 KR	29	—	29	—	43	42	0.6	0.127
NN 3006	NN 3006 KR	35	—	36	—	50	50	1	0.198
NN 3007	NN 3007 KR	40	—	41	—	57	56	1	0.258
NN 3008	NN 3008 KR	45	—	46	—	63	62	1	0.309
NN 3009	NN 3009 KR	50	—	51	—	70	69	1	0.407
NN 3010	NN 3010 KR	55	—	56	—	75	74	1	0.436
NN 3011	NN 3011 KR	61.5	—	62	—	83.5	83	1	0.647
NN 3012	NN 3012 KR	66.5	—	67	—	88.5	88	1	0.693
NN 3013	NN 3013 KR	71.5	—	72	—	93.5	93	1	0.741
NN 3014	NN 3014 KR	76.5	—	77	—	103.5	102	1	1.06
NN 3015	NN 3015 KR	81.5	—	82	—	108.5	107	1	1.11
NN 3016	NN 3016 KR	86.5	—	87	—	118.5	115	1	1.54
NN 3017	NN 3017 KR	91.5	—	92	—	123.5	120	1	1.63
NN 3018	NN 3018 KR	98	—	99	—	132	129	1.5	2.09
NN 3019	NN 3019 KR	103	—	104	—	137	134	1.5	2.19
NNU 4920	NNU 4920 KR	106.5	111	108	115	133.5	—	1	1.9
		108	—	109	—	142	139	1.5	2.28
NNU 4921	NNU 4921 KR	111.5	116	113	120	138.5	—	1	1.99
		114	—	115	—	151	148	2	2.88
NNU 4922	NNU 4922 KR	116.5	121	118	125	143.5	—	1	2.07
		119	—	121	—	161	157	2	3.71
NNU 4924	NNU 4924 KR	126.5	133	128	137	158.5	—	1	2.85
		129	—	131	—	171	167	2	4.04
NNU 4926	NNU 4926 KR	138	143	140	148	172	—	1.5	3.85
		139	—	141	—	191	185	2	5.88
NNU 4928	NNU 4928 KR	148	153	150	158	182	—	1.5	4.08
		149	—	151	—	201	195	2	6.34

**Note** <sup>(2)</sup>  $d_a$  (max.) refers to values for adjusting rings for NNU bearings.

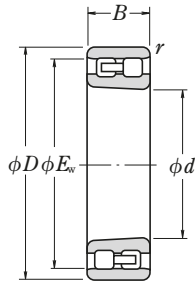


# DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

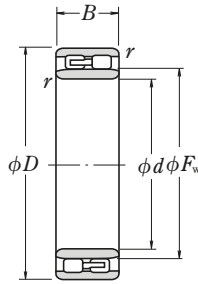
Bore Diameter 150 – 360 mm



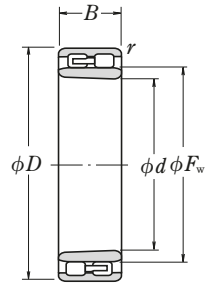
NN  
Cylindrical Bore



NN  
Tapered Bore



NNU  
Cylindrical Bore

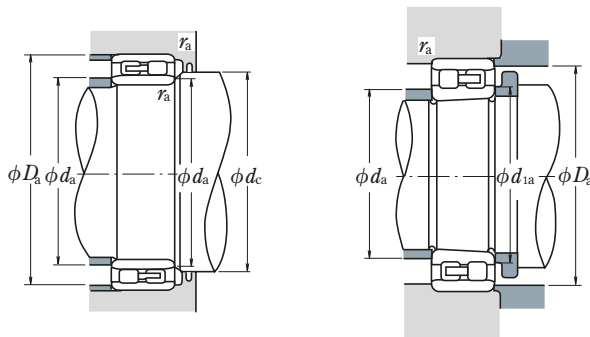


NNU  
Tapered Bore

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>F<sub>w</sub></i>	<i>E<sub>w</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>150</b>	210	60	2	167	—	350 000	715 000	2 600	3 200
	225	56	2.1	—	206	335 000	585 000	2 600	3 000
<b>160</b>	220	60	2	177	—	365 000	760 000	2 400	3 000
	240	60	2.1	—	219	375 000	660 000	2 400	2 800
<b>170</b>	230	60	2	187	—	375 000	805 000	2 400	2 800
	260	67	2.1	—	236	450 000	805 000	2 200	2 600
<b>180</b>	250	69	2	200	—	480 000	1 020 000	2 200	2 600
	280	74	2.1	—	255	565 000	995 000	2 000	2 400
<b>190</b>	260	69	2	211.5	—	485 000	1 060 000	2 000	2 600
	290	75	2.1	—	265	595 000	1 080 000	2 000	2 400
<b>200</b>	280	80	2.1	223	—	570 000	1 220 000	1 900	2 400
	310	82	2.1	—	282	655 000	1 170 000	1 800	2 200
<b>220</b>	300	80	2.1	243	—	600 000	1 330 000	1 700	2 200
	340	90	3	—	310	815 000	1 480 000	1 700	2 000
<b>240</b>	320	80	2.1	263	—	625 000	1 450 000	1 600	2 000
	360	92	3	—	330	855 000	1 600 000	1 500	1 800
<b>260</b>	360	100	2.1	289	—	935 000	2 100 000	1 400	1 800
	400	104	4	—	364	1 030 000	1 920 000	1 400	1 700
<b>280</b>	380	100	2.1	309	—	960 000	2 230 000	1 300	1 700
	420	106	4	—	384	1 080 000	2 080 000	1 300	1 500
<b>300</b>	420	118	3	336	—	1 230 000	2 870 000	1 200	1 500
	460	118	4	—	418	1 290 000	2 460 000	1 200	1 400
<b>320</b>	440	118	3	356	—	1 260 000	3 050 000	1 100	1 400
	480	121	4	—	438	1 350 000	2 670 000	1 100	1 300
<b>340</b>	520	133	5	—	473	1 670 000	3 300 000	1 000	1 200
<b>360</b>	540	134	5	—	493	1 700 000	3 450 000	950	1 200

**Note** (1) Suffix KR represents bearings with tapered bores (taper 1 : 12).

**Remark** Double-row cylindrical roller bearings are generally produced in high precision classes (Class 5 or better).



Bearing Designations		Abutment and Fillet Dimensions (mm)								Mass (kg)
Cylindrical Bore	Tapered Bore <sup>(1)</sup>	$d_a^{(2)}$		$d_{1a}$	$d_c$	$D_a$		$r_a$	approx.	
		min.	max.	min.	min.	max.	min.	max.		
NNU 4930 NN 3030	NNU 4930 KR NN 3030 KR	159	166	162	171	201	—	2	6.39	
		161	—	162	—	214	209	2	7.77	
NNU 4932 NN 3032	NNU 4932 KR NN 3032 KR	169	176	172	182	211	—	2	6.76	
		171	—	172	—	229	222	2	9.41	
NNU 4934 NN 3034	NNU 4934 KR NN 3034 KR	179	186	182	192	221	—	2	7.12	
		181	—	183	—	249	239	2	12.8	
NNU 4936 NN 3036	NNU 4936 KR NN 3036 KR	189	199	193	205	241	—	2	10.4	
		191	—	193	—	269	258	2	16.8	
NNU 4938 NN 3038	NNU 4938 KR NN 3038 KR	199	211	203	217	251	—	2	10.9	
		201	—	203	—	279	268	2	17.8	
NNU 4940 NN 3040	NNU 4940 KR NN 3040 KR	211	222	214	228	269	—	2	15.3	
		211	—	214	—	299	285	2	22.7	
NNU 4944 NN 3044	NNU 4944 KR NN 3044 KR	231	242	234	248	289	—	2	16.6	
		233	—	236	—	327	313	2.5	29.6	
NNU 4948 NN 3048	NNU 4948 KR NN 3048 KR	251	262	254	269	309	—	2	18	
		253	—	256	—	347	334	2.5	32.7	
NNU 4952 NN 3052	NNU 4952 KR NN 3052 KR	271	288	275	295	349	—	2	31.1	
		276	—	278	—	384	368	3	47.7	
NNU 4956 NN 3056	NNU 4956 KR NN 3056 KR	291	308	295	315	369	—	2	33	
		296	—	298	—	404	388	3	51.1	
NNU 4960 NN 3060	NNU 4960 KR NN 3060 KR	313	335	318	343	407	—	2.5	51.9	
		316	—	319	—	444	422	3	70.7	
NNU 4964 NN 3064	NNU 4964 KR NN 3064 KR	333	355	338	363	427	—	2.5	54.9	
		336	—	340	—	464	442	3	76.6	
NN 3068	NN 3068 KR	360	—	365	—	500	477	4	102	
NN 3072	NN 3072 KR	380	—	385	—	520	497	4	106	

**Note** <sup>(2)</sup>  $d_a$  (max.) refers to values for adjusting rings for NNU bearings.



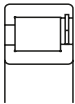
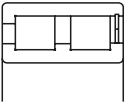
# FULL COMPLEMENT SINGLE-ROW (NCF) / DOUBLE-ROW (NNCF) CYLINDRICAL ROLLER BEARINGS

## Design, Types, and Features

Cageless, full complement cylindrical roller bearings have the maximum possible number of rollers and can sustain much heavier loads than cylindrical roller bearings of the same size with cages. On the other hand, high-speed capability is inferior to the bearings with cages.

Open single- and double-row bearings are mostly used in general industrial applications at low speed and under heavy load, while shielded double-row bearings are often used in crane sheaves.

Table 1 Features of Full Complement Cylindrical Roller Bearings

Appearance	Type	Design and Features
	NCF	The outer and inner rings and rollers are inseparable since a retaining snap ring is installed at the side opposite the outer ring rib. It can sustain axial loads in only one direction.
	NNCF	NNCF is a double-row version of NCF. It can sustain heavy radial loads.

**Tolerances and Running Accuracy** .....Table 7.2 (Pages A128 to A131)

**Single-Row**  
**Double-Row**

### Recommended Fits

**Single-Row**  
**Double-Row**

**Inner Ring Rotation** .....Table 8.3 (Page A164)  
Table 8.5 (Page A165)

**Outer Ring Rotation** .....Table 2 below

**Table 2 Fits and Internal Clearances for Full Complement Cylindrical Roller Bearings**

Operating Conditions		Fitting Between Inner Ring and Shaft	Fitting Between Outer Ring and Housing Bore	Recommended Internal Clearance
Outer Ring Rotation	Thin-walled housings and heavy loads	g6 or h6	P7	C 3
	Normal to heavy loads	g6 or h6	N7	C 3
	Light or fluctuating loads	g6 or h6	M7	CN

### Permissible Misalignment

The permissible misalignment of full complement single-row cylindrical roller bearings is generally 0.0006 radian (2') under normal load.

For double-row bearings, nearly no misalignment is allowed.



# FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

## DESIGN, TYPES, AND FEATURES

Cylindrical roller bearings for sheaves are specially designed thin-walled, broad-width, full complement double-row bearings. They are also widely used in general industrial machines running at low speed and under heavy loads. There are several Series, as shown in Table 1.

**Table 1 Series of Cylindrical Roller Bearings for Sheaves**

Bearing Type		Fixed-End	Free-End
Open Type	Without Snap Ring	RS-48E4 RS-49E4	RSF-48E4 RSF-49E4
	With Snap Ring	RS-50 RS-50NR	—

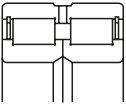
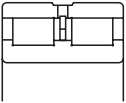
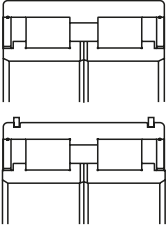
All bearings are inseparable, and the RSF type can be used as a free-end bearing. In this case, please refer to the permissible axial displacement in the bearing tables.

Since these cylindrical roller bearings are double-row and full complement, they can withstand heavy shock loads and moments and have sufficient axial load capacity for use in sheaves.

Shielded bearing units allow for the reduction of the number of parts surrounding the bearing, therefore allowing for a simple, compact design.

The surface of these bearings is treated with a rust preventive.

**Table 2 Features of Full Complement Cylindrical Roller Bearings for Sheaves**

Diagram	Type	Design and Features
	RS-48E4 RS-49E4	These types feature a double-row outer ring with center rib and two single-row inner rings with ribs. The outer and inner rings and rollers are inseparable since there are two retaining snap rings at the sides of the outer ring. They can sustain an axial load in either direction, so they may be used as fixed-end bearings. An oil groove and holes are located at the center of the outer ring.
	RSF-48E4 RSF-49E4	These types feature a double-row outer ring without ribs and a double-row inner ring with three ribs. The outer and inner rings and rollers are inseparable since there is a retaining snap ring at the middle of the outer ring. They can be used as free-end bearings, and permissible axial movement is listed in the bearing tables. An oil groove and holes are located at the center of the outer ring.
	RS-50  RS-50NR	These types are shielded on both sides and feature a double-row outer ring with center rib and two inner rings with ribs. They can sustain an axial load in either direction. They are prelubricated, but it is possible to replenish the grease through an oil groove and hole. The RS-50NR type is designated if there are snap rings at the outside of the outer ring. Surfaces are treated with a rust preventive.

## TOLERANCES AND RUNNING ACCURACY..... Table 7.2 (Pages A128 to A131)

### RECOMMENDED FITS AND INTERNAL CLEARANCES

When used with outer ring rotation for sheaves or wheels, the fit and radial internal clearance should conform to Table 3.

**Table 3 Fits and Internal Clearances for Cylindrical Roller Bearings for Sheaves**

Operating Conditions		Fitting Between Inner Ring and Shaft	Fitting Between Outer Ring and Housing Bore	Recommended Internal Clearance
Outer Ring Rotation	Thin-walled housings and heavy loads	g6 or h6	P7	C3
	Normal to heavy loads	g6 or h6	N7	C3
	Light or fluctuating loads	g6 or h6	M7	CN

The fits listed in Tables 8.3 (Page A164) and 8.5 (Page A165) apply when used with inner ring rotation in general applications, and internal clearance should conform to Table 4.

**Table 4**

Units :  $\mu\text{m}$

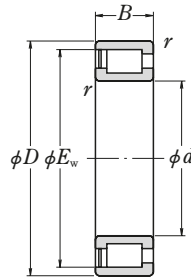
Nominal Bore Dia. $d$ (mm)		Clearances			
		CN		C3	
over	incl.	min.	max.	min.	max.
<b>30 40</b>		15	50	35	70
<b>40 50</b>		20	55	40	75
<b>50 65</b>		20	65	45	90
<b>65 80</b>		25	75	55	105
<b>80 100</b>		30	80	65	115
<b>100 120</b>		35	90	80	135
<b>120 140</b>		40	105	90	155
<b>140 160</b>		50	115	100	165
<b>160 180</b>		60	125	110	175
<b>180 200</b>		65	135	125	195
<b>200 225</b>		75	150	140	215
<b>225 250</b>		90	165	155	230
<b>250 280</b>		100	180	175	255
<b>280 315</b>		110	195	195	280
<b>315 355</b>		125	215	215	305
<b>355 400</b>		140	235	245	340
<b>400 450</b>		155	275	270	390
<b>450 500</b>		180	300	300	420



# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS

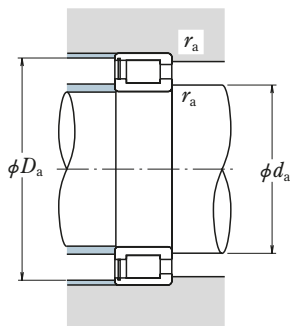
NCF Type, Single-Row

Bore Diameter 100 – 260 mm



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
$d$	$D$	$B$	$r_{\min}$	$E_w$	$C_r$	$C_{0r}$	
100	140	24	1.1	130.5	132	209	NCF2920V
	150	37	1.5	139.7	209	310	NCF3020V
110	150	24	1.1	141	138	229	NCF2922V
	170	45	2	156.3	278	405	NCF3022V
120	165	27	1.1	154	177	305	NCF2924V
	180	46	2	167.58	293	440	NCF3024V
130	180	30	1.5	166.5	210	370	NCF2926V
	200	52	2	183.81	415	615	NCF3026V
140	190	30	1.5	179.4	227	395	NCF2928V
	210	53	2	197.82	435	680	NCF3028V
150	210	36	2	195	289	505	NCF2930V
	225	56	2.1	206.82	460	710	NCF3030V
160	220	36	2	207	310	535	NCF2932V
	240	60	2.1	224.8	520	810	NCF3032V
170	215	22	1.5	203.5	149	272	NCF1834V
	230	36	2	218	320	570	NCF2934V
	260	67	2.1	242.87	675	1 070	NCF3034V
180	225	22	1.5	215	154	290	NCF1836V
	250	42	2	231.5	390	695	NCF2936V
	280	74	2.1	260.3	785	1 260	NCF3036V
190	240	24	1.5	228.7	178	335	NCF1838V
	260	42	2	243.6	435	785	NCF2938V
	290	75	2.1	269.9	805	1 320	NCF3038V
200	250	24	1.5	237	182	350	NCF1840V
	280	48	2.1	261	530	955	NCF2940V
	310	82	2.1	287.8	910	1 510	NCF3040V
220	270	24	2	257.7	191	385	NCF1844V
	300	48	2.1	282	555	1 050	NCF2944V
	340	90	3	312.3	1 100	1 820	NCF3044V
240	300	28	2	283	236	470	NCF1848V
	320	48	2.1	303	580	1 140	NCF2948V
	360	92	3	335.25	1 160	1 990	NCF3048V
260	320	28	2	307	247	510	NCF1852V
	360	60	2.1	333.2	750	1 460	NCF2952V
	400	104	4	376.1	1 570	2 600	NCF3052V

**Remark** Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.



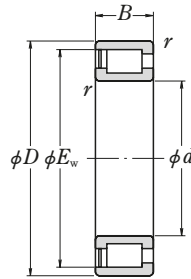
Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a$	$D_a$	$r_a$ max.	approx.
109	131	1	1.0
111	140	1.5	2.1
119	142	1	1.1
122	157	2	3.3
130	155	1	1.7
132	168	2	3.6
141	168	1.5	2.2
142	187	2	5.6
151	180	1.5	2.3
152	198	2	5.9
163	196	2	3.7
165	209	2	7.1
173	208	2	3.8
175	225	2	8.6
182	204	1.5	1.8
183	219	2	4.1
185	244	2	11.9
192	216	1.5	1.8
193	236	2	6.0
195	263	2	15.8
202	229	1.5	2.4
203	245	2	6.5
206	273	2	16.7
213	238	1.5	2.5
216	263	2	8.9
216	293	2	21.4
234	258	2	2.7
236	283	2	9.6
238	320	2.5	28.2
254	285	2	4.2
257	304	2	10.4
259	340	2.5	31.2
275	308	2	4.5
277	342	2	18.1
282	377	3	45.3



# **FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS**

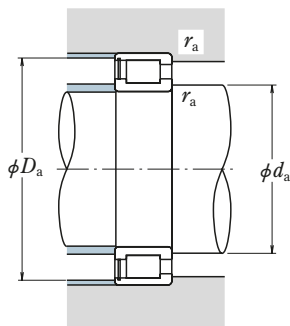
**NCF Type, Single-Row**

**Bore Diameter 300 – 800 mm**



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>E<sub>w</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	
<b>300</b>	380	38	2.5	359	445	870	<b>NCF1860V</b>
	420	72	3	389.6	1 120	2 200	<b>NCF2960V</b>
	460	118	4	431.7	1 980	3 500	<b>NCF3060V</b>
<b>320</b>	400	38	2.1	380	460	925	<b>NCF1864V</b>
	440	72	3	410	1 150	2 340	<b>NCF2964V</b>
	480	121	4	449.6	2 170	3 900	<b>NCF3064V</b>
<b>340</b>	420	38	2.1	401	475	985	<b>NCF1868V</b>
	460	72	3	430.3	1 190	2 470	<b>NCF2968V</b>
	520	133	5	485.8	2 480	4 350	<b>NCF3068V</b>
<b>360</b>	440	38	2.5	422	490	1 040	<b>NCF1872V</b>
	480	72	3	450.7	1 220	2 610	<b>NCF2972V</b>
	540	134	5	503.6	2 550	4 600	<b>NCF3072V</b>
<b>380</b>	480	46	2.5	452.8	575	1 230	<b>NCF1876V</b>
	520	82	4	486.7	1 600	3 350	<b>NCF2976V</b>
	560	135	5	521.4	2 610	4 800	<b>NCF3076V</b>
<b>400</b>	500	46	2.5	475.7	590	1 300	<b>NCF1880V</b>
	540	82	4	511	1 650	3 550	<b>NCF2980V</b>
	600	148	5	558.7	3 050	5 750	<b>NCF3080AV</b>
<b>420</b>	520	46	2.1	491	600	1 340	<b>NCF1884V</b>
	560	82	4	523.2	1 680	3 650	<b>NCF2984V</b>
	620	150	5	577.7	3 000	5 650	<b>NCF3084V</b>
<b>440</b>	540	46	2.1	514	615	1 410	<b>NCF1888V</b>
	600	95	4	562	2 070	4 300	<b>NCF2988V</b>
<b>460</b>	580	56	3	552.7	920	1 950	<b>NCF1892V</b>
	620	95	4	576.5	2 100	4 450	<b>NCF2992V</b>
<b>480</b>	600	56	3	573	940	2 040	<b>NCF1896V</b>
	650	100	5	615	2 380	5 100	<b>NCF2996V</b>
<b>500</b>	620	56	3	593.5	960	2 120	<b>NCF18/500V</b>
	670	100	5	630.2	2 420	5 250	<b>NCF29/500V</b>
<b>530</b>	650	56	3	624	990	2 240	<b>NCF18/530V</b>
<b>560</b>	680	56	3	654.7	1 020	2 360	<b>NCF18/560V</b>
	820	195	6	770	5 600	11 300	<b>NCF30/560V</b>
<b>600</b>	730	60	3	695.5	1 140	2 680	<b>NCF18/600V</b>
	800	118	5	752	3 050	7 300	<b>NCF29/600V</b>
<b>630</b>	780	69	4	742	1 470	3 400	<b>NCF18/630V</b>
<b>670</b>	820	69	4	780	1 520	3 550	<b>NCF18/670V</b>
<b>710</b>	870	74	4	832.5	1 650	3 900	<b>NCF18/710V</b>
<b>750</b>	920	78	5	882.3	1 930	4 600	<b>NCF18/750V</b>
<b>800</b>	980	82	5	936	2 110	5 100	<b>NCF18/800V</b>

**Remark** Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.



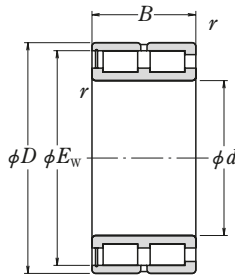
Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a$	$D_a$	$r_a$ max.	approx.
319	360	2	9.7
320	398	2.5	30.7
323	435	3	67.6
338	381	2	10.3
340	418	2.5	33
343	454	3	73
359	402	2	10.7
361	438	2.5	34.1
368	490	4	97
380	423	2	11.5
381	457	2.5	36
388	509	4	102
400	458	2	18.6
404	493	3	52
408	529	4	108
421	478	2	19.5
425	513	3	53.4
429	568	4	139
440	498	2	20.5
445	533	3	55.7
449	588	4	147
461	518	2	21.3
466	572	3	78.2
483	555	2.5	32.5
486	591	3	81.2
503	575	2.5	33.8
510	617	4	95.1
524	594	2.5	35
531	637	4	98.4
554	625	2.5	36.9
585	655	2.5	39.3
598	778	5	332.5
626	702	2.5	48.9
633	764	4	164.9
659	748	3	68.8
700	787	3	72.7
741	836	3	87.6
786	883	4	103.3
832	950	4	123.1



# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS

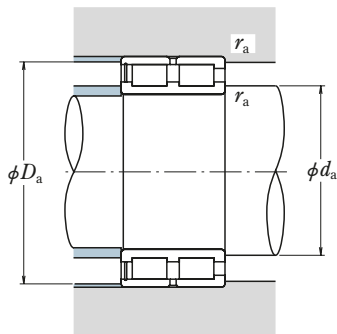
NNCF Type, Double-Row

Bore Diameter 100 – 260 mm



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
$d$	$D$	$B$	$r$ min.	$E_w$	$C_r$	$C_{0r}$	
100	140	40	1.1	129.8	194	400	NNCF4920V
	150	67	1.5	139.7	360	615	<b>NNCF5020V</b>
110	150	40	1.1	138.4	202	430	NNCF4922V
	170	80	2	156.3	490	840	<b>NNCF5022V</b>
120	165	45	1.1	153.8	226	480	NNCF4924V
	180	80	2	167.58	500	885	<b>NNCF5024V</b>
130	180	50	1.5	165.7	262	555	NNCF4926V
	200	95	2	183.81	710	1 230	NNCF5026V
140	190	50	1.5	176.2	272	595	NNCF4928V
	210	95	2	197.82	750	1 360	<b>NNCF5028V</b>
150	210	60	2	191.6	390	865	NNCF4930V
	225	100	2.1	206.82	785	1 420	<b>NNCF5030V</b>
160	220	60	2	204.1	410	930	NNCF4932V
	240	109	2.1	224.8	895	1 620	<b>NNCF5032V</b>
170	230	60	2	212.4	415	975	<b>NNCF4934V</b>
	260	122	2.1	242.87	1 160	2 140	<b>NNCF5034V</b>
180	250	69	2	230.5	550	1 230	<b>NNCF4936V</b>
	280	136	2.1	260.3	1 340	2 510	<b>NNCF5036V</b>
190	260	69	2	240.7	565	1 290	<b>NNCF4938V</b>
	290	136	2.1	269.9	1 380	2 630	NNCF5038V
200	250	50	1.5	235.9	320	825	NNCF4840V
	280	80	2.1	259.5	665	1 500	NNCF4940V
	310	150	2.1	287.75	1 560	3 000	NNCF5040V
220	270	50	1.5	256.9	340	905	NNCF4844V
	300	80	2.1	277	695	1 620	NNCF4944V
	340	160	3	312.3	1 890	3 650	<b>NNCF5044V</b>
240	300	60	2	282.6	495	1 340	NNCF4848V
	320	80	2.1	300	725	1 770	NNCF4948V
	360	160	3	335.25	1 990	4 000	<b>NNCF5048V</b>
260	320	60	2	303.6	515	1 450	NNCF4852V
	360	100	2.1	331.5	1 050	2 530	NNCF4952V
	400	190	4	376.1	2 690	5 200	NNCF5052V

**Remark** Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.



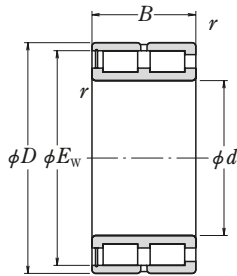
Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a$	$D_a$	$r_a$ max.	approx.
109	130	1	2.0
111	140	1.5	3.8
119	140	1	2.1
122	157	2	6.1
130	155	1	2.9
132	168	2	6.5
141	168	1.5	3.9
142	187	2	10.3
151	178	1.5	4.2
152	198	2	10.8
163	196	2	6.6
165	209	2	13
173	206	2	7.0
175	225	2	15.8
183	216	2	7.3
185	244	2	22.1
193	236	2	10.7
195	263	2	29.4
203	245	2	11.1
206	273	2	30.8
213	237	1.5	5.9
216	263	2	15.7
216	293	2	39.7
233	257	1.5	6.4
236	283	2	17
238	320	2.5	50.7
254	285	2	10.3
257	302	2	18.4
259	340	2.5	54.3
275	304	2	11
277	342	2	32
282	377	3	82.7



# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS

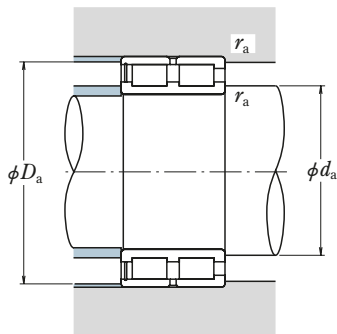
NNCF Type, Double-Row

Bore Diameter 280 – 500 mm



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>E<sub>w</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	
280	350	69	2	332.5	685	1 860	NNCF4856V
	380	100	2.1	352.5	1 090	2 720	NNCF4956V
	420	190	4	390.5	2 770	5 450	NNCF5056V
300	380	80	2.1	357.2	805	2 160	NNCF4860V
	420	118	3	386.5	1 580	3 800	NNCF4960V
	460	218	4	431.7	3 400	7 000	NNCF5060V
320	400	80	2.1	380.2	835	2 310	NNCF4864V
	440	118	3	404.5	1 620	4 000	NNCF4964V
	480	218	4	446.9	3 500	7 350	NNCF5064V
340	420	80	2.1	397.4	855	2 430	NNCF4868V
	460	118	3	431	1 690	4 300	NNCF4968V
	520	243	5	485.8	4 250	8 750	NNCF5068V
360	440	80	2.1	420.4	885	2 580	NNCF4872V
	480	118	3	449	1 730	4 500	NNCF4972V
	540	243	5	503.6	4 350	9 150	NNCF5072V
380	480	100	2.1	450.6	1 260	3 600	NNCF4876V
	520	140	4	482.5	2 180	5 650	NNCF4976V
	560	243	5	521.4	4 500	9 600	NNCF5076V
400	500	100	2.1	471.7	1 290	3 750	NNCF4880V
	540	140	4	503	2 240	5 900	NNCF4980V
	600	272	5	558.7	5 050	10 900	NNCF5080V
420	520	100	2.1	492	1 320	3 950	NNCF4884V
	560	140	4	523	2 290	6 200	NNCF4984V
	620	272	5	577.7	5 150	11 300	<b>NNCF5084V</b>
440	540	100	2.1	513	1 350	4 150	NNCF4888V
	600	160	4	560.5	3 000	7 850	NNCF4988V
460	580	118	3	549.2	1 730	5 150	NNCF4892V
	620	160	4	573	3 050	8 050	NNCF4992V
480	600	118	3	565.8	1 760	5 300	NNCF4896V
	650	170	5	603	3 350	8 900	NNCF4996V
500	620	118	3	590.7	1 810	5 600	NNCF48/500V
	670	170	5	629	3 400	9 350	NNCF49/500V

**Remark** Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.



Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_a$	$D_a$	$r_a$ max.	approx.
295	334	2	16
297	361	2	34
302	395	3	87.7
318	361	2	23
320	398	2.5	52
323	435	3	125
338	381	2	24.3
340	418	2.5	55
343	454	3	131
359	400	2	25.6
361	438	2.5	58
368	490	4	177
379	421	2	27
381	457	2.5	61
388	509	4	186
399	459	2	45.5
404	493	3	90.5
408	529	4	194
420	479	2	47.5
425	513	3	94.5
429	568	4	256
440	498	2	49.5
445	533	3	98.5
449	588	4	267
461	518	2	51.5
466	572	3	136
483	555	2.5	77.5
486	591	3	142
503	575	2.5	80.5
510	617	4	167
524	594	2.5	83.5
531	637	4	173

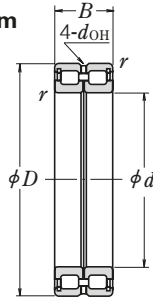


# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

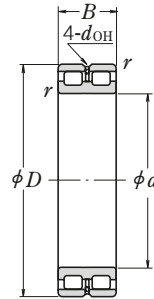
RS-48 · RS-49 Types

RSF-48 · RSF-49 Types

Bore Diameter 50 – 220 mm



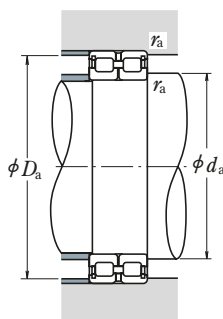
Fixed-End Bearing  
RS



Free-End Bearing  
RSF

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
50	72	22	0.6	48 000	75 500	2 000	4 000
60	85	25	1	68 500	118 000	1 600	3 200
65	90	25	1	70 500	125 000	1 600	3 200
70	100	30	1	102 000	168 000	1 400	2 800
80	110	30	1	109 000	191 000	1 300	2 600
90	125	35	1.1	147 000	268 000	1 100	2 200
100	125	25	1	87 500	189 000	1 100	2 200
	140	40	1.1	194 000	400 000	1 000	2 000
105	130	25	1	89 000	196 000	1 000	2 000
	145	40	1.1	199 000	420 000	950	1 900
110	140	30	1	114 000	260 000	950	1 900
	150	40	1.1	202 000	430 000	900	1 800
120	150	30	1	119 000	283 000	900	1 800
	165	45	1.1	226 000	480 000	800	1 600
130	165	35	1.1	162 000	390 000	800	1 600
	180	50	1.5	262 000	555 000	750	1 500
140	175	35	1.1	167 000	415 000	750	1 500
	190	50	1.5	272 000	595 000	710	1 400
150	190	40	1.1	235 000	575 000	670	1 400
	210	60	2	390 000	865 000	670	1 300
160	200	40	1.1	243 000	615 000	630	1 300
	220	60	2	410 000	930 000	600	1 200
170	215	45	1.1	265 000	650 000	600	1 200
	230	60	2	415 000	975 000	600	1 200
180	225	45	1.1	272 000	685 000	560	1 100
	250	69	2	495 000	1 130 000	530	1 100
190	240	50	1.5	315 000	785 000	530	1 100
	260	69	2	510 000	1 180 000	500	1 000
200	250	50	1.5	320 000	825 000	500	1 000
	280	80	2.1	665 000	1 500 000	480	950
220	270	50	1.5	340 000	905 000	450	900
	300	80	2.1	695 000	1 620 000	430	850

**Remark** Cylindrical roller bearings for sheaves are designed for specific applications; when using them, please contact NSK.



Bearing Designations <sup>(1)</sup>		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
Fixed-End Bearing	Free-End Bearing	$d_{OH}^{(2)}$	Axial Disp. <sup>(3)</sup>	$d_a$ min.	$D_a$ max.	$r_a$ max.	approx.
<b>RS-4910E4</b>	<b>RSF-4910E4</b>	2.5	1.5	54	68	0.6	0.30
<b>RS-4912E4</b>	<b>RSF-4912E4</b>	2.5	1.5	65	80	1	0.46
<b>RS-4913E4</b>	<b>RSF-4913E4</b>	2.5	2	70	85	1	0.50
<b>RS-4914E4</b>	<b>RSF-4914E4</b>	3	2	75	95	1	0.79
<b>RS-4916E4</b>	<b>RSF-4916E4</b>	3	2	85	105	1	0.89
<b>RS-4918E4</b>	<b>RSF-4918E4</b>	3	2	96.5	118.5	1	1.35
<b>RS-4820E4</b>	<b>RSF-4820E4</b>	2.5	1.5	105	120	1	0.74
<b>RS-4920E4</b>	<b>RSF-4920E4</b>	3	2	106.5	133.5	1	1.97
<b>RS-4821E4</b>	<b>RSF-4821E4</b>	2.5	1.5	110	125	1	0.77
<b>RS-4921E4</b>	<b>RSF-4921E4</b>	3	2	111.5	138.5	1	2.05
<b>RS-4822E4</b>	<b>RSF-4822E4</b>	3	2	115	135	1	1.09
<b>RS-4922E4</b>	<b>RSF-4922E4</b>	3	2	116.5	143.5	1	2.15
<b>RS-4824E4</b>	<b>RSF-4824E4</b>	3	2	125	145	1	1.28
<b>RS-4924E4</b>	<b>RSF-4924E4</b>	4	3	126.5	158.5	1	2.95
<b>RS-4826E4</b>	<b>RSF-4826E4</b>	3	2	136.5	158.5	1	1.9
<b>RS-4926E4</b>	<b>RSF-4926E4</b>	5	3.5	138	172	1.5	3.95
<b>RS-4828E4</b>	<b>RSF-4828E4</b>	3	2	146.5	168.5	1	2.03
<b>RS-4928E4</b>	<b>RSF-4928E4</b>	5	3.5	148	182	1.5	4.25
<b>RS-4830E4</b>	<b>RSF-4830E4</b>	3	2	156.5	183.5	1	2.85
<b>RS-4930E4</b>	<b>RSF-4930E4</b>	5	3.5	159	201	2	6.65
<b>RS-4832E4</b>	<b>RSF-4832E4</b>	3	2	166.5	193.5	1	3.05
<b>RS-4932E4</b>	<b>RSF-4932E4</b>	5	3.5	169	211	2	7.0
<b>RS-4834E4</b>	<b>RSF-4834E4</b>	4	3	176.5	208.5	1	4.1
<b>RS-4934E4</b>	<b>RSF-4934E4</b>	4	3.5	179	221	2	7.35
<b>RS-4836E4</b>	<b>RSF-4836E4</b>	4	3	186.5	218.5	1	4.3
<b>RS-4936E4</b>	<b>RSF-4936E4</b>	6	4.5	189	241	2	10.7
<b>RS-4838E4</b>	<b>RSF-4838E4</b>	5	3.5	198	232	1.5	5.65
<b>RS-4938E4</b>	<b>RSF-4938E4</b>	6	4.5	199	251	2	11.1
<b>RS-4840E4</b>	<b>RSF-4840E4</b>	5	3.5	208	242	1.5	5.95
<b>RS-4940E4</b>	<b>RSF-4940E4</b>	7	5	211	269	2	15.7
<b>RS-4844E4</b>	<b>RSF-4844E4</b>	5	3.5	228	262	1.5	6.45
<b>RS-4944E4</b>	<b>RSF-4944E4</b>	7	5	231	289	2	17

**Notes** <sup>(1)</sup> Suffix E4 indicates that the outer ring contains oil holes and an oil groove.

<sup>(2)</sup>  $d_{OH}$  represents the oil hole diameter in the outer ring.

<sup>(3)</sup> Axial Disp. refers to permissible axial displacement for free-end bearings.

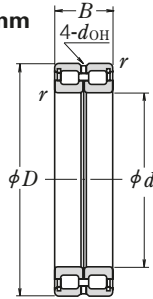


# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

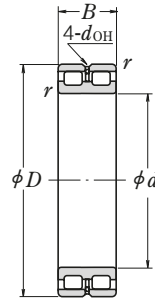
RS-48 · RS-49 Types

RSF-48 · RSF-49 Types

Bore Diameter 240 – 560 mm



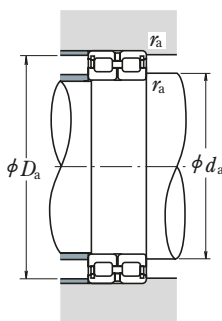
Fixed-End Bearing  
RS



Free-End Bearing  
RSF

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>240</b>	300	60	2	495 000	1 340 000	430	850
	320	80	2.1	725 000	1 770 000	400	800
<b>260</b>	320	60	2	515 000	1 450 000	380	750
	360	100	2.1	1 050 000	2 530 000	360	710
<b>280</b>	350	69	2	610 000	1 690 000	340	710
	380	100	2.1	1 090 000	2 720 000	340	670
<b>300</b>	380	80	2.1	805 000	2 160 000	320	630
	420	118	3	1 460 000	3 400 000	300	600
<b>320</b>	400	80	2.1	835 000	2 310 000	300	600
	440	118	3	1 500 000	3 600 000	280	560
<b>340</b>	420	80	2.1	855 000	2 430 000	280	560
	460	118	3	1 560 000	3 900 000	260	530
<b>360</b>	440	80	2.1	885 000	2 580 000	260	530
	480	118	3	1 600 000	4 050 000	260	500
<b>380</b>	480	100	2.1	1 260 000	3 600 000	240	500
	520	140	4	2 040 000	5 200 000	240	450
<b>400</b>	500	100	2.1	1 290 000	3 750 000	240	480
	540	140	4	2 100 000	5 450 000	220	450
<b>420</b>	520	100	2.1	1 320 000	3 950 000	220	450
	560	140	4	2 150 000	5 700 000	200	430
<b>440</b>	540	100	2.1	1 350 000	4 150 000	200	430
	600	160	4	2 840 000	7 350 000	190	380
<b>460</b>	580	118	3	1 730 000	5 150 000	190	380
	620	160	4	2 870 000	7 500 000	190	380
<b>480</b>	600	118	3	1 760 000	5 300 000	190	380
	650	170	5	3 200 000	8 500 000	180	360
<b>500</b>	620	118	3	1 810 000	5 600 000	180	360
	670	170	5	3 300 000	8 900 000	170	340
<b>530</b>	710	180	5	3 400 000	9 200 000	160	320
<b>560</b>	750	190	5	3 800 000	10 100 000	150	300

**Remark** Cylindrical roller bearings for sheaves are designed for specific applications; when using them, please contact NSK.



Bearing Designations <sup>(1)</sup>		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
Fixed-End Bearing	Free-End Bearing	$d_{OH}^{(2)}$	Axial Disp. <sup>(3)</sup>	$d_a$ min.	$D_a$ max.	$r_a$ max.	approx.
<b>RS-4848E4</b>	<b>RSF-4848E4</b>	5	3.5	249	291	2	10.3
<b>RS-4948E4</b>	<b>RSF-4948E4</b>	7	5	251	309	2	18.4
<b>RS-4852E4</b>	<b>RSF-4852E4</b>	5	3.5	269	311	2	11
<b>RS-4952E4</b>	<b>RSF-4952E4</b>	8	6	271	349	2	32
<b>RS-4856E4</b>	<b>RSF-4856E4</b>	6	4.5	289	341	2	16
<b>RS-4956E4</b>	<b>RSF-4956E4</b>	8	6	291	369	2	34
<b>RS-4860E4</b>	<b>RSF-4860E4</b>	6	5	311	369	2	23
<b>RS-4960E4</b>	<b>RSF-4960E4</b>	9	7	313	407	2.5	52
<b>RS-4864E4</b>	<b>RSF-4864E4</b>	6	5	331	389	2	24.3
<b>RS-4964E4</b>	<b>RSF-4964E4</b>	9	7	333	427	2.5	55
<b>RS-4868E4</b>	<b>RSF-4868E4</b>	6	5	351	409	2	25.6
<b>RS-4968E4</b>	<b>RSF-4968E4</b>	9	7	353	447	2.5	58
<b>RS-4872E4</b>	<b>RSF-4872E4</b>	6	5	371	429	2	27
<b>RS-4972E4</b>	<b>RSF-4972E4</b>	9	7	373	467	2.5	61
<b>RS-4876E4</b>	<b>RSF-4876E4</b>	8	6	391	469	2	45.5
<b>RS-4976E4</b>	<b>RSF-4976E4</b>	11	8	396	504	3	90.5
<b>RS-4880E4</b>	<b>RSF-4880E4</b>	8	6	411	489	2	47.5
<b>RS-4980E4</b>	<b>RSF-4980E4</b>	11	8	416	524	3	94.5
<b>RS-4884E4</b>	<b>RSF-4884E4</b>	8	6	431	509	2	49.5
<b>RS-4984E4</b>	<b>RSF-4984E4</b>	11	8	436	544	3	98.5
<b>RS-4888E4</b>	<b>RSF-4888E4</b>	8	6	451	529	2	51.5
<b>RS-4988E4</b>	<b>RSF-4988E4</b>	11	8	456	584	3	136
<b>RS-4892E4</b>	<b>RSF-4892E4</b>	9	7	473	567	2.5	77.5
<b>RS-4992E4</b>	<b>RSF-4992E4</b>	11	8	476	604	3	142
<b>RS-4896E4</b>	<b>RSF-4896E4</b>	9	7	493	587	2.5	80.5
<b>RS-4996E4</b>	<b>RSF-4996E4</b>	12	9	500	630	4	167
<b>RS-48/500E4</b>	<b>RSF-48/500E4</b>	9	7	513	607	2.5	83.5
<b>RS-49/500E4</b>	<b>RSF-49/500E4</b>	12	9	520	650	4	173
<b>RS-49/530E4</b>	<b>RSF-49/530E4</b>	12	11	550	690	4	206
<b>RS-49/560E4</b>	<b>RSF-49/560E4</b>	12	11	580	730	4	231

**Notes** <sup>(1)</sup> Suffix E4 indicates that the outer ring contains oil holes and an oil groove.

<sup>(2)</sup>  $d_{OH}$  represents the oil hole diameter in the outer ring.

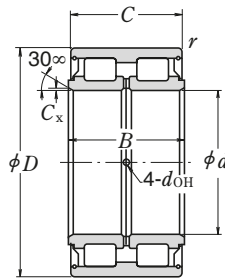
<sup>(3)</sup> Axial Disp. refers to permissible axial displacement for free-end bearings.



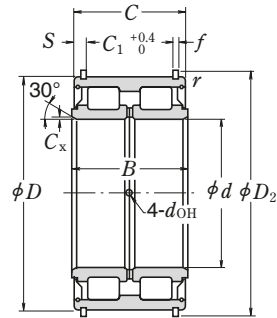
# ■ FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

RS-50 Type (Prelubricated)

Bore Diameter 40 – 400 mm



Without Locating Ring



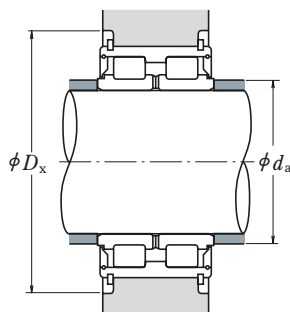
With Locating Ring

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> ) Grease
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i>	<i>C<sub>x</sub></i> <sup>(1)</sup> min.	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	
40	68	38	37	0.4	0.6	79 500	116 000	2 400
45	75	40	39	0.4	0.6	95 500	144 000	2 200
50	80	40	39	0.4	0.6	100 000	158 000	2 000
55	90	46	45	0.6	0.6	118 000	193 000	1 800
60	95	46	45	0.6	0.6	123 000	208 000	1 700
65	100	46	45	0.6	0.6	128 000	224 000	1 600
70	110	54	53	0.6	0.6	171 000	285 000	1 400
75	115	54	53	0.6	0.6	179 000	305 000	1 400
80	125	60	59	0.6	0.6	251 000	430 000	1 200
85	130	60	59	0.6	0.6	256 000	445 000	1 200
90	140	67	66	1	0.6	305 000	540 000	1 100
95	145	67	66	1	0.6	310 000	565 000	1 100
100	150	67	66	1	0.6	320 000	585 000	1 000
110	170	80	79	1.1	1	385 000	695 000	900
120	180	80	79	1.1	1	400 000	750 000	850
130	200	95	94	1.1	1	535 000	1 000 000	750
140	210	95	94	1.1	1	550 000	1 040 000	710
150	225	100	99	1.3	1	620 000	1 210 000	670
160	240	109	108	1.3	1.1	695 000	1 370 000	630
170	260	122	121	1.3	1.1	860 000	1 680 000	600
180	280	136	135	1.3	1.1	980 000	1 910 000	530
190	290	136	135	1.3	1.1	1 120 000	2 230 000	500
200	310	150	149	1.3	1.1	1 310 000	2 650 000	480
220	340	160	159	1.5	1.1	1 510 000	3 100 000	430
240	360	160	159	1.5	1.1	1 570 000	3 350 000	400
260	400	190	189	2	1.5	2 130 000	4 500 000	360
280	420	190	189	2	1.5	2 170 000	4 700 000	340
300	460	218	216	2	1.5	2 670 000	5 850 000	300
320	480	218	216	2	1.5	2 720 000	6 100 000	300
340	520	243	241	2.1	2	3 350 000	7 550 000	260
360	540	243	241	2.1	2	3 450 000	7 850 000	260
380	560	243	241	2.1	2	3 550 000	8 400 000	240
400	600	272	270	2.1	2	4 250 000	9 950 000	220

**Note** <sup>(1)</sup> These values represent chamfer dimensions of the inner ring in the radial direction.

**Remarks** 1. Quality grease is prepacked in the bearings.

2. Grease can be supplied through oil holes in the inner rings.



Bearing Designations		Locating Ring Dimensions (mm)				Oil Holes (mm)	Abutment and Fillet Dimensions (mm)		Mass (kg)
Without Locating Ring	With Locating Ring	$C_1$	$S$	$D_2$	$f$	$d_{OH}$	$d_a$ min.	$D_x$ min.	approx.
RS-5008	RS-5008NR	28	4.5	71.8	2	2.5	43.5	77.5	0.56
RS-5009	RS-5009NR	30	4.5	78.8	2	2.5	48.5	84.5	0.70
RS-5010	RS-5010NR	30	4.5	83.8	2	2.5	53.5	89.5	0.76
RS-5011	RS-5011NR	34	5.5	94.8	2.5	3	60	101	1.17
RS-5012	RS-5012NR	34	5.5	99.8	2.5	3	65	106	1.25
RS-5013	RS-5013NR	34	5.5	104.8	2.5	3	70	111	1.32
RS-5014	RS-5014NR	42	5.5	114.5	2.5	3	75	121	1.87
RS-5015	RS-5015NR	42	5.5	119.5	2.5	3	80	126	2.0
RS-5016	RS-5016NR	48	5.5	129.5	2.5	3	85	136	2.65
RS-5017	RS-5017NR	48	5.5	134.5	2.5	3	90	141	2.75
RS-5018	RS-5018NR	54	6	145.4	2.5	4	96	153.5	3.75
RS-5019	RS-5019NR	54	6	150.4	2.5	4	101	158.5	3.95
RS-5020	RS-5020NR	54	6	155.4	2.5	4	106	163.5	4.05
RS-5022	RS-5022NR	65	7	175.4	2.5	5	116.5	183.5	6.1
RS-5024	RS-5024NR	65	7	188	3	5	126.5	197	7.0
RS-5026	RS-5026NR	77	8.5	207	3	5	136.5	217	10.6
RS-5028	RS-5028NR	77	8.5	217	3	5	146.5	227	11.3
RS-5030	RS-5030NR	81	9	232	3	6	157	242	13.7
RS-5032	RS-5032NR	89	9.5	247	3	6	167	257	16.8
RS-5034	RS-5034NR	99	11	270	4	6	177	285	22.2
RS-5036	RS-5036NR	110	12.5	294	5	6	187	318	30
RS-5038	RS-5038NR	110	12.5	304	5	6	197	328	32
RS-5040	RS-5040NR	120	14.5	324	5	6	207	352	41
RS-5044	RS-5044NR	130	14.5	356	6	7	228.5	382	53
RS-5048	RS-5048NR	130	14.5	376	6	7	248.5	402	57
RS-5052	RS-5052NR	154	17.5	416	7	8	270	444	86
RS-5056	RS-5056NR	154	17.5	436	7	8	290	472	92
RS-5060	RS-5060NR	178	19	476	7	8	310	512	130
RS-5064	—	—	—	—	—	8	330	—	135
RS-5068	—	—	—	—	—	10	352	—	185
RS-5072	—	—	—	—	—	10	372	—	192
RS-5076	—	—	—	—	—	10	392	—	196
RS-5080	—	—	—	—	—	10	412	—	280

- Remarks**
3. Cylindrical roller bearings for sheaves are designed for specific applications; when using them, please contact NSK.
  4. For shields with outside diameters larger than 180 mm, the above figure is different from the actual shape. For detailed drawings, please contact NSK.



## 6. TAPERED ROLLER BEARINGS

INTRODUCTION .....	C 182
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### TECHNICAL DATA

Free Space of Tapered Roller Bearings .....	C 188
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### BEARING TABLES

#### METRIC SERIES TAPERED ROLLER BEARINGS

Bore Diameter 15 – 100 mm .....	C 190
Bore Diameter 105 – 240 mm .....	C 202
Bore Diameter 260 – 440 mm .....	C 208

#### INCH SERIES TAPERED ROLLER BEARINGS

Bore Diameter 12.000 – 47.625 mm .....	C 210
Bore Diameter 48.412 – 69.850 mm .....	C 224
Bore Diameter 70.000 – 206.375 mm .....	C 232

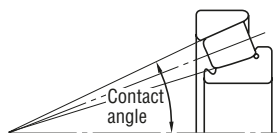
Appendix 14 (Page E020) contains the index for inch series tapered roller bearings.

#### DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 260 mm .....	C 246
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## DESIGN, TYPES, AND FEATURES

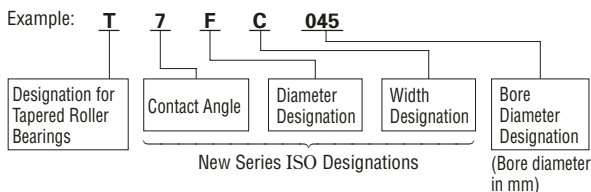


Tapered roller bearings are designed so the apices of the cones formed by the raceways of the inner and outer rings and the inner ring rollers all coincide at one point on the axis of the bearing. When a radial load is imposed, a component axial force occurs; therefore, it is necessary to use two bearings in opposition or some other multiple-bearing arrangement.

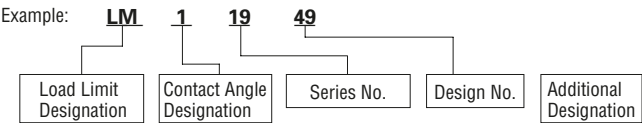
For Metric Series medium-angle or steep-angle tapered roller bearings, the respective contact angle designation C or D is added after the bore number. For normal-angle tapered roller bearings, no contact angle designation is used. Medium-angle tapered roller bearings are primarily used for the pinion shafts of differential gears in automobiles.

Some bearings with high load capacity (HR Series) contain a J suffix that indicates they conform to ISO specifications for outer ring back face raceway diameter, outer ring width, and contact angle. Therefore, the inner ring assembly and outer ring of bearings with a J suffix are internationally interchangeable.

Some Metric Series tapered roller bearings specified by ISO 355 have different dimensions from past Series 3XX bearings. Some of these are listed in the bearing tables. These conform to ISO specifications for the small-end diameter of the inner ring and contact angle. The inner and outer ring assemblies are internationally interchangeable. The bearing designation structure, which has changed from the past, is listed below:

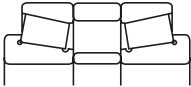
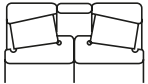
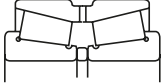
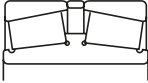


Inch Series bearings also exist. Inner ring assemblies and outer rings are approximately formulated as follows (excluding four-row tapered roller bearings):



Various arrangements of tapered roller bearings (excluding single-row bearings) are available.  
The cages of tapered roller bearings are usually made of pressed steel.

Table 1 Design and Features of Tapered Roller Bearing Arrangements

Design	Arrangement	Ex. Bearing Designation	Features
	Back-to-back	HR30210JDB+KLR10	Two standard bearings are combined. The bearing clearances are adjusted by inner ring spacers or outer ring spacers. The inner rings, outer rings, and spacers are marked with serial numbers and mating marks. Components with the same serial number can be assembled by referring to the matching indications.
	Face-to-face	HR30210JDF+KR	
	KBE Type	100KBE31+L	The KBE type is a back-to-back arrangement of bearings with an integrated outer ring spacer. The KH type is a face-to-face arrangement in which the inner rings are integrated. Since the bearing clearance is adjusted using spacers, components must have the same serial number for assembly with reference to the matching indications.
	KH Type	110KH31+K	



## TOLERANCES AND RUNNING ACCURACY

### METRIC SERIES TAPERED ROLLER

**BEARINGS** ..... Table 7.3 (Pages A132 to A135)

### INCH SERIES TAPERED ROLLER

**BEARINGS** ..... Table 7.4 (Pages A136 and A137)

The following precision classes apply to some Inch Series tapered roller bearings. For more details, please consult with NSK.

(1) J line bearings (bearings preceded by ▲ in the bearing tables)

**Table 2 Tolerances for Inner Rings (CLASS K)**

Units :  $\mu\text{m}$

Nominal Bore Diameter $d$ (mm)		$\Delta_{dmp}$		$V_{dp}$	$V_{dmp}$	$K_{ia}$
over	incl.	high	low	max.	max.	max.
10	18	0	-12	12	9	15
18	30	0	-12	12	9	18
30	50	0	-12	12	9	20
50	80	0	-15	15	11	25
80	120	0	-20	20	15	30
120	180	0	-25	25	19	35
180	250	0	-30	30	23	50
250	315	0	-35	35	26	60
315	400	0	-40	40	30	70

**Table 3 Tolerances for Outer Rings (CLASS K)**

Units :  $\mu\text{m}$

Nominal Outside Diameter $D$ (mm)		$\Delta_{Dmp}$		$V_{Dp}$	$V_{Dmp}$	$K_{ea}$
over	incl.	high	low	max.	max.	max.
18	30	0	-12	12	9	18
30	50	0	-14	14	11	20
50	80	0	-16	16	12	25
80	120	0	-18	18	14	35
120	150	0	-20	20	15	40
150	180	0	-25	25	19	45
180	250	0	-30	30	23	50
250	315	0	-35	35	26	60
315	400	0	-40	40	30	70
400	500	0	-45	45	34	80

**Table 4 Deviations of Actual Bearing Width and Actual Effective Widths of Inner Subunit and Outer Ring (CLASS K)**

Units : m

Nominal Bore Diameter $d$ (mm)		Deviation of Actual Effective Width of Inner Subunit $\Delta T_{1s}$		Deviation of Actual Effective Width of Outer Ring $\Delta T_{2s}$		Deviation of Actual Bearing Width $\Delta T_s$	
over	incl.	high	low	high	low	high	low
10	80	+100	0	+100	0	+200	0
80	120	+100	-100	+100	-100	+200	-200
120	315	+150	-150	+200	-100	+350	-250
315	400	+200	-200	+200	-200	+400	-400

(2) Bearings for Front Axles of Automobiles

(In the bearing tables, these are preceded by "T")

**Table 5 Tolerances for Deviations of a Single Bore Diameter and Actual Bearing Width**

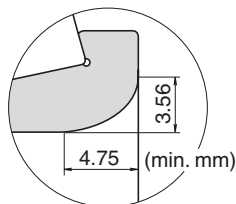
Units : m

Nominal Bore Diameter $d$		Deviation of a Single Bore Diameter $\Delta d_s$		Deviation of Actual Bearing Width $\Delta T_s$	
over (mm)	incl. (mm)	high	low	high	low
—	76.200 3.0000	+20	0	+356	0

The tolerances for outside diameter and those for radial runout of the inner rings and outer rings conform to Table 7.4.2 (Pages A136 and A137).

(3) Special Chamfer Dimensions

For bearings marked "spec." in the  $r$  column of the bearing tables have inner ring back-face side dimensions as shown in the following figure:



## RECOMMENDED FITS

<b>METRIC SERIES TAPERED ROLLER BEARINGS</b> .....	Table 8.3 (Page A164) Table 8.5 (Page A165)
<b>INCH SERIES TAPERED ROLLER BEARINGS</b> .....	Table 8.7 (Page A166) Table 8.8 (Page A167)

## INTERNAL CLEARANCE

<b>METRIC SERIES TAPERED ROLLER BEARINGS (Matched and Double-Row)</b> .....	Table 8.17 (Page A173)
<b>INCH SERIES TAPERED ROLLER BEARINGS (Matched and Double-Row)</b> .....	Table 8.17 (Page A173)

## 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 inner ring rib.

## PERMISSIBLE MISALIGNMENT

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

## LIMITING SPEEDS (GREASE/OIL)

The limiting speeds (grease) and limiting speeds (oil) listed in the bearing tables should be adjusted depending on bearing load conditions. Furthermore, higher speeds are attainable by making changes in the lubrication method, cage design, etc. Refer to page A098 for more detailed information.

## PRECAUTIONS FOR USE OF TAPERED ROLLER BEARINGS

1. If the load on tapered roller bearings becomes too small, or if the ratio of the axial and radial loads for matched bearings during operation exceeds ' $e$ ' as listed in the bearing tables, slippage between the rollers and raceways occurs, which may result in smearing. This is especially prevalent with large bearings since the weight of the rollers and cage is high. If such load conditions are expected, please contact NSK for selection of the bearings.
2. Confirm the dimensions of  $D_a$ ,  $D_b$ ,  $S_a$ , and  $S_b$  when adopting HR Series bearings.



## TECHNICAL DATA

### Free Space of Tapered Roller Bearings

Tapered roller bearings can carry radial loads and offer high capacity. These bearings are used widely in machines with relatively severe loading conditions, usually in various combinations of opposed or combined single-row bearings.

Tapered roller bearings are usually lubricated with grease to facilitate easier maintenance and inspection. Be sure to select a grease appropriate for operating conditions and use the proper amount of grease in the housing space. The necessary free space for various bearing Series are listed in Table 6.

The free space of a tapered roller bearing is measured as the outer volume of the bearing less the inner ring, outer ring, and cage, as shown in Figure 1. The bearing is filled so that grease reaches the inner ring rib surface and pocket surface sufficiently. Take care regarding the fill amount and state of the grease, especially if grease leakage occurs or if maintaining low running torque is important.

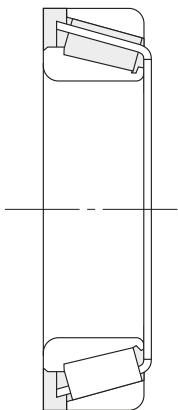


Fig. 1 Free Space in a Tapered Roller Bearing

Bearing Bore No.			
	HR329-J	HR320-XJ	
02	—	—	
03	—	—	
04	—	3.5	
/22	—	3.6	
05	—	3.7	
/28	—	5.3	
06	—	6.2	
/32	—	6.6	
07	4.0	7.5	
08	5.8	9.1	
09	—	11	
10	—	12	
11	8.8	19	
12	9.0	20	
13	—	21	
14	17	29	
15	—	30	
16	—	40	
17	—	43	
18	28	58	
19	29	60	
20	37	64	

Table 6 Free Space of Tapered Roller Bearings

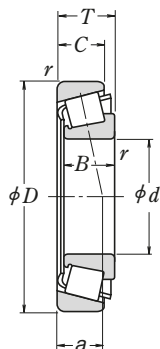
Units: cm<sup>3</sup>

Bearing Free Space							
Bearing Series							
HR330-J	HR331-J	HR302-J	HR322-J	HR332-J	HR303-J	HR303-DJ	HR323-J
—	—	—	—	—	4.5	—	—
—	—	3.3	4.3	—	5.7	—	—
—	—	5.3	6.6	—	7.2	—	9.2
—	—	—	7.3	—	9.1	—	—
4.3	—	6.3	7.4	7.5	11	13	15
—	—	8.8	9.8	10	16	—	—
6.7	—	9.2	11	12	18	21	23
—	—	11	13	14	20	—	—
8.9	—	13	17	18	23	26	35
11	—	18	23	25	31	35	45
—	18	22	24	26	41	48	58
15	20	23	26	29	55	59	77
21	29	30	36	40	72	78	99
23	—	39	47	53	88	95	130
25	—	45	62	65	110	120	150
33	—	53	67	69	130	150	190
34	—	58	73	74	160	180	230
—	—	75	91	100	200	200	270
49	76	92	120	130	230	250	320
—	110	110	150	—	260	310	370
—	—	140	170	—	310	350	430
—	150	160	210	240	380	460	580



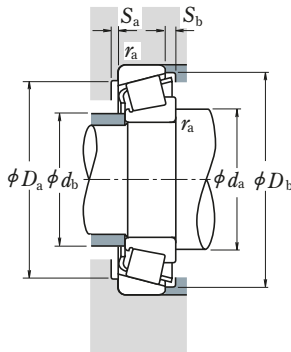
# SINGLE-ROW TAPERED ROLLER BEARINGS

Bores Diameter 15 – 28 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)			Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
15	35	11.75	11	10	0.6	0.6	14 800	13 200	11 000	15 000
	42	14.25	13	11	1	1	23 600	21 100	9 500	13 000
17	40	13.25	12	11	1	1	20 100	19 900	9 500	13 000
	40	17.25	16	14	1	1	27 100	28 000	9 500	13 000
	47	15.25	14	12	1	1	29 200	26 700	8 500	12 000
	47	15.25	14	10.5	1	1	22 000	20 300	8 000	11 000
	47	20.25	19	16	1	1	37 500	36 500	8 500	11 000
20	42	15	15	12	0.6	0.6	24 600	27 400	9 000	12 000
	47	15.25	14	12	1	1	27 900	28 500	8 000	11 000
	47	15.25	14	12	0.3	1	23 900	24 000	8 000	11 000
	47	19.25	18	15	1	1	35 500	37 500	8 500	11 000
	47	19.25	18	15	1	1	31 500	33 500	8 000	11 000
	52	16.25	15	13	1.5	1.5	35 000	33 500	7 500	10 000
	52	16.25	15	12	1.5	1.5	25 300	24 500	7 100	10 000
	52	22.25	21	18	1.5	1.5	45 500	47 500	8 000	11 000
22	44	15	15	11.5	0.6	0.6	25 600	29 400	8 500	11 000
	50	15.25	14	12	1	1	29 200	30 500	7 500	10 000
	50	15.25	14	12	1	1	27 200	29 500	7 500	10 000
	50	19.25	18	15	1	1	36 500	40 500	7 500	11 000
	50	19.25	18	15	1	1	33 500	39 500	7 500	10 000
	56	17.25	16	14	1.5	1.5	37 000	36 500	7 100	9 500
	56	17.25	16	13	1.5	1.5	34 500	34 000	6 700	9 500
	56	17.25	16	13	1.5	1.5	27 400	33 000	8 000	11 000
25	47	15	15	11.5	0.6	0.6	27 400	33 000	8 000	11 000
	47	17	17	14	0.6	0.6	31 000	38 000	8 000	11 000
	52	16.25	15	13	1	1	32 000	35 000	7 100	10 000
	52	16.25	15	12	1	1	28 100	31 500	9 700	9 500
	52	19.25	18	16	1	1	40 000	45 000	7 100	10 000
	52	19.25	18	15	1	1	35 000	42 000	7 100	9 500
	52	22	22	18	1	1	47 500	56 500	7 500	10 000
	62	18.25	17	15	1.5	1.5	47 500	46 000	6 300	8 500
	62	18.25	17	14	1.5	1.5	42 000	45 000	6 000	8 500
	62	18.25	17	13	1.5	1.5	38 000	40 500	5 600	8 000
	62	18.25	17	13	1.5	1.5	38 000	40 500	5 600	8 000
	62	25.25	24	20	1.5	1.5	62 500	66 000	6 300	8 500
28	52	16	16	12	1	1	32 000	39 000	7 100	9 500
	58	17.25	16	14	1	1	39 500	41 500	6 300	9 000
	58	17.25	16	12	1	1	34 000	38 500	6 300	8 500
	58	20.25	19	16	1	1	47 500	54 000	6 300	9 000
	58	20.25	19	16	1	1	42 000	49 500	6 300	9 000
	68	19.75	18	15	1.5	1.5	55 000	55 500	6 000	8 000
	68	19.75	18	14	1.5	1.5	49 500	50 500	5 600	7 500

**Remark** Suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

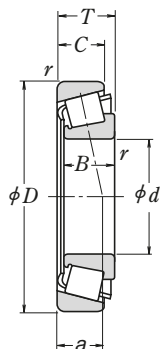
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner Outer $r_a$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$S_a$ min.	$S_b$ min.						$Y_1$	$Y_0$	
30202	—	23	19	30	30	33	2	1.5	0.6	0.6	8.2	0.32	1.9	1.0	0.053
HR 30302 J	2FB	24	22	36	36	38.5	2	3	1	1	9.5	0.29	2.1	1.2	0.098
HR 30203 J	2DB	26	23	34	34	37.5	2	2	1	1	9.7	0.35	1.7	0.96	0.079
HR 32203 J	2DD	26	22	34	34	37	2	3	1	1	11.2	0.31	1.9	1.1	0.103
HR 30303 J	2FB	26	24	41	40	43	2	3	1	1	10.4	0.29	2.1	1.2	0.134
30303 D	—	29	23	41	34	44	2	4.5	1	1	15.4	0.81	0.74	0.41	0.129
HR 32303 J	2FD	28	23	41	39	43	2	4	1	1	12.5	0.29	2.1	1.2	0.178
HR 32004 XJ	3CC	28	24	37	35	40	3	3	0.6	0.6	10.6	0.37	1.6	0.88	0.097
HR 30204 J	2DB	29	27	41	40	44	2	3	1	1	11.0	0.35	1.7	0.96	0.127
HR 30204 C-A-	—	29	26	41	37	44	2	3	0.3	1	13.0	0.55	1.1	0.60	0.126
HR 32204 J	2DD	29	25	41	38	44.5	3	4	1	1	12.6	0.33	1.8	1.0	0.161
HR 32204 CJ	5DD	29	25	41	36	44	2	4	1	1	14.5	0.52	1.2	0.64	0.166
HR 30304 J	2FB	31	27	44	44	47.5	2	3	1.5	1.5	11.6	0.30	2.0	1.1	0.172
30304 D	—	34	26	43	37	49	2	4	1.5	1.5	16.7	0.81	0.74	0.41	0.168
HR 32304 J	2FD	33	26	43	42	48	3	4	1.5	1.5	13.9	0.30	2.0	1.1	0.241
HR 320/22 XJ	3CC	30	27	39	37	42	3	3.5	0.6	0.6	11.1	0.40	1.5	0.83	0.103
HR 302/22	—	31	29	44	42	47	2	3	1	1	11.6	0.37	1.6	0.90	0.139
HR 302/22 C	—	31	29	44	40	47	2	3	1	1	13.0	0.49	1.2	0.67	0.144
HR 322/22	—	31	28	44	41	47	2	4	1	1	13.5	0.37	1.6	0.89	0.18
HR 322/22 C	—	31	29	44	39	48	2	4	1	1	15.2	0.51	1.2	0.65	0.185
HR 303/22	—	33	30	47	46	50	2	3	1.5	1.5	12.4	0.32	1.9	1.0	0.208
HR 303/22 C	—	33	30	47	44	52.5	3	4	1.5	1.5	15.9	0.59	1.0	0.56	0.207
HR 32005 XJ	4CC	33	30	42	40	45	3	3.5	0.6	0.6	11.8	0.43	1.4	0.77	0.116
HR 33005 J	2CE	33	29	42	41	44	3	3	0.6	0.6	11.0	0.29	2.1	1.1	0.131
HR 30205 J	3CC	34	31	46	44	48.5	2	3	1	1	12.7	0.37	1.6	0.88	0.157
HR 30205 C	—	34	32	46	43	49.5	2	4	1	1	14.4	0.53	1.1	0.62	0.155
HR 32205 J	2CD	34	30	46	44	50	2	3	1	1	13.5	0.36	1.7	0.92	0.189
HR 32205 C	—	34	30	46	40	50	2	4	1	1	15.8	0.53	1.1	0.62	0.19
HR 33205 J	2DE	34	29	46	43	49.5	4	4	1	1	14.1	0.35	1.7	0.94	0.221
HR 30305 J	2FB	36	34	54	54	57	2	3	1.5	1.5	13.2	0.30	2.0	1.1	0.27
HR 30305 C	—	36	35	53	49	58.5	3	4	1.5	1.5	16.4	0.55	1.1	0.60	0.276
HR 30305 DJ	(7FB)	39	34	53	47	59	2	5	1.5	1.5	19.9	0.83	0.73	0.40	0.265
HR 31305 J	7FB	39	33	53	47	59	3	5	1.5	1.5	19.9	0.83	0.73	0.40	0.265
HR 32305 J	2FD	38	32	53	51	57	3	5	1.5	1.5	15.6	0.30	2.0	1.1	0.376
HR 320/28 XJ	4CC	37	33	46	44	50	3	4	1	1	12.8	0.43	1.4	0.77	0.146
HR 302/28	—	37	34	52	50	55	2	3	1	1	13.2	0.35	1.7	0.93	0.203
HR 302/28 C	—	37	34	52	48	54	2	5	1	1	16.9	0.64	0.94	0.52	0.198
HR 322/28	—	37	34	52	49	55	2	4	1	1	14.6	0.37	1.6	0.89	0.243
HR 322/28 CJ	5DD	37	33	52	45	55	2	4	1	1	16.8	0.56	1.1	0.59	0.251
HR 303/28	—	39	37	59	58	61	2	4.5	1.5	1.5	14.5	0.31	1.9	1.1	0.341
HR 303/28 C	—	39	38	59	57	63	3	5.5	1.5	1.5	17.4	0.52	1.2	0.64	0.335



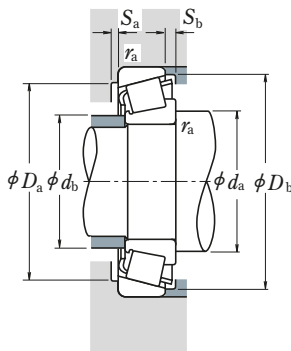
# ■ SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 30 – 35 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)				Ring: Inner <i>r</i> min.	Outer	Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>				<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
30	47	12	12	9	0.3	0.3		17 600	24 400	7 500	10 000
	55	17	17	13	1	1		36 000	44 500	6 700	9 000
	55	20	20	16	1	1		42 000	54 000	6 700	9 000
	62	17.25	16	14	1	1		43 000	47 500	6 000	8 000
	62	17.25	16	12	1	1		35 500	37 000	5 600	7 500
	62	21.25	20	17	1	1		52 000	60 000	6 000	8 500
	62	21.25	20	16	1	1		48 000	56 000	6 000	8 000
	62	25	25	19.5	1	1		66 500	79 500	6 000	8 000
	72	20.75	19	16	1.5	1.5		59 500	60 000	5 300	7 500
	72	20.75	19	14	1.5	1.5		56 500	55 500	5 300	7 100
	72	20.75	19	14	1.5	1.5		49 000	52 500	4 800	6 700
	72	20.75	19	14	1.5	1.5		49 000	52 500	4 800	6 800
	72	28.75	27	23	1.5	1.5		80 000	88 500	5 600	7 500
	72	28.75	27	23	1.5	1.5		76 000	86 500	5 600	7 500
	72	28.75	27	23	1.5	1.5		76 000	86 500	5 600	7 500
	72	28.75	27	23	1.5	1.5		76 000	86 500	5 600	7 500
32	58	17	17	13	1	1		37 500	47 000	6 300	8 500
	58	21	20	16	1	1		41 000	50 000	6 300	8 500
	65	18.25	17	15	1	1		48 500	54 000	5 600	8 000
	65	18.25	17	14	1	1		45 500	52 500	5 600	7 500
	65	22.25	21	18	1	1		56 000	65 000	6 000	8 000
	65	22.25	21	17	1	1		49 500	60 000	5 600	7 500
	65	26	26	20.5	1	1		70 000	86 500	5 600	8 000
	75	21.75	20	17	1.5	1.5		56 000	56 000	5 300	7 100
	75	21.75	20	17	1.5	1.5		56 000	56 000	5 300	7 100
	75	21.75	20	17	1.5	1.5		56 000	56 000	5 300	7 100
35	55	14	14	11.5	0.6	0.6		27 400	39 000	6 300	8 500
	62	18	18	14	1	1		43 500	55 500	5 600	8 000
	62	21	21	17	1	1		49 000	65 000	5 600	8 000
	72	18.25	17	15	1.5	1.5		54 000	59 500	5 300	7 100
	72	18.25	17	13	1.5	1.5		47 000	54 500	5 000	6 700
	72	24.25	23	19	1.5	1.5		70 500	83 500	5 300	7 100
	72	24.25	23	18	1.5	1.5		60 500	71 500	5 000	7 100
	72	28	28	22	1.5	1.5		86 500	108 000	5 300	7 100
	80	22.75	21	18	2	1.5		76 000	79 000	4 800	6 700
	80	22.75	21	16	2	1.5		68 000	70 500	4 800	6 300
	80	22.75	21	15	2	1.5		62 000	68 000	4 300	6 000
	80	22.75	21	15	2	1.5		62 000	68 000	4 300	6 000
	80	32.75	31	25	2	1.5		99 000	111 000	5 000	6 700
	80	32.75	31	25	2	1.5		99 000	111 000	5 000	6 700

**Remark** Suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

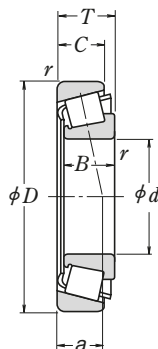
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Eff. Load Center (mm) <i>a</i>	Constant <i>e</i>	Axial Load Factors		Mass (kg) approx.	
		<i>d<sub>a</sub></i> min.	<i>d<sub>b</sub></i> max.	<i>D<sub>a</sub></i>		<i>D<sub>b</sub></i>		<i>S<sub>a</sub></i> min.	<i>S<sub>b</sub></i> min.			Ring: Inner Outer <i>r<sub>a</sub></i> max.			
				max.	min.	min.	max.					<i>r<sub>a</sub></i> max.	<i>r<sub>b</sub></i> max.		
HR 32906 J HR 32006 XJ HR 33006 J	2BD	34	34	44	42	44	3	3	0.3	0.3	9.2	0.32	1.9	1.0	0.074
	4CC	39	35	49	47	53	3	4	1	1	13.5	0.43	1.4	0.77	0.172
	2CE	39	35	49	48	52	3	4	1	1	13.1	0.29	2.1	1.1	0.208
HR 30206 J HR 30206 C HR 32206 J	3DB	39	37	56	52	58	2	3	1	1	13.9	0.37	1.6	0.88	0.238
	—	39	36	56	49	59	2	5	1	1	17.8	0.68	0.88	0.49	0.221
	3DC	39	36	56	51	58.5	2	4	1	1	15.4	0.37	1.6	0.88	0.297
HR 32206 C HR 33206 J HR 30306 J HR 30306 C	—	39	35	56	48	59	2	5	1	1	17.8	0.55	1.1	0.60	0.293
	2DE	39	35	56	52	59.5	5	5.5	1	1	16.1	0.34	1.8	0.97	0.355
	2FB	41	40	63	62	66	3	4.5	1.5	1.5	15.1	0.32	1.9	1.1	0.403
	—	41	38	63	59	67	3	6.5	1.5	1.5	18.5	0.55	1.1	0.60	0.383
HR 30306 DJ HR 31306 J HR 32306 J HR 32306 CJ	(7FB)	44	40	63	55	68	3	6.5	1.5	1.5	23.1	0.83	0.73	0.40	0.393
	7FB	44	40	63	55	68	3	6.5	1.5	1.5	23.1	0.83	0.73	0.40	0.393
	2FD	43	38	63	59	66	3	5.5	1.5	1.5	18.0	0.32	1.9	1.1	0.57
	5FD	43	36	63	54	68	3	5.5	1.5	1.5	22.0	0.55	1.1	0.60	0.583
HR 320/32 XJ HR 330/32 HR 302/32 HR 302/32 C	4CC	41	37	52	49	55	3	4	1	1	14.2	0.45	1.3	0.73	0.191
	—	41	37	52	50	55	2	4	1	1	13.8	0.31	1.9	1.1	0.225
	—	41	39	59	56	61	3	3	1	1	14.7	0.37	1.6	0.88	0.277
	—	41	39	59	54	62	3	4	1	1	16.9	0.55	1.1	0.60	0.273
HR 322/32 HR 322/32 C HR 332/32 J HR 303/32	—	41	38	59	54	61	3	4	1	1	15.9	0.37	1.6	0.88	0.336
	—	41	39	59	51	62	3	5	1	1	20.2	0.59	1.0	0.56	0.335
	2DE	41	38	59	55	62	5	5.5	1	1	17.0	0.35	1.7	0.95	0.40
	—	44	42	66	64	68	3	4.5	1.5	1.5	15.9	0.33	1.8	1.0	0.435
HR 32907 J HR 32007 XJ HR 33007 J	2BD	43	40	50	50	52.5	3	2.5	0.6	0.6	10.7	0.29	2.1	1.1	0.123
	4CC	44	40	56	54	60	4	4	1	1	15.0	0.45	1.3	0.73	0.229
	2CE	44	40	56	55	59	4	4	1	1	14.1	0.31	2.0	1.1	0.267
HR 30207 J HR 30207 C HR 32207 J	3DB	46	43	63	62	67	3	3	1.5	1.5	15.0	0.37	1.6	0.88	0.34
	—	46	44	63	59	68	3	5	1.5	1.5	19.6	0.66	0.91	0.50	0.331
	3DC	46	42	63	61	67.5	3	5	1.5	1.5	17.9	0.37	1.6	0.88	0.456
HR 32207 C HR 33207 J HR 30307 J	—	46	42	63	58	68.5	3	6	1.5	1.5	20.6	0.55	1.1	0.60	0.442
	2DE	46	41	63	61	68	5	6	1.5	1.5	18.3	0.35	1.7	0.93	0.54
	2FB	47	45	71	69	74	3	4.5	2	1.5	16.7	0.32	1.9	1.1	0.538
HR 30307 C HR 30307 DJ HR 31307 J HR 32307 J	—	47	44	71	65	74	3	6.5	2	1.5	20.3	0.55	1.1	0.60	0.518
	7FB	51	44	71	62	77	3	7.5	2	1.5	25.2	0.83	0.73	0.40	0.519
	7FB	51	44	71	62	77	3	7.5	2	1.5	25.2	0.83	0.73	0.40	0.52
	2FE	49	43	71	66	74	3	7.5	2	1.5	20.7	0.32	1.9	1.1	0.765



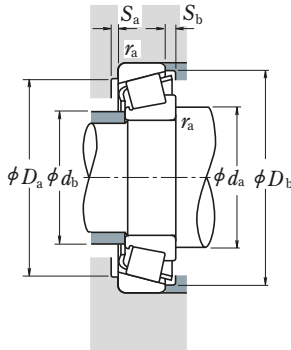
# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 50 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)			Ring: Inner      Outer		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>	<i>r</i> min.	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
40	62	15	15	12	0.6	0.6	34 000	47 000	5 600	7 500
	68	19	19	14.5	1	1	53 000	71 000	5 300	7 100
	68	22	22	18	1	1	59 000	81 500	5 300	7 100
	75	26	26	20.5	1.5	1.5	78 500	101 000	4 800	6 700
	80	19.75	18	16	1.5	1.5	63 500	70 000	4 800	6 300
	80	24.75	23	19	1.5	1.5	77 000	90 500	4 800	6 300
	80	24.75	23	19	1.5	1.5	74 000	90 500	4 500	6 300
	80	32	32	25	1.5	1.5	107 000	137 000	4 800	6 300
	90	25.25	23	20	2	1.5	90 500	101 000	4 300	5 600
	90	25.25	23	18	2	1.5	84 500	93 500	4 300	5 600
	90	25.25	23	17	2	1.5	80 000	89 500	3 800	5 300
	90	25.25	23	17	2	1.5	80 000	89 500	3 800	5 300
	90	35.25	33	27	2	1.5	120 000	145 000	4 300	6 000
	90	35.25	33	27	2	1.5	120 000	145 000	4 300	6 000
45	68	15	15	12	0.6	0.6	34 500	50 500	5 000	6 700
	75	20	20	15.5	1	1	60 000	83 000	4 500	6 300
	75	24	24	19	1	1	69 000	99 000	4 800	6 300
	80	26	26	20.5	1.5	1.5	84 000	113 000	4 500	6 000
	85	20.75	19	16	1.5	1.5	68 500	79 500	4 300	6 000
	85	24.75	23	19	1.5	1.5	83 000	102 000	4 300	6 000
	85	24.75	23	19	1.5	1.5	75 500	95 500	4 300	5 600
	85	32	32	25	1.5	1.5	111 000	147 000	4 300	6 000
	95	29	26.5	20	2.5	2.5	88 500	109 000	3 600	5 000
	95	36	35	30	2.5	2.5	139 000	174 000	4 000	5 300
	100	27.25	25	22	2	1.5	112 000	127 000	3 800	5 300
	100	27.25	25	18	2	1.5	95 500	109 000	3 400	4 800
	100	27.25	25	18	2	1.5	95 500	109 000	3 400	4 800
	100	38.25	36	30	2	1.5	144 000	177 000	3 800	5 300
	100	38.25	36	30	2	1.5	144 000	177 000	3 800	5 300
50	100	36	35	30	2.5	2.5	144 000	185 000	3 800	5 000
	72	15	15	12	0.6	0.6	36 000	54 000	4 500	6 300
	80	20	20	15.5	1	1	61 000	87 000	4 300	6 000
	80	24	24	19	1	1	70 500	104 000	4 300	6 000
	85	26	26	20	1.5	1.5	89 000	126 000	4 300	5 600
	90	21.75	20	17	1.5	1.5	76 000	91 500	4 000	5 300
	90	24.75	23	19	1.5	1.5	87 500	109 000	4 000	5 300
	90	24.75	23	18	1.5	1.5	77 500	102 000	3 800	5 300
	90	32	32	24.5	1.5	1.5	118 000	165 000	4 000	5 300
	105	32	29	22	3	3	109 000	133 000	3 200	4 500
	110	29.25	27	23	2.5	2	130 000	148 000	3 400	4 800
	110	29.25	27	19	2.5	2	114 000	132 000	3 200	4 300
	110	29.25	27	19	2.5	2	114 000	132 000	3 200	4 300
	110	42.25	40	33	2.5	2	176 000	220 000	3 600	4 800
	110	42.25	40	33	2.5	2	164 000	218 000	3 400	4 800

**Remark** Suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

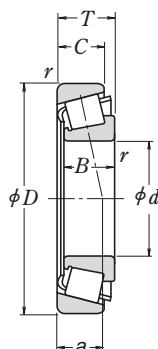
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner $r_a$ Outer $r_b$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$	$d_b$	$D_a$		$D_b$		$S_a$	$S_b$				$Y_1$	$Y_0$	
		min.	max.	max.	min.	min.	min.	min.							
HR 32908 J	2BC	48	44	57	57	59	3	3	0.6	0.6	11.5	0.29	2.1	1.1	0.161
HR 32008 XJ	3CD	49	45	62	60	65.5	4	4.5	1	1	15.0	0.38	1.6	0.87	0.28
HR 33008 J	2BE	49	45	62	61	65	4	4	1	1	14.6	0.28	2.1	1.2	0.322
HR 33108 J	2CE	51	46	66	65	71	4	5.5	1.5	1.5	18.0	0.36	1.7	0.93	0.503
HR 30208 J	3DB	51	48	71	69	75	3	3.5	1.5	1.5	16.6	0.37	1.6	0.88	0.437
HR 32208 J	3DC	51	48	71	68	75	3	5.5	1.5	1.5	18.9	0.37	1.6	0.88	0.548
HR 32208 CJ	5DC	51	47	71	65	76	3	5.5	1.5	1.5	21.9	0.55	1.1	0.60	0.558
HR 33208 J	2DE	51	46	71	67	76	5	7	1.5	1.5	20.8	0.36	1.7	0.92	0.744
HR 30308 J	2FB	52	52	81	76	82	3	5	2	1.5	19.5	0.35	1.7	0.96	0.758
HR 30308 C	—	52	50	81	72	84	3	7	2	1.5	22.8	0.53	1.1	0.62	0.735
HR 30308 DJ	7FB	56	50	81	70	87	3	8	2	1.5	28.7	0.83	0.73	0.40	0.728
HR 31308 J	7FB	56	50	81	70	87	3	8	2	1.5	28.7	0.83	0.73	0.40	0.728
HR 32308 J	2FD	54	50	81	73	82	3	8	2	1.5	23.4	0.35	1.7	0.96	1.05
HR 32909 J	2BC	53	50	63	62	64	3	3	0.6	0.6	12.3	0.32	1.9	1.0	0.187
HR 32009 XJ	3CC	54	51	69	67	72	4	4.5	1	1	16.6	0.39	1.5	0.84	0.354
HR 33009 J	2CE	54	51	69	67	71	4	5	1	1	16.3	0.29	2.0	1.1	0.414
HR 33109 J	3CE	56	51	71	69	77	4	5.5	1.5	1.5	19.1	0.38	1.6	0.86	0.552
HR 30209 J	3DB	56	53	76	74	80	3	4.5	1.5	1.5	18.3	0.41	1.5	0.81	0.488
HR 32209 J	3DC	56	53	76	73	81	3	5.5	1.5	1.5	20.1	0.41	1.5	0.81	0.602
HR 32209 CJ	5DC	56	52	76	70	82	3	5.5	1.5	1.5	23.6	0.59	1.0	0.56	0.603
HR 33209 J	3DE	56	51	76	72	81	5	7	1.5	1.5	22.0	0.39	1.6	0.86	0.817
T 7 FC045	7FC	60	53	83	71	91	3	9	2	2	32.1	0.87	0.69	0.38	0.918
T 2 ED045	2ED	60	54	83	79	89	5	6	2	2	23.5	0.32	1.9	1.02	1.22
HR 30309 J	2FB	57	58	91	86	93	3	5	2	1.5	21.1	0.35	1.7	0.96	1.01
HR 30309 DJ	7FB	61	57	91	79	96	3	9	2	1.5	31.5	0.83	0.73	0.40	0.957
HR 31309 J	7FB	61	57	91	79	96	3	9	2	1.5	31.5	0.83	0.73	0.40	0.947
HR 32309 J	2FD	59	56	91	82	93	3	8	2	1.5	25.0	0.35	1.7	0.96	1.42
T 2 ED050	2ED	65	59	88	83	94	6	6	2	2	24.2	0.34	1.8	0.96	1.3
HR 32910 J	2BC	58	54	67	66	69	3	3	0.6	0.6	13.5	0.34	1.8	0.97	0.193
HR 32010 XJ	3CC	59	56	74	71	77	4	4.5	1	1	17.9	0.42	1.4	0.78	0.38
HR 33010 J	2CE	59	55	74	71	76	4	5	1	1	17.4	0.32	1.9	1.0	0.452
HR 33110 J	3CE	61	56	76	74	82	4	6	1.5	1.5	20.3	0.41	1.5	0.8	0.597
HR 30210 J	3DB	61	58	81	79	85	3	4.5	1.5	1.5	19.6	0.42	1.4	0.79	0.557
HR 32210 J	3DC	61	57	81	78	86	3	5.5	1.5	1.5	21.0	0.42	1.4	0.79	0.642
HR 32210 CJ	5DC	61	58	81	76	87	3	6.5	1.5	1.5	24.6	0.59	1.0	0.56	0.655
HR 33210 J	3DE	61	56	81	76	87	5	7.5	1.5	1.5	23.2	0.41	1.5	0.80	0.867
T 7 FC050	7FC	74	59	91	78	100	5	10	2.5	2.5	36.4	0.87	0.69	0.38	1.22
HR 30310 J	2FB	65	65	100	95	102	3	6	2	2	23.1	0.35	1.7	0.96	1.28
HR 30310 DJ	7FB	70	62	100	87	105	3	10	2	2	34.3	0.83	0.73	0.40	1.26
HR 31310 J	7FB	70	62	100	87	105	3	10	2	2	34.3	0.83	0.73	0.40	1.26
HR 32310 J	2FD	68	62	100	91	102	3	9	2	2	28.0	0.35	1.7	0.96	1.88
HR 32310 CJ	5FD	68	59	100	82	103	3	9	2	2	32.8	0.55	1.1	0.60	1.93



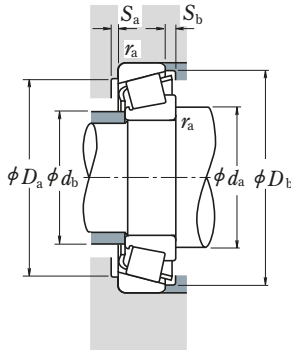
# ■ SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 55 – 65 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)			Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
55	80	17	17	14	1	1	45 500	74 500	4 300	5 600
	90	23	23	17.5	1.5	1.5	81 500	117 000	3 800	5 300
	90	27	27	21	1.5	1.5	91 500	138 000	3 800	5 300
	95	30	30	23	1.5	1.5	112 000	158 000	3 800	5 000
	100	22.75	21	18	2	1.5	94 500	113 000	3 600	5 000
	100	26.75	25	21	2	1.5	110 000	137 000	3 600	5 000
	100	35	35	27	2	1.5	141 000	193 000	3 600	5 000
	115	34	31	23.5	3	3	126 000	164 000	3 000	4 300
	120	31.5	29	25	2.5	2	150 000	171 000	3 200	4 300
	120	31.5	29	21	2.5	2	131 000	153 000	2 800	4 000
	120	31.5	29	21	2.5	2	131 000	153 000	2 800	4 000
	120	45.5	43	35	2.5	2	204 000	258 000	3 200	4 300
	120	45.5	43	35	2.5	2	195 000	262 000	3 200	4 300
	120	45.5	43	35	2.5	2	195 000	262 000	3 200	4 300
60	85	17	17	14	1	1	49 000	84 500	3 800	5 300
	95	23	23	17.5	1.5	1.5	85 500	127 000	3 600	5 000
	95	27	27	21	1.5	1.5	96 000	150 000	3 600	5 000
	100	30	30	23	1.5	1.5	115 000	166 000	3 400	4 800
	110	23.75	22	19	2	1.5	104 000	123 000	3 400	4 500
	110	29.75	28	24	2	1.5	131 000	167 000	3 400	4 500
	110	38	38	29	2	1.5	166 000	231 000	3 400	4 500
	125	37	33.5	26	3	3	151 000	197 000	2 800	3 800
	130	33.5	31	26	3	2.5	174 000	201 000	3 000	4 000
	130	33.5	31	22	3	2.5	151 000	177 000	2 600	3 800
	130	33.5	31	22	3	2.5	151 000	177 000	2 600	3 800
	130	48.5	46	37	3	2.5	233 000	295 000	3 000	4 000
	130	48.5	46	35	3	2.5	196 000	249 000	2 800	3 800
	130	48.5	46	35	3	2.5	196 000	249 000	2 800	3 800
65	90	17	17	14	1	1	49 000	86 500	3 600	5 000
	100	23	23	17.5	1.5	1.5	86 500	132 000	3 400	4 500
	100	27	27	21	1.5	1.5	97 500	156 000	3 400	4 500
	110	34	34	26.5	1.5	1.5	148 000	218 000	3 200	4 300
	120	24.75	23	20	2	1.5	122 000	151 000	3 000	4 000
	120	32.75	31	27	2	1.5	157 000	202 000	3 000	4 000
	120	41	41	32	2	1.5	202 000	282 000	3 000	4 000
	140	36	33	28	3	2.5	200 000	233 000	2 600	3 600
	140	36	33	23	3	2.5	173 000	205 000	2 400	3 400
	140	36	33	23	3	2.5	173 000	205 000	2 400	3 400
	140	51	48	39	3	2.5	267 000	340 000	2 800	3 800
	140	51	48	39	3	2.5	267 000	340 000	2 800	3 800

**Remark** Suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

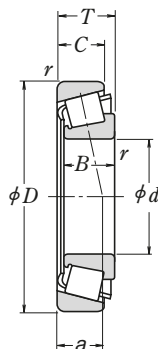
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner   Outer		Eff. Load Center (mm) <i>a</i>	Constant  <i>e</i>	Axial Load Factors		Mass (kg)  approx.
		<i>d<sub>a</sub></i> min.	<i>d<sub>b</sub></i> max.	<i>D<sub>a</sub></i> max.	<i>D<sub>b</sub></i> min.	<i>S<sub>a</sub></i> min.	<i>S<sub>b</sub></i> min.	<i>r<sub>a</sub></i> max.	<i>r<sub>b</sub></i> max.	<i>Y<sub>1</sub></i>	<i>Y<sub>0</sub></i>					
HR 32911 J	2BC	64	60	74	73	76	4	3	1	1	14.6	0.31	1.9	1.1	0.282	
HR 32011 XJ	3CC	66	62	81	80	86	4	5.5	1.5	1.5	19.7	0.41	1.5	0.81	0.568	
HR 33011 J	2CE	66	62	81	80	86	5	6	1.5	1.5	19.2	0.31	1.9	1.1	0.657	
HR 33111 J	3CE	66	62	86	82	91	5	7	1.5	1.5	22.4	0.37	1.6	0.88	0.877	
HR 30211 J	3DB	67	64	91	89	94	4	4.5	2	1.5	20.9	0.41	1.5	0.81	0.736	
HR 32211 J	3DC	67	63	91	87	95	4	5.5	2	1.5	22.7	0.41	1.5	0.81	0.859	
HR 33211 J	3DE	67	62	91	86	96	6	8	2	1.5	25.2	0.40	1.5	0.83	1.18	
T 7 FC055	7FC	73	66	101	86	109	4	10.5	2.5	2.5	39.0	0.87	0.69	0.38	1.58	
HR 30311 J	2FB	70	71	110	104	111	4	6.5	2	2	24.6	0.35	1.7	0.96	1.63	
HR 30311 DJ	7FB	75	67	110	94	114	4	10.5	2	2	37.0	0.83	0.73	0.40	1.58	
HR 31311 J	7FB	75	67	110	94	114	4	10.5	2	2	37.0	0.83	0.73	0.40	1.58	
HR 32311 J	2FD	73	67	110	99	111	4	10.5	2	2	29.9	0.35	1.7	0.96	2.39	
HR 32311 CJ	5FD	73	65	110	91	112	4	10.5	2	2	35.8	0.55	1.1	0.60	2.47	
HR 32912 J	2BC	69	65	79	78	81	4	3	1	1	15.5	0.33	1.8	1.0	0.306	
HR 32012 XJ	4CC	71	66	86	85	91	4	5.5	1.5	1.5	20.9	0.43	1.4	0.77	0.608	
HR 33012 J	2CE	71	66	86	85	90	5	6	1.5	1.5	20.0	0.33	1.8	1.0	0.713	
HR 33112 J	3CE	71	68	91	88	96	5	7	1.5	1.5	23.6	0.40	1.5	0.83	0.91	
HR 30212 J	3EB	72	69	101	96	103	4	4.5	2	1.5	22.0	0.41	1.5	0.81	0.930	
HR 32212 J	3EC	72	68	101	95	104	4	5.5	2	1.5	24.1	0.41	1.5	0.81	1.18	
HR 33212 J	3EE	72	68	101	94	105	6	9	2	1.5	27.6	0.40	1.5	0.82	1.56	
T 7 FC060	7FC	78	72	111	94	119	4	11	2.5	2.5	41.4	0.82	0.73	0.40	2.03	
HR 30312 J	2FB	78	77	118	112	120	4	7.5	2.5	2	26.0	0.35	1.7	0.96	2.03	
HR 30312 DJ	7FB	84	74	118	103	125	4	11.5	2.5	2	40.3	0.83	0.73	0.40	1.98	
HR 31312 J	7FB	84	74	118	103	125	4	11.5	2.5	2	40.3	0.83	0.73	0.40	1.98	
HR 32312 J	2FD	81	74	118	107	120	4	11.5	2.5	2	31.4	0.35	1.7	0.96	2.96	
32312 C	—	81	74	116	102	125	4	13.5	2.5	2	39.9	0.58	1.0	0.57	2.86	
HR 32913 J	2BC	74	70	84	82	86	4	3	1	1	16.8	0.35	1.7	0.93	0.323	
HR 32013 XJ	4CC	76	71	91	90	97	4	5.5	1.5	1.5	22.4	0.46	1.3	0.72	0.646	
HR 33013 J	2CE	76	71	91	90	96	5	6	1.5	1.5	21.1	0.35	1.7	0.95	0.76	
HR 33113 J	3DE	76	73	101	96	106	6	7.5	1.5	1.5	26.0	0.39	1.5	0.85	1.32	
HR 30213 J	3EB	77	78	111	106	113	4	4.5	2	1.5	23.8	0.41	1.5	0.81	1.18	
HR 32213 J	3EC	77	75	111	104	115	4	5.5	2	1.5	27.1	0.41	1.5	0.81	1.55	
HR 33213 J	3EE	77	74	111	102	115	6	9	2	1.5	29.2	0.39	1.5	0.85	2.04	
HR 30313 J	2GB	83	83	128	121	130	4	8	2.5	2	27.9	0.35	1.7	0.96	2.51	
HR 30313 DJ	7GB	89	80	128	111	133	4	13	2.5	2	43.2	0.83	0.73	0.40	2.43	
HR 31313 J	7GB	89	80	128	111	133	4	13	2.5	2	43.2	0.83	0.73	0.40	2.43	
HR 32313 J	2GD	86	80	128	116	130	4	12	2.5	2	34.0	0.35	1.7	0.96	3.6	



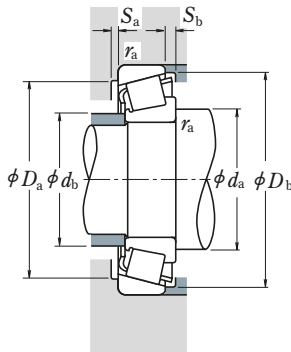
# SINGLE-ROW TAPERED ROLLER BEARINGS

Bores Diameter 70 – 80 mm



<i>d</i>	Boundary Dimensions (mm)				Ring: Inner      Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
70	100	20	20	16	1	1	70 000	113 000	3 200	4 500
	110	25	25	19	1.5	1.5	104 000	158 000	3 200	4 300
	110	31	31	25.5	1.5	1.5	127 000	204 000	3 000	4 300
	120	37	37	29	2	1.5	177 000	262 000	3 000	4 000
	125	26.25	24	21	2	1.5	132 000	163 000	2 800	4 000
	125	33.25	31	27	2	1.5	157 000	205 000	2 800	4 000
	125	41	41	32	2	1.5	209 000	299 000	2 800	4 000
	140	39	35.5	27	3	3	178 000	235 000	2 400	3 400
	150	38	35	30	3	2.5	227 000	268 000	2 400	3 400
	150	38	35	25	3	2.5	192 000	229 000	2 200	3 200
	150	38	35	25	3	2.5	192 000	229 000	2 200	3 200
	150	54	51	42	3	2.5	300 000	390 000	2 600	3 400
	150	54	51	42	3	2.5	280 000	390 000	2 400	3 400
	150	54	51	42	3	2.5	280 000	390 000	2 400	3 400
75	105	20	20	16	1	1	72 500	120 000	3 200	4 300
	115	25	25	19	1.5	1.5	109 000	171 000	3 000	4 000
	115	31	31	25.5	1.5	1.5	133 000	220 000	3 000	4 000
	125	37	37	29	2	2	182 000	275 000	2 800	3 800
	130	27.25	25	22	2	1.5	143 000	182 000	2 800	3 800
	130	33.25	31	27	2	1.5	165 000	219 000	2 800	3 800
	130	41	41	31	2	1.5	215 000	315 000	2 800	3 800
	160	40	37	31	3	2.5	253 000	300 000	2 400	3 200
	160	40	37	26	3	2.5	211 000	251 000	2 200	3 000
	160	40	37	26	3	2.5	211 000	251 000	2 200	3 000
	160	58	55	45	3	2.5	340 000	445 000	2 400	3 200
	160	58	55	43	3	2.5	310 000	420 000	2 200	3 200
	160	58	55	43	3	2.5	310 000	420 000	2 200	3 200
	160	58	55	43	3	2.5	310 000	420 000	2 200	3 200
80	110	20	20	16	1	1	75 000	128 000	3 000	4 000
	125	29	29	22	1.5	1.5	140 000	222 000	2 800	3 600
	125	36	36	29.5	1.5	1.5	172 000	282 000	2 800	3 600
	130	37	37	29	2	1.5	186 000	289 000	2 600	3 600
	140	28.25	26	22	2.5	2	157 000	195 000	2 600	3 400
	140	28.25	26	20	2.5	2	147 000	190 000	2 400	3 400
	140	35.25	33	28	2.5	2	192 000	254 000	2 600	3 400
	140	46	46	35	2.5	2	256 000	385 000	2 600	3 400
	170	42.5	39	33	3	2.5	276 000	330 000	2 200	3 000
	170	42.5	39	27	3	2.5	235 000	283 000	2 000	2 800
	170	42.5	39	27	3	2.5	235 000	283 000	2 000	2 800
	170	61.5	58	48	3	2.5	385 000	505 000	2 200	3 000
	170	61.5	58	48	3	2.5	365 000	530 000	2 200	3 000
	170	61.5	58	48	3	2.5	365 000	530 000	2 200	3 000

**Remark** Suffix CA represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix CA.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

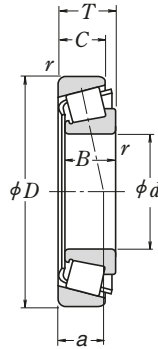
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner Outer $r_a$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$S_a$ min.	$S_b$ min.						$Y_1$	$Y_0$	
HR 32914 J	2BC	79	76	94	93	96	4	4	1	1	17.6	0.32	1.9	1.1	0.494
HR 32014 XJ	4CC	81	77	101	98	105	5	6	1.5	1.5	23.7	0.43	1.4	0.76	0.869
HR 33014 J	2CE	81	78	101	100	105	5	5.5	1.5	1.5	22.2	0.28	2.1	1.2	1.11
HR 33114 J	3DE	82	79	111	104	115	6	8	2	1.5	27.9	0.38	1.6	0.87	1.71
HR 30214 J	3EB	82	81	116	110	118	4	5	2	1.5	25.6	0.42	1.4	0.79	1.3
HR 32214 J	3EC	82	80	116	108	119	4	6	2	1.5	28.6	0.42	1.4	0.79	1.66
HR 33214 J	3EE	82	78	116	107	120	7	9	2	1.5	30.4	0.41	1.5	0.81	2.15
T 7 FC070	7FC	88	81	126	106	133	5	12	2.5	2.5	46.4	0.87	0.69	0.38	2.58
HR 30314 J	2GB	88	89	138	132	140	4	8	2.5	2	29.7	0.35	1.7	0.96	3.03
HR 30314 DJ	7GB	94	85	138	118	142	4	13	2.5	2	45.8	0.83	0.73	0.40	2.94
HR 31314 J	7GB	94	85	138	118	142	4	13	2.5	2	45.8	0.83	0.73	0.40	2.94
HR 32314 J	2GD	91	86	138	124	140	4	12	2.5	2	36.1	0.35	1.7	0.96	4.35
HR 32314 CJ	5GD	91	84	138	115	141	4	12	2.5	2	43.3	0.55	1.1	0.60	4.47
HR 32915 J	2BC	84	81	99	98	101	4	4	1	1	18.7	0.33	1.8	0.99	0.53
HR 32015 XJ	4CC	86	82	106	103	110	5	6	1.5	1.5	25.1	0.46	1.3	0.72	0.925
HR 33015 J	2CE	86	83	106	104	110	6	5.5	1.5	1.5	23.0	0.30	2.0	1.1	1.18
HR 33115 J	3DE	87	83	115	109	120	6	8	2	2	29.2	0.40	1.5	0.83	1.8
HR 30215 J	4DB	87	85	121	115	124	4	5	2	1.5	27.0	0.44	1.4	0.76	1.43
HR 32215 J	4DC	87	84	121	113	125	4	6	2	1.5	29.8	0.44	1.4	0.76	1.72
HR 33215 J	3EE	87	83	121	111	125	7	10	2	1.5	31.6	0.43	1.4	0.77	2.25
HR 30315 J	2GB	93	95	148	141	149	4	9	2.5	2	31.8	0.35	1.7	0.96	3.63
HR 30315 DJ	7GB	99	91	148	129	152	6	14	2.5	2	48.8	0.83	0.73	0.40	3.47
HR 31315 J	7GB	99	91	148	129	152	6	14	2.5	2	48.8	0.83	0.73	0.40	3.47
HR 32315 J	2GD	96	91	148	134	149	4	13	2.5	2	38.9	0.35	1.7	0.96	5.31
32315 CA	—	96	90	148	124	153	4	15	2.5	2	47.7	0.58	1.0	0.57	5.3
HR 32916 J	2BC	89	85	104	102	106	4	4	1	1	19.8	0.35	1.7	0.94	0.56
HR 32016 XJ	3CC	91	89	116	112	120	6	7	1.5	1.5	26.9	0.42	1.4	0.78	1.32
HR 33016 J	2CE	91	88	116	112	119	6	6.5	1.5	1.5	25.5	0.28	2.2	1.2	1.66
HR 33116 J	3DE	82	88	121	113	126	6	8	2	1.5	30.4	0.42	1.4	0.79	1.88
HR 30216 J	3EB	95	91	130	124	132	4	6	2	2	28.1	0.42	1.4	0.79	1.68
30216 CA	—	95	92	130	122	133	4	8	2	2	33.8	0.58	1.0	0.57	1.66
HR 32216 J	3EC	95	90	130	122	134	4	7	2	2	30.6	0.42	1.4	0.79	2.13
HR 33216 J	3EE	95	89	130	119	135	7	11	2	2	34.8	0.43	1.4	0.78	2.93
HR 30316 J	2GB	98	102	158	150	159	4	9.5	2.5	2	34.0	0.35	1.7	0.96	4.27
HR 30316 DJ	7GB	104	97	158	136	159	6	15.5	2.5	2	51.8	0.83	0.73	0.40	4.07
HR 31316 J	7GB	104	97	158	136	159	6	15.5	2.5	2	51.8	0.83	0.73	0.40	4.07
HR 32316 J	2GD	101	98	158	143	159	4	13.5	2.5	2	41.4	0.35	1.7	0.96	6.35
HR 32316 CJ	5GD	101	95	158	132	160	4	13.5	2.5	2	49.3	0.55	1.1	0.60	6.59



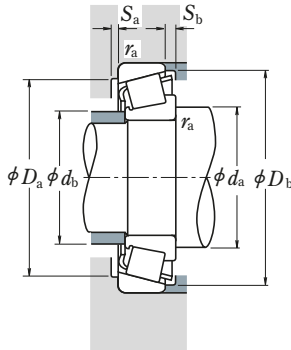
# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 85 – 100 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)			Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
85	120	23	23	18	1.5	1.5	93 500	157 000	2 800	3 800
	130	29	29	22	1.5	1.5	143 000	231 000	2 600	3 600
	130	36	36	29.5	1.5	1.5	180 000	305 000	2 600	3 600
	140	41	41	32	2.5	2	230 000	365 000	2 400	3 400
	150	30.5	28	24	2.5	2	184 000	233 000	2 400	3 200
	150	30.5	28	22	2.5	2	171 000	226 000	2 200	3 200
	150	38.5	36	30	2.5	2	210 000	277 000	2 200	3 200
	150	49	49	37	2.5	2	281 000	415 000	2 400	3 200
	180	44.5	41	34	4	3	310 000	375 000	2 000	2 800
	180	44.5	41	28	4	3	261 000	315 000	1 900	2 600
	180	44.5	41	28	4	3	261 000	315 000	1 900	2 600
	180	63.5	60	49	4	3	410 000	535 000	2 000	2 800
90	125	23	23	18	1.5	1.5	97 000	167 000	2 600	3 600
	140	32	32	24	2	1.5	170 000	273 000	2 400	3 200
	140	39	39	32.5	2	1.5	220 000	360 000	2 400	3 200
	150	45	45	35	2.5	2	259 000	405 000	2 400	3 200
	160	32.5	30	26	2.5	2	201 000	256 000	2 200	3 000
	160	42.5	40	34	2.5	2	256 000	350 000	2 200	3 000
	190	46.5	43	36	4	3	345 000	425 000	1 900	2 600
	190	46.5	43	30	4	3	264 000	315 000	1 800	2 400
	190	46.5	43	30	4	3	264 000	315 000	1 800	2 400
	190	67.5	64	53	4	3	450 000	590 000	2 000	2 600
95	130	23	23	18	1.5	1.5	98 000	172 000	2 400	3 400
	145	32	32	24	2	1.5	173 000	283 000	2 400	3 200
	145	39	39	32.5	2	1.5	231 000	390 000	2 400	3 200
	160	46	46	38	3	3	283 000	445 000	2 200	3 000
	170	34.5	32	27	3	2.5	223 000	286 000	2 200	2 800
	170	45.5	43	37	3	2.5	289 000	400 000	2 200	2 800
	200	49.5	45	38	4	3	370 000	455 000	1 900	2 600
	200	49.5	45	36	4	3	350 000	435 000	1 800	2 400
	200	49.5	45	32	4	3	310 000	375 000	1 700	2 400
	200	49.5	45	32	4	3	310 000	375 000	1 700	2 400
	200	71.5	67	55	4	3	525 000	710 000	1 900	2 600
100	140	25	25	20	1.5	1.5	117 000	205 000	2 200	3 200
	145	24	22.5	17.5	3	3	113 000	163 000	2 200	3 000
	150	32	32	24	2	1.5	176 000	294 000	2 200	3 000
	150	39	39	32.5	2	1.5	235 000	405 000	2 200	3 000
	165	52	52	40	2.5	2	315 000	515 000	2 000	2 800
	180	37	34	29	3	2.5	255 000	330 000	2 000	2 600
	180	49	46	39	3	2.5	325 000	450 000	2 000	2 600
	180	63	63	48	3	2.5	410 000	635 000	2 000	2 600
	215	51.5	47	39	4	3	425 000	525 000	1 700	2 400
	215	56.5	51	35	4	3	385 000	505 000	1 500	2 200
	215	77.5	73	60	4	3	565 000	755 000	1 700	2 400

**Remark** Suffix CA represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix CA.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

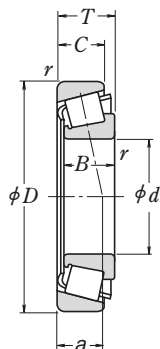
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)										Eff. Load Center (mm) <i>a</i>	Constant <i>e</i>	Axial Load Factors		Mass (kg) approx.
		<i>d<sub>a</sub></i> min.	<i>d<sub>b</sub></i> max.	<i>D<sub>a</sub></i> max.	<i>D<sub>b</sub></i> min.	<i>S<sub>a</sub></i> min.	<i>S<sub>b</sub></i> min.	Ring:		<i>Y<sub>1</sub></i>	<i>Y<sub>0</sub></i>					
								Inner <i>r<sub>a</sub></i> max.	Outer							
HR 32917 J	2BC	96	92	111	111	115	5	5	1.5	1.5	20.9	0.33	1.8	1.0	0.8	
HR 32017 XJ	4CC	96	94	121	116	125	6	7	1.5	1.5	28.2	0.44	1.4	0.75	1.38	
HR 33017 J	2CE	96	94	121	117	125	6	6.5	1.5	1.5	26.5	0.29	2.1	1.1	1.75	
HR 33117 J	3DE	100	94	130	122	135	7	9	2	2	32.7	0.41	1.5	0.81	2.51	
HR 30217 J	3EB	100	97	140	133	141	5	6.5	2	2	30.3	0.42	1.4	0.79	2.12	
30217 CA	—	100	98	140	131	142	5	8.5	2	2	36.2	0.58	1.0	0.57	2.07	
HR 32217 J	3EC	100	96	140	131	142	5	8.5	2	2	33.9	0.42	1.4	0.79	2.64	
HR 33217 J	3EE	100	95	140	129	144	7	12	2	2	37.3	0.42	1.4	0.79	3.57	
HR 30317 J	2GB	106	108	166	157	167	5	10.5	3	2.5	35.8	0.35	1.7	0.96	5.08	
HR 30317 DJ	7GB	113	103	166	144	169	6	16.5	3	2.5	55.4	0.83	0.73	0.40	4.88	
HR 31317 J	7GB	113	103	166	144	169	6	16.5	3	2.5	55.4	0.83	0.73	0.40	4.88	
HR 32317 J	2GD	110	104	166	151	167	5	14.5	3	2.5	43.6	0.35	1.7	0.96	7.31	
HR 32918 J	2BC	101	97	116	116	120	5	5	1.5	1.5	22.0	0.34	1.8	0.96	0.838	
HR 32018 XJ	3CC	102	99	131	124	134	6	8	2	1.5	29.7	0.42	1.4	0.78	1.78	
HR 33018 J	2CE	102	99	131	129	135	7	6.5	2	1.5	27.9	0.27	2.2	1.2	2.21	
HR 33118 J	3DE	105	100	140	132	144	7	10	2	2	35.2	0.40	1.5	0.83	3.14	
HR 30218 J	3FB	105	103	150	141	150	5	6.5	2	2	31.7	0.42	1.4	0.79	2.6	
HR 32218 J	3FC	105	102	150	139	152	5	8.5	2	2	36.2	0.42	1.4	0.79	3.41	
HR 30318 J	2GB	111	114	176	176	176	5	10.5	3	2.5	37.3	0.35	1.7	0.96	5.91	
HR 30318 DJ	7GB	118	110	176	152	179	6	16.5	3	2.5	58.7	0.83	0.73	0.40	5.52	
HR 31318 J	7GB	118	110	176	152	179	6	16.5	3	2.5	58.7	0.83	0.73	0.40	5.52	
HR 32318 J	2GD	115	109	176	158	177	5	14.5	3	2.5	46.5	0.35	1.7	0.96	8.6	
HR 32919 J	2BC	106	102	121	121	125	5	5	1.5	1.5	23.2	0.36	1.7	0.92	0.877	
HR 32019 XJ	4CC	107	104	136	131	140	6	8	2	1.5	31.2	0.44	1.4	0.75	1.88	
HR 33019 J	2CE	107	103	136	133	139	7	6.5	2	1.5	28.6	0.28	2.2	1.2	2.3	
T 2 ED095	2ED	113	108	146	141	152	6	8	2.5	2.5	34.5	0.34	1.8	0.97	3.74	
HR 30219 J	3FB	113	110	158	150	159	5	7.5	2.5	2	33.7	0.42	1.4	0.79	3.13	
HR 32219 J	3FC	113	108	158	147	161	5	8.5	2.5	2	39.3	0.42	1.4	0.79	4.22	
HR 30319 J	2GB	116	119	186	172	184	5	11.5	3	2.5	38.6	0.35	1.7	0.96	6.92	
30319 CA	—	116	119	186	168	188	5	13.5	3	2.5	48.6	0.54	1.1	0.61	6.71	
HR 30319 DJ	7GB	123	115	186	158	187	6	17.5	3	2.5	61.9	0.83	0.73	0.40	6.64	
HR 31319 J	7GB	123	115	186	158	187	6	17.5	3	2.5	61.9	0.83	0.73	0.40	6.64	
HR 32319 J	2GD	120	115	186	167	186	5	16.5	3	2.5	48.6	0.35	1.7	0.96	10.4	
HR 32920 J	2CC	111	109	132	132	134	5	5	1.5	1.5	24.2	0.33	1.8	1.0	1.18	
T 4 CB100	4CB	118	108	135	135	142	6	6.5	2.5	2.5	30.1	0.47	1.3	0.70	1.18	
HR 32020 XJ	4CC	112	109	141	136	144	6	8	2	1.5	32.5	0.46	1.3	0.72	1.95	
HR 33020 J	2CE	112	107	141	137	143	7	6.5	2	1.5	29.3	0.29	2.1	1.2	2.38	
HR 33120 J	3EE	115	110	155	144	159	8	12	2	2	40.5	0.41	1.5	0.81	4.32	
HR 30220 J	3FB	118	116	168	158	168	5	8	2.5	2	36.1	0.42	1.4	0.79	3.78	
HR 32220 J	3FC	118	115	168	155	171	5	10	2.5	2	41.5	0.42	1.4	0.79	5.05	
HR 33220 J	3FE	118	113	168	152	172	10	15	2.5	2	46.0	0.40	1.5	0.82	6.76	
HR 30320 J	2GB	121	128	201	185	197	5	12.5	3	2.5	41.4	0.35	1.7	0.96	8.41	
HR 31320 J	7GB	136	125	201	169	202	7	21.5	3	2.5	67.7	0.83	0.73	0.40	9.02	
HR 32320 J	2GD	125	125	201	178	200	5	17.5	3	2.5	53.2	0.35	1.7	0.96	12.7	

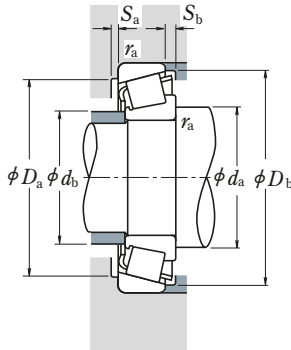


# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 105 – 130 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
$d$	$D$	$T$	$B$	$C$	Ring: Inner	Outer $r$ min.	$C_r$	$C_{0r}$	Grease	Oil
105	145	25	25	20	1.5	1.5	119 000	212 000	2 200	3 000
	160	35	35	26	2.5	2	204 000	340 000	2 000	2 800
	160	43	43	34	2.5	2	256 000	435 000	2 000	2 800
	190	39	36	30	3	2.5	280 000	365 000	1 900	2 600
	190	53	50	43	3	2.5	360 000	510 000	1 900	2 600
	225	53.5	49	41	4	3	455 000	565 000	1 600	2 200
	225	58	53	36	4	3	415 000	540 000	1 500	2 000
	225	81.5	77	63	4	3	670 000	925 000	1 700	2 200
110	150	25	25	20	1.5	1.5	123 000	224 000	2 200	2 800
	170	38	38	29	2.5	2	236 000	390 000	2 000	2 600
	170	47	47	37	2.5	2	294 000	515 000	2 000	2 600
	180	56	56	43	2.5	2	365 000	610 000	1 900	2 600
	200	41	38	32	3	2.5	315 000	420 000	1 800	2 400
	200	56	53	46	3	2.5	400 000	565 000	1 800	2 400
	240	54.5	50	42	4	3	485 000	595 000	1 500	2 000
	240	63	57	38	4	3	470 000	605 000	1 400	1 900
240	84.5	80	65	4	3	675 000	910 000	1 500	2 000	
120	165	29	29	23	1.5	1.5	161 000	291 000	1 900	2 600
	170	27	25	19.5	3	3	153 000	243 000	1 800	2 600
	180	38	38	29	2.5	2	242 000	405 000	1 800	2 400
	180	48	48	38	2.5	2	300 000	540 000	1 800	2 600
	200	62	62	48	2.5	2	460 000	755 000	1 700	2 400
	215	43.5	40	34	3	2.5	335 000	450 000	1 600	2 200
	215	61.5	58	50	3	2.5	440 000	635 000	1 600	2 200
	260	59.5	55	46	4	3	535 000	655 000	1 400	1 900
	260	68	62	42	4	3	560 000	730 000	1 300	1 800
	260	90.5	86	69	4	3	770 000	1 060 000	1 400	1 900
130	180	32	30	26	2	1.5	167 000	281 000	1 800	2 400
	180	32	32	25	2	1.5	200 000	365 000	1 800	2 400
	185	29	27	21	3	3	183 000	296 000	1 700	2 400
	200	45	45	34	2.5	2	320 000	535 000	1 600	2 200
	200	55	55	43	2.5	2	395 000	715 000	1 700	2 200
	230	43.75	40	34	4	3	375 000	505 000	1 500	2 000
	230	67.75	64	54	4	3	530 000	790 000	1 500	2 000
	280	63.75	58	49	5	4	545 000	675 000	1 300	1 800
	280	63.75	58	49	5	4	650 000	820 000	1 300	1 800
	280	72	66	44	5	4	625 000	820 000	1 200	1 700
	280	98.75	93	78	5	4	830 000	1 150 000	1 300	1 800

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

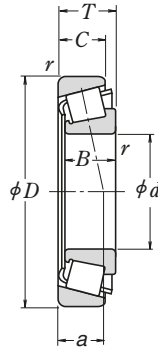
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner $r_a$ max.	Outer $r_b$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$S_a$ min.	$S_b$ min.	$Y_1$	$Y_0$							
HR 32921 J	2CC	116	114	137	137	140	5	5	1.5	1.5	25.3	0.34	1.8	0.96	1.23	
HR 32021 XJ	4DC	120	115	150	144	154	6	9	2	2	34.3	0.44	1.4	0.74	2.48	
HR 33021 J	2DE	120	115	150	146	153	7	9	2	2	30.9	0.28	2.1	1.2	3.03	
HR 30221 J	3FB	123	123	178	166	177	6	9	2.5	2	38.1	0.42	1.4	0.79	4.51	
HR 32221 J	3FC	123	120	178	162	180	5	10	2.5	2	44.8	0.42	1.4	0.79	6.25	
HR 30321 J	2GB	126	133	211	195	206	6	12.5	3	2.5	43.3	0.35	1.7	0.96	9.52	
HR 31321 J	7GB	141	130	211	177	211	7	22	3	2.5	70.2	0.83	0.73	0.40	10	
HR 32321 J	2GD	130	129	211	186	209	6	18.5	3	2.5	55.2	0.35	1.7	0.96	14.9	
HR 32922 J	2CC	121	119	142	142	145	5	5	1.5	1.5	26.5	0.36	1.7	0.93	1.29	
HR 32022 XJ	4DC	125	121	160	153	163	7	9	2	2	35.9	0.43	1.4	0.77	3.09	
HR 33022 J	2DE	125	121	160	153	161	7	10	2	2	33.7	0.29	2.1	1.2	3.84	
HR 33122 J	3EE	125	121	170	156	174	9	13	2	2	44.1	0.42	1.4	0.79	5.54	
HR 30222 J	3FB	128	129	188	175	187	6	9	2.5	2	40.2	0.42	1.4	0.79	5.28	
HR 32222 J	3FC	128	127	188	171	190	5	10	2.5	2	47.2	0.42	1.4	0.79	7.35	
HR 30322 J	2GB	131	143	226	208	220	6	12.5	3	2.5	45.1	0.35	1.7	0.96	11	
HR 31322 J	7GB	146	136	226	191	224	7	25	3	2.5	74.8	0.83	0.73	0.40	12.3	
HR 32322 J	2GD	135	139	226	201	222	6	19.5	3	2.5	58.6	0.35	1.7	0.96	17.1	
HR 32924 J	2CC	131	129	156	155	160	6	6	1.5	1.5	29.2	0.35	1.7	0.95	1.8	
T 4 CB120	4CB	138	129	158	158	164	7	7.5	2.5	2.5	35.0	0.47	1.3	0.70	1.78	
HR 32024 XJ	4DC	135	131	170	162	173	7	9	2	2	39.7	0.46	1.3	0.72	3.27	
HR 33024 J	2DE	135	130	168	161	171	6	10	2	2	36.0	0.31	2.0	1.1	4.2	
HR 33124 J	3FE	135	133	190	173	192	9	14	2	2	47.9	0.40	1.5	0.83	7.67	
HR 30224 J	4FB	138	141	203	190	201	6	9.5	2.5	2	44.4	0.44	1.4	0.76	6.28	
HR 32224 J	4FD	138	137	203	181	204	6	11.5	2.5	2	52.1	0.44	1.4	0.76	9.0	
HR 30324 J	2GB	141	154	246	223	237	6	13.5	3	2.5	50.0	0.35	1.7	0.96	13.9	
HR 31324 J	7GB	156	148	246	206	244	9	26	3	2.5	81.7	0.83	0.73	0.40	15.6	
HR 32324 J	2GD	145	149	246	216	239	6	21.5	3	2.5	62.5	0.35	1.7	0.96	21.8	
32926	—	142	141	171	168	175	6	6	2	1.5	34.7	0.36	1.7	0.92	2.25	
HR 32926 J	2CC	142	140	170	168	173	6	7	2	1.5	31.4	0.34	1.8	0.97	2.46	
T 4 CB130	4CB	148	141	171	171	179	8	8	2.5	2.5	37.5	0.47	1.3	0.70	2.32	
HR 32026 XJ	4EC	145	144	190	179	192	8	11	2	2	43.9	0.43	1.4	0.76	5.06	
HR 33026 J	2EE	145	144	188	179	192	8	12	2	2	42.4	0.34	1.8	0.97	6.25	
HR 30226 J	4FB	151	151	216	205	217	7	9.5	3	2.5	45.9	0.44	1.4	0.76	7.25	
HR 32226 J	4FD	151	147	216	196	219	7	13.5	3	2.5	57.0	0.44	1.4	0.76	11.3	
30326	—	157	168	262	239	255	8	14.5	4	3	53.9	0.36	1.7	0.92	16.6	
HR 30326 J	2GB	157	166	262	241	255	8	14.5	4	3	52.8	0.35	1.7	0.96	17.2	
HR 31326 J	7GB	174	159	262	220	261	9	28	4	3	87.1	0.83	0.73	0.40	18.8	
32326	—	162	165	262	233	263	8	20.5	4	3	69.2	0.36	1.7	0.92	26.6	

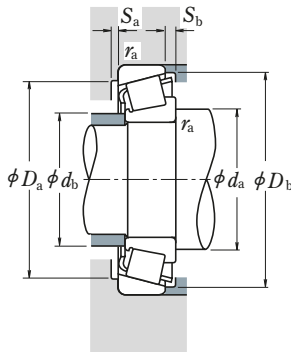


# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 140 – 170 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)				Ring: Inner Outer		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>			<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>140</b>	190	32	32	25	2	1.5		206 000	390 000	1 700	2 200
	210	45	45	34	2.5	2		325 000	555 000	1 600	2 200
	210	56	56	44	2.5	2		410 000	770 000	1 600	2 200
	250	45.75	42	36	4	3		390 000	515 000	1 400	1 900
	250	71.75	68	58	4	3		610 000	915 000	1 400	1 900
	300	67.75	62	53	5	4		740 000	945 000	1 200	1 700
	300	77	70	47	5	4		695 000	955 000	1 100	1 500
	300	107.75	102	85	5	4		985 000	1 440 000	1 200	1 600
	210	38	36	31	2.5	2		247 000	440 000	1 500	2 000
	210	38	38	30	2.5	2		281 000	520 000	1 500	2 000
<b>150</b>	225	48	48	36	3	2.5		375 000	650 000	1 400	2 000
	225	59	59	46	3	2.5		435 000	805 000	1 400	2 000
	270	49	45	38	4	3		485 000	665 000	1 300	1 800
	270	77	73	60	4	3		705 000	1 080 000	1 300	1 800
	320	72	65	55	5	4		690 000	860 000	1 100	1 500
	320	72	65	55	5	4		825 000	1 060 000	1 100	1 600
	320	82	75	50	5	4		790 000	1 100 000	1 000	1 400
	320	114	108	90	5	4		1 120 000	1 700 000	1 100	1 500
	220	38	38	30	2.5	2		296 000	570 000	1 400	1 900
	240	51	51	38	3	2.5		425 000	750 000	1 300	1 800
<b>160</b>	290	52	48	40	4	3		530 000	730 000	1 200	1 600
	290	84	80	67	4	3		795 000	1 220 000	1 200	1 600
	340	75	68	58	5	4		765 000	960 000	1 000	1 400
	340	75	68	58	5	4		915 000	1 180 000	1 100	1 400
	340	75	68	48	5	4		675 000	875 000	950	1 300
	340	121	114	95	5	4		1 210 000	1 770 000	1 000	1 400
	230	38	36	31	2.5	2.5		258 000	485 000	1 300	1 800
	230	38	38	30	2.5	2		294 000	560 000	1 400	1 800
	260	57	57	43	3	2.5		505 000	890 000	1 200	1 700
	310	57	52	43	5	4		630 000	885 000	1 100	1 500
<b>170</b>	310	91	86	71	5	4		930 000	1 450 000	1 100	1 500
	360	80	72	62	5	4		845 000	1 080 000	950	1 300
	360	80	72	62	5	4		960 000	1 230 000	1 000	1 300
	360	80	72	50	5	4		760 000	1 040 000	900	1 200
	360	127	120	100	5	4		1 370 000	2 050 000	1 000	1 300
	360	127	120	100	5	4		1 370 000	2 050 000	1 000	1 300

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

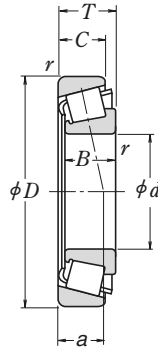
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner Outer $r_a$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$S_a$ min.	$S_b$ min.						$Y_1$	$Y_0$	
HR 32928 J	2CC	152	150	180	178	184	6	7	2	1.5	33.6	0.36	1.7	0.92	2.64
HR 32028 XJ	4DC	155	152	200	189	202	8	11	2	2	46.6	0.46	1.3	0.72	5.32
HR 33028 J	2DE	155	153	198	189	202	7	12	2	2	45.5	0.36	1.7	0.92	6.74
HR 30228 J	4FB	161	164	236	221	234	7	9.5	3	2.5	48.9	0.44	1.4	0.76	8.74
HR 32228 J	4FD	161	159	236	213	238	9	13.5	3	2.5	60.5	0.44	1.4	0.76	14.3
HR 30328 J	2GB	167	177	282	256	273	9	14.5	4	3	55.7	0.35	1.7	0.96	21.1
HR 31328 J	7GB	184	174	282	236	280	9	30	4	3	92.9	0.83	0.73	0.40	28.5
32328	—	172	177	282	246	281	9	22.5	4	3	76.4	0.37	1.6	0.88	33.9
32930	—	165	162	200	195	201	7	7	2	2	36.7	0.33	1.8	1.0	3.8
HR 32930 J	2DC	165	163	198	196	202	7	8	2	2	36.5	0.33	1.8	1.0	4.05
HR 32030 XJ	4EC	168	164	213	202	216	8	12	2.5	2	49.8	0.46	1.3	0.72	6.6
HR 33030 J	2EE	168	165	213	203	217	8	13	2.5	2	48.7	0.36	1.7	0.90	8.07
HR 30230 J	2GB	171	175	256	236	250	7	11	3	2.5	51.3	0.44	1.4	0.76	11.2
HR 32230 J	4GD	171	171	256	228	254	8	17	3	2.5	64.7	0.44	1.4	0.76	17.8
30330	—	177	193	302	275	292	8	17	4	3	61.4	0.36	1.7	0.92	24.2
HR 30330 J	2GB	177	190	302	276	292	8	17	4	3	60.0	0.35	1.7	0.96	25
HR 31330 J	7GB	194	187	302	253	300	9	32	4	3	99.3	0.83	0.73	0.40	28.5
32330	—	182	191	302	262	297	8	24	4	3	81.5	0.37	1.6	0.88	41.4
HR 32932 J	2DC	175	173	208	206	212	7	8	2	2	38.7	0.35	1.7	0.95	4.32
HR 32032 XJ	4EC	178	175	228	216	231	8	13	2.5	2	53.0	0.46	1.3	0.72	7.93
HR 30232 J	4GB	181	189	276	253	269	8	12	3	2.5	55.0	0.44	1.4	0.76	13.7
HR 32232 J	4GD	181	184	276	243	274	10	17	3	2.5	70.5	0.44	1.4	0.76	22.5
30332	—	187	205	322	293	311	10	17	4	3	64.6	0.36	1.7	0.92	28.4
HR 30332 J	2GB	187	201	322	293	310	10	17	4	3	62.9	0.35	1.7	0.96	29.7
30332 D	—	196	198	322	270	313	9	27	4	3	99.4	0.81	0.74	0.41	27.5
32332	—	192	202	322	281	319	10	26	4	3	87.1	0.37	1.6	0.88	48.3
32934	—	185	183	220	216	223	7	7	2	2	41.6	0.36	1.7	0.90	4.3
HR 32934 J	3DC	185	180	218	215	222	7	8	2	2	41.7	0.38	1.6	0.86	4.44
HR 32034 XJ	4EC	188	187	248	232	249	10	14	2.5	2	56.6	0.44	1.4	0.74	10.6
HR 30234 J	4GB	197	202	292	273	288	8	14	4	3	59.4	0.44	1.4	0.76	17.1
HR 32234 J	4GD	197	197	292	262	294	10	20	4	3	76.4	0.44	1.4	0.76	28
30334	—	197	221	342	312	332	10	18	4	3	70.1	0.37	1.6	0.90	33.5
HR 30334 J	2GB	197	214	342	310	329	10	18	4	3	67.3	0.35	1.7	0.96	34.5
30334 D	—	206	215	342	288	332	10	30	4	3	107.3	0.81	0.74	0.41	33.4
32334	—	202	213	342	297	337	10	27	4	3	91.3	0.37	1.6	0.88	57

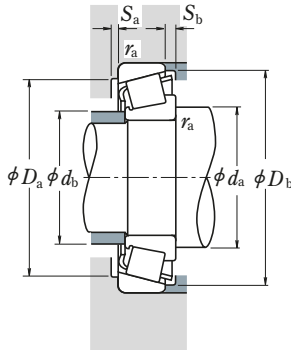


# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 180 – 240 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)			Ring: Inner    Outer		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>	<i>r</i> min.		<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>180</b>	250	45	45	34	2.5	2	350 000	685 000	1 300	1 700
	280	64	64	48	3	2.5	640 000	1 130 000	1 200	1 600
	320	57	52	43	5	4	650 000	930 000	1 100	1 400
	320	91	86	71	5	4	960 000	1 540 000	1 100	1 400
	380	83	75	64	5	4	935 000	1 230 000	900	1 300
	380	83	75	53	5	4	820 000	1 120 000	850	1 200
	380	134	126	106	5	4	1 520 000	2 290 000	950	1 300
<b>190</b>	260	45	45	34	2.5	2	365 000	715 000	1 200	1 600
	290	64	64	48	3	2.5	650 000	1 170 000	1 100	1 500
	340	60	55	46	5	4	715 000	1 020 000	1 000	1 300
	340	97	92	75	5	4	1 110 000	1 770 000	1 000	1 400
	400	86	78	65	6	5	1 010 000	1 340 000	850	1 200
	400	140	132	109	6	5	1 660 000	2 580 000	850	1 200
	400	140	132	109	6	5	1 660 000	2 580 000	850	1 200
<b>200</b>	280	51	48	41	3	2.5	410 000	780 000	1 100	1 500
	280	51	51	39	3	2.5	480 000	935 000	1 100	1 500
	310	70	70	53	3	2.5	760 000	1 370 000	1 000	1 400
	360	64	58	48	5	4	795 000	1 120 000	950	1 300
	360	104	98	82	5	4	1 210 000	1 920 000	950	1 300
	420	89	80	67	6	5	1 030 000	1 390 000	850	1 200
	420	89	80	56	6	5	965 000	1 330 000	750	1 000
<b>220</b>	420	146	138	115	6	5	1 820 000	2 870 000	800	1 100
	300	51	51	39	3	2.5	490 000	990 000	1 000	1 400
	340	76	76	57	4	3	885 000	1 610 000	950	1 300
	400	72	65	54	5	4	810 000	1 150 000	850	1 100
	400	114	108	90	5	4	1 340 000	2 210 000	850	1 100
	460	97	88	73	6	5	1 430 000	1 990 000	750	1 000
	460	154	145	122	6	5	2 020 000	3 200 000	750	1 000
<b>240</b>	320	51	51	39	3	2.5	500 000	1 040 000	950	1 300
	360	76	76	57	4	3	920 000	1 730 000	850	1 200
	440	79	72	60	5	4	990 000	1 400 000	750	1 000
	440	127	120	100	5	4	1 630 000	2 730 000	750	1 000
	500	105	95	80	6	5	1 660 000	2 340 000	670	950
	500	165	155	132	6	5	2 520 000	4 100 000	670	900
	500	165	155	132	6	5	2 520 000	4 100 000	670	900

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

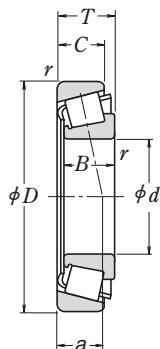
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)										Eff. Load Center (mm) <i>a</i>	Constant <i>e</i>	Axial Load Factors		Mass (kg)  approx.
		<i>d<sub>a</sub></i>	<i>d<sub>b</sub></i>	<i>D<sub>a</sub></i>		<i>D<sub>b</sub></i>		<i>S<sub>a</sub></i>	<i>S<sub>b</sub></i>	Ring: Inner Outer <i>r<sub>a</sub></i> max.				<i>Y<sub>1</sub></i>	<i>Y<sub>0</sub></i>	
		min.	max.	max.	min.	min.	min.	min.	min.	min.	max.					
HR 32936 J HR 32036 XJ HR 30236 J	4DC	195	192	240	227	241	8	11	2	2	53.9	0.48	1.3	0.69	6.56	
	3FD	198	199	268	248	267	10	16	2.5	2	60.4	0.42	1.4	0.78	14.3	
	4GB	207	210	302	281	297	9	14	4	3	61.8	0.45	1.3	0.73	17.8	
HR 32236 J 30336 30336 D 32336	4GD	207	205	302	270	303	10	20	4	3	78.9	0.45	1.3	0.73	29.8	
	—	207	233	362	324	345	10	19	4	3	72.5	0.36	1.7	0.92	39.3	
	—	216	229	362	304	352	10	30	4	3	113.1	0.81	0.74	0.41	38.5	
	—	212	225	362	310	353	10	28	4	3	96.6	0.37	1.6	0.88	66.8	
HR 32938 J HR 32038 XJ HR 30238 J	4DC	205	201	250	237	251	8	11	2	2	55.3	0.48	1.3	0.69	6.83	
	4FD	208	209	278	258	279	10	16	2.5	2	63.4	0.44	1.4	0.75	14.9	
	4GB	217	223	322	302	318	9	14	4	3	65.6	0.44	1.4	0.76	21.4	
HR 32238 J 30338 32338	4GD	217	216	322	290	323	10	22	4	3	80.5	0.44	1.4	0.76	35.2	
	—	223	248	378	346	366	11	21	5	4	76.1	0.36	1.7	0.92	46	
	—	229	243	378	332	375	11	31	5	4	102.7	0.37	1.6	0.88	78.9	
32940 HR 32940 J HR 32040 XJ	—	218	217	268	256	269	9	10	2.5	2	53.4	0.37	1.6	0.88	9.26	
	3EC	218	216	268	258	271	9	12	2.5	2	54.2	0.39	1.5	0.84	9.65	
	4FD	218	221	298	277	297	11	17	2.5	2	67.4	0.43	1.4	0.77	18.9	
HR 30240 J HR 32240 J 30340	4GB	227	236	342	318	336	10	16	4	3	69.1	0.44	1.4	0.76	25.5	
	3GD	227	230	342	305	340	11	22	4	3	85.1	0.41	1.5	0.81	42.6	
	—	233	253	398	346	368	11	22	5	4	81.4	0.37	1.6	0.88	52.3	
30340 D 32340	—	244	253	398	336	385	11	33	5	4	122.9	0.81	0.74	0.41	49.6	
	—	239	253	398	346	392	11	31	5	4	106.7	0.37	1.6	0.88	90.9	
HR 32944 J HR 32044 XJ 30244	3EC	238	235	288	278	293	9	12	2.5	2	59.2	0.43	1.4	0.78	10.3	
	4FD	241	244	326	303	326	12	19	3	2.5	73.6	0.43	1.4	0.77	24.4	
	—	247	267	382	350	367	11	18	4	3	74.7	0.40	1.5	0.82	33.6	
32244 30344 32344	—	247	260	382	340	377	12	24	4	3	93.0	0.40	1.5	0.82	57.4	
	—	253	283	438	390	414	12	24	5	4	85.4	0.36	1.7	0.92	72.4	
	—	259	274	438	372	421	12	32	5	4	114.9	0.37	1.6	0.88	114	
HR 32948 J HR 32048 XJ 30248	4EC	258	255	308	297	314	9	12	2.5	2	65.1	0.46	1.3	0.72	11.1	
	4FD	261	262	346	321	346	12	19	3	2.5	79.1	0.46	1.3	0.72	26.2	
	—	267	288	422	384	408	11	19	4	3	85.1	0.44	1.4	0.74	45.2	
32248 30348 32348	—	267	285	422	374	416	12	27	4	3	102.5	0.40	1.5	0.82	78	
	—	273	308	478	422	447	12	25	5	4	92.8	0.36	1.7	0.92	92.6	
	—	279	301	478	410	464	12	33	5	4	123.2	0.37	1.6	0.88	145	

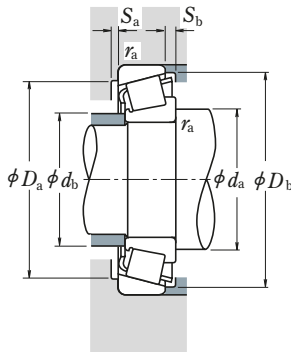


# SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 260 – 440 mm



<i>d</i>	<i>D</i>	Boundary Dimensions (mm)				Ring: Inner      Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
		<i>T</i>	<i>B</i>	<i>C</i>				<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>260</b>	360	63.5	63.5	48	3	2.5		730 000	1 450 000	850	1 100
	400	87	87	65	5	4		1 160 000	2 160 000	800	1 100
	480	89	80	67	6	5		1 190 000	1 700 000	670	900
	480	137	130	106	6	5		1 900 000	3 300 000	670	950
	540	113	102	85	6	6		1 870 000	2 640 000	630	850
	540	176	165	136	6	6		2 910 000	4 800 000	630	850
<b>280</b>	380	63.5	63.5	48	3	2.5		765 000	1 580 000	800	1 100
	420	87	87	65	5	4		1 180 000	2 240 000	710	1 000
	500	89	80	67	6	5		1 240 000	1 900 000	630	850
	500	137	130	106	6	5		1 950 000	3 450 000	630	850
	580	187	175	145	6	6		3 300 000	5 400 000	560	800
	580	187	175	145	6	6		3 300 000	5 400 000	560	800
<b>300</b>	420	76	72	62	4	3		895 000	1 820 000	710	950
	420	76	76	57	4	3		1 010 000	2 100 000	710	950
	460	100	100	74	5	4		1 440 000	2 700 000	670	900
	540	96	85	71	6	5		1 440 000	2 100 000	600	800
	540	149	140	115	6	5		2 220 000	3 700 000	600	800
	540	149	140	115	6	5		2 220 000	3 700 000	600	800
<b>320</b>	440	76	72	63	4	3		900 000	1 880 000	970	900
	440	76	76	57	4	3		1 040 000	2 220 000	670	900
	480	100	100	74	5	4		1 510 000	2 910 000	630	850
	580	104	92	75	6	5		1 640 000	2 420 000	530	750
	580	159	150	125	6	5		2 860 000	5 050 000	530	750
	670	210	200	170	7.5	7.5		4 200 000	7 100 000	480	670
<b>340</b>	460	76	72	63	4	3		910 000	1 940 000	630	850
	460	76	76	57	4	3		1 050 000	2 220 000	630	850
	520	112	106	92	6	5		1 650 000	3 400 000	560	750
<b>360</b>	480	76	72	62	4	3		945 000	2 100 000	600	800
	480	76	76	57	4	3		1 080 000	2 340 000	560	800
	540	112	106	92	6	5		1 680 000	3 500 000	530	750
<b>380</b>	520	87	82	71	5	4		1 210 000	2 550 000	560	750
<b>400</b>	540	87	82	71	5	4		1 250 000	2 700 000	530	710
	600	125	118	100	6	5		1 960 000	4 050 000	480	670
<b>420</b>	560	87	82	72	5	4		1 300 000	2 810 000	500	670
	620	125	118	100	6	5		2 000 000	4 200 000	450	630
<b>440</b>	650	130	122	104	6	6		2 230 000	4 600 000	430	600

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$ .

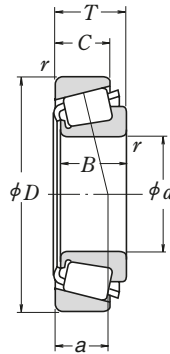
The values of  $e$ ,  $Y_1$ , and  $Y_0$  are given in the table below.

Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm)								Ring: Inner Outer $r_a$ max.	Eff. Load Center (mm) $a$	Constant $e$	Axial Load Factors		Mass (kg) approx.
		$d_a$ min.	$d_b$ max.	$D_a$ max.	$D_b$ min.	$S_a$ min.	$S_b$ min.						$Y_1$	$Y_0$	
<b>HR 32952 J</b>	3EC	278	278	348	333	347	11	15.5	2.5	2	69.8	0.41	1.5	0.81	18.6
<b>HR 32052 XJ</b>	4FC	287	287	382	357	383	14	22	4	3	86.3	0.43	1.4	0.76	38.5
<b>30252</b>	—	293	316	458	421	447	12	22	5	4	94.6	0.44	1.4	0.74	60.7
<b>32252</b>	—	293	305	458	394	446	14	31	5	4	116.0	0.45	1.3	0.73	103
<b>30352</b>	—	293	336	512	460	487	16	28	5	5	101.6	0.36	1.7	0.92	114
<b>32352</b>	—	293	328	512	441	495	13	40	5	5	130.5	0.37	1.6	0.88	188
<b>HR 32956 J</b>	4EC	298	297	368	352	368	12	15.5	2.5	2	75.3	0.43	1.4	0.76	20
<b>HR 32056 XJ</b>	4FC	307	305	402	374	402	14	22	4	3	91.6	0.46	1.3	0.72	40.6
<b>30256</b>	—	313	339	478	436	462	12	22	5	4	98.5	0.44	1.4	0.74	66.3
<b>32256</b>	—	313	325	478	412	467	14	31	5	4	123.1	0.47	1.3	0.70	109
<b>32356</b>	—	319	353	552	475	532	14	42	5	5	139.6	0.37	1.6	0.89	224
<b>32960</b>	—	321	326	406	386	405	13	14	3	2.5	79.3	0.37	1.6	0.88	30.5
<b>HR 32960 J</b>	3FD	321	324	406	387	405	13	19	3	2.5	79.9	0.39	1.5	0.84	31.4
<b>HR 32060 XJ</b>	4GD	327	330	442	408	439	15	26	4	3	98.4	0.43	1.4	0.76	56.6
<b>30260</b>	—	333	355	518	470	499	14	25	5	4	105.1	0.44	1.4	0.74	80.6
<b>32260</b>	—	333	352	518	458	514	15	34	5	4	131.7	0.46	1.3	0.72	132
<b>32964</b>	—	341	345	426	404	425	13	13	3	2.5	84.3	0.39	1.5	0.84	32
<b>HR 32964 J</b>	3FD	341	344	426	406	426	13	19	3	2.5	85.0	0.42	1.4	0.79	33.3
<b>HR 32064 XJ</b>	4GD	347	350	462	430	461	15	26	4	3	104.5	0.46	1.3	0.72	60
<b>30264</b>	—	353	381	558	503	533	14	29	5	4	113.7	0.44	1.4	0.74	99.3
<b>32264</b>	—	353	383	558	487	550	15	34	5	4	141.7	0.46	1.3	0.72	175
<b>32364</b>	—	383	412	634	547	616	14	42	6	6	157.5	0.37	1.6	0.88	343
<b>32968</b>	—	361	364	446	426	446	13	13	3	2.5	89.2	0.41	1.5	0.80	33.6
<b>HR 32968 J</b>	4FD	361	362	446	427	446	13	19	3	2.5	91.0	0.44	1.4	0.75	34.3
<b>32068</b>	—	373	386	498	464	496	3.5	22	5	4	104.5	0.37	1.6	0.89	83.7
<b>32972</b>	—	381	386	466	445	465	14	14	3	2.5	91.4	0.40	1.5	0.82	35.8
<b>HR 32972 J</b>	4FD	381	381	466	445	466	13	19	3	2.5	96.8	0.46	1.3	0.72	36.1
<b>32072</b>	—	393	402	518	480	514	5.5	22	5	4	108.6	0.38	1.6	0.86	86.5
<b>32976</b>	—	407	406	502	478	501	16	16	4	3	95.2	0.39	1.6	0.86	49.5
<b>32980</b>	—	427	428	522	499	524	16	16	4	3	100.8	0.40	1.5	0.82	52.7
<b>32080</b>	—	433	443	578	533	565	5	25	5	4	115.3	0.36	1.7	0.92	116
<b>32984</b>	—	447	448	542	521	544	3.5	15	4	3	106.1	0.41	1.5	0.81	54.8
<b>32084</b>	—	453	463	598	552	586	6.5	25	5	4	120.0	0.37	1.6	0.88	121
<b>32088</b>	—	473	487	622	582	616	5	26	5	5	126.3	0.36	1.7	0.92	136

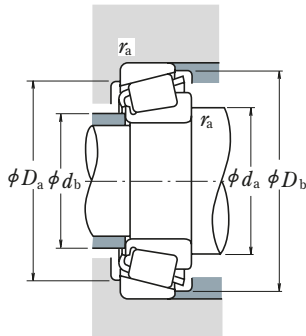


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 12.000 – 22.225 mm



$d$	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$	Ring: Inner Outer $r$ min.	$C_r$	$C_{0r}$	Grease	Oil
<b>12.000</b>	31.991	10.008	10.785	7.938	0.8 1.3	10 300	8 900	13 000	18 000
<b>12.700</b>	34.988	10.998	10.988	8.730	1.3 1.3	11 700	10 900	12 000	16 000
<b>15.000</b>	34.988	10.998	10.988	8.730	0.8 1.3	11 700	10 900	12 000	16 000
<b>15.875</b>	34.988	10.998	10.998	8.712	1.3 1.3	13 800	13 400	11 000	15 000
	39.992	12.014	11.153	9.525	1.3 1.3	14 900	15 700	9 500	13 000
	41.275	14.288	14.681	11.112	1.3 2.0	21 300	19 900	10 000	13 000
	42.862	14.288	14.288	9.525	1.5 1.5	17 300	17 200	8 500	12 000
	42.862	16.670	16.670	13.495	1.5 1.5	26 900	26 300	9 500	13 000
	44.450	15.494	14.381	11.430	1.5 1.5	23 800	23 900	8 500	11 000
	49.225	19.845	21.539	14.288	0.8 1.3	37 500	37 000	8 500	11 000
<b>16.000</b>	47.000	21.000	21.000	16.000	1.0 2.0	35 000	36 500	9 000	12 000
<b>16.993</b>	39.992	12.014	11.153	9.525	0.8 1.3	14 900	15 700	9 500	13 000
<b>17.455</b>	36.525	11.112	11.112	7.938	1.5 1.5	11 600	11 000	10 000	14 000
<b>17.462</b>	39.878	13.843	14.605	10.668	1.3 1.3	22 500	22 500	10 000	13 000
	47.000	14.381	14.381	11.112	0.8 1.3	23 800	23 900	8 500	11 000
<b>19.050</b>	39.992	12.014	11.153	9.525	1.0 1.3	14 900	15 700	9 500	13 000
	45.237	15.494	16.637	12.065	1.3 1.3	28 500	28 900	9 000	12 000
	47.000	14.381	14.381	11.112	1.3 1.3	23 800	23 900	8 500	11 000
	49.225	18.034	19.050	14.288	1.3 1.3	37 500	37 000	8 500	11 000
	49.225	19.845	21.539	14.288	1.2 1.3	37 500	37 000	8 500	11 000
	49.225	21.209	19.050	17.462	1.3 1.5	37 500	37 000	8 500	11 000
	49.225	23.020	21.539	17.462	C1.5 3.5	37 500	37 000	8 500	11 000
	53.975	22.225	21.839	15.875	1.5 2.3	40 500	39 500	7 500	10 000
<b>19.990</b>	47.000	14.381	14.381	11.112	1.5 1.3	23 800	23 900	8 500	11 000
<b>20.000</b>	51.994	15.011	14.260	12.700	1.5 1.3	26 000	27 900	7 500	10 000
<b>20.625</b>	49.225	23.020	21.539	17.462	1.5 1.5	37 500	37 000	8 500	11 000
<b>20.638</b>	49.225	19.845	19.845	15.875	1.5 1.5	36 000	37 000	8 000	11 000
<b>21.430</b>	50.005	17.526	18.288	13.970	1.3 1.3	38 500	40 000	8 000	11 000
<b>22.000</b>	45.237	15.494	16.637	12.065	1.3 1.3	29 200	33 500	8 500	11 000
	45.975	15.494	16.637	12.065	1.3 1.3	29 200	33 500	8 500	11 000
<b>22.225</b>	50.005	13.495	14.260	9.525	1.3 1.0	26 000	27 900	7 500	10 000
	50.005	17.526	18.288	13.970	1.3 1.3	38 500	40 000	8 000	11 000
	52.388	19.368	20.168	14.288	1.5 1.5	40 500	43 000	7 500	10 000
	53.975	19.368	20.168	14.288	1.5 1.5	40 500	43 000	7 500	10 000
	56.896	19.368	19.837	15.875	1.3 1.3	38 000	40 500	7 100	9 500
	57.150	22.225	22.225	17.462	0.8 1.5	48 000	50 000	7 100	9 500

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

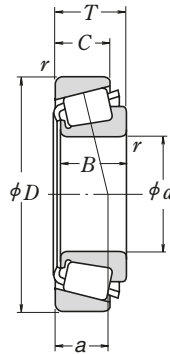
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer $r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx.	Inner Ring Outer Ring
*A 2047	A 2126	16.5	15.5	26	29	0.8	1.3	6.8	0.41	1.5	0.81	0.023	0.017
A 4050	A 4138	18.5	17	29	32	1.3	1.3	8.2	0.45	1.3	0.73	0.033	0.022
*A 4059	A 4138	19.5	19	29	32	0.8	1.3	8.2	0.45	1.3	0.73	0.029	0.022
L 21549	L 21511	21.5	19.5	29	32.5	1.3	1.3	7.7	0.32	1.9	1.0	0.031	0.018
A 6062	A 6157	22	20.5	34	37	1.3	1.3	10.3	0.53	1.1	0.63	0.044	0.031
03062	03162	21.5	20	34	37.5	1.3	2	9.1	0.31	1.9	1.1	0.061	0.035
11590	11520	24.5	22.5	34.5	39.5	1.5	1.5	13.0	0.70	0.85	0.47	0.061	0.040
17580	17520	23	21	36.5	39	1.5	1.5	10.6	0.33	1.8	1.0	0.075	0.048
05062	05175	23.5	21	38	42	1.5	1.5	11.2	0.36	1.7	0.93	0.081	0.039
09062	09195	22	21.5	42	44.5	0.8	1.3	10.7	0.27	2.3	1.2	0.139	0.065
*HM 81649	**HM 81610	27.5	23	37.5	43	1	2	14.9	0.55	1.1	0.60	0.115	0.082
A 6067	A 6157	22	21	34	37	0.8	1.3	10.3	0.53	1.1	0.63	0.042	0.031
A 5069	A 5144	23.5	21.5	30	33.5	1.5	1.5	8.9	0.49	1.2	0.68	0.030	0.020
† LM 11749	† LM 11710	23	21.5	34	37	1.3	1.3	8.7	0.29	2.1	1.2	0.055	0.028
05068	05185	23	22.5	40.5	42.5	0.8	1.3	10.1	0.36	1.7	0.93	0.082	0.047
A 6075	A 6157	24	23	34	37	1	1.3	10.3	0.53	1.1	0.63	0.037	0.031
† LM 11949	† LM 11910	25	23.5	39.5	41.5	1.3	1.3	9.5	0.30	2.0	1.1	0.081	0.044
05075	05185	25	23.5	40.5	42.5	1.3	1.3	10.1	0.36	1.7	0.93	0.077	0.047
09067	09195	25.5	24	42	44.5	1.3	1.3	10.7	0.27	2.3	1.2	0.115	0.065
09078	09195	25.5	24	42	44.5	1.2	1.3	10.7	0.27	2.3	1.2	0.124	0.065
09067	09196	25.5	24	41.5	44.5	1.3	1.5	13.8	0.27	2.3	1.2	0.115	0.085
09074	09194	26	24	39	44.5	1.5	3.5	13.8	0.27	2.3	1.2	0.124	0.082
21075	21212	31.5	26	43	50	1.5	2.3	16.3	0.59	1.0	0.56	0.156	0.097
05079	05185	26.5	24	40.5	42.5	1.5	1.3	10.1	0.36	1.7	0.93	0.073	0.047
07079	07204	27.5	27	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.105	0.061
09081	09196	27.5	25.5	41.5	44.5	1.5	1.5	13.8	0.27	2.3	1.2	0.115	0.085
12580	12520	28.5	26	42.5	45.5	1.5	1.5	12.9	0.32	1.9	1.0	0.114	0.067
† M 12649	† M 12610	27.5	25.5	44	46	1.3	1.3	10.9	0.28	2.2	1.2	0.115	0.059
*† LM 12749	† LM 12710	27.5	26	39.5	42.5	1.3	1.3	10.0	0.31	2.0	1.1	0.078	0.038
*† LM 12749	† LM 12711	27.5	26	40	42.5	1.3	1.3	10.0	0.31	2.0	1.1	0.078	0.043
07087	07196	28.5	27	44.5	47	1.3	1	10.6	0.40	1.5	0.82	0.097	0.035
† M 12648	† M 12610	28.5	26.5	44	46	1.3	1.3	10.9	0.28	2.2	1.2	0.111	0.059
1380	1328	29.5	27	45	48.5	1.5	1.5	11.3	0.29	2.1	1.1	0.137	0.067
1380	1329	29.5	27	46	49	1.5	1.5	11.3	0.29	2.1	1.1	0.137	0.082
1755	1729	29	27.5	49	51	1.3	1.3	12.2	0.31	2.0	1.1	0.152	0.102
1280	1220	29.5	29	49	52	0.8	1.5	15.1	0.35	1.7	0.95	0.183	0.106

**Notes**

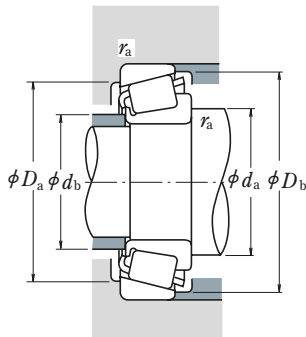
- \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).
- \*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).
- † The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).
- \* † The tolerance for the bore diameter is 0 to -20 μm, and the tolerance for overall bearing width is +356 to 0 μm.

# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 22.606 – 28.575 mm



$d$	Boundary Dimensions (mm)				Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$			$C_r$	$C_{0r}$	Grease	Oil
<b>22.606</b>	47.000	15.500	15.500	12.000	1.5	1.0	26 300	30 000	8 000	11 000
<b>23.812</b>	50.292	14.224	14.732	10.668	1.5	1.3	27 600	32 000	7 100	10 000
	56.896	19.368	19.837	15.875	0.8	1.3	38 000	40 500	7 100	9 500
<b>24.000</b>	55.000	25.000	25.000	21.000	2.0	2.0	49 500	55 000	7 100	9 500
<b>24.981</b>	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000
	52.001	15.011	14.260	12.700	1.5	2.0	26 000	27 900	7 500	10 000
	62.000	16.002	16.566	14.288	1.5	1.5	37 000	39 500	6 300	8 500
<b>25.000</b>	50.005	13.495	14.260	9.525	1.5	1.0	26 000	27 900	7 500	10 000
	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000
<b>25.400</b>	50.005	13.495	14.260	9.525	3.3	1.0	26 000	27 900	7 500	10 000
	50.005	13.495	14.260	9.525	1.0	1.0	26 000	27 900	7 500	10 000
	50.292	14.224	14.732	10.668	1.3	1.3	27 600	32 000	7 100	10 000
	57.150	17.462	17.462	13.495	1.3	1.5	39 500	45 500	6 700	9 000
	57.150	19.431	19.431	14.732	1.5	1.5	42 500	49 000	6 700	9 000
	59.530	23.368	23.114	18.288	0.8	1.5	50 000	58 000	6 300	9 000
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
	63.500	20.638	20.638	15.875	3.5	1.5	46 000	53 000	6 000	8 000
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000
	65.088	22.225	21.463	15.875	1.5	1.5	45 000	47 500	5 600	8 000
	68.262	22.225	22.225	17.462	0.8	1.5	55 000	64 000	5 600	7 500
	72.233	25.400	25.400	19.842	0.8	2.3	63 500	83 500	5 000	7 100
	72.626	24.608	24.257	17.462	2.3	1.5	60 000	58 000	5 600	7 500
	50.292	14.224	14.732	10.668	3.5	1.3	27 600	32 000	7 100	10 000
<b>26.988</b>	57.150	19.845	19.355	15.875	3.3	1.5	40 000	44 500	6 700	9 000
	60.325	19.842	17.462	15.875	3.5	1.5	39 500	45 500	6 700	9 000
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
<b>28.575</b>	57.150	19.845	19.355	15.875	3.5	1.5	40 000	44 500	6 700	9 000
	59.131	15.875	16.764	11.811	spec.	1.3	34 500	41 500	6 300	8 500
	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000
	68.262	22.225	22.225	17.462	0.8	1.5	55 000	64 000	5 600	7 500
	72.626	24.608	24.257	17.462	4.8	1.5	60 000	58 000	5 600	7 500
	72.626	24.608	24.257	17.462	1.5	1.5	60 000	58 000	5 600	7 500
	73.025	22.225	22.225	17.462	0.8	3.3	54 500	64 500	5 300	7 100

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

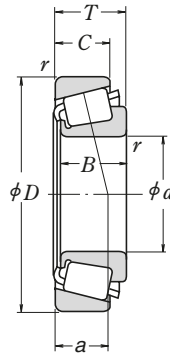
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Cone $r_a$	Cup $r_b$	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
<b>LM 72849</b>	<b>LM 72810</b>	29	27	40.5	44.5	1.5	1	12.2	0.47	1.3	0.70	0.086	0.046
† <b>L 44640</b>	† <b>L 44610</b>	30.5	28.5	44.5	47	1.5	1.3	10.9	0.37	1.6	0.88	0.097	0.039
<b>1779</b>	<b>1729</b>	29.5	28.5	49	51	0.8	1.3	12.2	0.31	2.0	1.1	0.143	0.102
▲ <b>JHM 33449</b>	▲ <b>JHM 33410</b>	35	30	47	52	2	2	15.8	0.35	1.7	0.93	0.181	0.107
<b>07098</b>	<b>07204</b>	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
<b>07098</b>	<b>07205</b>	31	29	44.5	48	1.5	2	12.1	0.40	1.5	0.82	0.085	0.061
<b>17098</b>	<b>17244</b>	33	30.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.165	0.091
<b>07097</b>	<b>07196</b>	31	29	44.5	47	1.5	1	10.6	0.40	1.5	0.82	0.085	0.035
<b>07097</b>	<b>07204</b>	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
<b>07100 SA</b>	<b>07196</b>	35	29.5	44.5	47	3.3	1	10.6	0.40	1.5	0.82	0.082	0.035
<b>07100</b>	<b>07196</b>	30.5	29.5	44.5	47	1	1	10.6	0.40	1.5	0.82	0.084	0.035
† <b>L 44643</b>	† <b>L 44610</b>	31.5	29.5	44.5	47	1.3	1.3	10.9	0.37	1.6	0.88	0.090	0.039
<b>15578</b>	<b>15520</b>	32.5	30.5	51	53	1.3	1.5	12.4	0.35	1.7	0.95	0.151	0.070
<b>M 84548</b>	<b>M 84510</b>	36	33	48.5	54	1.5	1.5	16.1	0.55	1.1	0.60	0.156	0.089
<b>M 84249</b>	<b>M 84210</b>	36	32.5	49.5	56	0.8	1.5	18.3	0.55	1.1	0.60	0.194	0.13
<b>15101</b>	<b>15245</b>	32.5	31.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.222	0.081
<b>15100</b>	<b>15250 X</b>	38	31.5	55	59	3.5	1.5	14.9	0.35	1.7	0.94	0.22	0.113
<b>M 86643</b>	<b>M 86610</b>	38	36.5	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.246	0.128
<b>23100</b>	<b>23256</b>	39	34.5	53	61	1.5	1.5	20.0	0.73	0.82	0.45	0.214	0.142
<b>02473</b>	<b>02420</b>	34.5	33.5	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.28	0.152
<b>HM 88630</b>	<b>HM 88610</b>	39.5	39.5	60	69	0.8	2.3	20.7	0.55	1.1	0.60	0.398	0.188
<b>41100</b>	<b>41286</b>	41	36.5	61	68	2.3	1.5	20.7	0.60	1.0	0.55	0.32	0.177
† <b>L 44649</b>	† <b>L 44610</b>	37.5	31	44.5	47	3.5	1.3	10.9	0.37	1.6	0.88	0.081	0.039
<b>1997 X</b>	<b>1922</b>	37.5	31.5	51	53.5	3.3	1.5	13.9	0.33	1.8	1.0	0.152	0.077
<b>15580</b>	<b>15523</b>	38.5	32	51	54	3.5	1.5	14.7	0.35	1.7	0.95	0.141	0.123
<b>15106</b>	<b>15245</b>	33.5	33	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.211	0.081
<b>1988</b>	<b>1922</b>	39.5	33.5	51	53.5	3.5	1.5	13.9	0.33	1.8	1.0	0.141	0.077
† <b>LM 67043</b>	† <b>LM 67010</b>	40	33.5	52	56	3.5	1.3	12.6	0.41	1.5	0.80	0.147	0.062
<b>15112</b>	<b>15245</b>	40	34	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.199	0.081
<b>15113</b>	<b>15245</b>	34.5	34	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.20	0.081
<b>M 86647</b>	<b>M 86610</b>	40	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.223	0.128
<b>02474</b>	<b>02420</b>	36.5	36	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.257	0.152
<b>41125</b>	<b>41286</b>	48	36.5	61	68	4.8	1.5	20.7	0.60	1.0	0.55	0.292	0.177
<b>41126</b>	<b>41286</b>	41.5	36.5	61	68	1.5	1.5	20.7	0.60	1.0	0.55	0.295	0.177
<b>02872</b>	<b>02820</b>	37.5	37	62	68	0.8	3.3	18.3	0.45	1.3	0.73	0.321	0.16

**Notes** † The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).

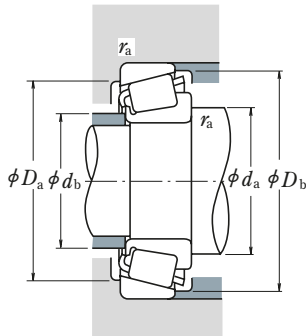
▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 29.000 – 32.000 mm



<i>d</i>	Boundary Dimensions (mm)				Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>29.000</b>	50.292	14.224	14.732	10.668	3.5	1.3	26 800	34 000	7 100	9 500
<b>29.367</b>	66.421	23.812	25.433	19.050	3.5	1.3	65 000	73 000	6 000	8 000
<b>30.000</b>	62.000	16.002	16.566	14.288	1.5	1.5	37 000	39 500	6 300	8 500
	62.000	19.050	20.638	14.288	1.3	1.3	46 000	53 000	6 000	8 000
	63.500	20.638	20.638	15.875	1.3	1.3	46 000	53 000	6 000	8 000
	72.000	19.000	18.923	15.875	1.5	1.5	52 000	56 000	5 600	7 500
<b>30.112</b>	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
<b>30.162</b>	58.738	14.684	15.080	10.716	3.5	1.0	28 800	33 500	6 000	8 000
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000
	68.262	22.225	22.225	17.462	2.3	1.5	55 500	70 500	5 300	7 500
	69.850	23.812	25.357	19.050	2.3	1.3	71 000	84 000	5 600	7 500
<b>30.213</b>	69.850	23.812	25.357	19.050	0.8	1.3	71 000	84 000	5 600	7 500
	76.200	24.608	24.074	16.670	1.5	C3.3	67 500	69 500	5 000	6 700
	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
<b>30.955</b>	62.000	19.050	20.638	14.288	1.5	1.3	46 000	53 000	6 000	8 000
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000
	59.131	15.875	16.764	11.811	spec.	1.3	34 500	41 500	6 300	8 500
<b>31.750</b>	62.000	18.161	19.050	14.288	spec.	1.3	46 000	53 000	6 000	8 000
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000
	63.500	20.638	20.638	15.875	0.8	1.3	46 000	53 000	6 000	8 000
	68.262	22.225	22.225	17.462	3.5	1.5	55 000	64 000	5 600	7 500
	68.262	22.225	22.225	17.462	1.5	1.5	55 500	70 500	5 300	7 500
	69.012	19.845	19.583	15.875	3.5	1.3	47 000	56 000	5 600	7 500
	69.012	26.982	26.721	15.875	4.3	3.3	47 000	56 000	5 600	7 500
	69.850	23.812	25.357	19.050	0.8	1.3	71 000	84 000	5 600	7 500
	69.850	23.812	25.357	19.050	3.5	1.3	71 000	84 000	5 600	7 500
	72.626	30.162	29.997	23.812	0.8	3.3	79 500	90 000	5 300	7 500
	73.025	29.370	27.783	23.020	1.3	3.3	74 000	100 000	5 000	7 100
<b>32.000</b>	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300
	72.233	25.400	25.400	19.842	3.3	2.3	63 500	83 500	5 000	7 100

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: $r_a$ Inner Outer max.		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring Outer Ring	
† L 45449	† L 45410	39.5	33	44.5	48	3.5	1.3	10.8	0.37	1.6	0.89	0.079	0.036
2690	2631	41	35	58	60	3.5	1.3	14.3	0.25	2.4	1.3	0.242	0.165
* 17118	17244	37	34.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.136	0.091
* 15117	15245	36.5	35	55	58	1.3	1.3	13.3	0.35	1.7	0.94	0.189	0.081
* 15117	15250	36.5	35	56	59	1.3	1.3	14.9	0.35	1.7	0.94	0.189	0.113
* 26118	26283	38	36	62	65	1.5	1.5	14.8	0.36	1.7	0.92	0.225	0.163
15116	15245	36	35.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.189	0.081
08118	08231	41.5	35	52	55	3.5	1	13.3	0.47	1.3	0.70	0.12	0.057
M 86649	M 86610	41	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.211	0.128
M 88043	M 88010	43.5	39.5	58	65	2.3	1.5	19.1	0.55	1.1	0.60	0.263	0.146
2558	2523	40	36.5	61	64	2.3	1.3	14.5	0.27	2.2	1.2	0.297	0.169
2559	2523	37	36.5	61	64	0.8	1.3	14.5	0.27	2.2	1.2	0.298	0.169
43118	43300	45	42	64	73	1.5	3.3	22.9	0.67	0.90	0.49	0.383	0.146
15118	15245	41.5	35.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.186	0.081
15120	15245	36	35.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.188	0.081
15119	15245	37.5	35.5	55	58	1.5	1.3	13.3	0.35	1.7	0.94	0.188	0.081
M 86648 A	M 86610	42	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.205	0.128
08125	08231	37.5	36	52	55	1	1	13.3	0.47	1.3	0.70	0.113	0.057
† LM 67048	† LM 67010	42.5	36	52	56	3.5	1.3	12.6	0.41	1.5	0.80	0.127	0.062
15123	15245	42.5	36.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.165	0.081
15126	15245	37	36.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.176	0.081
15125	15245	42.5	36.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.174	0.081
15126	15250	37	36.5	56	59	0.8	1.3	14.9	0.35	1.7	0.94	0.176	0.113
02475	02420	44.5	38.5	59	63	3.5	1.5	16.9	0.42	1.4	0.79	0.229	0.152
M 88046	M 88010	43	40.5	58	65	1.5	1.5	19.1	0.55	1.1	0.60	0.25	0.146
14125 A	14276	44	37.5	60	63	3.5	1.3	15.3	0.38	1.6	0.86	0.219	0.135
14123 A	14274	41.5	37.5	59	63	4.3	3.3	15.1	0.38	1.6	0.87	0.289	0.132
2580	2523	38.5	37.5	61	64	0.8	1.3	14.5	0.27	2.2	1.2	0.282	0.169
2582	2523	44	37.5	61	64	3.5	1.3	14.5	0.27	2.2	1.2	0.28	0.169
3188	3120	39.5	39.5	61	67	0.8	3.3	19.6	0.33	1.8	0.99	0.368	0.225
HM 88542	HM 88510	45.5	42.5	59	70	1.3	3.3	23.5	0.55	1.1	0.60	0.379	0.242
346	332	40	39.5	73	75	0.8	1.3	14.6	0.27	2.2	1.2	0.419	0.146
*HM 88638	HM 88610	48.5	42.5	60	69	3.3	2.3	20.7	0.55	1.1	0.60	0.337	0.188

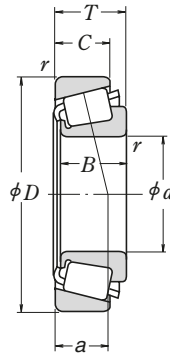
**Notes** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

† The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).

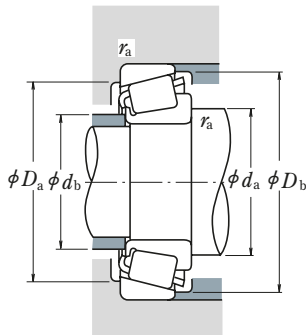


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 33.338 – 35.000 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		
<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>	Inner	Ring: <i>r</i> Outer min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil	
33.338	66.675	20.638	20.638	15.875	3.5	1.5	46 000	53 500	5 600	7 500	
	68.262	22.225	22.225	17.462	0.8	1.5	55 500	70 500	5 300	7 500	
	69.012	19.845	19.583	15.875	3.5	3.3	47 000	56 000	5 600	7 500	
	69.012	19.845	19.583	15.875	0.8	1.3	47 000	56 000	5 600	7 500	
	69.850	23.812	25.357	19.050	3.5	1.3	71 000	84 000	5 600	7 500	
	72.000	19.000	18.923	15.875	3.5	1.5	52 000	56 000	5 600	7 500	
	72.626	30.162	29.997	23.812	0.8	3.3	79 500	90 000	5 300	7 500	
	73.025	29.370	27.783	23.020	0.8	3.3	74 000	100 000	5 000	7 100	
	76.200	29.370	28.575	23.020	3.8	0.8	78 500	106 000	4 800	6 700	
	76.200	29.370	28.575	23.020	0.8	3.3	78 500	106 000	4 800	6 700	
	79.375	25.400	24.074	17.462	3.5	1.5	67 500	69 500	5 000	6 700	
	34.925	65.088	18.034	18.288	13.970	spec.	1.3	47 500	57 500	5 600	7 500
		65.088	20.320	18.288	16.256	spec.	1.3	47 500	57 500	5 600	7 500
66.675		20.638	20.638	16.670	3.5	2.3	53 000	62 500	5 600	7 500	
69.012		19.845	19.583	15.875	3.5	1.3	47 000	56 000	5 600	7 500	
69.012		19.845	19.583	15.875	1.5	1.3	47 000	56 000	5 600	7 500	
72.233		25.400	25.400	19.842	2.3	2.3	63 500	83 500	5 000	7 100	
73.025		22.225	22.225	17.462	0.8	3.3	54 500	64 500	5 300	7 100	
73.025		22.225	23.812	17.462	3.5	3.3	63 500	77 000	5 300	7 100	
73.025		23.812	24.608	19.050	1.5	0.8	71 000	86 000	5 300	7 100	
73.025		23.812	24.608	19.050	3.5	2.3	71 000	86 000	5 300	7 100	
76.200		29.370	28.575	23.020	0.8	0.8	78 500	106 000	4 800	6 700	
76.200		29.370	28.575	23.020	3.5	0.8	78 500	106 000	4 800	6 700	
76.200		29.370	28.575	23.020	3.5	3.3	78 500	106 000	4 800	6 700	
76.200	29.370	28.575	23.812	1.5	3.3	80 500	96 500	5 000	6 700		
79.375	29.370	29.771	23.812	3.5	3.3	88 000	106 000	4 800	6 700		
34.976	68.262	15.875	16.520	11.908	1.5	1.5	45 000	53 500	5 300	7 100	
	72.085	22.385	19.583	18.415	1.3	2.3	47 000	56 000	5 600	7 500	
	80.000	21.006	20.940	15.875	1.5	1.5	56 500	64 500	5 000	6 700	
35.000	59.131	15.875	16.764	11.938	spec.	1.3	35 000	47 000	6 000	8 000	
	59.975	15.875	16.764	11.938	spec.	1.3	35 000	47 000	6 000	8 000	
	62.000	16.700	17.000	13.600	spec.	1.0	38 000	50 000	5 600	8 000	
	62.000	16.700	17.000	13.600	spec.	1.5	38 000	50 000	5 600	8 000	
	65.987	20.638	20.638	16.670	3.5	2.3	53 000	62 500	5 600	7 500	
	73.025	26.988	26.975	22.225	3.5	0.8	75 500	88 500	5 300	7 500	



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

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

## Static Equivalent Load

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

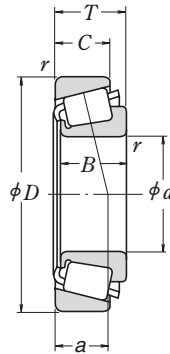
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Cone $r_a$	Cup $r_b$	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	approx. Outer Ring
1680	1620	44.5	38.5	58	61	3.5	1.5	15.2	0.37	1.6	0.89	0.196	0.121
M 88048	M 88010	42.5	41	58	65	0.8	1.5	19.0	0.55	1.1	0.60	0.236	0.146
14130	14274	45	38.5	59	63	3.5	3.3	15.3	0.38	1.6	0.86	0.207	0.132
14131	14276	39.5	38.5	60	63	0.8	1.3	15.3	0.38	1.6	0.86	0.209	0.135
2585	2523	45	39	61	64	3.5	1.3	14.5	0.27	2.2	1.2	0.263	0.169
26131	26283	44.5	38.5	62	65	3.5	1.5	14.7	0.36	1.7	0.92	0.20	0.163
3197	3120	41.5	40.5	61	67	0.8	3.3	19.6	0.33	1.8	0.99	0.348	0.225
HM 88547	HM 88510	45.5	42.5	59	70	0.8	3.3	23.5	0.55	1.1	0.60	0.362	0.242
HM 89444	HM 89411	53	44.5	65	73	3.8	0.8	23.6	0.55	1.1	0.60	0.419	0.261
HM 89443	HM 89410	46.5	44.5	62	73	0.8	3.3	23.6	0.55	1.1	0.60	0.421	0.257
43131	43312	51	42	67	74	3.5	1.5	23.7	0.67	0.90	0.49	0.348	0.22
† LM 48548	† LM 48510	46	40	58	61	3.5	1.3	14.1	0.38	1.6	0.88	0.172	0.087
† LM 48548	† LM 48511	46	40	58	61	3.5	1.3	16.4	0.38	1.6	0.88	0.172	0.108
M 38549	M 38510	46.5	40	58	62	3.5	2.3	15.2	0.35	1.7	0.94	0.194	0.112
14138 A	14276	46	40	60	63	3.5	1.3	15.3	0.38	1.6	0.86	0.194	0.135
14137 A	14276	42	40	60	63	1.5	1.3	15.1	0.38	1.6	0.86	0.196	0.135
HM 88649	HM 88610	48.5	42.5	60	69	2.3	2.3	20.7	0.55	1.1	0.60	0.307	0.188
02878	02820	42.5	42	62	68	0.8	3.3	18.3	0.45	1.3	0.73	0.266	0.16
2877	2820	47	41.5	63	68	3.5	3.3	16.1	0.37	1.6	0.90	0.291	0.15
25877	25821	43	40.5	65	68	1.5	0.8	15.7	0.29	2.1	1.1	0.306	0.167
25878	25820	47	40.5	64	68	3.5	2.3	15.7	0.29	2.1	1.1	0.304	0.165
HM 89446 A	HM 89411	47.5	44.5	65	73	0.8	0.8	23.6	0.55	1.1	0.60	0.403	0.261
HM 89446	HM 89411	53	44.5	65	73	3.5	0.8	23.6	0.55	1.1	0.60	0.40	0.261
HM 89446	HM 89410	53	44.5	62	73	3.5	3.3	23.6	0.55	1.1	0.60	0.40	0.257
31594	31520	46	43.5	64	72	1.5	3.3	21.6	0.40	1.5	0.82	0.404	0.235
3478	3420	50	43.5	67	74	3.5	3.3	20.0	0.37	1.6	0.90	0.448	0.259
19138	19268	42.5	40.5	61	65	1.5	1.5	14.5	0.44	1.4	0.74	0.196	0.073
14139	14283	41.5	40	60	65	1.3	2.3	17.7	0.38	1.6	0.87	0.198	0.21
28138	28315	43.5	41	69	73	1.5	1.5	16.0	0.40	1.5	0.82	0.308	0.199
*† L 68149	† L 68110	45.5	39	52	56	3.5	1.3	13.2	0.42	1.4	0.79	0.117	0.056
*† L 68149	† L 68111	45.5	39	53	56	3.5	1.3	13.2	0.42	1.4	0.79	0.117	0.064
* LM 78349	** LM 78310	46	40	55	59	3.5	1	14.4	0.44	1.4	0.74	0.137	0.074
* LM 78349	** LM 78310 A	46	40	54	59	3.5	1.5	14.4	0.44	1.4	0.74	0.138	0.073
M 38547	M 38511	46	39.5	59	61	3.5	2.3	15.2	0.35	1.7	0.94	0.193	0.103
23691	23621	49	42	63	68	3.5	0.8	18.1	0.37	1.6	0.89	0.309	0.212

## Notes

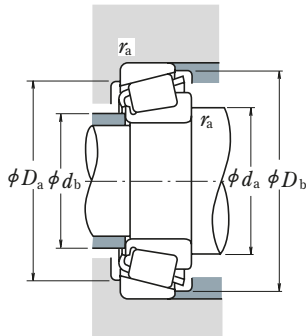
- \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).
- \*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).
- † The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).
- \*† The tolerance for the bore diameter is 0 to -20  $\mu\text{m}$ , and the tolerance for overall bearing width is +356 to 0  $\mu\text{m}$ .

# SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 35.717 – 41.275 mm



$d$	Boundary Dimensions (mm)					Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$				$C_r$	$C_{0r}$	Grease	Oil
<b>35.717</b>	72.233	25.400	25.400	19.842	3.5	2.3		63 500	83 500	5 000	7 100
<b>36.487</b>	73.025	23.812	24.608	19.050	1.5	0.8		71 000	86 000	5 300	7 100
<b>36.512</b>	76.200	29.370	28.575	23.020	3.5	3.3		78 500	106 000	4 800	6 700
	79.375	29.370	29.771	23.812	0.8	3.3		88 000	106 000	4 800	6 700
	88.501	25.400	23.698	17.462	2.3	1.5		73 000	81 000	4 000	5 600
	93.662	31.750	31.750	26.195	1.5	3.3		110 000	142 000	4 000	5 600
<b>38.000</b>	63.000	17.000	17.000	13.500	spec.	1.3		38 500	52 000	5 600	7 500
<b>38.100</b>	63.500	12.700	11.908	9.525	1.5	0.8		24 100	30 500	5 300	7 100
	65.088	18.034	18.288	13.970	2.3	1.3		42 500	55 000	5 300	7 500
	65.088	18.034	18.288	13.970	spec.	1.3		42 500	55 000	5 300	7 500
	65.088	19.812	18.288	15.748	2.3	1.3		42 500	55 000	5 300	7 500
	68.262	15.875	16.520	11.908	1.5	1.5		45 000	53 500	5 300	7 100
	69.012	19.050	19.050	15.083	2.0	2.3		49 000	61 000	5 300	7 100
	69.012	19.050	19.050	15.083	3.5	0.8		49 000	61 000	5 300	7 100
	72.238	20.638	20.638	15.875	3.5	1.3		48 500	59 500	5 300	7 100
	73.025	23.812	25.654	19.050	3.5	0.8		73 500	91 000	5 000	6 700
	76.200	23.812	25.654	19.050	3.5	3.3		73 500	91 000	5 000	6 700
	76.200	23.812	25.654	19.050	3.5	0.8		73 500	91 000	5 000	6 700
	79.375	29.370	29.771	23.812	3.5	3.3		88 000	106 000	4 800	6 700
	80.035	24.608	23.698	18.512	0.8	1.5		69 000	84 500	4 500	6 300
	82.550	29.370	28.575	23.020	0.8	3.3		87 000	117 000	4 500	6 000
	88.501	25.400	23.698	17.462	2.3	1.5		73 000	81 000	4 000	5 600
	88.501	26.988	29.083	22.225	3.5	1.5		96 500	109 000	4 500	6 000
	95.250	30.958	28.301	20.638	1.5	0.8		87 500	97 000	3 600	5 300
<b>39.688</b>	73.025	25.654	22.098	21.336	0.8	2.3		62 500	80 000	5 000	6 700
	76.200	23.812	25.654	19.050	3.5	3.3		73 500	91 000	5 000	6 700
	80.167	29.370	30.391	23.812	0.8	3.3		92 500	108 000	4 800	6 300
<b>40.000</b>	80.000	21.000	22.403	17.826	3.5	1.3		68 500	75 500	4 500	6 300
	80.000	21.000	22.403	17.826	0.8	1.3		68 500	75 500	4 500	6 300
	88.501	25.400	23.698	17.462	2.3	1.5		73 000	81 000	4 000	5 600
<b>41.000</b>	68.000	17.500	18.000	13.500	spec.	1.5		43 500	58 000	5 300	7 100
<b>41.275</b>	73.025	16.667	17.462	12.700	3.5	1.5		44 500	54 000	4 800	6 700
	73.431	19.558	19.812	14.732	3.5	0.8		54 500	67 000	4 800	6 700
	73.431	21.430	19.812	16.604	3.5	0.8		54 500	67 000	4 800	6 700

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer $r_a$ max.		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring Outer Ring	
HM 88648	HM 88610	52	43	60	69	3.5	2.3	20.7	0.55	1.1	0.60	0.298	0.188
25880	25821	44	42	65	68	1.5	0.8	15.7	0.29	2.1	1.1	0.291	0.167
HM 89449	HM 89410	54	44.5	62	73	3.5	3.3	23.6	0.55	1.1	0.60	0.38	0.257
3479	3420	45.5	44.5	67	74	0.8	3.3	20.0	0.37	1.6	0.90	0.429	0.259
44143	44348	54	50	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.502	0.245
46143	46368	48.5	46.5	79	87	1.5	3.3	24.0	0.40	1.5	0.82	0.765	0.405
▲ JL 69349	▲ JL 69310	49	42.5	56	60	3.5	1.3	14.6	0.42	1.4	0.79	0.132	0.071
13889	13830	45	42.5	59	60	1.5	0.8	11.9	0.35	1.7	0.95	0.109	0.046
LM 29749	LM 29710	46	42.5	59	62	2.3	1.3	13.7	0.33	1.8	0.99	0.16	0.079
LM 29748	LM 29710	49	42.5	59	62	3.5	1.3	13.7	0.33	1.8	0.99	0.158	0.079
LM 29749	LM 29711	46	42.5	58	62	2.3	1.3	15.5	0.33	1.8	0.99	0.16	0.094
19150	19268	45	43	61	65	1.5	1.5	14.5	0.44	1.4	0.74	0.173	0.073
13687	13621	46.5	43	61	65	2	2.3	15.8	0.40	1.5	0.82	0.193	0.104
13685	13620	49.5	43	62	65	3.5	0.8	15.8	0.40	1.5	0.82	0.191	0.105
16150	16284	49.5	43	63	67	3.5	1.3	16.0	0.40	1.5	0.82	0.212	0.146
2788	2735 X	50	43.5	66	69	3.5	0.8	15.9	0.30	2.0	1.1	0.312	0.135
2788	2720	50	43.5	66	70	3.5	3.3	15.9	0.30	2.0	1.1	0.312	0.187
2788	2729	50	43.5	68	70	3.5	0.8	15.9	0.30	2.0	1.1	0.312	0.191
3490	3420	52	45.5	67	74	3.5	3.3	20.0	0.37	1.6	0.90	0.404	0.259
27880	27820	48	47	68	75	0.8	1.5	21.5	0.56	1.1	0.59	0.362	0.209
HM 801346	HM 801310	51	49	68	78	0.8	3.3	24.2	0.55	1.1	0.60	0.483	0.282
44150	44348	55	51	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.484	0.245
418	414	51	44.5	77	80	3.5	1.5	17.1	0.26	2.3	1.3	0.50	0.329
53150	53375	55	53	81	89	1.5	0.8	30.7	0.74	0.81	0.45	0.665	0.365
M 201047	M 201011	45.5	48	64	69	0.8	2.3	19.7	0.33	1.8	0.99	0.266	0.169
2789	2720	52	45	66	70	3.5	3.3	15.9	0.30	2.0	1.1	0.292	0.187
3386	3320	46.5	45.5	70	75	0.8	3.3	18.4	0.27	2.2	1.2	0.442	0.217
344	332	52	45.5	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.338	0.146
344 A	332	46	45.5	73	75	0.8	1.3	14.5	0.27	2.2	1.2	0.339	0.146
44157	44348	56	51	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.463	0.245
* LM 300849	** LM 300811	52	45	61	65	3.5	1.5	13.9	0.35	1.7	0.95	0.16	0.082
18590	18520	53	46	66	69	3.5	1.5	14.0	0.35	1.7	0.94	0.199	0.086
LM 501349	LM 501310	53	46.5	67	70	3.5	0.8	16.3	0.40	1.5	0.83	0.226	0.108
LM 501349	LM 501314	53	46.5	66	70	3.5	0.8	18.2	0.40	1.5	0.83	0.226	0.129

**Notes**

\* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

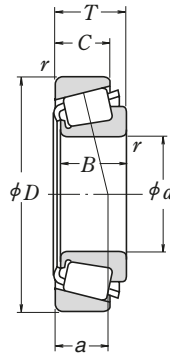
\*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

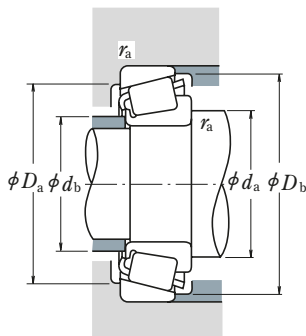


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 41.275 – 44.450 mm



$d$	Boundary Dimensions (mm)				Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$			$C_r$	$C_{0r}$	Grease	Oil
<b>41.275</b>	76.200	18.009	17.384	14.288	1.5	1.5	42 500	51 000	4 500	6 300
	76.200	22.225	23.020	17.462	3.5	0.8	66 000	82 000	4 800	6 700
	76.200	25.400	23.020	20.638	3.5	2.3	66 000	82 000	4 800	6 700
	79.375	23.812	25.400	19.050	3.5	0.8	77 000	98 500	4 800	6 300
	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300
	80.000	21.000	22.403	17.826	3.5	1.3	68 500	75 500	4 500	6 300
	80.167	25.400	25.400	20.638	3.5	3.3	77 000	98 500	4 800	6 300
	82.550	26.543	25.654	20.193	3.5	3.3	78 500	102 000	4 300	6 000
	85.725	30.162	30.162	23.812	3.5	3.3	91 000	115 000	4 300	6 000
	87.312	30.162	30.886	23.812	0.8	3.3	96 000	120 000	4 300	6 000
	88.501	25.400	23.698	17.462	2.3	1.5	69 000	75 500	4 000	5 600
	88.900	30.162	29.370	23.020	3.5	3.3	96 500	129 000	4 000	5 600
	88.900	30.162	29.370	23.020	0.8	3.3	96 500	129 000	4 000	5 600
	90.488	39.688	40.386	33.338	3.5	3.3	139 000	180 000	4 300	5 600
	93.662	31.750	31.750	26.195	0.8	3.3	110 000	142 000	4 000	5 600
	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300
	98.425	30.958	28.301	20.638	1.5	0.8	87 500	97 000	3 600	5 300
<b>42.862</b>	76.992	17.462	17.145	11.908	1.5	1.5	44 000	54 000	4 500	6 000
	82.550	19.842	19.837	15.080	2.3	1.5	58 500	69 000	4 500	6 300
	82.931	23.812	25.400	19.050	2.3	0.8	76 500	99 000	4 500	6 000
	82.931	26.988	25.400	22.225	2.3	2.3	76 500	99 000	4 500	6 000
<b>42.875</b>	76.200	25.400	25.400	20.638	3.5	1.5	77 000	98 500	4 800	6 300
	80.000	21.000	22.403	17.826	3.5	1.3	68 500	75 500	4 500	6 300
	82.931	26.988	25.400	22.225	3.5	2.3	76 500	99 000	4 500	6 000
	83.058	23.812	25.400	19.050	3.5	3.3	76 500	99 000	4 500	6 000
<b>43.000</b>	74.988	19.368	19.837	14.288	1.5	1.3	52 500	68 000	4 800	6 300
<b>44.450</b>	80.962	19.050	17.462	14.288	0.3	1.5	45 000	57 000	4 300	6 000
	82.931	23.812	25.400	19.050	3.5	0.8	76 500	99 000	4 500	6 000
	83.058	23.812	25.400	19.050	3.5	3.3	76 500	99 000	4 500	6 000
	87.312	30.162	30.886	23.812	3.5	3.3	96 000	120 000	4 300	6 000
	88.900	30.162	29.370	23.020	3.5	3.3	96 500	129 000	4 000	5 600
	93.264	30.162	30.302	23.812	3.5	3.2	103 000	136 000	3 800	5 300
	93.662	31.750	31.750	25.400	0.8	3.3	120 000	147 000	4 000	5 600
	93.662	31.750	31.750	25.400	3.5	3.3	120 000	147 000	4 000	5 600
	93.662	31.750	31.750	26.195	3.5	3.3	110 000	142 000	4 000	5 600
	95.250	27.783	29.901	22.225	3.5	2.3	106 000	126 000	4 300	5 600

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

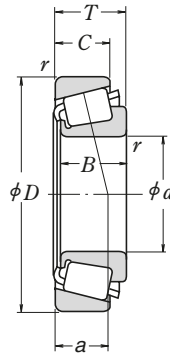
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer $r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
11162	11300	49	46.5	67	71	1.5	1.5	17.4	0.49	1.2	0.68	0.212	0.129
24780	24720	53	47.5	68	72	3.5	0.8	17.0	0.39	1.5	0.84	0.279	0.15
24780	24721	54	47	66	72	3.5	2.3	20.2	0.39	1.5	0.84	0.279	0.189
26882	26822	54	47	71	74	3.5	0.8	16.4	0.32	1.9	1.0	0.349	0.186
336	332	47	46	73	75	0.8	1.3	14.5	0.27	2.2	1.2	0.325	0.146
342	332	53	46	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.323	0.146
26882	26820	54	47	69	74	3.5	3.3	18.0	0.32	1.9	1.0	0.349	0.219
M 802048	M 802011	57	51	70	79	3.5	3.3	22.9	0.55	1.1	0.60	0.406	0.23
3877	3820	57	50	73	81	3.5	3.3	21.8	0.40	1.5	0.82	0.506	0.285
3576	3525	49	48	75	81	0.8	3.3	19.5	0.31	2.0	1.1	0.532	0.304
44162	44348	57	51	75	84	2.3	1.5	28.0	0.78	0.77	0.42	0.447	0.245
HM 803146	HM 803110	60	53	74	85	3.5	3.3	25.6	0.55	1.1	0.60	0.579	0.322
HM 803145	HM 803110	54	53	74	85	0.8	3.3	25.6	0.55	1.1	0.60	0.582	0.322
4388	4335	57	51	77	85	3.5	3.3	24.6	0.28	2.1	1.2	0.789	0.459
46162	46368	52	51	79	87	0.8	3.3	24.0	0.40	1.5	0.82	0.695	0.405
HM 804840	HM 804810	61	54	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.726	0.354
53162	53387	57	53	82	91	1.5	0.8	30.7	0.74	0.81	0.45	0.618	0.442
12168	12303	51	48.5	68	73	1.5	1.5	17.7	0.51	1.2	0.65	0.228	0.098
22168	22325	52	48.5	73	76	2.3	1.5	17.6	0.43	1.4	0.77	0.283	0.176
25578	25520	53	49.5	74	77	2.3	0.8	17.6	0.33	1.8	0.99	0.383	0.203
25578	25523	53	49.5	72	77	2.3	2.3	20.8	0.33	1.8	0.99	0.383	0.248
26884	26823	55	48.5	69	73	3.5	1.5	18.0	0.32	1.9	1.0	0.337	0.136
342 S	332	54	47.5	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.305	0.146
25577	25523	55	49	72	77	3.5	2.3	20.8	0.33	1.8	0.99	0.381	0.248
25577	25521	55	49	72	77	3.5	3.3	17.6	0.33	1.8	0.99	0.381	0.201
* 16986	16929	51	48.5	67	71	1.5	1.3	17.2	0.44	1.4	0.74	0.24	0.106
13175	13318	50	50	72	76	0.3	1.5	20.1	0.53	1.1	0.63	0.252	0.144
25580	25520	57	50	74	77	3.5	0.8	17.6	0.33	1.8	0.99	0.359	0.203
25580	25521	56	51	72	78	3.5	3.3	17.6	0.33	1.8	0.99	0.359	0.201
3578	3525	57	51	75	81	3.5	3.3	19.5	0.31	2.0	1.1	0.477	0.304
HM 803149	HM 803110	62	53	74	85	3.5	3.3	25.6	0.55	1.1	0.60	0.528	0.322
3782	3720	58	52	82	88	3.5	3.2	22.4	0.34	1.8	0.97	0.678	0.292
49176	49368	54	53	82	87	0.8	3.3	21.6	0.36	1.7	0.92	0.648	0.371
49175	49368	59	53	82	87	3.5	3.3	21.6	0.36	1.7	0.92	0.645	0.371
46176	46368	60	54	79	87	3.5	3.3	24.0	0.40	1.5	0.82	0.635	0.405
438	432	57	51	83	87	3.5	2.3	18.6	0.28	2.1	1.2	0.555	0.384

**Note** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

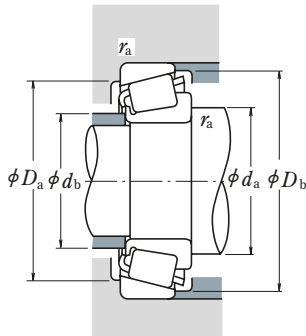


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 44.450 – 47.625 mm



$d$	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$	Ring: Inner Outer $r$ min.	$C_r$	$C_{0r}$	Grease	Oil
<b>44.450</b>	95.250	30.162	29.370	23.020	3.5 3.3	106 000	143 000	3 800	5 300
	95.250	30.958	28.301	20.638	3.5 0.8	87 500	97 000	3 600	5 300
	95.250	30.958	28.301	20.638	1.3 0.8	87 500	97 000	3 600	5 300
	95.250	30.958	28.301	20.638	2.0 0.8	87 500	97 000	3 600	5 300
	95.250	30.958	28.301	22.225	1.3 0.8	100 000	122 000	3 600	5 000
	95.250	30.958	28.575	22.225	3.5 0.8	100 000	122 000	3 600	5 000
	98.425	30.958	28.301	20.638	3.5 0.8	87 500	97 000	3 600	5 300
	103.188	43.658	44.475	36.512	1.3 3.3	178 000	238 000	3 800	5 000
	104.775	36.512	36.512	28.575	3.5 3.3	139 000	192 000	3 400	4 800
	107.950	27.783	29.317	22.225	3.5 0.8	116 000	149 000	3 400	4 800
	111.125	30.162	26.909	20.638	3.5 3.3	92 500	110 000	3 200	4 300
	114.300	44.450	44.450	34.925	3.5 3.3	172 000	205 000	3 600	4 800
<b>44.983</b>	82.931	23.812	25.400	19.050	1.5 0.8	76 500	99 000	4 500	6 000
<b>45.000</b>	93.264	20.638	22.225	15.082	0.8 1.3	77 000	93 000	3 800	5 300
<b>45.230</b>	79.985	19.842	20.638	15.080	2.0 1.3	62 000	78 500	4 500	6 000
<b>45.242</b>	73.431	19.558	19.812	15.748	3.5 0.8	53 500	75 000	4 800	6 300
	77.788	19.842	19.842	15.080	3.5 0.8	56 000	71 000	4 500	6 300
	77.788	21.430	19.842	16.667	3.5 0.8	56 000	71 000	4 500	6 300
<b>45.618</b>	82.931	23.812	25.400	19.050	3.5 0.8	76 500	99 000	4 500	6 000
	82.931	26.988	25.400	22.225	3.5 2.3	76 500	99 000	4 500	6 000
<b>46.000</b>	75.000	18.000	18.000	14.000	2.3 1.5	51 000	71 500	4 500	6 300
<b>46.038</b>	79.375	17.462	17.462	13.495	2.8 1.5	46 000	57 000	4 500	6 000
	80.962	19.050	17.462	14.288	0.8 1.5	45 000	57 000	4 300	6 000
	85.000	20.638	21.692	17.462	2.3 1.3	71 500	81 500	4 300	6 000
	85.000	25.400	25.608	20.638	3.5 1.3	79 500	105 000	4 300	6 000
	95.250	27.783	29.901	22.225	3.5 0.8	106 000	126 000	4 300	5 600
<b>47.625</b>	88.900	20.638	22.225	16.513	3.5 1.3	73 000	85 000	4 000	5 600
	88.900	25.400	25.400	19.050	3.5 3.3	86 000	107 000	4 000	5 600
	95.250	30.162	29.370	23.020	3.5 3.3	106 000	143 000	3 800	5 300
	101.600	34.925	36.068	26.988	3.5 3.3	137 000	169 000	3 800	5 000
	111.125	30.162	26.909	20.638	3.5 3.3	92 500	110 000	3 200	4 300
	112.712	30.162	26.909	20.638	3.5 3.3	92 500	110 000	3 200	4 300
	117.475	33.338	31.750	23.812	3.5 3.3	137 000	156 000	3 200	4 300
	123.825	36.512	32.791	25.400	3.5 3.3	143 000	160 000	3 000	4 000

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

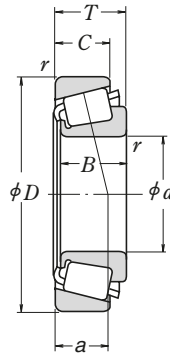
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
HM 804843	HM 804810	63	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.677	0.354
53177	53375	63	53	81	89	3.5	0.8	30.7	0.74	0.81	0.45	0.572	0.365
53176	53375	59	53	81	89	1.3	0.8	30.7	0.74	0.81	0.45	0.574	0.365
53178	53375	60	53	81	89	2	0.8	30.7	0.74	0.81	0.45	0.574	0.365
HM 903247	HM 903210	61	54	81	91	1.3	0.8	31.5	0.74	0.81	0.45	0.651	0.389
HM 903249	HM 903210	65	54	81	91	3.5	0.8	31.5	0.74	0.81	0.45	0.635	0.389
53177	53387	63	53	82	91	3.5	0.8	30.7	0.74	0.81	0.45	0.568	0.442
5356	5335	58	56	89	97	1.3	3.3	27.0	0.30	2.0	1.1	1.23	0.637
HM 807040	HM 807010	66	59	89	100	3.5	3.3	29.7	0.49	1.2	0.68	1.14	0.502
460	453 A	60	54	97	100	3.5	0.8	20.7	0.34	1.8	0.98	0.93	0.42
55175	55437	67	60	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.867	0.514
65385	65320	65	59	97	107	3.5	3.3	32.2	0.43	1.4	0.77	1.39	0.894
25584	25520	53	51	74	77	1.5	0.8	17.6	0.33	1.8	0.99	0.354	0.203
376	374	54	54	85	88	0.8	1.3	17.1	0.34	1.8	0.97	0.492	0.174
17887	17831	57	52	68	74	2	1.3	15.9	0.37	1.6	0.90	0.274	0.136
LM 102949	LM 102910	56	50	68	70	3.5	0.8	14.6	0.31	2.0	1.1	0.213	0.102
LM 603049	LM 603011	57	50	71	74	3.5	0.8	17.2	0.43	1.4	0.77	0.249	0.119
LM 603049	LM 603012	57	50	70	74	3.5	0.8	18.8	0.43	1.4	0.77	0.249	0.137
25590	25520	58	51	74	77	3.5	0.8	17.6	0.33	1.8	0.99	0.343	0.203
25590	25523	58	51	72	77	3.5	2.3	20.8	0.33	1.8	0.99	0.343	0.248
* LM 503349	** LM 503310	55	51	67	71	2.3	1.5	15.9	0.40	1.5	0.82	0.209	0.096
18690	18620	56	51	71	74	2.8	1.5	15.5	0.37	1.6	0.88	0.211	0.126
13181	13318	52	52	72	76	0.8	1.5	20.1	0.53	1.1	0.63	0.236	0.144
359 S	354 A	55	51	77	80	2.3	1.3	15.4	0.31	2.0	1.1	0.343	0.162
2984	2924	58	52	76	80	3.5	1.3	19.0	0.35	1.7	0.95	0.397	0.223
436	432 A	59	52	84	87	3.5	0.8	18.6	0.28	2.1	1.2	0.536	0.381
369 A	362 A	60	53	81	84	3.5	1.3	16.6	0.32	1.9	1.0	0.381	0.166
M 804049	M 804010	63	56	77	85	3.5	3.3	23.8	0.55	1.1	0.60	0.455	0.218
HM 804846	HM 804810	66	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.626	0.354
528	522	62	55	89	95	3.5	3.3	22.1	0.29	2.1	1.2	0.894	0.416
55187	55437	69	62	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.817	0.514
55187	55443	69	62	92	106	3.5	3.3	37.3	0.88	0.68	0.37	0.816	0.554
66187	66462	66	62	100	111	3.5	3.3	32.1	0.63	0.96	0.53	1.19	0.552
72187	72487	72	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.29	0.79

**Notes** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

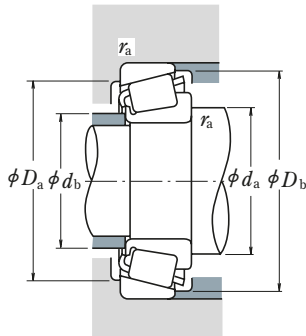
\*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

# SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 48.412 – 52.388 mm



$d$	Boundary Dimensions (mm)				Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$			$C_r$	$C_{0r}$	Grease	Oil
<b>48.412</b>	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300
	95.250	30.162	29.370	23.020	2.3	3.3	106 000	143 000	3 800	5 300
<b>49.212</b>	104.775	36.512	36.512	28.575	3.5	0.8	139 000	192 000	3 400	4 800
	114.300	44.450	44.450	36.068	3.5	3.3	196 000	243 000	3 400	4 800
<b>50.000</b>	82.000	21.500	21.500	17.000	3.0	0.5	71 000	96 000	4 300	5 600
	82.550	21.590	22.225	16.510	0.5	1.3	71 000	96 000	4 300	5 600
	88.900	20.638	22.225	16.513	2.3	1.3	73 000	85 000	4 000	5 600
	90.000	28.000	28.000	23.000	3.0	2.5	104 000	136 000	4 000	5 600
	105.000	37.000	36.000	29.000	3.0	2.5	139 000	192 000	3 400	4 800
<b>50.800</b>	80.962	18.258	18.258	14.288	1.5	1.5	53 000	81 000	4 300	5 600
	82.550	23.622	22.225	18.542	3.5	0.8	71 000	96 000	4 300	5 600
	82.931	21.590	22.225	16.510	3.5	1.3	71 000	96 000	4 300	5 600
	85.000	17.462	17.462	13.495	3.5	1.5	48 500	63 000	4 300	5 600
	85.725	19.050	18.263	12.700	1.5	1.5	42 500	54 000	4 000	5 300
	88.900	20.638	22.225	16.513	3.5	1.3	73 000	85 000	4 000	5 600
	88.900	20.638	22.225	16.513	1.5	1.3	73 000	85 000	4 000	5 600
	92.075	24.608	25.400	19.845	3.5	0.8	84 500	117 000	4 000	5 300
	93.264	30.162	30.302	23.812	0.8	0.8	103 000	136 000	3 800	5 300
	93.264	30.162	30.302	23.812	3.5	0.8	103 000	136 000	3 800	5 300
	95.250	27.783	28.575	22.225	3.5	2.3	110 000	144 000	3 800	5 300
	101.600	31.750	31.750	25.400	3.5	3.3	118 000	150 000	3 600	5 000
	101.600	34.925	36.068	26.988	0.8	3.3	137 000	169 000	3 800	5 000
	101.600	34.925	36.068	26.988	3.5	3.3	137 000	169 000	3 800	5 000
	104.775	36.512	36.512	28.575	3.5	0.8	139 000	192 000	3 400	4 800
	104.775	36.512	36.512	28.575	3.5	3.3	139 000	192 000	3 400	4 800
	108.966	34.925	36.512	26.988	3.5	3.3	145 000	181 000	3 600	4 800
	111.125	30.162	26.909	20.638	3.5	3.3	113 000	152 000	3 000	4 300
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000
<b>52.388</b>	127.000	44.450	44.450	34.925	3.5	3.3	199 000	258 000	3 000	4 000
	127.000	50.800	52.388	41.275	3.5	3.3	236 000	300 000	3 200	4 300
	92.075	24.608	25.400	19.845	3.5	0.8	84 500	117 000	4 000	5 300
	100.000	25.000	22.225	21.824	2.3	2.0	77 000	93 000	3 800	5 300
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer	$r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
HM 804849	HM 804810	66	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.61	0.354
HM 804848	HM 804810	63	57	81	91	2.3	3.3	26.1	0.55	1.1	0.60	0.614	0.354
HM 807044	HM 807011	69	63	91	100	3.5	0.8	29.7	0.49	1.2	0.68	1.03	0.508
HH 506348	HH 506310	71	61	97	107	3.5	3.3	30.8	0.40	1.5	0.82	1.43	0.837
▲ JLM 104948	▲ JLM 104910	60	55	76	78	3	0.5	16.1	0.31	2.0	1.1	0.306	0.129
* LM 104947 A	LM 104911	55	55	75	78	0.5	1.3	15.7	0.31	2.0	1.1	0.316	0.133
366	362 A	59	55	81	84	2.3	1.3	16.6	0.32	1.9	1.0	0.351	0.166
▲ JM 205149	▲ JM 205110	62	57	80	85	3	2.5	19.9	0.33	1.8	1.0	0.507	0.246
▲ JHM 807045	▲ JHM 807012	69	63	90	100	3	2.5	29.7	0.49	1.2	0.68	1.01	0.523
L 305649	L 305610	58	56	73	77	1.5	1.5	15.7	0.36	1.7	0.93	0.239	0.119
LM 104949	LM 104911 A	62	55	75	78	3.5	0.8	17.8	0.31	2.0	1.1	0.303	0.156
LM 104949	LM 104912	62	55	75	78	3.5	1.3	15.7	0.31	2.0	1.1	0.301	0.14
18790	18720	62	56	77	80	3.5	1.5	16.7	0.41	1.5	0.81	0.239	0.136
18200	18337	59	56	76	81	1.5	1.5	21.0	0.57	1.1	0.58	0.268	0.136
368 A	362 A	62	56	81	84	3.5	1.3	16.6	0.32	1.9	1.0	0.338	0.166
368	362 A	58	56	81	84	1.5	1.3	16.6	0.32	1.9	1.0	0.341	0.166
28580	28521	63	57	83	87	3.5	0.8	20.0	0.38	1.6	0.87	0.46	0.247
3775	3730	58	58	84	88	0.8	0.8	22.4	0.34	1.8	0.97	0.568	0.297
3780	3730	64	58	84	88	3.5	0.8	22.4	0.34	1.8	0.97	0.564	0.297
33889	33821	64	58	85	90	3.5	2.3	19.8	0.33	1.8	1.0	0.601	0.267
49585	49520	66	59	88	96	3.5	3.3	23.4	0.40	1.5	0.82	0.744	0.389
529	522	59	58	89	95	0.8	3.3	22.1	0.29	2.1	1.2	0.822	0.416
529 X	522	65	58	89	95	3.5	3.3	22.1	0.29	2.1	1.2	0.819	0.416
HM 807046	HM 807011	70	63	91	100	3.5	0.8	29.7	0.49	1.2	0.68	0.992	0.508
HM 807046	HM 807010	70	63	89	100	3.5	3.3	29.7	0.49	1.2	0.68	0.993	0.502
59200	59429	68	61	93	101	3.5	3.3	25.4	0.40	1.5	0.82	0.943	0.594
55200 C	55437	71	65	92	105	3.5	3.3	37.6	0.88	0.68	0.37	0.845	0.514
55200	55437	71	64	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.767	0.514
72200 C	72487	77	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.33	0.79
72200	72487	74	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.22	0.79
65200	65500	75	69	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.86	1.03
6279	6220	71	65	108	117	3.5	3.3	30.7	0.30	2.0	1.1	2.08	1.22
28584	28521	65	58	83	87	3.5	0.8	20.0	0.38	1.6	0.87	0.435	0.247
377	372	62	58	86	90	2.3	2	21.4	0.34	1.8	0.97	0.392	0.435
55206	55437	72	64	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.737	0.514

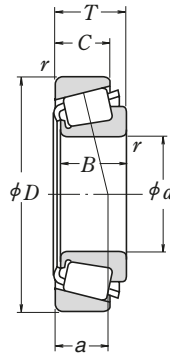
**Notes** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

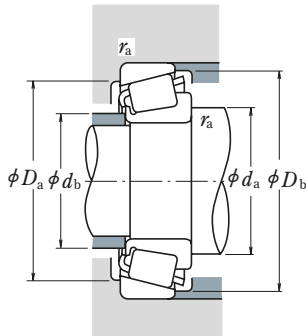


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 53.975 – 58.738 mm



$d$	Boundary Dimensions (mm)				Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$			$C_r$	$C_{0r}$	Grease	Oil
<b>53.975</b>	104.775	39.688	40.157	33.338	3.5	3.3	148 000	207 000	3 600	4 800
	107.950	36.512	36.957	28.575	3.5	3.3	144 000	182 000	3 600	4 800
	122.238	33.338	31.750	23.812	3.5	3.3	135 000	156 000	3 000	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000
	127.000	44.450	44.450	34.925	3.5	3.3	199 000	258 000	3 000	4 000
	127.000	50.800	52.388	41.275	3.5	3.3	236 000	300 000	3 200	4 300
	130.175	36.512	33.338	23.812	3.5	3.3	133 000	154 000	2 600	3 600
<b>55.000</b>	90.000	23.000	23.000	18.500	1.5	0.5	79 000	111 000	3 800	5 300
	95.000	29.000	29.000	23.500	1.5	2.5	111 000	152 000	3 800	5 000
	96.838	21.000	21.946	15.875	2.3	0.8	80 500	100 000	3 600	5 000
	110.000	39.000	39.000	32.000	3.0	2.5	177 000	225 000	3 400	4 500
	115.000	41.021	41.275	31.496	3.0	3.0	172 000	214 000	3 200	4 500
<b>55.562</b>	97.630	24.608	24.608	19.446	3.5	0.8	89 000	129 000	3 600	5 000
	122.238	43.658	43.764	36.512	1.3	3.3	198 000	292 000	3 000	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000
<b>57.150</b>	96.838	21.000	21.946	15.875	3.5	0.8	80 500	100 000	3 600	5 000
	96.838	21.000	21.946	15.875	2.3	0.8	80 500	100 000	3 600	5 000
	96.838	25.400	21.946	20.275	3.5	2.3	80 500	100 000	3 600	5 000
	98.425	21.000	21.946	17.826	3.5	0.8	80 500	100 000	3 600	5 000
	104.775	30.162	29.317	24.605	3.5	3.3	116 000	149 000	3 400	4 800
	104.775	30.162	29.317	24.605	2.3	3.3	116 000	149 000	3 400	4 800
	104.775	30.162	30.958	23.812	0.8	3.3	130 000	170 000	3 400	4 800
	104.775	30.162	30.958	23.812	0.8	0.8	130 000	170 000	3 400	4 800
	122.238	33.338	31.750	23.812	3.5	3.3	135 000	156 000	3 000	4 000
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000
	140.030	36.512	33.236	23.520	3.5	2.3	152 000	183 000	2 600	3 600
<b>57.531</b> <b>58.738</b>	144.983	36.000	33.236	23.007	3.5	3.5	152 000	183 000	2 600	3 600
	149.225	53.975	54.229	44.450	3.5	3.3	287 000	410 000	2 600	3 400
	96.838	21.000	21.946	15.875	3.5	0.8	80 500	100 000	3 600	5 000
	112.712	33.338	30.048	26.988	3.5	3.3	120 000	173 000	3 200	4 300

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

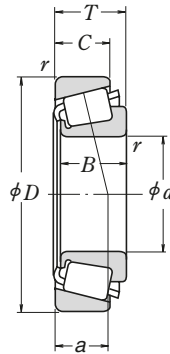
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)		
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer	$r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
4595	4535	70	63	90	99	3.5	3.3	27.4	0.34	1.79	0.98	0.989	0.589	
539	532 X	68	61	94	100	3.5	3.3	24.3	0.30	2.0	1.1	0.88	0.57	
66584	66520	75	68	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.2	0.558	
72212	72487	77	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.16	0.79	
72212 C	72487	79	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.27	0.79	
557 S	552 A	71	65	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.49	0.764	
65212	65500	77	71	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.76	1.03	
6280	6220	74	67	108	117	3.5	3.3	30.7	0.30	2.0	1.1	1.97	1.22	
HM911242	HM911210	79	74	109	124	3.5	3.3	42.2	0.82	0.73	0.40	1.45	0.725	
▲ JLM506849	▲ JLM506810	63	61	82	86	1.5	0.5	19.7	0.40	1.5	0.82	0.378	0.186	
▲ JM207049	▲ JM207010	64	62	85	91	1.5	2.5	21.3	0.33	1.8	0.99	0.59	0.26	
385	382 A	65	61	89	92	2.3	0.8	17.6	0.35	1.7	0.93	0.455	0.179	
▲ JH307749	▲ JH307710	71	64	97	104	3	2.5	27.2	0.35	1.7	0.95	1.13	0.567	
622 X	614 X	70	64	101	108	3	3	26.6	0.31	1.9	1.1	1.3	0.597	
28680	28622	68	62	88	92	3.5	0.8	21.3	0.40	1.5	0.82	0.499	0.27	
5566	5535	70	68	106	116	1.3	3.3	29.9	0.36	1.7	0.92	1.76	0.815	
72218	72487	78	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.12	0.79	
72218 C	72487	80	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.23	0.79	
387 A	382 A	69	62	89	92	3.5	0.8	17.6	0.35	1.7	0.93	0.42	0.179	
387	382 A	66	62	89	92	2.3	0.8	17.6	0.35	1.7	0.93	0.423	0.179	
387 A	382 S	69	62	87	91	3.5	2.3	22.0	0.35	1.7	0.93	0.42	0.249	
387 A	382	69	62	90	92	3.5	0.8	17.6	0.35	1.7	0.93	0.42	0.226	
469	453 X	70	63	92	98	3.5	3.3	23.1	0.34	1.8	0.98	0.692	0.376	
462	453 X	67	63	92	98	2.3	3.3	23.1	0.34	1.8	0.98	0.694	0.376	
45289	45220	65	65	93	99	0.8	3.3	21.9	0.33	1.8	0.99	0.752	0.347	
45289	45221	65	65	95	99	0.8	0.8	21.9	0.33	1.8	0.99	0.76	0.35	
66587	66520	77	71	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.14	0.558	
72225 C	72487	81	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.19	0.79	
555 S	552 A	83	68	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.41	0.764	
78225	78551	83	77	117	132	3.5	2.3	44.2	0.87	0.69	0.38	1.67	0.926	
78225	78571	83	77	118	132	3.5	3.5	43.6	0.87	0.69	0.38	1.68	1.08	
6455	6420	81	75	129	140	3.5	3.3	39.0	0.36	1.7	0.91	3.49	1.63	
388 A	382 A	69	63	89	92	3.5	0.8	17.6	0.35	1.7	0.93	0.416	0.179	
3981	3926	73	67	98	106	3.5	3.3	28.7	0.40	1.5	0.82	0.899	0.541	

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

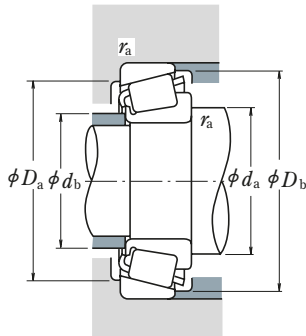


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 60.000 – 64.963 mm



$d$	Boundary Dimensions (mm)					Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$				$C_r$	$C_{0r}$	Grease	Oil
<b>60.000</b>	95.000	24.000	24.000	19.000	5.0	2.5		86 500	125 000	3 600	5 000
	104.775	21.433	22.000	15.875	2.3	2.0		83 500	107 000	3 400	4 500
	110.000	22.000	21.996	18.824	0.8	1.3		85 500	113 000	3 200	4 300
	122.238	33.338	31.750	23.812	3.5	3.3		135 000	156 000	3 000	4 000
<b>60.325</b>	100.000	25.400	25.400	19.845	3.5	3.3		91 000	135 000	3 400	4 800
	101.600	25.400	25.400	19.845	3.5	3.3		91 000	135 000	3 400	4 800
	122.238	38.100	36.678	30.162	2.3	3.3		161 000	221 000	3 000	4 000
	122.238	38.100	38.354	29.718	8.0	1.5		188 000	245 000	3 000	4 000
	122.238	43.658	43.764	36.512	0.8	3.3		198 000	292 000	3 000	4 000
	127.000	44.450	44.450	34.925	3.5	3.3		199 000	258 000	3 000	4 000
	130.175	41.275	41.275	31.750	3.5	3.3		195 000	263 000	2 800	3 800
	135.755	53.975	56.007	44.450	3.5	3.3		264 000	355 000	2 800	3 800
<b>61.912</b>	136.525	46.038	46.038	36.512	3.5	3.3		233 000	370 000	2 600	3 400
	146.050	41.275	39.688	25.400	3.5	3.3		193 000	225 000	2 400	3 400
	152.400	47.625	46.038	31.750	3.5	3.3		237 000	267 000	2 400	3 400
<b>63.500</b>	94.458	19.050	19.050	15.083	1.5	1.5		59 000	100 000	3 600	4 800
	104.775	21.433	22.000	15.875	2.0	2.0		83 500	107 000	3 400	4 500
	107.950	25.400	25.400	19.050	1.5	3.3		90 000	138 000	3 200	4 300
	110.000	22.000	21.996	18.824	3.5	1.3		85 500	113 000	3 200	4 300
	110.000	22.000	21.996	18.824	1.5	1.3		85 500	113 000	3 200	4 300
	112.712	30.162	30.048	23.812	3.5	3.2		120 000	173 000	3 200	4 300
	112.712	30.162	30.162	23.812	3.5	3.3		142 000	202 000	3 200	4 300
	112.712	33.338	30.048	26.988	3.5	3.3		120 000	173 000	3 200	4 300
	122.238	38.100	38.354	29.718	7.0	3.3		188 000	245 000	3 000	4 000
	122.238	38.100	38.354	29.718	7.0	1.5		188 000	245 000	3 000	4 000
	122.238	38.100	38.354	29.718	3.5	1.5		188 000	245 000	3 000	4 000
	122.238	43.658	43.764	36.512	3.5	3.3		198 000	292 000	3 000	4 000
	123.825	38.100	36.678	30.162	3.5	3.3		161 000	221 000	3 000	4 000
	127.000	36.512	36.170	28.575	3.5	3.3		166 000	234 000	2 800	3 800
	130.175	41.275	41.275	31.750	3.5	3.3		195 000	263 000	2 800	3 800
	136.525	36.512	33.236	23.520	2.3	3.3		152 000	183 000	2 600	3 600
	136.525	41.275	41.275	31.750	3.5	3.3		195 000	263 000	2 800	3 800
	140.030	36.512	33.236	23.520	2.3	2.3		152 000	183 000	2 600	3 600
<b>64.963</b>	127.000	36.512	36.170	28.575	3.5	3.3		166 000	234 000	2 800	3 800

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Cone $r_a$ max.	Cup $r_b$ max.	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
▲ JLM 508748	▲ JLM 508710	75	66	85	91	5	2.5	21.6	0.40	1.5	0.82	0.43	0.20
* 39236	39412	71	67	96	100	2.3	2	20.0	0.39	1.5	0.85	0.559	0.186
397	394 A	69	68	101	104	0.8	1.3	20.9	0.40	1.5	0.82	0.642	0.263
66585	66520	79	73	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.07	0.558
28985	28921	73	67	89	96	3.5	3.3	22.9	0.43	1.4	0.78	0.538	0.232
28985	28920	73	67	90	97	3.5	3.3	22.9	0.43	1.4	0.78	0.538	0.272
558	553 X	73	69	108	115	2.3	3.3	28.8	0.35	1.7	0.95	1.33	0.692
HM 212044	HM 212010	85	70	110	116	8	1.5	27.0	0.34	1.8	0.98	1.43	0.604
5582	5535	73	72	106	116	0.8	3.3	29.9	0.36	1.7	0.92	1.61	0.815
65237	65500	82	71	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.56	1.03
637	633	78	72	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.87	0.712
6376	6320	81	74	117	126	3.5	3.3	35.0	0.32	1.8	1.0	2.45	1.39
H 715334	H 715311	84	78	119	132	3.5	3.3	37.1	0.47	1.3	0.70	2.51	0.961
H 913842	H 913810	90	82	124	138	3.5	3.3	44.4	0.78	0.77	0.42	2.2	0.898
9180	9121	90	81	130	145	3.5	3.3	44.3	0.66	0.92	0.50	2.77	1.21
L 610549	L 610510	71	69	86	91	1.5	1.5	19.6	0.42	1.4	0.78	0.306	0.154
39250	39412	73	69	96	100	2	2	20.0	0.39	1.5	0.85	0.501	0.186
29586	29520	73	71	96	103	1.5	3.3	24.0	0.46	1.3	0.72	0.661	0.281
395	394 A	77	70	101	104	3.5	1.3	20.9	0.40	1.5	0.82	0.58	0.263
390 A	394 A	73	70	101	104	1.5	1.3	20.9	0.40	1.5	0.82	0.583	0.263
3982	3920	77	71	99	106	3.5	3.2	25.5	0.40	1.5	0.82	0.789	0.454
39585	39520	77	71	101	107	3.5	3.3	23.5	0.34	1.8	0.97	0.899	0.359
3982	3926	78	71	98	106	3.5	3.3	28.7	0.40	1.5	0.82	0.789	0.541
HM 212047	HM 212011	87	73	108	116	7	3.3	26.9	0.34	1.8	0.98	1.34	0.598
HM 212047	HM 212010	87	73	110	116	7	1.5	26.9	0.34	1.8	0.98	1.34	0.604
HM 212046	HM 212010	80	73	110	116	3.5	1.5	26.9	0.34	1.8	0.98	1.35	0.604
5584	5535	81	75	106	116	3.5	3.3	29.9	0.36	1.7	0.92	1.5	0.815
559	522 A	78	73	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.23	0.764
565	563	80	73	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.46	0.655
639	633	81	74	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.77	0.712
78250	78537	85	79	115	130	2.3	3.3	44.2	0.87	0.69	0.38	1.51	0.782
639	632	79	76	119	125	3.5	3.3	29.9	0.36	1.7	0.91	1.77	1.04
78250	78551	85	79	117	132	2.3	2.3	44.2	0.87	0.69	0.38	1.51	0.926
569	563	81	74	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.41	0.655

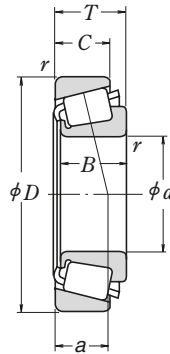
**Notes** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

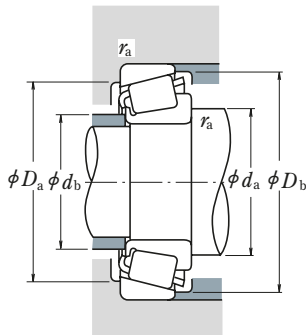


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 65.000 – 69.850 mm



<i>d</i>	Boundary Dimensions (mm)				Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>65.000</b>	105.000	24.000	23.000	18.500	3.0	1.0	93 000	126 000	3 400	4 500
	110.000	28.000	28.000	22.500	3.0	2.5	120 000	173 000	3 200	4 300
	120.000	29.002	29.007	23.444	2.3	3.3	123 000	169 000	3 000	4 000
	120.000	39.000	38.500	32.000	3.0	2.5	185 000	249 000	3 000	4 000
<b>65.088</b>	135.755	53.975	56.007	44.450	3.5	3.3	264 000	355 000	2 800	3 800
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400
<b>66.675</b>	110.000	22.000	21.996	18.824	0.8	1.3	85 500	113 000	3 200	4 300
	110.000	22.000	21.996	18.824	3.5	1.3	85 500	113 000	3 200	4 300
	112.712	30.162	30.048	23.812	3.5	3.2	120 000	173 000	3 200	4 300
	112.712	30.162	30.048	23.812	5.5	3.2	120 000	173 000	3 200	4 300
	112.712	30.162	30.162	23.812	3.5	0.8	142 000	202 000	3 200	4 300
	112.712	30.162	30.162	23.812	3.5	3.3	142 000	202 000	3 200	4 300
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000
	122.238	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000
	122.238	38.100	38.354	29.718	3.5	1.5	188 000	245 000	3 000	4 000
	122.238	38.100	38.354	29.718	3.5	3.3	188 000	245 000	3 000	4 000
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400
	110.000	22.000	21.996	18.824	2.3	1.3	85 500	113 000	3 200	4 300
	120.000	29.795	29.007	24.237	3.5	2.0	123 000	169 000	3 000	4 000
	122.238	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000
<b>68.262</b>	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800
	136.525	41.275	41.275	31.750	3.5	3.3	229 000	297 000	2 600	3 600
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400
	152.400	47.625	46.038	31.750	3.5	3.3	237 000	267 000	2 400	3 400
	112.712	22.225	21.996	15.875	1.5	0.8	85 000	113 000	3 000	4 000
	112.712	25.400	25.400	19.050	1.5	3.3	96 000	152 000	2 800	4 000
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000
	120.000	32.545	32.545	26.195	3.5	3.3	152 000	225 000	3 000	4 000
<b>69.850</b>	120.650	25.400	25.400	19.050	1.5	3.3	96 000	152 000	2 800	4 000
	127.000	36.512	36.170	28.575	3.5	0.8	166 000	234 000	2 800	3 800
	130.175	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800
	146.050	41.275	39.688	25.400	3.5	3.3	193 000	225 000	2 400	3 400
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	149.225	53.975	54.229	44.450	5.0	3.3	271 000	385 000	2 600	3 400
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

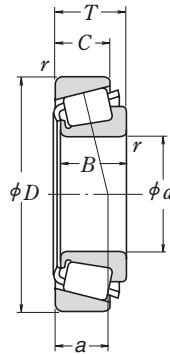
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer $r_a$ max.		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
▲ JLM 710949	▲ JLM 710910	77	71	96	101	3	1	23.7	0.45	1.3	0.73	0.526	0.237
▲ JM 511946	▲ JM 511910	78	72	99	105	3	2.5	24.5	0.40	1.5	0.82	0.72	0.342
478	472 A	77	73	106	114	2.3	3.3	24.3	0.38	1.6	0.86	0.942	0.466
▲ JH 211749	▲ JH 211710	80	74	107	114	3	2.5	27.9	0.34	1.8	0.98	1.25	0.625
6379	6320	84	77	117	126	3.5	3.3	35.0	0.32	1.8	1.0	2.25	1.39
H 715340	H 715311	88	82	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.4	0.961
395 A	394 A	73	73	101	104	0.8	1.3	20.9	0.40	1.5	0.82	0.528	0.263
395 S	394 A	79	73	101	104	3.5	1.3	20.9	0.40	1.5	0.82	0.524	0.263
3984	3920	80	74	99	106	3.5	3.2	25.5	0.40	1.5	0.82	0.712	0.454
3994	3920	84	74	99	106	5.5	3.2	25.5	0.40	1.5	0.82	0.706	0.454
39590	39521	80	74	103	107	3.5	0.8	23.5	0.34	1.8	0.97	0.822	0.365
39590	39520	80	74	101	107	3.5	3.3	23.5	0.34	1.8	0.97	0.822	0.359
33262	33462	81	75	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.911	0.442
560	553 X	81	75	108	115	3.5	3.3	28.8	0.35	1.7	0.95	1.14	0.692
HM 212049	HM 212010	82	75	110	116	3.5	1.5	26.9	0.34	1.8	0.98	1.25	0.604
HM 212049	HM 212011	81	74	108	116	3.5	3.3	26.9	0.34	1.8	0.98	1.25	0.598
560	552 A	81	75	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.14	0.764
H 715341	H 715311	89	83	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.34	0.961
399 A	394 A	78	74	101	104	2.3	1.3	20.9	0.40	1.5	0.82	0.497	0.263
480	472	83	76	106	113	3.5	2	25.1	0.38	1.6	0.86	0.862	0.493
560 S	553 X	83	76	108	115	3.5	3.3	28.8	0.35	1.7	0.95	1.09	0.692
570	563	83	77	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.32	0.655
H 414245	H 414210	86	82	121	129	3.5	3.3	30.6	0.36	1.7	0.92	1.95	0.796
H 715343	H 715311	90	84	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.28	0.961
9185	9121	94	81	130	145	3.5	3.3	44.3	0.66	0.92	0.50	2.53	1.21
LM 613449	LM 613410	78	76	104	107	1.5	0.8	22.1	0.42	1.4	0.79	0.562	0.238
29675	29620	80	77	101	109	1.5	3.3	26.3	0.49	1.2	0.68	0.695	0.273
33275	33462	84	77	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.83	0.442
47487	47420	84	78	107	114	3.5	3.3	26.0	0.36	1.7	0.92	1.02	0.477
29675	29630	79	78	105	113	1.5	3.3	26.3	0.49	1.2	0.68	0.695	0.489
566	563 X	85	78	114	120	3.5	0.8	28.3	0.36	1.6	0.91	1.27	0.658
643	633	86	80	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.56	0.712
H 913849	H 913810	95	82	124	138	3.5	3.3	44.4	0.78	0.77	0.42	1.95	0.898
655	653	88	82	131	139	3.5	3.3	33.2	0.41	1.5	0.81	2.35	0.891
6454	6420	94	85	129	140	5	3.3	39.0	0.36	1.7	0.91	2.95	1.63
745 A	742	88	82	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.82	1.07

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

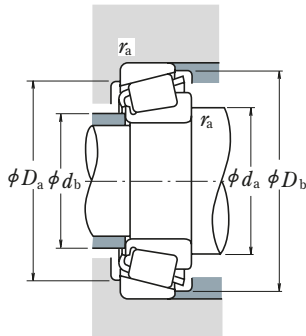


# SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 70.000 – 76.200 mm



<i>d</i>	Boundary Dimensions (mm)				Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>70.000</b>	110.000	26.000	25.000	20.500	1.0	2.5	98 500	152 000	3 000	4 000
	115.000	29.000	29.000	23.000	3.0	2.5	126 000	177 000	3 000	4 000
	120.000	29.795	29.007	24.237	2.0	2.0	123 000	169 000	3 000	4 000
<b>71.438</b>	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000
	120.000	32.545	32.545	26.195	3.5	3.3	152 000	225 000	3 000	4 000
	127.000	36.512	36.170	28.575	6.4	3.3	166 000	234 000	2 800	3 800
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800
	130.175	41.275	41.275	31.750	6.4	3.3	195 000	263 000	2 800	3 800
	136.525	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800
	136.525	41.275	41.275	31.750	3.5	3.3	229 000	297 000	2 600	3 600
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400
<b>73.025</b>	112.712	25.400	25.400	19.050	3.5	3.3	96 000	152 000	2 800	4 000
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	149.225	53.975	54.229	44.450	3.5	3.3	287 000	410 000	2 600	3 400
<b>73.817</b>	127.000	36.512	36.170	28.575	0.8	3.3	166 000	234 000	2 800	3 800
<b>74.612</b>	150.000	41.275	41.275	31.750	3.5	3.0	207 000	296 000	2 400	3 200
<b>75.000</b>	115.000	25.000	25.000	19.000	3.0	2.5	101 000	150 000	3 000	4 000
	120.000	31.000	29.500	25.000	3.0	2.5	129 000	198 000	2 800	3 800
	145.000	51.000	51.000	42.000	3.0	2.5	283 000	410 000	2 600	3 400
<b>76.200</b>	121.442	24.608	23.012	17.462	2.0	2.0	89 000	124 000	2 800	3 800
	127.000	30.162	31.000	22.225	3.5	3.3	134 000	195 000	2 800	3 800
	127.000	30.162	31.001	22.225	6.4	3.3	134 000	195 000	2 800	3 800
	133.350	33.338	33.338	26.195	0.8	3.3	154 000	237 000	2 600	3 600
	135.733	44.450	46.101	34.925	3.5	3.3	216 000	340 000	2 600	3 600
	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400
	136.525	30.162	29.769	22.225	6.4	3.3	130 000	192 000	2 600	3 400
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400
	149.225	53.975	54.229	44.450	3.5	3.3	271 000	385 000	2 600	3 400
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200
	152.400	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	161.925	49.212	46.038	31.750	3.5	3.3	248 000	290 000	2 200	3 000
	161.925	53.975	55.100	42.862	3.5	3.3	325 000	480 000	2 200	3 000
	161.925	53.975	55.100	42.862	6.4	3.3	325 000	480 000	2 200	3 000
	161.925	53.975	55.100	42.862	6.4	0.8	325 000	480 000	2 200	3 000

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

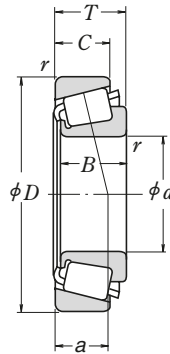
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer	$r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx.	Inner Ring Outer Ring
▲ JLM 813049	▲ JLM 813010	78	77	98	105	1	2.5	26.2	0.49	1.2	0.68	0.604	0.304
▲ JM 612949	▲ JM 612910	83	77	103	110	3	2.5	26.4	0.43	1.4	0.77	0.800	0.362
484	472	80	78	106	113	2	2	25.1	0.38	1.6	0.86	0.822	0.493
33281	33462	85	79	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.789	0.442
47490	47420	86	79	107	114	3.5	3.3	26.0	0.36	1.7	0.92	0.983	0.477
567 S	563	92	80	112	120	6.4	3.3	28.3	0.36	1.6	0.91	1.21	0.655
567 A	563	86	80	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.23	0.655
645	633	93	81	116	124	6.4	3.3	29.9	0.36	1.7	0.91	1.49	0.712
644	632	87	81	118	125	3.5	3.3	29.9	0.36	1.7	0.91	1.5	1.04
H 414249	H 414210	89	83	121	129	3.5	3.3	30.6	0.36	1.7	0.92	1.83	0.796
H 715345	H 715311	92	84	119	132	3.5	3.3	37.1	0.47	1.3	0.70	2.15	0.961
29685	29620	86	80	101	109	3.5	3.3	26.3	0.49	1.2	0.68	0.62	0.273
33287	33462	87	80	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.746	0.442
567	563	88	81	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.17	0.655
657	653	91	85	131	139	3.5	3.3	33.2	0.41	1.5	0.81	2.24	0.891
6460	6420	93	87	129	140	3.5	3.3	39.0	0.36	1.7	0.91	2.8	1.63
568	563	83	82	112	120	0.8	3.3	28.3	0.36	1.6	0.91	1.15	0.655
658	653 X	92	86	133	141	3.5	3	33.2	0.41	1.5	0.81	2.37	0.932
▲ JLM 714149	▲ JLM 714110	87	81	104	110	3	2.5	25.3	0.46	1.3	0.72	0.638	0.272
▲ JM 714249	▲ JM 714210	88	83	108	115	3	2.5	28.8	0.44	1.4	0.74	0.863	0.436
▲ JH 415647	▲ JH 415610	94	89	129	139	3	2.5	36.7	0.36	1.7	0.91	2.64	1.19
34300	34478	86	84	111	116	2	2	26.3	0.45	1.3	0.73	0.65	0.316
42687	42620	90	84	114	121	3.5	3.3	27.3	0.42	1.4	0.79	1.03	0.438
42688	42620	94	84	114	121	6.4	3.3	27.3	0.42	1.4	0.79	1.01	0.438
47680	47620	86	85	119	128	0.8	3.3	29.0	0.40	1.5	0.82	1.39	0.577
5760	5735	94	88	119	130	3.5	3.3	32.9	0.41	1.5	0.81	1.86	0.887
495 A	493	92	86	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.27	0.55
495 AX	493	98	86	122	130	6.4	3.3	28.7	0.44	1.4	0.74	1.26	0.55
575	572	92	86	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.61	0.788
6461	6420	96	89	129	140	3.5	3.3	39.0	0.36	1.7	0.91	2.45	1.67
590 A	592 A	95	89	135	145	3.5	3.2	37.1	0.44	1.4	0.75	2.2	1.06
659	652	93	87	134	141	3.5	3.3	33.2	0.41	1.5	0.81	2.11	1.26
9285	9220	103	90	138	153	3.5	3.3	49.8	0.71	0.85	0.47	2.82	1.4
6576	6535	99	92	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.74	1.67
6575	6535	104	92	141	154	6.4	3.3	40.7	0.40	1.5	0.82	3.73	1.67
6575	6536	104	92	144	154	6.4	0.8	40.7	0.40	1.5	0.82	3.73	1.68

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

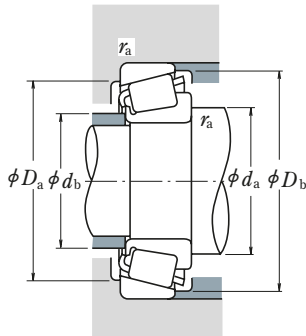


# SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 76.200 – 83.345 mm



<i>d</i>	Boundary Dimensions (mm)				Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>76.200</b>	168.275	53.975	56.363	41.275	6.4	3.3	345 000	470 000	2 200	3 000
	168.275	53.975	56.363	41.275	0.8	3.3	345 000	470 000	2 200	3 000
	171.450	49.212	46.038	31.750	3.5	3.3	257 000	310 000	2 000	2 800
	177.800	55.562	50.800	34.925	3.5	3.3	257 000	310 000	2 000	2 800
<b>77.788</b>	121.442	24.608	23.012	17.462	3.5	2.0	89 000	124 000	2 800	3 800
	127.000	30.162	31.000	22.225	3.5	3.3	134 000	195 000	2 800	3 800
	135.733	44.450	46.101	34.925	3.5	3.3	216 000	340 000	2 600	3 600
<b>79.375</b>	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200
<b>80.000</b>	130.000	35.000	34.000	28.500	3.0	2.5	166 000	251 000	2 600	3 600
<b>80.962</b>	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400
	139.700	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400
<b>82.550</b>	125.412	25.400	25.400	19.845	3.5	1.5	102 000	164 000	2 600	3 600
	133.350	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400
	133.350	33.338	33.338	26.195	3.5	3.3	154 000	237 000	2 600	3 600
	133.350	33.338	33.338	26.195	0.8	3.3	154 000	237 000	2 600	3 600
	133.350	33.338	33.338	26.195	6.8	3.3	154 000	237 000	2 600	3 600
	133.350	39.688	39.688	32.545	6.8	3.3	179 000	310 000	2 600	3 600
	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400
	139.700	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400
	139.992	36.512	36.098	28.575	6.8	3.3	175 000	260 000	2 600	3 400
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	150.000	44.455	46.672	35.000	3.5	3.3	265 000	370 000	2 400	3 200
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200
	152.400	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200
	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000
<b>83.345</b>	161.925	53.975	55.100	42.862	3.5	3.3	325 000	480 000	2 200	3 000
	168.275	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000
	168.275	53.975	56.363	41.275	3.5	3.3	345 000	470 000	2 200	3 000
	125.412	25.400	25.400	19.845	3.5	1.5	102 000	164 000	2 600	3 600
	125.412	25.400	25.400	19.845	0.8	1.5	102 000	164 000	2 600	3 600

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

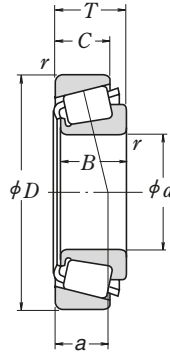
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)		
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer	$r_a$ max.	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
843	832	101	89	149	155	6.4	3.3	35.2	0.30	2.0	1.1	4.11	1.74	
837	832	90	89	149	155	0.8	3.3	35.2	0.30	2.0	1.1	4.13	1.74	
9380	9321	105	98	147	164	3.5	3.3	54.1	0.76	0.79	0.43	3.47	1.51	
9378	9320	105	98	148	164	3.5	3.3	57.3	0.76	0.79	0.43	3.71	2.24	
34306	34478	90	84	110	116	3.5	2	26.3	0.45	1.3	0.73	0.612	0.316	
42690	42620	91	85	114	121	3.5	3.3	27.3	0.42	1.4	0.79	0.976	0.438	
5795	5735	96	89	119	130	3.5	3.3	32.9	0.41	1.5	0.81	1.79	0.887	
661	653	96	90	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.99	0.891	
750	742	96	90	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.42	1.07	
▲ JM 515649	▲ JM 515610	94	88	117	125	3	2.5	29.9	0.39	1.5	0.85	1.18	0.583	
496	493	95	89	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.13	0.55	
581	572 X	96	90	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.44	0.774	
581	572	96	90	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.44	0.788	
27687	27620	96	89	115	120	3.5	1.5	25.7	0.42	1.4	0.79	0.747	0.348	
495	492 A	97	90	120	128	3.5	3.3	28.7	0.44	1.4	0.74	1.08	0.434	
47686	47620	97	90	119	128	3.5	3.3	29.0	0.40	1.5	0.82	1.18	0.577	
47685	47620	90	90	119	128	0.8	3.3	29.0	0.40	1.5	0.82	1.18	0.577	
47687	47620	103	90	119	128	6.8	3.3	29.0	0.40	1.5	0.82	1.16	0.577	
HM 516448	HM 516410	105	92	118	128	6.8	3.3	32.4	0.40	1.5	0.82	1.35	0.767	
495	493	97	90	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.08	0.55	
580	572 X	98	91	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.39	0.774	
580	572	98	91	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.39	0.788	
582	572	104	91	125	133	6.8	3.3	31.1	0.40	1.5	0.82	1.37	0.788	
663	653	99	92	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.85	0.891	
749 A	743	99	93	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.26	1.04	
749 A	742	98	93	135	143	3.5	3.3	32.5	0.33	1.8	1.0	2.26	1.07	
663	652	99	92	134	141	3.5	3.3	33.2	0.41	1.5	0.81	1.85	1.26	
757	752	100	94	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.79	1.61	
6559	6535	104	98	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.4	1.67	
757	753	100	94	147	150	3.5	3.3	35.6	0.34	1.8	0.97	2.79	2.1	
842	832	101	94	149	155	3.5	3.3	35.2	0.30	2.0	1.1	3.76	1.74	
27690	27620	96	90	115	120	3.5	1.5	25.7	0.42	1.4	0.79	0.727	0.348	
27689	27620	90	90	115	120	0.8	1.5	25.7	0.42	1.4	0.79	0.732	0.348	

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

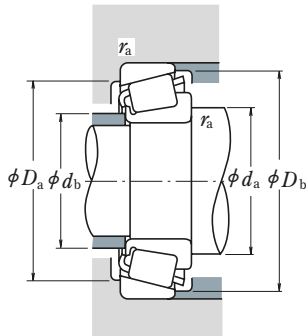


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 84.138 – 90.488 mm



$d$	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$	Ring: Inner Outer $r$ min.	$C_r$	$C_{0r}$	Grease	Oil
<b>84.138</b>	136.525	30.162	29.769	22.225	3.5 3.3	130 000	192 000	2 600	3 400
	146.050	41.275	41.275	31.750	3.5 3.3	207 000	296 000	2 400	3 200
	171.450	49.212	46.038	31.750	3.5 3.3	257 000	310 000	2 000	2 800
<b>85.000</b>	130.000	30.000	29.000	24.000	6.0 2.5	138 000	222 000	2 600	3 600
	130.000	30.000	29.000	24.000	3.0 2.5	138 000	222 000	2 600	3 600
	140.000	39.000	38.000	31.500	3.0 2.5	202 000	305 000	2 400	3 400
	150.000	46.000	46.000	38.000	3.0 2.5	275 000	390 000	2 400	3 200
<b>85.026</b>	150.089	44.450	46.672	36.512	3.5 3.3	265 000	370 000	2 400	3 200
	150.089	44.450	46.672	36.512	5.0 3.3	265 000	370 000	2 400	3 200
<b>85.725</b>	133.350	30.162	29.769	22.225	3.5 3.3	130 000	192 000	2 600	3 400
	136.525	30.162	29.769	22.225	3.5 3.3	130 000	192 000	2 600	3 400
	142.138	42.862	42.862	34.133	4.8 3.3	221 000	360 000	2 400	3 400
	146.050	41.275	41.275	31.750	6.4 3.3	207 000	296 000	2 400	3 200
	146.050	41.275	41.275	31.750	3.5 3.3	207 000	296 000	2 400	3 200
	152.400	39.688	36.322	30.162	3.5 3.2	183 000	285 000	2 200	3 200
	161.925	47.625	48.260	38.100	3.5 3.3	274 000	390 000	2 200	3 000
	168.275	41.275	41.275	30.162	3.5 3.3	223 000	345 000	2 000	2 800
	190.500	57.150	57.531	46.038	8.0 3.3	390 000	520 000	1 900	2 600
	190.500	57.150	57.531	46.038	8.0 3.3	390 000	520 000	1 900	2 600
<b>87.312</b>	149.225	31.750	28.971	24.608	3.0 3.3	140 000	218 000	2 200	3 000
	152.400	39.688	36.322	30.162	3.5 3.2	183 000	285 000	2 200	3 200
	152.400	39.688	39.688	30.162	6.4 3.3	253 000	365 000	2 200	3 200
	161.925	47.625	48.260	38.100	3.5 3.3	274 000	390 000	2 200	3 000
	161.925	47.625	48.260	38.100	7.0 3.3	274 000	390 000	2 200	3 000
	161.925	53.975	55.100	42.862	3.5 3.3	325 000	480 000	2 200	3 000
	168.275	47.625	48.260	38.100	3.5 3.3	274 000	390 000	2 200	3 000
	168.275	53.975	56.363	41.275	3.5 3.3	345 000	470 000	2 200	3 000
	190.500	57.150	57.531	44.450	8.0 3.3	355 000	500 000	1 900	2 600
	190.500	57.150	57.531	46.038	8.0 3.3	390 000	520 000	1 900	2 600
<b>90.000</b>	145.000	35.000	34.000	27.000	3.0 2.5	190 000	285 000	2 400	3 200
	147.000	40.000	40.000	32.500	7.0 3.5	229 000	345 000	2 400	3 200
	155.000	44.000	44.000	35.500	3.0 2.5	274 000	390 000	2 200	3 000
<b>90.488</b>	161.925	47.625	48.260	38.100	3.5 3.3	274 000	390 000	2 200	3 000



## Dynamic Equivalent Load

$$P = XF_r + YF_a$$

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

## Static Equivalent Load

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Outer	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	Outer Ring
498	493	98	91	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.04	0.55
664	653	99	93	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.79	0.891
9385	9321	111	98	147	164	3.5	3.3	54.1	0.76	0.79	0.43	3.11	1.51
▲ JM 716648	▲ JM 716610	104	92	117	125	6	2.5	29.5	0.44	1.4	0.74	0.931	0.461
▲ JM 716649	▲ JM 716610	98	92	117	125	3	2.5	29.5	0.44	1.4	0.74	0.943	0.461
▲ JHM 516849	▲ JHM 516810	100	94	125	134	3	2.5	33.3	0.41	1.5	0.81	1.55	0.768
▲ JH 217249	▲ JH 217210	101	95	134	142	3	2.5	33.9	0.33	1.8	0.99	2.29	1.09
749	742	101	95	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.14	1.07
749 S	742	104	95	134	142	5	3.3	32.5	0.33	1.8	1.0	2.14	1.07
497	492 A	99	93	120	128	3.5	3.3	28.7	0.44	1.4	0.74	0.987	0.434
497	493	99	93	122	130	3.5	3.3	28.7	0.44	1.4	0.74	0.987	0.55
HM 617049	HM 617010	106	95	125	137	4.8	3.3	35.4	0.43	1.4	0.76	1.77	0.911
665 A	653	107	95	131	139	6.4	3.3	33.2	0.41	1.5	0.81	1.71	0.891
665	653	102	95	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.72	0.891
596	592 A	102	96	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.85	1.06
758	752	103	97	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.63	1.61
677	672	105	99	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.91	1.24
HH 221432	HH 221410	118	103	171	179	8	3.3	42.3	0.33	1.8	0.99	5.51	2.24
42350	42587	104	98	134	143	3	3.3	34.9	0.49	1.2	0.67	1.39	0.711
593	592 A	104	98	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.73	1.06
HM 518445	HM 518410	107	96	137	148	6.4	3.3	33.1	0.40	1.5	0.82	2.11	0.776
759	752	106	99	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.47	1.61
766	752	113	99	144	150	7	3.3	35.6	0.34	1.8	0.97	2.45	1.61
6580	6535	109	102	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.03	1.67
759	753	106	99	147	150	3.5	3.3	35.6	0.34	1.8	0.97	2.47	2.1
850	832	106	100	149	155	3.5	3.3	35.2	0.30	2.0	1.1	3.39	1.74
855	854	118	103	170	174	8	3.3	41.8	0.33	1.8	0.99	4.99	2.55
HH 221434	HH 221410	120	105	171	179	8	3.3	42.3	0.33	1.8	0.99	5.41	2.24
▲ JM 718149	▲ JM 718110	105	99	131	139	3	2.5	33.0	0.44	1.4	0.74	1.49	0.66
*HM 218248	**HM 218210	111	98	133	141	7	3.5	30.8	0.33	1.8	0.99	1.77	0.796
▲ JHM 318448	▲ JHM 318410	106	100	140	148	3	2.5	34.1	0.34	1.7	0.96	2.32	1.01
760	752	107	101	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.38	1.61

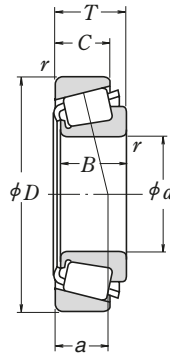
## Notes

- \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).
- \*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).
- ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

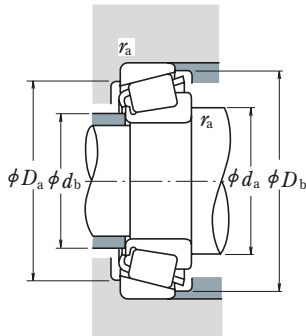


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 92.075 – 100.012 mm



$d$	Boundary Dimensions (mm)				Ring: Inner Outer $r$ min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$			$C_r$	$C_{0r}$	Grease	Oil
<b>92.075</b>	146.050	33.338	34.925	26.195	3.5	3.3	169 000	280 000	2 400	3 200
	148.430	28.575	28.971	21.433	3.5	3.0	140 000	218 000	2 200	3 000
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200
	152.400	39.688	36.322	30.162	6.4	3.2	183 000	285 000	2 200	3 200
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600
<b>93.662</b>	148.430	28.575	28.971	21.433	3.0	3.0	140 000	218 000	2 200	3 000
	149.225	31.750	28.971	24.608	3.0	3.3	140 000	218 000	2 200	3 000
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200
<b>95.000</b>	150.000	35.000	34.000	27.000	3.0	2.5	183 000	285 000	2 200	3 200
<b>95.250</b>	146.050	33.338	34.925	26.195	3.5	3.3	169 000	280 000	2 400	3 200
	148.430	28.575	28.971	21.433	3.0	3.0	140 000	218 000	2 200	3 000
	149.225	31.750	28.971	24.608	3.5	3.3	140 000	218 000	2 200	3 000
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200
	152.400	39.688	36.322	33.338	3.5	3.3	183 000	285 000	2 200	3 200
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800
	171.450	47.625	48.260	38.100	3.5	3.3	282 000	415 000	2 000	2 800
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600
	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600
<b>96.838</b>	148.430	28.575	28.971	21.433	3.5	3.0	140 000	218 000	2 200	3 000
	149.225	31.750	28.971	24.606	3.5	3.3	140 000	218 000	2 200	3 000
<b>98.425</b>	161.925	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600
	190.500	57.150	57.531	44.450	3.5	3.3	355 000	500 000	1 900	2 600
	190.500	57.150	57.531	46.038	3.5	3.3	390 000	520 000	1 900	2 600
<b>99.982</b>	190.500	57.150	57.531	46.038	6.4	3.3	390 000	520 000	1 900	2 600
<b>100.000</b>	150.000	32.000	30.000	26.000	2.3	2.3	146 000	235 000	2 200	3 000
	155.000	36.000	35.000	28.000	3.0	2.5	191 000	325 000	2 000	2 800
	160.000	41.000	40.000	32.000	3.0	2.5	239 000	380 000	2 000	2 800
<b>100.012</b>	157.162	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

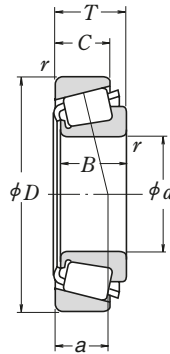
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner	Ring: Outer	$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring	approx. Outer Ring
47890	47820	107	101	131	140	3.5	3.3	32.3	0.45	1.3	0.74	1.46	0.664
42362	42584	107	101	134	142	3.5	3	31.8	0.49	1.2	0.67	1.29	0.553
598	592 A	107	101	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.6	1.06
598 A	592 A	113	101	135	144	6.4	3.2	37.1	0.44	1.4	0.75	1.59	1.06
681	672	110	104	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.62	1.24
857	854	121	106	170	174	8	3.3	41.8	0.33	1.8	0.99	4.78	2.55
42368	42584	107	102	134	142	3	3	31.8	0.49	1.2	0.67	1.24	0.553
42368	42587	107	102	134	143	3	3.3	34.9	0.49	1.2	0.67	1.24	0.711
597	592 A	109	102	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.54	1.06
▲ JM 719149	▲ JM 719113	109	104	135	143	3	2.5	33.4	0.44	1.4	0.75	1.46	0.765
47896	47820	110	103	131	140	3.5	3.3	32.3	0.45	1.3	0.74	1.33	0.664
42375	42584	108	103	134	142	3	3	31.8	0.49	1.2	0.67	1.18	0.553
42376	42587	109	103	134	143	3.5	3.3	34.9	0.49	1.2	0.67	1.18	0.711
594	592 A	110	104	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.47	1.06
594	592	109	103	135	145	3.5	3.3	37.1	0.44	1.4	0.75	1.47	1.12
683	672	113	106	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.47	1.24
77375	77675	117	105	152	159	3.5	3.3	37.8	0.37	1.6	0.90	2.91	1.67
776	772	114	107	161	168	3.5	3.3	39.1	0.39	1.6	0.86	3.25	1.99
864	854	123	108	170	174	8	3.3	41.8	0.33	1.8	0.99	4.57	2.55
HH 221440	HH 221410	125	110	171	179	8	3.3	42.3	0.33	1.8	0.99	5.0	2.24
42381	42584	110	104	134	142	3.5	3	31.8	0.49	1.2	0.67	1.13	0.553
42381	42587	111	105	135	143	3.5	3.3	34.9	0.49	1.2	0.67	1.13	0.711
52387	52637	114	108	144	154	3.5	3.3	36.1	0.47	1.3	0.69	1.89	0.942
685	672	116	109	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.32	1.24
779	772	116	110	161	168	3.5	3.3	39.1	0.39	1.6	0.86	3.06	1.99
866	854	118	111	170	174	3.5	3.3	41.8	0.33	1.8	0.99	4.38	2.55
HH 221442	HH 221410	119	113	171	179	3.5	3.3	42.3	0.33	1.8	0.99	4.81	2.24
HH 221447	HH 221410	126	114	171	179	6.4	3.3	42.3	0.33	1.8	0.99	4.68	2.24
▲ JLM 820048	▲ JLM 820012	111	107	135	144	2.3	2.3	36.8	0.50	1.2	0.66	1.27	0.616
▲ JM 720249	▲ JM 720210	115	109	140	149	3	2.5	36.8	0.47	1.3	0.70	1.68	0.772
▲ JHM 720249	▲ JHM 720210	117	109	143	154	3	2.5	38.2	0.47	1.3	0.70	2.09	0.974
52393	52618	116	109	142	152	3.5	3.3	36.1	0.47	1.3	0.69	1.81	0.702

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

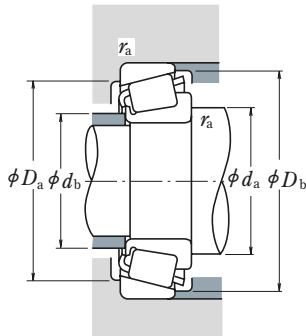


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 101.600 – 117.475 mm



$d$	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	$D$	$T$	$B$	$C$	Ring: Inner    Outer $r$ $r$ min.	$C_r$	$C_{0r}$	Grease	Oil
<b>101.600</b>	157.162	36.512	36.116	26.195	3.5 3.3	191 000	310 000	2 000	2 800
	161.925	36.512	36.116	26.195	3.5 3.3	191 000	310 000	2 000	2 800
	168.275	41.275	41.275	30.162	3.5 3.3	223 000	345 000	2 000	2 800
	180.975	47.625	48.006	38.100	3.5 3.3	258 000	375 000	2 000	2 600
	190.500	57.150	57.531	44.450	8.0 3.3	355 000	500 000	1 900	2 600
	190.500	57.150	57.531	46.038	8.0 3.3	390 000	520 000	1 900	2 600
<b>104.775</b>	212.725	66.675	66.675	53.975	7.0 3.3	570 000	810 000	1 700	2 200
	180.975	47.625	48.006	38.100	7.0 3.3	258 000	375 000	2 000	2 600
	180.975	47.625	48.006	38.100	3.5 3.3	258 000	375 000	2 000	2 600
	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
	165.100	36.512	36.512	26.988	3.5 3.3	195 000	320 000	2 000	2 600
	158.750	23.020	21.438	15.875	3.5 3.3	102 000	165 000	2 000	2 800
<b>107.950</b>	159.987	34.925	34.925	26.988	3.5 3.3	164 000	315 000	2 000	2 800
	161.925	34.925	34.925	26.988	3.5 3.3	164 000	280 000	2 000	2 800
	165.100	36.512	36.512	26.988	3.5 3.3	195 000	320 000	2 000	2 600
	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
	212.725	66.675	66.675	53.975	8.0 3.3	570 000	810 000	1 700	2 200
	159.987	34.925	34.925	26.988	3.5 3.3	164 000	315 000	2 000	2 800
<b>109.987</b>	159.987	34.925	34.925	26.988	8.0 3.3	164 000	315 000	2 000	2 800
	177.800	41.275	41.275	30.162	3.5 3.3	232 000	375 000	1 800	2 600
<b>109.992</b>	177.800	41.275	41.275	30.162	3.5 3.3	232 000	375 000	1 800	2 600
	165.000	35.000	35.000	26.500	3.0 2.5	195 000	320 000	2 000	2 600
<b>110.000</b>	180.000	47.000	46.000	38.000	3.0 2.5	310 000	490 000	1 900	2 600
	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
<b>111.125</b>	152.400	21.433	21.433	16.670	1.5 1.5	89 500	178 000	2 000	2 800
	177.800	41.275	41.275	30.162	3.5 3.3	232 000	375 000	1 800	2 600
	180.000	34.925	31.750	25.400	3.5 0.8	174 000	254 000	1 800	2 400
	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
	212.725	66.675	66.675	53.975	7.0 3.3	475 000	700 000	1 700	2 400
	212.725	66.675	66.675	53.975	7.0 3.3	570 000	810 000	1 700	2 200
<b>114.300</b>	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
	180.975	34.925	31.750	25.400	3.5 3.3	174 000	254 000	1 800	2 400
<b>115.087</b>	190.500	47.625	49.212	34.925	3.5 3.3	296 000	465 000	1 800	2 400
	117.475	180.975	34.925	31.750	25.400	174 000	254 000	1 800	2 400

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer $r_a$ max.		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring Outer Ring	
52400	52618	117	111	142	152	3.5	3.3	36.1	0.47	1.3	0.69	1.75	0.702
52400	52637	117	111	144	154	3.5	3.3	36.1	0.47	1.3	0.69	1.75	0.942
687	672	118	112	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.15	1.24
780	772	119	113	161	168	3.5	3.3	39.1	0.39	1.6	0.86	2.88	1.99
861	854	129	114	170	174	8	3.3	41.8	0.33	1.8	0.99	4.13	2.55
HH 221449	HH 221410	131	116	171	179	8	3.3	42.3	0.33	1.8	0.99	4.55	2.24
HH 224335	HH 224310	132	121	192	202	7	3.3	47.3	0.33	1.8	1.0	8.14	3.06
787	772	129	116	161	168	7	3.3	39.1	0.39	1.6	0.86	2.66	1.99
782	772	122	116	161	168	3.5	3.3	39.1	0.39	1.6	0.86	2.68	1.99
71412	71750	124	118	171	181	3.5	3.3	40.1	0.42	1.4	0.79	4.0	1.71
56418	56650	122	116	149	159	3.5	3.3	38.6	0.50	1.2	0.66	1.87	0.861
37425	37625	122	115	143	152	3.5	3.3	37.0	0.61	0.99	0.54	0.886	0.488
LM 522546	LM 522510	122	116	146	154	3.5	3.3	33.7	0.40	1.5	0.82	1.65	0.784
48190	48120	122	116	146	156	3.5	3.3	38.7	0.51	1.2	0.65	1.59	0.83
56425	56650	123	117	149	159	3.5	3.3	38.6	0.50	1.2	0.66	1.8	0.861
71425	71750	126	120	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.79	1.71
HH 224340	HH 224310	139	126	192	202	8	3.3	47.3	0.33	1.8	1.0	7.58	3.06
LM 522549	LM 522510	124	118	146	154	3.5	3.3	33.7	0.40	1.5	0.82	1.55	0.784
LM 522548	LM 522510	133	118	146	154	8	3.3	33.7	0.40	1.5	0.82	1.53	0.784
64433	64700	128	121	160	172	3.5	3.3	42.4	0.52	1.2	0.64	2.64	1.11
▲ JM 822049	▲ JM 822010	124	119	149	159	3	2.5	38.3	0.50	1.2	0.66	1.64	0.842
▲ JHM 522649	▲ JHM 522610	127	122	162	172	3	2.5	40.9	0.41	1.5	0.81	3.12	1.51
71437	71750	129	123	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.58	1.71
L 623149	L 623110	123	121	143	148	1.5	1.5	27.4	0.41	1.5	0.80	0.725	0.344
64450	64700	131	125	160	172	3.5	3.3	42.4	0.52	1.2	0.64	2.39	1.11
68450	** 68709	130	123	165	172	3.5	0.8	40.0	0.50	1.2	0.66	1.95	1.0
71450	71750	132	125	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.37	1.71
938	932	141	128	187	193	7	3.3	46.9	0.33	1.8	1.0	6.01	4.11
HH 224346	HH 224310	143	131	192	202	7	3.3	47.3	0.33	1.8	1.0	7.01	3.06
71453	71750	133	126	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.31	1.71
68462	68712	132	125	163	172	3.5	3.3	40.0	0.50	1.2	0.66	1.73	1.05

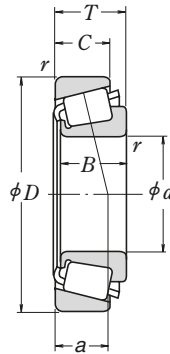
**Notes** \*\* The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

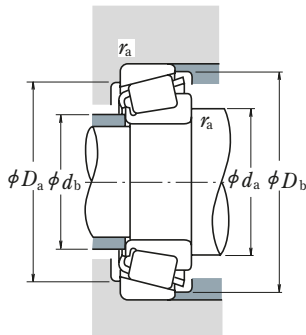


# ■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 120.000 – 165.100 mm



Boundary Dimensions (mm)					Ring: Inner Outer <i>r</i> min.		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>			<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
120.000	170.000	25.400	25.400	19.050	3.3	3.3	130 000	219 000	1 900	2 600
	174.625	35.720	36.512	27.783	3.5	1.5	212 000	385 000	1 900	2 600
120.650	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400
	206.375	47.625	47.625	34.925	3.3	3.3	320 000	530 000	1 600	2 200
123.825	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400
125.000	175.000	25.400	25.400	18.288	3.3	3.3	134 000	232 000	1 800	2 400
127.000	165.895	18.258	17.462	13.495	1.5	1.5	84 500	149 000	1 900	2 600
	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400
	196.850	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000
128.588	206.375	47.625	47.625	34.925	3.3	3.3	320 000	530 000	1 600	2 200
130.000	206.375	47.625	47.625	34.925	3.5	3.3	320 000	530 000	1 600	2 200
130.175	203.200	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200
	206.375	47.625	47.625	34.925	3.5	3.3	320 000	530 000	1 600	2 200
133.350	177.008	25.400	26.195	20.638	1.5	1.5	124 000	258 000	1 800	2 400
	190.500	39.688	39.688	33.338	3.5	3.3	240 000	485 000	1 700	2 200
	196.850	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000
136.525	190.500	39.688	39.688	33.338	3.5	3.3	216 000	440 000	1 700	2 200
	217.488	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000
139.700	187.325	28.575	29.370	23.020	1.5	1.5	153 000	305 000	1 700	2 200
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000
	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800
142.875	200.025	41.275	39.688	34.130	3.5	3.3	227 000	460 000	1 600	2 200
146.050	193.675	28.575	28.575	23.020	1.5	1.5	170 000	355 000	1 600	2 200
	236.538	57.150	56.642	44.450	3.5	3.3	455 000	720 000	1 400	1 900
	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800
149.225	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800
152.400	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800
158.750	225.425	41.275	39.688	33.338	3.5	3.3	240 000	540 000	1 400	1 900
165.100	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring Outer Ring	
▲ JL 724348	▲ JL 724314	132	127	156	163	3.3	3.3	32.9	0.46	1.3	0.72	1.08	0.591
* M 224748	M 224710	135	129	163	168	3.5	1.5	32.2	0.33	1.8	0.99	1.9	0.866
48282	48220	136	133	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.56	1.14
795	792	139	134	186	198	3.3	3.3	45.7	0.46	1.3	0.72	4.44	1.9
48286	48220	139	133	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.37	1.14
▲ JL 725346	▲ JL 725316	138	133	161	168	3.3	3.3	34.3	0.48	1.3	0.69	1.19	0.573
LL 225749	LL 225710	135	132	158	160	1.5	1.5	24.2	0.33	1.8	0.99	0.647	0.288
48290	48220	141	135	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.19	1.14
67388	67322	144	138	180	189	3.5	3.3	39.7	0.34	1.7	0.96	3.74	1.46
74500	74850	148	141	196	208	3.5	3.3	48.4	0.49	1.2	0.68	4.92	1.99
799	792	146	140	186	198	3.3	3.3	45.7	0.46	1.3	0.72	3.86	1.9
797	792	148	141	186	198	3.5	3.3	45.7	0.46	1.3	0.72	3.76	1.9
67389	67320	146	141	183	191	3.5	3.3	39.7	0.34	1.7	0.96	3.51	2.06
799 A	792	148	142	186	198	3.5	3.3	45.7	0.46	1.3	0.72	3.74	1.9
L 327249	L 327210	143	141	167	171	1.5	1.5	29.5	0.35	1.7	0.95	1.18	0.55
48385	48320	148	142	177	184	3.5	3.3	35.9	0.32	1.9	1.0	2.58	1.16
67390	67322	149	143	180	189	3.5	3.3	39.7	0.34	1.7	0.96	3.27	1.46
74525	74850	152	146	196	208	3.5	3.3	48.4	0.49	1.2	0.68	4.44	1.99
48393	48320	151	144	177	184	3.5	3.3	35.9	0.32	1.9	1.0	2.31	1.16
74537	74856	155	148	197	210	3.5	3.3	48.4	0.49	1.2	0.68	4.19	2.13
LM 328448	LM 328410	149	147	176	182	1.5	1.5	31.7	0.36	1.7	0.93	1.59	0.67
74550	74850	158	151	196	208	3.5	3.3	48.4	0.49	1.2	0.68	3.93	1.99
99550	99100	170	156	227	238	7	3.3	55.3	0.41	1.5	0.81	9.99	3.83
48685	48620	158	151	185	193	3.5	3.3	37.6	0.34	1.8	0.98	2.63	1.19
36690	36620	155	154	182	188	1.5	1.5	33.5	0.37	1.6	0.90	1.64	0.725
HM 231140	HM 231110	164	160	217	224	3.5	3.3	45.9	0.32	1.9	1.0	6.07	2.93
99575	99100	175	162	227	238	7	3.3	55.3	0.41	1.5	0.81	9.24	3.83
99587	99100	178	165	227	238	7	3.3	55.3	0.41	1.5	0.81	8.86	3.83
99600	99100	181	167	227	238	7	3.3	55.3	0.41	1.5	0.81	8.46	3.83
46780	46720	176	169	209	218	3.5	3.3	44.3	0.38	1.6	0.86	3.69	1.66
67780	67720	185	179	229	240	3.5	3.3	52.4	0.44	1.4	0.75	5.83	2.33

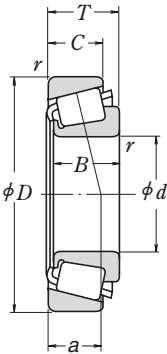
**Notes** \* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

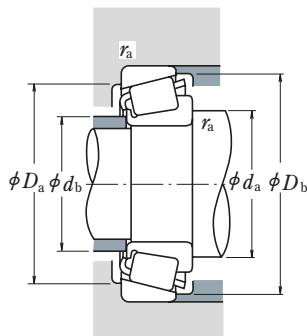


■ SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 170.000 – 206.375 mm



Boundary Dimensions (mm)					Ring: Inner      Outer		Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>	<i>C</i>	<i>r</i> min.		<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Grease	Oil
<b>170.000</b>	230.000	39.000	38.000	31.000	3.0	2.5	278 000	520 000	1 300	1 800
	240.000	46.000	44.500	37.000	3.0	2.5	380 000	720 000	1 300	1 800
<b>174.625</b>	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700
<b>177.800</b>	227.012	30.162	30.162	23.020	1.5	1.5	181 000	415 000	1 300	1 800
	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700
	260.350	53.975	53.975	41.275	3.5	3.3	455 000	835 000	1 200	1 700
<b>190.000</b>	260.000	46.000	44.000	36.500	3.0	2.5	370 000	730 000	1 100	1 600
<b>190.500</b>	266.700	47.625	46.833	38.100	3.5	3.3	345 000	720 000	1 100	1 500
<b>200.000</b>	300.000	65.000	62.000	51.000	3.5	2.5	615 000	1 130 000	1 000	1 400
<b>203.200</b>	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400
<b>206.375</b>	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

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

**Static Equivalent Load**

$$P_0 = 0.5F_r + Y_0F_a$$

When  $F_r > 0.5F_r + Y_0F_a$ , use  $P_0 = F_r$

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

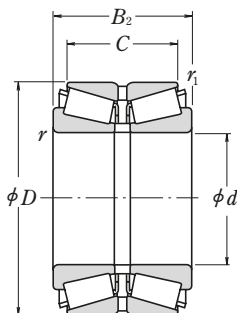
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	$d_a$	$d_b$	$D_a$	$D_b$	Ring: Inner Outer $r_a$ max.		$a$	$e$	$Y_1$	$Y_0$	approx. Inner Ring Outer Ring	
▲ JHM 534149	▲ JHM 534110	184	178	217	224	3	2.5	43.2	0.38	1.6	0.86	3.1	1.3
▲ JM 734449	▲ JM 734410	185	180	222	232	3	2.5	50.5	0.44	1.4	0.75	4.42	2.02
67787	67720	192	185	229	240	3.5	3.3	52.4	0.44	1.4	0.75	4.88	2.33
36990	36920	189	186	214	221	1.5	1.5	42.9	0.44	1.4	0.75	2.1	0.907
67790	67720	194	188	229	240	3.5	3.3	52.4	0.44	1.4	0.75	4.56	2.33
M 236849	M 236810	195	192	241	249	3.5	3.3	47.5	0.33	1.8	0.99	6.49	2.86
▲ JM 738249	▲ JM 738210	206	200	242	252	3	2.5	56.4	0.48	1.3	0.69	4.73	2.2
67885	67820	209	203	246	259	3.5	3.3	57.9	0.48	1.3	0.69	5.4	2.64
▲ JHM 840449	▲ JHM 840410	223	215	273	289	3.5	2.5	73.1	0.52	1.2	0.63	10.3	5.19
67983	67920	222	216	260	275	3.5	3.3	61.9	0.51	1.2	0.65	6.03	2.82
67985	67920	224	219	260	275	3.5	3.3	61.9	0.51	1.2	0.65	5.66	2.82

**Note** ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.



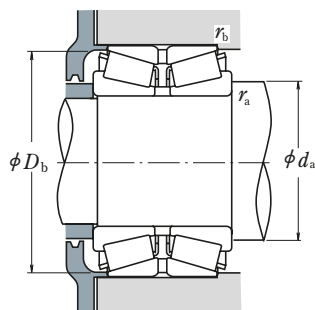
# DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 90 mm



<i>d</i>	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>B</i> <sub>2</sub>	<i>C</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
<b>40</b>	80	45	37.5	1.5	0.6	109 000	140 000	3 700	5 100
<b>45</b>	85	47	37.5	1.5	0.6	117 000	159 000	3 400	4 700
	85	55	43.5	1.5	0.6	143 000	204 000	3 400	4 700
<b>50</b>	90	48	38.5	1.5	0.6	131 000	183 000	3 200	4 400
	90	49	39.5	1.5	0.6	131 000	183 000	3 200	4 400
	90	55	43.5	1.5	0.6	150 000	218 000	3 200	4 400
	110	64	51.5	2.5	0.6	224 000	297 000	2 700	3 700
<b>55</b>	100	51	41.5	2	0.6	162 000	226 000	2 900	3 900
	100	52	42.5	2	0.6	162 000	226 000	2 900	3 900
	100	60	48.5	2	0.6	188 000	274 000	2 900	3 900
	120	70	57	2.5	0.6	256 000	342 000	2 500	3 400
<b>60</b>	110	53	43.5	2	0.6	178 000	246 000	2 700	3 600
	110	66	54.5	2	0.6	225 000	335 000	2 700	3 600
	130	74	59	3	1	298 000	405 000	2 300	3 200
<b>65</b>	120	56	46.5	2	0.6	210 000	300 000	2 400	3 200
	120	57	47.5	2	0.6	210 000	300 000	2 400	3 200
	120	73	61.5	2	0.6	269 000	405 000	2 400	3 300
	140	79	63	3	1	340 000	465 000	2 100	2 900
<b>70</b>	125	57	46.5	2	0.6	227 000	325 000	2 300	3 100
	125	59	48.5	2	0.6	227 000	325 000	2 300	3 100
	125	74	61.5	2	0.6	270 000	410 000	2 300	3 100
	150	83	67	3	1	390 000	535 000	2 000	2 700
<b>75</b>	130	62	51.5	2	0.6	245 000	365 000	2 200	3 000
	130	74	61.5	2	0.6	283 000	440 000	2 200	3 000
	160	87	69	3	1	435 000	600 000	1 900	2 500
<b>80</b>	140	61	49	2.5	0.6	269 000	390 000	2 000	2 800
	140	64	51.5	2.5	0.6	269 000	390 000	2 000	2 800
	140	78	63.5	2.5	0.6	330 000	505 000	2 000	2 800
	170	92	73	3	1	475 000	655 000	1 700	2 400
<b>85</b>	150	70	57	2.5	0.6	315 000	465 000	1 900	2 600
	150	86	69	2.5	0.6	360 000	555 000	1 900	2 600
	180	98	77	4	1	530 000	745 000	1 600	2 200
<b>90</b>	160	71	58	2.5	0.6	345 000	510 000	1 800	2 400
	160	74	61	2.5	0.6	345 000	510 000	1 800	2 400
	160	94	77	2.5	0.6	440 000	700 000	1 800	2 400

**Remark** For other double-row tapered roller bearings not listed above, please contact NSK.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

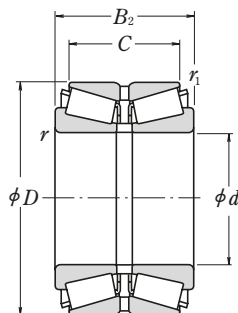
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Bearing Designation	Abutment and Fillet Dimensions (mm)				Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_b$ min.	$r_a$ max.	$r_b$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>HR 40 KBE 42+L</b>	51	75	1.5	0.6	0.37	2.7	1.8	1.8	0.97
<b>HR 45 KBE 42+L</b>	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.08
<b>HR 45 KBE 52X+L</b>	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.31
<b>HR 50 KBE 042+L</b>	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.20
<b>HR 50 KBE 42+L</b>	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.22
<b>HR 50 KBE 52X+L</b>	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.39
<b>HR 50 KBE 043+L</b>	65	104	2	0.6	0.35	2.9	2.0	1.9	2.77
<b>HR 55 KBE 042+L</b>	67	96	2	0.6	0.40	2.5	1.7	1.6	1.59
<b>HR 55 KBE 1003+L</b>	67	96	2	0.6	0.40	2.5	1.7	1.6	1.63
<b>HR 55 KBE 52X+L</b>	67	97	2	0.6	0.40	2.5	1.7	1.6	1.88
<b>HR 55 KBE 43+L</b>	70	113	2	0.6	0.35	2.9	2.0	1.9	3.52
<b>HR 60 KBE 042+L</b>	72	105	2	0.6	0.40	2.5	1.7	1.6	2.03
<b>HR 60 KBE 52X+L</b>	72	106	2	0.6	0.40	2.5	1.7	1.6	2.52
<b>HR 60 KBE 43+L</b>	78	122	2.5	1	0.35	2.9	2.0	1.9	4.40
<b>HR 65 KBE 42+L</b>	77	115	2	0.6	0.40	2.5	1.7	1.6	2.58
<b>HR 65 KBE 1202+L</b>	77	115	2	0.6	0.40	2.5	1.7	1.6	2.61
<b>HR 65 KBE 52X+L</b>	77	117	2	0.6	0.40	2.5	1.7	1.6	3.35
<b>HR 65 KBE 43+L</b>	83	132	2.5	1	0.35	2.9	2.0	1.9	5.42
<b>HR 70 KBE 042+L</b>	82	120	2	0.6	0.42	2.4	1.6	1.6	2.79
<b>HR 70 KBE 42+L</b>	82	120	2	0.6	0.42	2.4	1.6	1.6	2.85
<b>HR 70 KBE 52X+L</b>	82	121	2	0.6	0.42	2.4	1.6	1.6	3.58
<b>HR 70 KBE 43+L</b>	88	142	2.5	1	0.35	2.9	2.0	1.9	6.45
<b>HR 75 KBE 42+L</b>	87	126	2	0.6	0.44	2.3	1.6	1.5	3.15
<b>HR 75 KBE 52X+L</b>	87	127	2	0.6	0.44	2.3	1.6	1.5	3.73
<b>HR 75 KBE 043+L</b>	93	151	2.5	1	0.35	2.9	2.0	1.9	7.66
<b>HR 80 KBE 042+L</b>	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
<b>HR 80 KBE 42+L</b>	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
<b>HR 80 KBE 52X+L</b>	95	136	2	0.6	0.42	2.4	1.6	1.6	4.59
<b>HR 80 KBE 043+L</b>	98	161	2.5	1	0.35	2.9	2.0	1.9	9.02
<b>HR 85 KBE 42+L</b>	100	143	2	0.6	0.42	2.4	1.6	1.6	4.69
<b>HR 85 KBE 52X+L</b>	100	144	2	0.6	0.42	2.4	1.6	1.6	5.70
<b>HR 85 KBE 043+L</b>	106	169	3	1	0.35	2.9	2.0	1.9	10.8
<b>HR 90 KBE 042+L</b>	105	152	2	0.6	0.42	2.4	1.6	1.6	5.53
<b>HR 90 KBE 42+L</b>	105	152	2	0.6	0.42	2.4	1.6	1.6	5.71
<b>HR 90 KBE 52X+L</b>	105	154	2	0.6	0.42	2.4	1.6	1.6	7.26



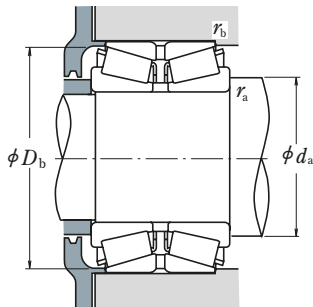
# DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 90 – 120 mm



<i>d</i>	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>B</i> <sub>2</sub>	<i>C</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
<b>90</b>	190	102	81	4	1	595 000	845 000	1 600	2 100
	190	144	115	4	1	770 000	1 180 000	1 600	2 200
<b>95</b>	170	78	63	3	1	385 000	570 000	1 700	2 300
	170	100	83	3	1	495 000	800 000	1 700	2 300
	200	108	85	4	1	640 000	910 000	1 500	2 000
<b>100</b>	165	52	46	2.5	0.6	222 000	340 000	1 700	2 300
	180	81	64	3	1	435 000	665 000	1 600	2 200
	180	81	65	3	1	435 000	665 000	1 600	2 200
	180	82	66	3	1	435 000	665 000	1 600	2 200
	180	83	67	3	1	435 000	665 000	1 600	2 200
	180	105	85	3	1	555 000	905 000	1 600	2 200
	180	107	87	3	1	555 000	905 000	1 600	2 200
	180	110	90	3	1	555 000	905 000	1 600	2 200
	215	112	87	4	1	725 000	1 050 000	1 400	1 900
	190	88	70	3	1	480 000	735 000	1 500	2 000
<b>105</b>	190	117	96	3	1	620 000	1 020 000	1 500	2 000
	190	115	95	3	1	620 000	1 020 000	1 500	2 000
	225	116	91	4	1	780 000	1 130 000	1 300	1 800
	180	56	50	2.5	0.6	264 000	400 000	1 500	2 000
<b>110</b>	180	70	56	2.5	0.6	340 000	555 000	1 500	2 000
	180	125	100	2.5	0.6	550 000	1 060 000	1 500	2 100
	200	90	72	3	1	540 000	840 000	1 400	1 900
	200	92	74	3	1	540 000	840 000	1 400	1 900
	200	120	100	3	1	685 000	1 130 000	1 400	1 900
	200	121	101	3	1	685 000	1 130 000	1 400	1 900
	240	118	93	4	1.5	830 000	1 190 000	1 200	1 700
	180	46	41	2.5	0.6	184 000	296 000	1 500	2 000
	180	58	46	2.5	0.6	260 000	450 000	1 500	2 000
	200	62	55	2.5	0.6	310 000	500 000	1 400	1 800
<b>120</b>	200	78	62	2.5	0.6	415 000	690 000	1 400	1 900
	200	100	84	2.5	0.6	515 000	885 000	1 400	1 800
	215	97	78	3	1	575 000	900 000	1 300	1 800
	215	132	109	3	1	750 000	1 270 000	1 300	1 800
	260	128	101	4	1	915 000	1 310 000	1 100	1 500
	260	188	145	4	1	1 320 000	2 110 000	1 100	1 500

**Remark** For other double-row tapered roller bearings not listed above, please contact NSK.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

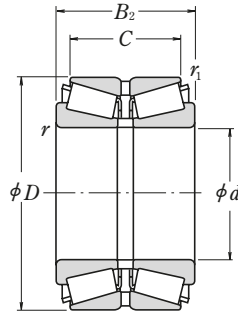
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Bearing Designation	Abutment and Fillet Dimensions (mm)				Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_b$ min.	$r_a$ max.	$r_b$ max.		$Y_2$	$Y_3$	$Y_0$	
HR 90 KBE 043+L	111	178	3	1	0.35	2.9	2.0	1.9	12.7
HR 90 KBE 1901+L	111	179	3	1	0.35	2.9	2.0	1.9	17.9
HR 95 KBE 42+L	113	161	2.5	1	0.42	2.4	1.6	1.6	6.75
HR 95 KBE 52+L	113	163	2.5	1	0.42	2.4	1.6	1.6	8.60
HR 95 KBE 43+L	116	187	3	1	0.35	2.9	2.0	1.9	14.7
100 KBE 31+L	115	156	2	0.6	0.33	3.0	2.0	2.0	4.04
HR100 KBE 1805+L	118	170	2.5	1	0.42	2.4	1.6	1.6	8.16
HR100 KBE 042+L	118	170	2.5	1	0.42	2.4	1.6	1.6	8.13
HR100 KBE 1801+L	118	170	2.5	1	0.42	2.4	1.6	1.6	8.22
HR100 KBE 42+L	118	170	2.5	1	0.42	2.4	1.6	1.6	8.7
HR100 KBE 1802+L	118	173	2.5	1	0.42	2.4	1.6	1.6	10.6
HR100 KBE 52X+L	118	173	2.5	1	0.42	2.4	1.6	1.6	10.7
HR100 KBE 1804+L	118	173	2.5	1	0.42	2.4	1.6	1.6	11
HR100 KBE 043+L	121	200	3	1	0.35	2.9	2.0	1.9	18.1
HR105 KBE 42X+L	123	179	2.5	1	0.42	2.4	1.6	1.6	9.76
HR105 KBE 1902+L	123	182	2.5	1	0.42	2.4	1.6	1.6	13.4
HR105 KBE 52+L	123	182	2.5	1	0.42	2.4	1.6	1.6	13.1
HR105 KBE 043+L	126	209	3	1	0.35	2.9	2.0	1.9	20.4
110 KBE 31+L	125	172	2	0.6	0.39	2.6	1.7	1.7	5.11
110 KBE 031+L	125	172	2	0.6	0.39	2.6	1.7	1.7	6.33
110 KBE 1802+L	125	172	2	0.6	0.26	3.8	2.6	2.5	11.4
HR110 KBE 42+L	128	190	2.5	1	0.42	2.4	1.6	1.6	11.2
HR110 KBE 42X+L	128	190	2.5	1	0.42	2.4	1.6	1.6	11.5
HR110 KBE 2001+L	128	193	2.5	1	0.42	2.4	1.6	1.6	15.4
HR110 KBE 52X+L	128	193	2.5	1	0.42	2.4	1.6	1.6	15.2
HR110 KBE 043+L	131	223	3	1.5	0.35	2.9	2.0	1.9	23.6
120 KBE 30+L	135	172	2	0.6	0.40	2.5	1.7	1.6	3.75
120 KBE 030+L	135	172	2	0.6	0.39	2.6	1.7	1.7	4.64
120 KBE 31+L	135	190	2	0.6	0.39	2.6	1.7	1.7	7.35
120 KBE 031+L	135	190	2	0.6	0.39	2.6	1.7	1.7	8.97
120 KBE 2001+L	135	193	2	0.6	0.37	2.7	1.8	1.8	11.3
HR120 KBE 42X+L	138	204	2.5	1	0.44	2.3	1.6	1.5	13.7
HR120 KBE 52X+L	138	207	2.5	1	0.44	2.3	1.6	1.5	18.8
HR120 KBE 43+L	141	240	3	1	0.35	2.9	2.0	1.9	29.4
HR120 KBE 2601+L	141	242	3	1	0.35	2.9	2.0	1.9	44.6



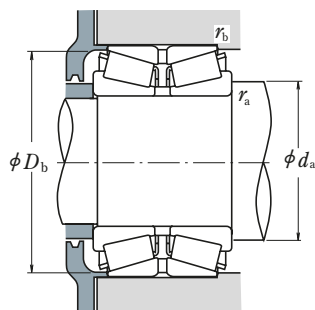
# DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 125 – 150 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>B</i> <sub>2</sub>	<i>C</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
<b>125</b>	210	110	88	4	1	560 000	1 030 000	1 300	1 800
<b>130</b>	230	98	78.5	4	1	640 000	1 010 000	1 200	1 600
	230	100	80.5	4	1	640 000	1 010 000	1 200	1 600
	280	137	107.5	5	1.5	940 000	1 350 000	1 000	1 400
	230	145	115	4	1	905 000	1 580 000	1 200	1 700
<b>140</b>	230	145	117.5	4	1	905 000	1 580 000	1 200	1 700
	230	150	120	4	1	905 000	1 580 000	1 200	1 700
	210	53	47	2.5	0.6	282 000	495 000	1 200	1 700
	210	66	53	2.5	1	305 000	530 000	1 200	1 700
<b>150</b>	210	106	94	2.5	0.6	555 000	1 200 000	1 300	1 700
	225	68	61	3	1	400 000	630 000	1 200	1 600
	225	84	68	3	1	490 000	850 000	1 200	1 600
	225	85	68	3	1	490 000	850 000	1 200	1 600
<b>140</b>	230	120	94	3	1	685 000	1 270 000	1 200	1 600
	230	140	110	3	1	820 000	1 550 000	1 200	1 600
	240	132	106	4	1.5	685 000	1 360 000	1 100	1 500
	250	102	82.5	4	1	670 000	1 030 000	1 100	1 500
<b>150</b>	250	153	125.5	4	1	1 040 000	1 830 000	1 100	1 500
	300	145	115.5	5	1.5	1 030 000	1 480 000	1 000	1 300
<b>150</b>	225	56	50	3	1	300 000	545 000	1 200	1 600
	225	70	56	3	1	395 000	685 000	1 200	1 600
	250	80	71	3	1	510 000	810 000	1 100	1 400
	250	100	80	3	1	630 000	1 090 000	1 100	1 400
<b>150</b>	250	115	95	3	1	745 000	1 320 000	1 100	1 500
	260	150	115	4	1	815 000	1 520 000	1 100	1 400
	270	109	87	4	1	830 000	1 330 000	1 000	1 400
	270	164	130	4	1	1 210 000	2 150 000	1 000	1 400
<b>150</b>	270	174	140	4	1	1 210 000	2 150 000	1 000	1 400
	320	154	120	5	1.5	1 420 000	2 130 000	900	1 200

**Remark** For other double-row tapered roller bearings not listed above, please contact NSK.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

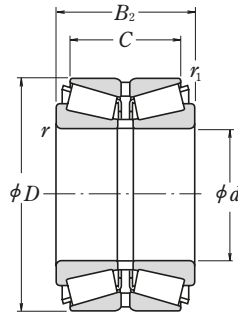
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Bearing Designation	Abutment and Fillet Dimensions (mm)				Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_b$ min.	$r_a$ max.	$r_b$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>125 KBE 2101+L</b>	146	201	3	1	0.43	2.3	1.6	1.5	14.5
<b>HR130 KBE 42+L</b>	151	220	3	1	0.44	2.3	1.6	1.5	15.8
<b>HR130 KBE 2301+L</b>	151	220	3	1	0.44	2.3	1.6	1.5	15.9
<b>130 KBE 43+L</b>	157	258	4	1.5	0.36	2.8	1.9	1.8	35
<b>HR130 KBE 2302+L</b>	151	221	3	1	0.44	2.3	1.6	1.5	24.1
<b>HR130 KBE 52+L</b>	151	222	3	1	0.44	2.3	1.6	1.5	23.8
<b>HR130 KBE 2303+L</b>	151	221	3	1	0.44	2.3	1.6	1.5	24.2
<b>140 KBE 30+L</b>	155	202	2	0.6	0.39	2.6	1.7	1.7	6.02
<b>140 KBE 030+L</b>	155	202	2	1	0.40	2.5	1.7	1.6	7.02
<b>140 KBE 2101+L</b>	155	202	2	0.6	0.33	3.0	2.0	2.0	12.3
<b>140 KBE 31+L</b>	158	216	2.5	1	0.39	2.6	1.7	1.7	9.31
<b>140 KBE 031+L</b>	158	215	2.5	1	0.39	2.6	1.7	1.7	11.6
<b>140 KBE 2201+L</b>	158	215	2.5	1	0.39	2.6	1.7	1.7	11.7
<b>140 KBE 2301+L</b>	158	220	2.5	1	0.33	3.0	2.0	2.0	17.6
<b>140 KBE 2302+L</b>	158	221	2.5	1	0.35	2.9	2.0	1.9	20.7
<b>140 KBE 2401+L</b>	161	227	3	1.5	0.44	2.3	1.5	1.5	22.7
<b>HR140 KBE 42+L</b>	161	237	3	1	0.44	2.3	1.6	1.5	18.9
<b>HR140 KBE 52X+L</b>	161	241	3	1	0.44	2.3	1.6	1.5	29.6
<b>140 KBE 43+L</b>	167	275	4	1.5	0.36	2.8	1.9	1.8	42.6
<b>150 KBE 30+L</b>	168	213	2.5	1	0.35	2.9	2.0	1.9	7.41
<b>150 KBE 030+L</b>	168	215	2.5	1	0.35	2.9	2.0	1.9	8.70
<b>150 KBE 31+L</b>	168	240	2.5	1	0.40	2.5	1.7	1.6	14.2
<b>150 KBE 031+L</b>	168	238	2.5	1	0.39	2.6	1.7	1.7	17.8
<b>150 KBE 2502+L</b>	168	238	2.5	1	0.37	2.7	1.8	1.8	20.9
<b>150 KBE 2601+L</b>	171	242	3	1	0.43	2.3	1.6	1.5	30.0
<b>HR150 KBE 42+L</b>	171	253	3	1	0.44	2.3	1.6	1.5	24.3
<b>HR150 KBE 52X+L</b>	171	257	3	1	0.44	2.3	1.6	1.5	37.3
<b>HR150 KBE 2701+L</b>	171	257	3	1	0.44	2.3	1.6	1.5	39.7
<b>HR150 KBE 43+L</b>	177	295	4	1.5	0.35	2.9	2.0	1.9	53.4



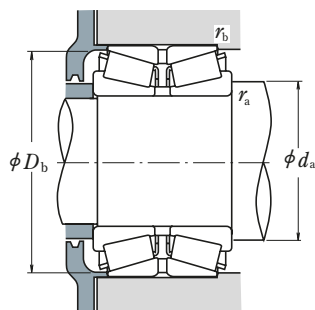
# DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 160 – 200 mm



<i>d</i>	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>B</i> <sub>2</sub>	<i>C</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
<b>160</b>	240	60	53	3	1	355 000	580 000	1 100	1 500
	240	75	60	3	1	395 000	710 000	1 100	1 500
	240	110	90	3	1	650 000	1 290 000	1 100	1 500
	270	86	76	3	1	540 000	885 000	1 000	1 300
	270	108	86	3	1	775 000	1 380 000	1 000	1 300
	270	140	120	3	1	990 000	1 880 000	1 000	1 300
	280	150	125	4	1	1 100 000	2 020 000	1 000	1 300
	290	115	91	4	1	800 000	1 220 000	900	1 300
	290	178	144	4	1	1 360 000	2 440 000	1 000	1 300
	340	160	126	5	1.5	1 310 000	1 920 000	800	1 100
<b>165</b>	290	150	125	4	1	1 140 000	2 130 000	900	1 300
<b>170</b>	250	85	65	3	1	435 000	845 000	1 000	1 400
	260	67	60	3	1	400 000	700 000	1 000	1 300
	260	84	67	3	1	575 000	1 030 000	1 000	1 300
	280	88	78	3	1	630 000	1 040 000	900	1 300
	280	110	88	3	1	820 000	1 450 000	900	1 300
	280	150	130	3	1	1 110 000	2 160 000	1 000	1 300
	310	192	152	5	1.5	1 590 000	2 910 000	900	1 200
	280	74	66	3	1	455 000	810 000	900	1 300
	280	93	74	3	1	655 000	1 220 000	900	1 200
	300	96	85	4	1.5	725 000	1 210 000	900	1 200
<b>180</b>	300	120	96	4	1.5	940 000	1 690 000	900	1 200
	320	127	99	5	1.5	895 000	1 390 000	800	1 200
	320	192	152	5	1.5	1 640 000	3 050 000	900	1 200
	340	180	140	5	1.5	1 410 000	2 510 000	800	1 100
	290	75	67	3	1	490 000	845 000	900	1 200
	290	94	75	3	1	670 000	1 230 000	900	1 200
	320	104	92	4	1.5	800 000	1 380 000	800	1 100
	320	130	104	4	1.5	1 070 000	1 960 000	800	1 100
<b>190</b>	340	133	105	5	1.5	990 000	1 580 000	800	1 100
	340	204	160	5	1.5	1 910 000	3 550 000	800	1 100
	310	152	123	3	1	1 300 000	2 740 000	800	1 100
	320	146	110	5	1.5	990 000	2 120 000	800	1 100
	330	180	140	5	1.5	1 390 000	2 730 000	800	1 100
	340	112	100	4	1.5	940 000	1 670 000	800	1 000
<b>200</b>	340	140	112	4	1.5	1 260 000	2 250 000	800	1 000
	360	142	110	5	1.5	1 100 000	1 780 000	700	1 000
	360	218	174	5	1.5	2 070 000	3 850 000	800	1 000

**Remark** For other double-row tapered roller bearings not listed above, please contact NSK.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

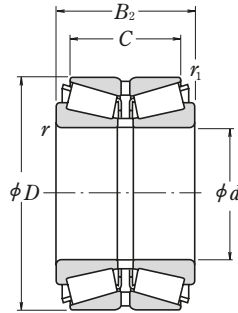
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Bearing Designation	Abutment and Fillet Dimensions (mm)				Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_b$ min.	$r_a$ max.	$r_b$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>160 KBE 30+L</b>	178	231	2.5	1	0.37	2.7	1.8	1.8	8.56
<b>160 KBE 030+L</b>	178	230	2.5	1	0.40	2.5	1.7	1.6	10.5
<b>160 KBE 2401+L</b>	178	232	2.5	1	0.38	2.6	1.8	1.7	16.2
<b>160 KBE 31+L</b>	178	255	2.5	1	0.40	2.5	1.7	1.6	18.6
<b>160 KBE 031+L</b>	178	256	2.5	1	0.39	2.6	1.7	1.7	23.1
<b>160 KBE 2701+L</b>	178	261	2.5	1	0.39	2.6	1.7	1.7	30.6
<b>160 KBE 2801+L</b>	181	266	3	1	0.32	3.2	2.1	2.1	35.9
<b>160 KBE 42+L</b>	181	275	3	1	0.43	2.3	1.6	1.5	28.2
<b>HR160 KBE 52X+L</b>	181	277	3	1	0.44	2.3	1.6	1.5	47.3
<b>160 KBE 43+L</b>	187	314	4	1.5	0.36	2.8	1.9	1.8	60.4
<b>165 KBE 2901+L</b>	186	272	3	1	0.33	3.1	2.1	2.0	39.5
<b>170 KBE 2501+L</b>	188	241	2.5	1	0.44	2.3	1.5	1.5	12.3
<b>170 KBE 30+L</b>	188	248	2.5	1	0.40	2.5	1.7	1.6	11.8
<b>170 KBE 030+L</b>	188	249	2.5	1	0.39	2.6	1.7	1.7	14.4
<b>170 KBE 31+L</b>	188	266	2.5	1	0.39	2.6	1.7	1.7	19.7
<b>170 KBE 031+L</b>	188	268	2.5	1	0.39	2.6	1.7	1.7	24.2
<b>170 KBE 2802+L</b>	188	269	2.5	1	0.39	2.6	1.7	1.7	34.6
<b>HR170 KBE 52X+L</b>	197	297	4	1.5	0.44	2.3	1.6	1.5	57.3
<b>180 KBE 30+L</b>	198	265	2.5	1	0.40	2.5	1.7	1.6	15.4
<b>180 KBE 030+L</b>	198	265	2.5	1	0.35	2.9	2.0	1.9	14.4
<b>180 KBE 31+L</b>	201	284	3	1.5	0.39	2.6	1.7	1.7	24.8
<b>180 KBE 031+L</b>	201	287	3	1.5	0.39	2.6	1.7	1.7	31.1
<b>180 KBE 42+L</b>	207	300	4	1.5	0.44	2.3	1.5	1.5	36.5
<b>HR180 KBE 52X+L</b>	207	308	4	1.5	0.45	2.2	1.5	1.5	59.2
<b>180 KBE 3401+L</b>	207	305	4	1.5	0.43	2.3	1.6	1.5	68.1
<b>190 KBE 30+L</b>	208	279	2.5	1	0.39	2.6	1.7	1.7	16.2
<b>190 KBE 030+L</b>	208	279	2.5	1	0.40	2.5	1.7	1.6	20.1
<b>190 KBE 31+L</b>	211	301	3	1.5	0.40	2.5	1.7	1.6	30.9
<b>190 KBE 031+L</b>	211	302	3	1.5	0.39	2.6	1.7	1.7	39.0
<b>190 KBE 42+L</b>	217	320	4	1.5	0.40	2.5	1.7	1.6	43.9
<b>HR190 KBE 52X+L</b>	217	327	4	1.5	0.44	2.3	1.6	1.5	70.8
<b>HR200 KBE 3101+L</b>	218	301	2.5	1	0.43	2.3	1.6	1.5	40.1
<b>200 KBE 3201+L</b>	227	301	4	1.5	0.52	1.9	1.3	1.3	41.6
<b>200 KBE 3301+L</b>	227	316	4	1.5	0.42	2.4	1.6	1.6	54.4
<b>200 KBE 31+L</b>	221	321	3	1.5	0.40	2.5	1.7	1.6	38.8
<b>200 KBE 031+L</b>	221	324	3	1.5	0.39	2.6	1.7	1.7	47.0
<b>200 KBE 42+L</b>	227	338	4	1.5	0.40	2.5	1.7	1.6	52.6
<b>HR200 KBE 52+L</b>	227	344	4	1.5	0.41	2.5	1.7	1.6	88.3



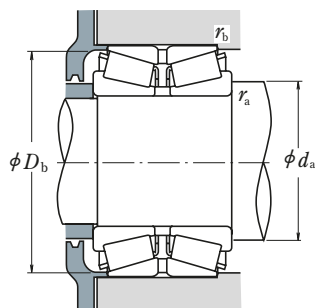
# DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 206 – 260 mm



<i>d</i>	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>D</i>	<i>B</i> <sub>2</sub>	<i>C</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
<b>206</b>	283	102	83	4	1.5	580 000	1 430 000	900	1 200
<b>210</b>	355	116	103	4	1.5	905 000	1 520 000	700	1 000
<b>220</b>	300	110	88	3	1	730 000	1 710 000	800	1 100
	340	90	80	4	1.5	695 000	1 280 000	700	1 000
	340	113	90	4	1.5	920 000	1 830 000	700	1 000
	370	120	107	5	1.5	1 110 000	1 940 000	700	1 000
	370	150	120	5	1.5	1 460 000	2 760 000	700	1 000
<b>240</b>	400	158	122	5	1.5	1 390 000	2 300 000	600	900
	360	92	82	4	1.5	780 000	1 490 000	700	900
	360	115	92	4	1.5	1 020 000	2 040 000	700	900
	400	128	114	5	1.5	1 180 000	2 190 000	600	900
	400	160	128	5	1.5	1 620 000	3 050 000	600	900
	400	209	168	5	1.5	2 220 000	4 450 000	600	900
	380	98	87	4	1	795 000	1 460 000	600	900
<b>250</b>	400	104	92	5	1.5	895 000	1 670 000	600	800
	400	130	104	5	1.5	1 210 000	2 460 000	600	800
	440	144	128	5	1.5	1 540 000	2 760 000	600	800
	440	172	145	5	1.5	1 870 000	3 500 000	600	800
	440	180	144	5	1.5	2 110 000	4 150 000	600	800

**Remark** For other double-row tapered roller bearings not listed above, please contact NSK.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Bearing Designation	Abutment and Fillet Dimensions (mm)				Constant $e$	Axial Load Factors			Mass (kg) approx.
	$d_a$ min.	$D_b$ min.	$r_a$ max.	$r_b$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>206 KBE 2801+L</b>	227	275	3	1.5	0.51	2.0	1.3	1.3	18.1
<b>210 KBE 31+L</b>	231	338	3	1.5	0.46	2.2	1.5	1.4	41.7
<b>220 KBE 3001+L</b>	238	292	2.5	1	0.37	2.7	1.8	1.8	21.2
<b>220 KBE 30+L</b>	241	324	3	1.5	0.40	2.5	1.7	1.6	27.9
<b>220 KBE 030+L</b>	241	327	3	1.5	0.40	2.5	1.7	1.6	34.7
<b>220 KBE 31+L</b>	247	345	4	1.5	0.39	2.6	1.7	1.7	48.3
<b>220 KBE 031+L</b>	247	349	4	1.5	0.39	2.6	1.7	1.7	60.2
<b>220 KBE 42+L</b>	247	371	4	1.5	0.40	2.5	1.7	1.6	74.2
<b>240 KBE 30+L</b>	261	344	3	1.5	0.39	2.6	1.7	1.7	30.1
<b>240 KBE 030+L</b>	261	344	3	1.5	0.35	2.9	2.0	1.9	37.3
<b>240 KBE 31+L</b>	267	380	4	1.5	0.43	2.3	1.6	1.5	60.0
<b>240 KBE 031+L</b>	267	378	4	1.5	0.39	2.6	1.7	1.7	73.6
<b>240 KBE 4003+L</b>	267	384	4	1.5	0.33	3.0	2.0	2.0	96.4
<b>250 KBE 3801+L</b>	271	365	3	1	0.40	2.5	1.7	1.6	35.5
<b>260 KBE 30+L</b>	287	379	4	1.5	0.40	2.5	1.7	1.6	43.4
<b>260 KBE 030+L</b>	287	382	4	1.5	0.40	2.5	1.7	1.6	54.1
<b>260 KBE 31+L</b>	287	416	4	1.5	0.39	2.6	1.7	1.7	82.5
<b>260 KBE 4401+L</b>	287	414	4	1.5	0.38	2.6	1.8	1.7	98.1
<b>260 KBE 031+L</b>	287	416	4	1.5	0.39	2.6	1.7	1.7	104.0





7. SPHERICAL ROLLER BEARINGS

INTRODUCTION ..... C 258

TECHNICAL DATA

Free Space of Spherical Roller Bearings ..... C 260

Measuring Bearing Clearance ..... C 262

BEARING TABLES

Spherical Roller Bearings

Cylindrical Bores, Tapered Bores

Bore Diameter 20 – 1400 mm ..... C 266



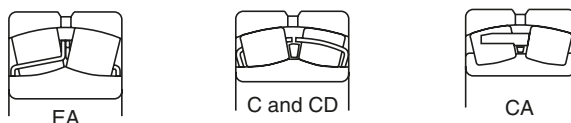
## DESIGN, TYPES, AND FEATURES

Various types of high load capacity spherical roller bearings are available. Types EA, C and CD have pressed-steel cages, and type CA has machined-brass cages. EA-type bearings listed here are classified as NSKHPS™ bearings, which offer particularly high load-carrying capacity, high limiting speeds, and superior performance under high-temperature operating conditions up to 200 °C.

An oil groove and holes are located in the outer ring to supply lubricant, and the bearing numbers are suffixed with E4.

To use bearings with oil grooves and holes, an oil groove should be located in the housing bore since depth for the groove in the bearing is limited. The dimensions of the oil groove and number of holes present are listed in Tables 1 and 2.

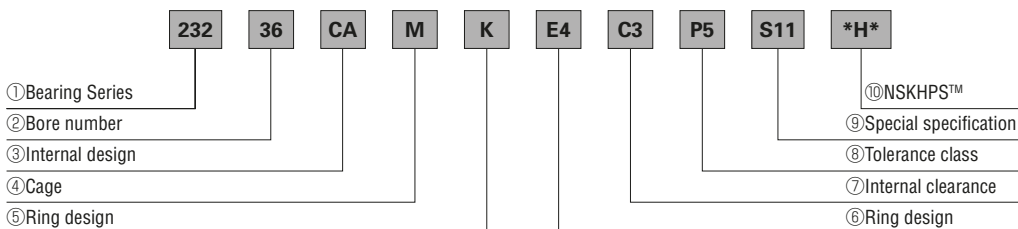
When bearings with a hole for a locking pin to prevent outer ring rotation are required, please contact NSK.



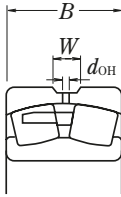
### Formulation of Bearing Designations

Spherical Roller Bearings

Example:



- ① Bearing Series  
239, 230, 240, 231, 241, 222, 232, 213, 223 : Spherical roller bearings
- ② Bore number  
Bore number indicates bore diameter. Bore number X 5 (mm)
- ③ Internal design  
EA, CA : High load capacity
- ④ Cage  
M : Machined-brass cage (for CA Design)  
Omitted : Pressed-steel cage (for EA Design)
- ⑤⑥ Ring design  
K : Tapered bore of inner ring (taper 1 : 12)  
K30 : Tapered bore of inner ring (taper 1 : 30)  
E4 : Lubricating groove in outside surface and holes in outer ring
- ⑦ Internal clearance  
Omitted : CN clearance, C3 : Clearance greater than CN,  
C4 : Clearance greater than C3, C5 : Clearance greater than C4
- ⑧ Tolerance class  
Omitted : ISO Normal, P6 : ISO Class 6, P5 : ISO Class 5, P4 : ISO Class 4
- ⑨ Special specification  
S11 : Dimensional stabilizing treatment: working temperature under 200 °C  
(omitted for EA design)
- ⑩ NSKHPS™  
\*H\* : NSKHPS™ designation  
Tolerance Class : ISO Normal

**Table 1 Dimensions of Oil Grooves and Holes**

Units : mm

Nominal Width <i>B</i>		Oil Groove	Hole Diameter
over	incl.	Width <i>W</i>	<i>d</i> <sub>OH</sub>
18	30	5	2.5
30	40	6	3
40	50	7	4
50	65	8	5
65	80	10	6
80	100	12	8
100	120	15	10
120	160	20	12
160	200	25	15
200	250	30	20
250	315	35	20
315	400	40	25
400	—	40	25

**Table 2 Number of Oil Holes**

Nominal Outer Ring Dia <i>D</i> (mm)		Number of Holes
over	incl.	
—	180	4
180	250	6
250	315	6
315	400	6
400	500	6
500	630	8
630	800	8
800	1000	8
1000	1250	8
1250	1600	8
1600	2000	8

## NSKHPS™ Spherical Roller Bearings

### Features

Compared with conventional bearings:

Bearing Life  
Up to  
**2**  
times  
longer

Working temp.  
up to  
**200 °C**

#### 1. Improved reliability

Bearing life is up to twice that of conventional bearings thanks to optimization of the bearing's internal design and improvement of processing technology.

2. High-temperature dimensional stabilizing treatment comes standard  
Dimensional stabilization up to 200 °C has been achieved through the application of NSK's proprietary heat treatment technology.

## TOLERANCES AND RUNNING ACCURACY

**SPHERICAL ROLLER BEARINGS**..... Table 7.2 (Pages A128 to A131)

**NSKHPS SPHERICAL ROLLER BEARINGS**

Tolerance for Dimensions: ISO Normal

Running Accuracy: ISO Normal

## RECOMMENDED FITS

**SPHERICAL ROLLER BEARINGS**..... Table 8.3 (Page A164)

Table 8.5 (Page A165)

## INTERNAL CLEARANCES

**SPHERICAL ROLLER BEARINGS**..... Table 8.16 (Page A172)

**NSKHPS SPHERICAL ROLLER BEARINGS**

INTERNAL CLEARANCE DESIGNATION : CN, C3, C4

## PERMISSIBLE MISALIGNMENT

The permissible misalignment of spherical roller bearings varies depending on bearing size and load but is approximately 0.018 to 0.045 radian (1° to 2.5°) with normal loads.

## LIMITING SPEEDS (GREASE)

The limiting speeds (grease) listed in the bearing tables should be adjusted depending on the bearing load condition. Furthermore, higher speeds are attainable by making changes in the lubrication method, cage design, etc. Refer to Page A098 for detailed information.

## PRECAUTIONS FOR USE OF SPHERICAL ROLLER BEARINGS

If the load on spherical roller bearings becomes too small during operation or if, the ratio of axial and radial loads is larger than the value of 'e' as listed in the bearing tables, slippage occurs between the rollers and raceways, which may result in smearing. The higher the weight, the higher this tendency becomes, especially for large spherical roller bearings.

If very small bearing loads are expected, please contact NSK for selection of an appropriate bearing.



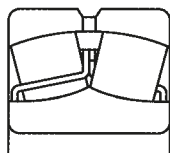
## TECHNICAL DATA

### Free Space of Spherical Roller Bearings

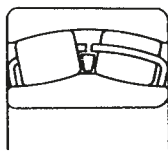
Spherical roller bearings have self-aligning capabilities and the capacity to carry substantially large radial and bi-axial loads. For these reasons, this bearing is used widely in many applications, such as plunger blocks. Application problems include a long span, which causes substantial deflection of the shaft, installation errors, and axial misalignment. These bearings may be exposed to large radial or shock loads.

Grease lubrication is common for spherical roller bearings because it simplifies the seal construction around the housing and makes maintenance and inspection easier. In this case, it is important to select a grease appropriate to the operating conditions and to fill the bearing with the proper amount of grease while considering the housing internal space.

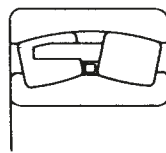
The amount of bearing free space for various spherical roller bearings is shown in Table 1. Under general operating conditions, a user may pack up to 1/3 to 2/3 of the free space of the bearing with grease.



EA type



C, CD type



CA type

**Table 1 Free Space of Spherical Roller Bearings  
(EA, C, CD, and CA)**
Units: cm<sup>3</sup>

Bearing Bore No.	Bearing Free Space				
	Bearing Series				
	230	231	222	232	223
11	—	—	29	—	78
12	—	—	42	—	96
13	—	—	48	—	113
14	—	—	52	—	139
15	—	—	57	—	170
16	—	—	71	—	206
17	—	—	91	—	234
18	—	—	110	130	283
19	—	—	135	—	327
20	—	—	169	203	410
22	100	150	242	294	560
24	109	228	297	340	700
26	161	240	365	405	955
28	170	292	400	530	1 230
30	209	465	505	680	1 430
32	254	575	680	850	1 710
34	355	610	785	1 090	2 070
36	465	785	810	1 120	2 460
38	565	970	1 160	1 340	2 830
40	715	1 160	1 400	1 640	2 900
44	940	1 500	1 880	2 270	3 750
48	1 030	1 900	2 550	3 550	4 700
52	1 530	2 940	3 300	4 750	5 900
56	1 820	3 150	3 400	4 950	7 250
60	2 200	4 050	4 300	6 200	8 750

**Remarks** 22211 to 22226 and 22311 to 22324 are EA bearings.  
 23122 to 23148 and 23218 to 23244 are C bearings.  
 23022 to 23036 and 22228 to 22236 are CD bearings.  
 23038 to 23060, 23152 to 23160, 22238 to 22260,  
 23248 to 23260, and 22326 to 22360 are CA bearings.



## Measurement of Clearance in SRBs

The measurement of internal bearing clearance before mounting is critical. Before handling the bearing and measuring the internal bearing clearance, be sure to wear thin rubber gloves.

If bearings are touched with bare hands, the touched part may rust.

When measuring the internal bearing clearance, ensure that the rollers are positioned correctly.

### 1. Measurement of Bearing Clearance

To measure only internal bearing clearance, set the bearing upright (vertically) on a flat surface while holding the outer ring with one hand. Take care not to incline the inner and outer rings, and stabilize the rollers by turning the inner ring clockwise and counter-clockwise by about one half to one full rotation. Adjust the rollers until a random roller is positioned at the very top of the bearing. Next, use a thickness gauge to measure the internal clearance. Measurement positioning and location may vary slightly depending on the size of the outer ring outside diameter.

#### 1.1 When Bearing Outside Diameter Is Under 200 mm

Insert the thickness gauge between the two rows of rollers and the outer ring at the rollers located at the very top of the bearing. Then, measure the internal clearance  $\Delta_r$  (see Fig. 1).

#### 1.2 When Bearing Outside Diameter Is Over 200 mm

Insert the thickness gauge between the two rows of rollers and the outer ring at the very top of the bearing and on the sides at two symmetrical points relative to the bearing center. Then, take respective measurements for the bearing internal clearance (see Fig. 2).

Take the individual values measured at the very top of bearing and outer ring as  $\Delta_{rT1}$  and  $\Delta_{rT2}$ , and determine the internal clearance at the top of the bearing  $\Delta_{rT}$  by the following equation:

$$\Delta_{rT} = 1/2 (\Delta_{rT1} + \Delta_{rT2})$$

Then, take the measurements between the two rows of rollers on the left side as  $\Delta_{rL1}$  and  $\Delta_{rL2}$ , and determine the internal clearance on the left side of the bearing  $\Delta_{rL}$  by the following equation:

$$\Delta_{rL} = 1/2 (\Delta_{rL1} + \Delta_{rL2})$$

Next, take the measurements between the two rows of rollers on the right side as  $\Delta_{rR1}$  and  $\Delta_{rR2}$ , and determine the internal clearance on the right side of the bearing  $\Delta_{rR}$  by the following equation:

$$\Delta_{rR} = 1/2 (\Delta_{rR1} + \Delta_{rR2})$$

Finally, determine the internal bearing clearance  $\Delta_r$  by the following equation:

$$\Delta_r = 1/2 (\Delta_{rT} + \Delta_{rL} + \Delta_{rR})$$

### 2. Measuring Bearing Clearance When Mounted on Shaft or Sleeve

In this case, clearance measurements are taken with the outer ring of the bearing hanging down from the rollers. First, while holding the bearing upright, rotate the outer ring clockwise and counter-clockwise by one-half to one full rotation until both rows have a random roller positioned exactly at the bottom. Use a thickness gauge to measure the clearance at the designated measuring points.

The measurement points vary slightly depending on the size of the outer ring outside diameter.

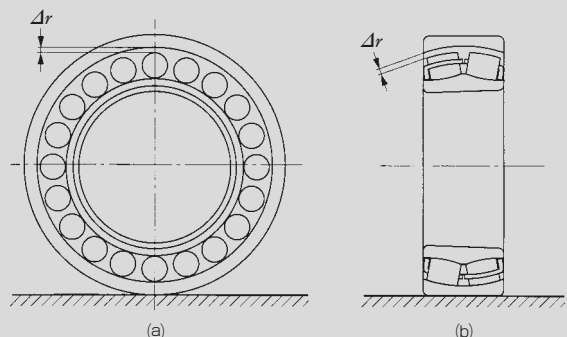


Fig. 1 Clearance Measurement Point (Bearing Outside Diameter: Less Than 200 mm)

## 2.1 When Bearing Outside Diameter is Under 200 mm

Insert the thickness gauge between the two rows of rollers and outer ring at the very bottom of the bearing, and measure the internal clearance  $\Delta_{rS}$  (Fig. 3).

## 2.2 When Bearing Outside Diameter Is Over 200 mm

Insert the thickness gauge between the two rows of rollers and the outer ring at the very bottom of the bearing and on the sides at two symmetrical points relative to the bearing center. Then, take respective measurements for the bearing internal clearance  $\Delta_r$  (Fig. 3). Because the bearing has two rows, two measurements of bearing internal clearance should be taken as  $\Delta_{rS1}$  and  $\Delta_{rS2}$ , and the internal clearance at the very bottom of the bearing  $\Delta_{rS}$  should be determined by the following equation:

$$\Delta_{rS} = 1/2 (\Delta_{rS1} + \Delta_{rS2})$$

Then, take the individual values on the left side as

$\Delta_{rL1}$  and  $\Delta_{rL2}$ , and determine the internal clearance on the left side of bearing  $\Delta_{rL}$  by the following equation:

$$\Delta_{rL} = 1/2 (\Delta_{rL1} + \Delta_{rL2})$$

Next, take the individual values on the right side as  $\Delta_{rR1}$  and  $\Delta_{rR2}$ , and determine the internal clearance on the right side of bearing  $\Delta_{rR}$  by the following equation:

$$\Delta_{rR} = 1/2 (\Delta_{rR1} + \Delta_{rR2})$$

Finally, determine internal bearing clearance ( $\Delta_r$ ) by the following equation:

$$\Delta_r = 1/2 (\Delta_{rS} + \Delta_{rL} + \Delta_{rR})$$

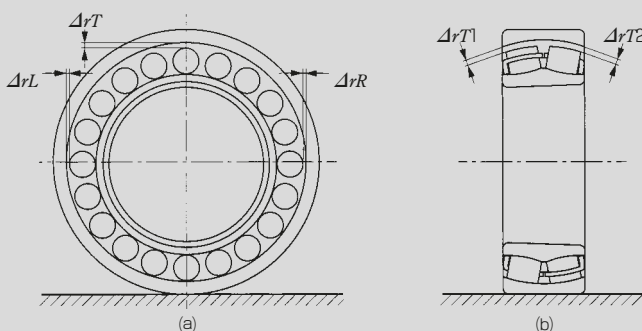


Fig. 2 Clearance Measurement Points (Bearing Outside Diameter: Larger Than 200 mm)

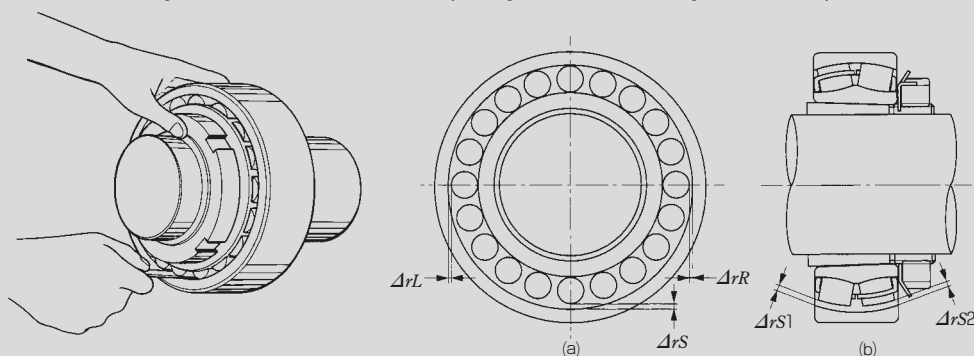


Fig. 3 Clearance Measurement Points

## 3. Temperature Equilibrium When Taking Measurements

To ensure accurate bearing measurements, the temperature of the measurement instrument and components to be measured must be the same. If the bearing is mounted with an oil heating tank or induction heater, be sure to measure the internal clearance only after a complete cooldown. If a bearing is brought from a warehouse to the measurement area, the temperature of the bearing may still be high; thus, if clearance or dimensions were measured without confirming bearing temperature, the measured value may be wrong.

For a large bearing with an outer ring outside diameter larger than 400 mm, the unpacked bearing should be left on a surface plate for about 24 hours before making a clearance or dimensional measurement. Put the end face of the bearing on a surface plate prior to measurement to ensure both objects have the same temperature.

## 4. Clearance Adjustment When Mounting a Bearing on a Tapered Shaft or Sleeve

When mounting a bearing with a tapered bore to a tapered shaft or sleeve (adapter or removable sleeve), the inner ring of the bearing will widen and interference will increase when pushing in the bearing, resulting in reduced internal clearance depending on the taper. Be sure to provide proper interference and internal clearance when mounting the bearing. See Table 2 for the clearance reduction amounts when mounting spherical roller bearings with tapered bores.

Each time the bearing is pushed further onto the tapered shaft or sleeve, measure the variation of the internal clearance and repeat the above procedure until the clearance reduction amount specified in Table 2 is attained. This procedure is called "clearance adjustment," and when the proper reduction amount is attained, the clearance necessary for operation is secured. The clearance reduction amount must be confirmed by a thickness gauge; however, depending on the method of clearance adjustment, the measured value obtained with the thickness gauge may not be correct. Therefore, execute the following corrective procedures:

1. When using heat:  
When the bearing and shaft are both at room temperature, measure the clearance again with a thickness gauge to confirm that the specified value is secured.
2. When using a lockwasher as a turning stopper for the locknut:  
Prior to bending the tooth of the lockwasher into the cutout for the locknut, measure the clearance with the thickness gauge again to confirm that the specified value is secured.
3. When using a hydraulic nut:

After removal of the hydraulic nut, mount the locknut and measure the clearance again to confirm that the specified value remains constant prior to stopping turning.

4. When using an oil injection pump:  
Drop the pressure of the oil fed from the oil injection pump to zero so that there is no pressure on the bearing or fitted part of the sleeve. Next, measure the clearance with a thickness gauge to confirm that the specified value remains secured.

## Radial Internal Clearance and Clearance Reduction Amount for the Bearing to be Mounted

- When radial internal clearance is CN (normal clearance):  
Perform the clearance adjustment by aiming for a middle value between the minimum and maximum clearance reduction amounts.
- When radial internal clearance is C3 or C4:  
Perform the clearance adjustment by aiming for the maximum clearance reduction amount.

## Internal Clearance Adjustment of Tapered Bore Bearings

Perform the adjustment by measuring the clearance reduction amount with a thickness gauge.

1. For measurement location and positioning, refer to Section 2 (Page C262) of this catalog.
2. When mounting a bearing on a tapered shaft, perform a clearance adjustment each time the bearing is pushed in by a locknut, end plate, end cap, or hydraulic nut.
3. When using an adapter sleeve, perform a clearance adjustment each time the bearing is pushed in by a locknut or hydraulic nut.
4. When using a removable sleeve, perform an adjustment each time the removable sleeve is pushed in by a locknut or hydraulic nut.

Since the outer ring of the bearing hangs down from the rollers, turn the outer ring clockwise and counterclockwise by one-half to one full rotation while maintaining the proper bearing position before taking clearance measurements for these operations. Position one randomly chosen roller from each row at the very bottom of the bearing. Then, insert the thickness gauge to measure the internal clearance at the appropriate location(s) based on the size of the outer ring outside diameter. These clearance measurement values should be recorded.

Table 2 Mounting of Spherical Roller Bearings With Tapered Bores

Units : mm

Bore Diameter <i>d</i> (mm)		Reduction in Radial Clearance		Axial Movement				Minimum Permissible Residual Clearance		
over	incl.	min.	max.	Taper 1 : 12		Taper 1 : 30		CN	C3	C4
				min.	max.	min.	max.			
<b>30</b>	<b>40</b>	0.025	0.030	0.40	0.45	—	—	0.010	0.025	0.035
<b>40</b>	<b>50</b>	0.030	0.035	0.45	0.55	—	—	0.015	0.030	0.045
<b>50</b>	<b>65</b>	0.030	0.035	0.45	0.55	—	—	0.025	0.035	0.060
<b>65</b>	<b>80</b>	0.040	0.045	0.60	0.70	—	—	0.030	0.040	0.075
<b>80</b>	<b>100</b>	0.045	0.055	0.70	0.85	1.75	2.15	0.035	0.050	0.085
<b>100</b>	<b>120</b>	0.050	0.060	0.75	0.90	1.9	2.25	0.045	0.065	0.110
<b>120</b>	<b>140</b>	0.060	0.070	0.90	1.1	2.25	2.75	0.055	0.080	0.130
<b>140</b>	<b>160</b>	0.065	0.080	1.0	1.3	2.5	3.25	0.060	0.100	0.150
<b>160</b>	<b>180</b>	0.070	0.090	1.1	1.4	2.75	3.5	0.070	0.110	0.170
<b>180</b>	<b>200</b>	0.080	0.100	1.3	1.6	3.25	4.0	0.070	0.110	0.190
<b>200</b>	<b>225</b>	0.090	0.110	1.4	1.7	3.5	4.25	0.080	0.130	0.210
<b>225</b>	<b>250</b>	0.100	0.120	1.6	1.9	4.0	4.75	0.090	0.140	0.230
<b>250</b>	<b>280</b>	0.110	0.140	1.7	2.2	4.25	5.5	0.100	0.150	0.250
<b>280</b>	<b>315</b>	0.120	0.150	1.9	2.4	4.75	6.0	0.110	0.160	0.280
<b>315</b>	<b>355</b>	0.140	0.170	2.2	2.7	5.5	6.75	0.120	0.180	0.300
<b>355</b>	<b>400</b>	0.150	0.190	2.4	3.0	6.0	7.5	0.130	0.200	0.330
<b>400</b>	<b>450</b>	0.170	0.210	2.7	3.3	6.75	8.25	0.140	0.220	0.360
<b>450</b>	<b>500</b>	0.190	0.240	3.0	3.7	7.5	9.25	0.160	0.240	0.390
<b>500</b>	<b>560</b>	0.210	0.270	3.4	4.3	8.5	11.0	0.170	0.270	0.410
<b>560</b>	<b>630</b>	0.230	0.300	3.7	4.8	9.25	12.0	0.200	0.310	0.460
<b>630</b>	<b>710</b>	0.260	0.330	4.2	5.3	10.5	13.0	0.220	0.330	0.520
<b>710</b>	<b>800</b>	0.280	0.370	4.5	5.9	11.5	15.0	0.240	0.390	0.590
<b>800</b>	<b>900</b>	0.310	0.410	5.0	6.6	12.5	16.5	0.280	0.430	0.660
<b>900</b>	<b>1000</b>	0.340	0.460	5.5	7.4	14.0	18.5	0.310	0.470	0.730
<b>1000</b>	<b>1120</b>	0.370	0.500	5.9	8.0	15.0	20.0	0.360	0.530	0.800

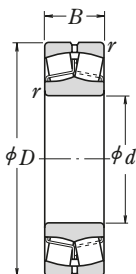
**Remarks** The values for reduction in radial internal clearance are for bearings with CN clearance.

For bearings with C3 or C4 Clearance, the maximum values listed should be used.

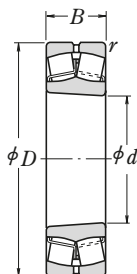


# ■ SPHERICAL ROLLER BEARINGS

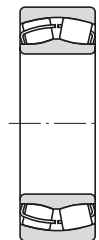
Bore Diameter 20 – 55 mm



Cylindrical Bore



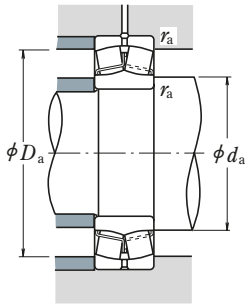
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )			Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Thermal Reference Speed	Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
20	52	15	1.1	29 300	26 900	10 000	—	6 300	21304CDE4
25	52	18	1	37 500	37 000	10 000	—	7 100	22205CE4
	62	17	1.1	43 000	40 500	9 000	—	5 300	21305CDE4
30	62	20	1	50 000	50 000	8 500	—	6 000	22206CE4
	72	19	1.1	55 000	54 000	7 500	—	4 500	21306CDE4
35	72	23	1.1	69 000	71 000	7 500	—	5 300	22207CE4
	80	21	1.5	71 500	76 000	7 100	—	4 000	21307CDE4
40	80	23	1.1	113 000	99 500	7 100	12 000	6 700	*22208EAE4
	90	23	1.5	118 000	111 000	6 700	11 000	6 000	*21308EAE4
	90	33	1.5	170 000	153 000	5 600	9 000	5 300	*22308EAE4
45	85	23	1.1	118 000	111 000	6 300	11 000	6 000	*22209EAE4
	100	25	1.5	149 000	144 000	6 000	9 000	5 000	*21309EAE4
	100	36	1.5	207 000	195 000	5 000	8 000	4 500	*22309EAE4
50	90	23	1.1	124 000	119 000	6 000	9 500	5 600	*22210EAE4
	110	27	2	178 000	174 000	5 300	8 000	4 500	*21310EAE4
	110	40	2	246 000	234 000	4 800	7 100	4 300	*22310EAE4
55	100	25	1.5	149 000	144 000	5 300	9 000	5 300	*22211EAE4
	120	29	2	178 000	174 000	5 300	8 000	4 500	*21311EAE4
	120	43	2	292 000	292 000	4 300	6 000	3 800	*22311EAE4

**Note** <sup>(1)</sup> Suffix K represents bearings with tapered bores (taper 1:12).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

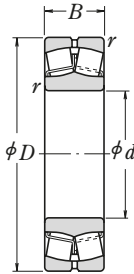
Designations  Tapered Bore <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)					Constant  $e$	Axial Load Factors			Mass (kg)  approx.
	$d_a$ min.	$d_a$ max.	$D_a$ max.	$d_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>21304CDKE4</b>	27	28	45	42	1	0.31	3.2	2.1	2.1	0.17
<b>22205CKE4</b> <b>21305CDKE4</b>	31 32	31 34	46 55	45 51	1 1	0.35 0.29	2.9 3.4	1.9 2.3	1.9 2.3	0.17 0.26
<b>22206CKE4</b> <b>21306CDKE4</b>	36 37	37 40	56 65	54 59	1 1	0.33 0.28	3.1 3.6	2.1 2.4	2.0 2.3	0.27 0.39
<b>22207CKE4</b> <b>21307CDKE4</b>	42 44	43 47	65 71	63 67	1 1.5	0.32 0.28	3.1 3.6	2.1 2.4	2.0 2.4	0.42 0.53
<b>*22208EAKE4</b> <b>*21308EAKE4</b> <b>*22308EAKE4</b>	47 49 49	49 55 52	73 81 81	70 75 77	1 1.5 1.5	0.28 0.25 0.35	3.6 3.9 2.8	2.4 2.7 1.9	2.4 2.6 1.9	0.50 0.73 0.98
<b>*22209EAKE4</b> <b>*21309EAKE4</b> <b>*22309EAKE4</b>	52 54 54	55 65 60	78 91 91	75 89 86	1 1.5 1.5	0.25 0.23 0.34	3.9 4.3 2.9	2.7 2.9 2.0	2.6 2.8 1.9	0.55 0.96 1.34
<b>*22210EAKE4</b> <b>*21310EAKE4</b> <b>*22310EAKE4</b>	57 60 60	60 72 64	83 100 100	81 98 93	1 2 2	0.24 0.23 0.35	4.3 4.4 2.8	2.9 3.0 1.9	2.8 2.9 1.9	0.61 1.21 1.78
<b>*22211EAKE4</b> <b>*21311EAKE4</b> <b>*22311EAKE4</b>	64 65 65	65 72 73	91 110 110	89 98 103	1.5 2 2	0.23 0.23 0.34	4.3 4.4 2.9	2.9 3.0 2.0	2.8 2.9 1.9	0.81 1.58 2.3

- Remarks**
1. Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  2. The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  3. For the dimensions of adapters and withdrawal sleeves, refer to Pages C348 – C349 and C356.

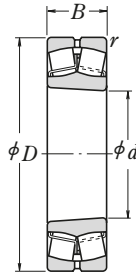


# SPHERICAL ROLLER BEARINGS

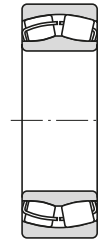
Bore Diameter 60 – 90 mm



Cylindrical Bore



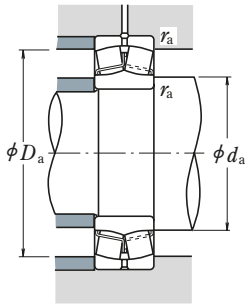
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )			Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Thermal Reference Speed	Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
60	95	26	1.1	98 500	141 000	4 800	—	3 600	23012CE4
	110	28	1.5	178 000	174 000	5 300	8 000	4 800	*22212EAE4
	130	31	2.1	238 000	244 000	4 800	6 700	3 800	*21312EAE4
	130	46	2.1	340 000	340 000	4 000	5 600	3 600	*22312EAE4
65	120	31	1.5	221 000	230 000	4 800	7 500	4 300	*22213EAE4
	140	33	2.1	264 000	275 000	4 500	6 000	3 600	*21313EAE4
	140	48	2.1	375 000	380 000	3 800	5 000	3 200	*22313EAE4
70	125	31	1.5	225 000	232 000	4 500	7 100	4 000	*22214EAE4
	150	35	2.1	310 000	325 000	4 300	5 600	3 200	*21314EAE4
	150	51	2.1	425 000	435 000	3 600	4 800	3 000	*22314EAE4
75	130	31	1.5	238 000	244 000	4 300	6 700	4 000	*22215EAE4
	160	37	2.1	310 000	325 000	4 000	5 600	3 200	*21315EAE4
	160	55	2.1	485 000	505 000	3 400	4 300	2 800	*22315EAE4
80	140	33	2	264 000	275 000	4 000	6 000	3 600	*22216EAE4
	170	39	2.1	355 000	375 000	3 800	4 800	3 000	*21316EAE4
	170	58	2.1	540 000	565 000	3 200	3 800	2 600	*22316EAE4
85	150	36	2	310 000	325 000	4 000	5 600	3 400	*22217EAE4
	180	41	3	360 000	395 000	3 800	5 000	3 000	*21317EAE4
	180	60	3	600 000	630 000	3 000	3 400	2 400	*22317EAE4
90	160	40	2	360 000	395 000	3 800	5 000	3 200	*22218EAE4
	160	52.4	2	340 000	490 000	2 800	—	1 800	23218CE4
	190	43	3	415 000	450 000	3 600	4 500	2 800	*21318EAE4
	190	64	3	665 000	705 000	2 800	3 000	2 400	*22318EAE4

**Note** (1) Suffix K represents bearings with tapered bores (taper 1:12).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

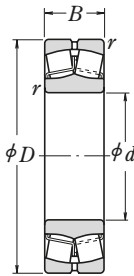
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$		$r_a$		$e$	$Y_2$	$Y_3$	
Tapered Bore <sup>(1)</sup>	min.	max.	max.	min.	max.					
<b>23012CKE4</b>	67	68	88	85	1	0.26	3.9	2.6	2.5	0.68
<b>*22212EAKE4</b>	69	72	101	98	1.5	0.23	4.4	3.0	2.9	1.1
<b>*21312EAKE4</b>	72	87	118	117	2	0.22	4.5	3.0	3.0	1.98
<b>*22312EAKE4</b>	72	79	118	111	2	0.34	3.0	2.0	1.9	2.89
<b>*22213EAKE4</b>	74	80	111	107	1.5	0.24	4.2	2.8	2.7	1.51
<b>*21313EAKE4</b>	77	94	128	126	2	0.22	4.6	3.1	3.0	2.45
<b>*22313EAKE4</b>	77	84	128	119	2	0.34	3.0	2.0	2.0	3.52
<b>*22214EAKE4</b>	79	84	116	111	1.5	0.23	4.3	2.9	2.8	1.58
<b>*21314EAKE4</b>	82	101	138	135	2	0.22	4.6	3.1	3.0	3.0
<b>*22314EAKE4</b>	82	91	138	129	2	0.33	3.0	2.0	2.0	4.28
<b>*22215EAKE4</b>	84	87	121	117	1.5	0.22	4.5	3.0	3.0	1.64
<b>*21315EAKE4</b>	87	101	148	134	2	0.22	4.6	3.1	3.0	3.64
<b>*22315EAKE4</b>	87	97	148	137	2	0.33	3.0	2.0	2.0	5.26
<b>*22216EAKE4</b>	90	94	130	126	2	0.22	4.6	3.1	3.0	2.01
<b>*21316EAKE4</b>	92	109	158	146	2	0.23	4.4	3.0	2.9	4.32
<b>*22316EAKE4</b>	92	103	158	145	2	0.33	3.0	2.0	2.0	6.23
<b>*22217EAKE4</b>	95	101	140	135	2	0.22	4.6	3.1	3.0	2.54
<b>*21317EAKE4</b>	99	108	166	142	2.5	0.24	4.3	2.9	2.8	5.2
<b>*22317EAKE4</b>	99	110	166	155	2.5	0.33	3.1	2.1	2.0	7.23
<b>*22218EAKE4</b>	100	108	150	142	2	0.24	4.3	2.9	2.8	3.3
<b>23218CKE4</b>	100	105	150	138	2	0.32	3.2	2.1	2.1	4.51
<b>*21318EAKE4</b>	104	115	176	152	2.5	0.24	4.3	2.9	2.8	6.1
<b>*22318EAKE4</b>	104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.56

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings. In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C349 – C350 and C356.

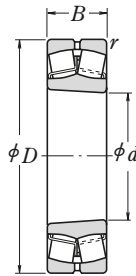


# SPHERICAL ROLLER BEARINGS

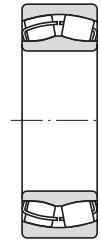
Bore Diameter 95 – 110 mm



Cylindrical Bore



Tapered Bore

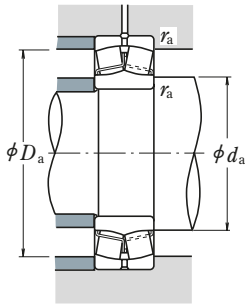


Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
95	170	43	2.1	415 000	450 000	3 800	4 500	3 000	*22219EAE4 23219CAME4 *21319CAME4
	170	55.6	2.1	370 000	525 000	2 600	—	1 700	
	200	45	3	430 000	435 000	3 600	4 800	1 500	
	200	45	3	345 000	435 000	3 400	—	1 500	21319CE4 *22319EAE4
	200	67	3	735 000	780 000	2 600	3 000	2 200	
100	150	37	1.5	212 000	335 000	3 200	—	2 200	23020CDE4 24020CE4 23120CE4
	150	50	1.5	276 000	470 000	2 800	—	1 800	
	165	52	2	345 000	530 000	2 800	—	1 700	
	165	65	2	345 000	535 000	2 400	—	1 700	24120CAME4 *22220EAE4 *23220CAME4
	180	46	2.1	455 000	490 000	3 600	4 300	2 800	
	180	60.3	2.1	525 000	605 000	2 800	3 800	1 600	
	180	60.3	2.1	420 000	605 000	2 600	—	1 600	23220CE4 *21320CAME4 21320CE4 *22320CAME4 <sup>(2)</sup>
	215	47	3	495 000	485 000	3 400	4 500	1 400	
	215	47	3	395 000	485 000	3 200	—	1 400	
	215	73	3	750 000	785 000	2 600	3 400	1 700	
110	170	45	2	293 000	465 000	3 200	—	2 000	23022CDE4 24022CE4 *23122CAME4
	170	60	2	380 000	645 000	2 600	—	1 600	
	180	56	2	480 000	630 000	3 200	4 000	1 600	
	180	56	2	385 000	630 000	2 600	—	1 600	23122CE4 *24122CAME4 24122CE4
	180	69	2	575 000	750 000	2 200	3 400	1 600	
	180	69	2	460 000	750 000	2 000	—	1 600	
	200	53	2.1	605 000	645 000	3 400	3 400	2 600	*22222EAE4 *23222CAME4 23222CE4
	200	69.8	2.1	645 000	760 000	2 600	3 400	1 500	
	200	69.8	2.1	515 000	760 000	2 200	—	1 500	
	240	50	3	565 000	545 000	3 000	4 300	1 300	*21322CAME4 *22322CAME4 <sup>(2)</sup>
	240	80	3	925 000	980 000	2 200	3 000	1 500	

**Notes** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

<sup>(2)</sup> EA bearings are also available. The load rating of EA bearings is around 10% higher than CAM bearings; please consult NSK for more information.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore <sup>(1)</sup>	$d_a$		$D_a$		$r_a$	$e$	$Y_2$	$Y_3$	$Y_0$	approx.
	min.	max.	max.	min.	max.					
*22219EAKE4	107	115	158	152	2	0.24	4.3	2.9	2.8	4.04
23219CAMKE4	107	—	158	146	2	0.32	3.1	2.1	2.0	5.33
*21319CAMKE4	109	—	186	172	2.5	0.22	4.6	3.1	3.0	6.92
21319CKE4	109	127	186	172	2.5	0.22	4.6	3.1	3.0	6.92
*22319EAKE4	109	121	186	172	2.5	0.33	3.1	2.1	2.0	9.91
23020CDKE4	109	112	141	136	1.5	0.22	4.6	3.1	3.0	2.31
24020CK30E4	109	110	141	132	1.5	0.30	3.4	2.3	2.2	3.08
23120CKE4	110	113	155	144	2	0.30	3.4	2.3	2.2	4.38
24120CAMK30E4	110	—	155	143	2	0.35	2.9	1.9	1.9	5.42
*22220EAKE4	112	119	168	160	2	0.24	4.3	2.9	2.8	4.84
*23220CAMKE4	112	—	168	155	2	0.32	3.2	2.1	2.1	6.6
23220CKE4	112	118	168	155	2	0.32	3.2	2.1	2.1	6.6
*21320CAMKE4	114	—	201	184	2.5	0.23	4.4	3.0	2.9	8.46
21320CKE4	114	133	201	184	2.5	0.21	4.7	3.2	3.1	8.46
*22320CAMKE4 <sup>(2)</sup>	114	—	201	184	2.5	0.35	2.9	1.9	1.9	12.7
23022CDKE4	120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
24022CK30E4	120	121	160	148	2	0.32	3.1	2.1	2.1	4.96
*23122CAMKE4	120	—	170	158	2	0.28	3.5	2.4	2.3	5.7
23122CKE4	120	127	170	158	2	0.28	3.5	2.4	2.3	5.7
*24122CAMK30E4	120	—	170	154	2	0.36	2.8	1.9	1.8	6.84
24122CK30E4	120	123	170	154	2	0.36	2.8	1.9	1.8	6.84
*22222EAKE4	122	129	188	178	2	0.25	4.0	2.7	2.6	6.99
*23222CAMKE4	122	—	188	170	2	0.34	3.0	2.0	1.9	9.54
23222CKE4	122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
*21322CAMKE4	124	—	226	206	2.5	0.22	4.6	3.1	3.0	11.2
*22322CAMKE4 <sup>(2)</sup>	124	—	226	206	2.5	0.35	2.9	1.9	1.9	17.6

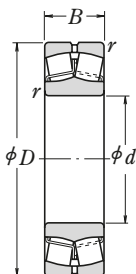
**Remarks**

- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
- The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
- For the dimensions of adapters and withdrawal sleeves, refer to Pages C351 and C357.

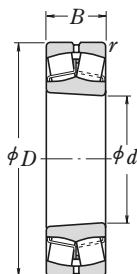


# SPHERICAL ROLLER BEARINGS

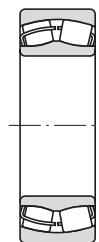
Bore Diameter 120 – 130 mm



Cylindrical Bore



Tapered Bore

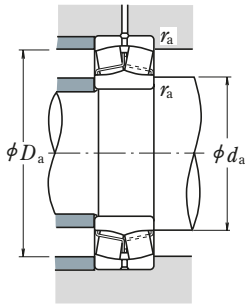


Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
120	180	46	2	395 000	525 000	3 200	4 500	1 800	*23024CAME4
	180	46	2	315 000	525 000	2 800	—	1 800	23024CDE4
	180	60	2	480 000	680 000	2 600	3 600	1 500	*24024CAME4
	180	60	2	395 000	705 000	2 400	—	1 500	24024CE4
	200	62	2	580 000	720 000	2 800	3 600	1 400	*23124CAME4
	200	62	2	465 000	720 000	2 400	—	1 400	23124CE4
	200	80	2	695 000	905 000	2 000	3 000	1 400	*24124CAME4
	200	80	2	575 000	950 000	1 800	—	1 400	24124CE4
	215	58	2.1	685 000	765 000	3 200	3 000	2 400	*22224EAE4
	215	76	2.1	790 000	970 000	2 200	3 000	1 300	*23224CAME4
	215	76	2.1	630 000	970 000	2 000	—	1 300	23224CE4
	260	86	3	1060 000	1 120 000	2 000	2 800	1 400	*22324CAME4 <sup>(2)</sup>
130	200	52	2	500 000	655 000	3 000	3 800	1 700	*23026CAME4
	200	52	2	400 000	655 000	2 800	—	1 700	23026CDE4
	200	69	2	620 000	865 000	2 200	3 200	1 400	*24026CAME4
	200	69	2	495 000	865 000	2 200	—	1 400	24026CE4
	210	64	2	630 000	825 000	2 600	3 400	1 300	*23126CAME4
	210	64	2	505 000	825 000	2 200	—	1 300	23126CE4
	210	80	2	735 000	1 010 000	1 800	2 800	1 300	*24126CAME4
	210	80	2	590 000	1 010 000	1 600	—	1 300	24126CE4
	230	64	3	820 000	940 000	2 800	2 600	2 200	*22226EAE4
	230	80	3	875 000	1 080 000	2 000	2 800	1 200	*23226CAME4
	230	80	3	700 000	1 080 000	1 800	—	1 200	23226CE4
	280	93	4	1 240 000	1 350 000	1 800	2 600	1 300	*22326CAME4
	280	93	4	995 000	1 350 000	1 900	—	1 300	22326CE4

**Notes** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

<sup>(2)</sup> EA bearings are also available. The load rating of EA bearings is around 10% higher than CAM bearings; please consult NSK for more information.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

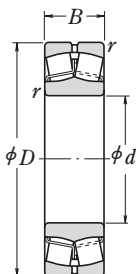
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore <sup>(1)</sup>	$d_a$		$D_a$		$r_a$	$e$	$Y_2$	$Y_3$	$Y_0$	approx.
	min.	max.	max.	min.	max.					
*23024CAMKE4	130	—	170	163	2	0.22	4.5	3.0	2.9	4.11
23024CDKE4	130	134	170	163	2	0.22	4.5	3.0	2.9	4.11
*24024CAMK30E4	130	—	170	158	2	0.32	3.2	2.1	2.1	5.33
24024CK30E4	130	131	170	158	2	0.32	3.2	2.1	2.1	5.33
*23124CAMKE4	130	—	190	175	2	0.29	3.5	2.4	2.3	7.85
23124CKE4	130	138	190	175	2	0.29	3.5	2.4	2.3	7.85
*24124CAMK30E4	130	—	190	171	2	0.37	2.7	1.8	1.8	10
24124CK30E4	130	136	190	171	2	0.37	2.7	1.8	1.8	10
*22224EAKE4	132	142	203	190	2	0.25	3.9	2.7	2.6	8.8
*23224CAMKE4	132	—	203	182	2	0.34	2.9	2.0	1.9	12.1
23224CKE4	132	140	203	182	2	0.34	2.9	2.0	1.9	12.1
*22324CAMKE4 <sup>(2)</sup>	134	—	246	222	2.5	0.35	2.9	1.9	1.9	22.2
*23026CAMKE4	140	—	190	180	2	0.23	4.3	2.9	2.8	5.98
23026CDKE4	140	147	190	180	2	0.23	4.3	2.9	2.8	5.98
*24026CAMK30E4	140	—	190	175	2	0.31	3.2	2.2	2.1	7.84
24026CK30E4	140	143	190	175	2	0.31	3.2	2.2	2.1	7.84
*23126CAMKE4	140	—	200	184	2	0.28	3.6	2.4	2.4	8.69
23126CKE4	140	149	200	184	2	0.28	3.6	2.4	2.4	8.69
*24126CAMK30E4	140	—	200	180	2	0.37	2.7	1.8	1.8	10.7
24126CK30E4	140	146	200	180	2	0.35	2.9	1.9	1.9	10.7
*22226EAKE4	144	152	216	204	2.5	0.26	3.8	2.6	2.5	11
*23226CAMKE4	144	—	216	196	2.5	0.34	2.9	2.0	1.9	14.3
23226CKE4	144	150	216	196	2.5	0.34	2.9	2.0	1.9	14.3
*22326CAMKE4	148	—	262	236	3	0.34	2.9	2.0	1.9	28.1
22326CKE4	148	166	262	236	3	0.34	2.9	2.0	1.9	28.1

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings. In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C351 and C357.

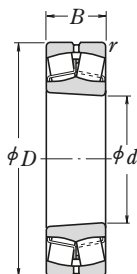


# SPHERICAL ROLLER BEARINGS

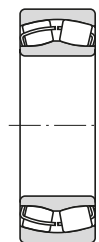
**Bore Diameter 140 – 150 mm**



Cylindrical Bore



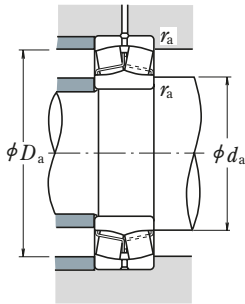
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
<b>140</b>	210	53	2	525 000	715 000	2 800	3 800	1 600	*23028CAME4
	210	53	2	420 000	715 000	2 400	—	1 600	23028CDE4
	210	69	2	635 000	905 000	2 200	3 000	1 300	*24028CAME4
	210	69	2	525 000	945 000	2 000	—	1 300	24028CE4
	225	68	2.1	725 000	945 000	2 400	3 200	1 200	*23128CAME4
	225	68	2.1	580 000	945 000	2 000	—	1 200	23128CE4
	225	85	2.1	835 000	1 160 000	1 600	2 600	1 200	*24128CAME4
	225	85	2.1	670 000	1 160 000	1 500	—	1 200	24128CE4
	250	68	3	835 000	945 000	2 600	3 200	1 400	*22228CAME4
	250	68	3	645 000	930 000	2 400	—	1 400	22228CDE4
	250	88	3	1 040 000	1 300 000	1 800	2 600	1 100	*23228CAME4
	250	88	3	835 000	1 300 000	1 600	—	1 100	23228CE4
	300	102	4	1 450 000	1 590 000	1 700	2 400	1 200	*22328CAME4
	300	102	4	1 160 000	1 590 000	1 700	—	1 200	22328CE4
<b>150</b>	225	56	2.1	590 000	815 000	2 600	3 600	1 400	*23030CAME4
	225	56	2.1	470 000	815 000	2 200	—	1 400	23030CDE4
	225	75	2.1	740 000	1 090 000	1 900	3 000	1 200	*24030CAME4
	225	75	2.1	590 000	1 090 000	1 800	—	1 200	24030CE4
	250	80	2.1	905 000	1 180 000	2 200	2 800	1 100	*23130CAME4
	250	80	2.1	725 000	1 180 000	1 800	—	1 100	23130CE4
	250	100	2.1	1 070 000	1 450 000	1 400	2 400	1 100	*24130CAME4
	250	100	2.1	890 000	1 530 000	1 300	—	1 100	24130CE4
	270	73	3	955 000	1 120 000	2 400	3 000	1 300	*22230CAME4
	270	73	3	765 000	1 120 000	2 200	—	1 300	22230CDE4
	270	96	3	1 220 000	1 560 000	1 700	2 400	1 100	*23230CAME4
	270	96	3	975 000	1 560 000	1 500	—	1 100	23230CE4
	320	108	4	1 530 000	1 690 000	1 600	2 200	1 100	*22330CAME4
	320	108	4	1 220 000	1 690 000	1 600	—	1 100	22330CE4

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

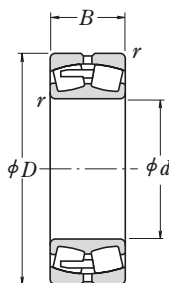
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$		$r_a$		$e$	$Y_2$	$Y_3$	
Tapered Bore <sup>(1)</sup>	min.	max.	max.	min.	max.					
*23028CAMKE4	150	—	200	190	2	0.22	4.5	3.0	2.9	6.49
23028CDKE4	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
*24028CAMK30E4	150	—	200	186	2	0.31	3.4	2.3	2.2	8.37
24028CK30E4	150	154	200	186	2	0.29	3.4	2.3	2.2	8.37
*23128CAMKE4	152	—	213	198	2	0.28	3.6	2.4	2.3	10.5
23128CKE4	152	158	213	198	2	0.28	3.6	2.4	2.3	10.5
*24128CAMK30E4	152	—	213	193	2	0.37	2.7	1.8	1.8	13
24128CK30E4	152	156	213	193	2	0.35	2.9	1.9	1.9	13
*22228CAMKE4	154	—	236	221	2.5	0.26	3.9	2.6	2.5	14.5
22228CDKE4	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
*23228CAMKE4	154	—	236	213	2.5	0.35	2.9	1.9	1.9	18.8
23228CKE4	154	163	236	213	2.5	0.35	2.9	1.9	1.9	18.8
*22328CAMKE4	158	—	282	253	3	0.35	2.9	1.9	1.9	35.4
22328CKE4	158	177	282	253	3	0.35	2.9	1.9	1.9	35.4
*23030CAMKE4	162	—	213	203	2	0.22	4.6	3.1	3.0	7.9
23030CDKE4	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
*24030CAMK30E4	162	—	213	198	2	0.30	3.4	2.3	2.2	10.5
24030CK30E4	162	165	213	198	2	0.30	3.4	2.3	2.2	10.5
*23130CAMKE4	162	—	238	218	2	0.30	3.4	2.3	2.2	15.8
23130CKE4	162	174	238	218	2	0.30	3.4	2.3	2.2	15.8
*24130CAMK30E4	162	—	238	212	2	0.38	2.6	1.8	1.7	19.8
24130CK30E4	162	169	238	212	2	0.38	2.6	1.8	1.7	19.8
*22230CAMKE4	164	—	256	236	2.5	0.26	3.9	2.6	2.5	18.4
22230CDKE4	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
*23230CAMKE4	164	—	256	230	2.5	0.35	2.9	1.9	1.9	24.2
23230CKE4	164	176	256	230	2.5	0.35	2.9	1.9	1.9	24.2
*22330CAMKE4	168	—	302	270	3	0.35	2.9	1.9	1.9	41.5

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C352 and C357 – C358.

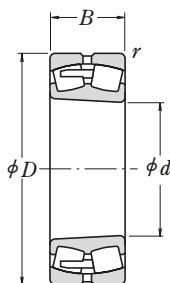


# SPHERICAL ROLLER BEARINGS

Bore Diameter 160 – 170 mm



Cylindrical Bore



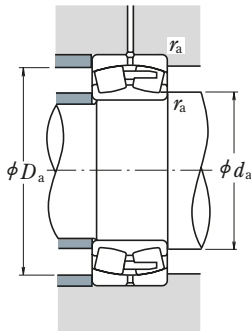
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
160	220	45	2	450 000	675 000	3 000	3 200	1 400	*23932CAME4
	240	60	2.1	675 000	955 000	2 400	3 200	1 300	*23032CAME4
	240	60	2.1	540 000	955 000	2 200	—	1 300	23032CDE4
	240	80	2.1	845 000	1 260 000	1 800	2 800	1 100	*24032CAME4
	240	80	2.1	680 000	1 260 000	1 700	—	1 100	24032CE4
	270	86	2.1	1 070 000	1 400 000	2 000	2 600	1 000	*23132CAME4
	270	86	2.1	855 000	1 400 000	1 700	—	1 000	23132CE4
	270	109	2.1	1 240 000	1 670 000	1 300	2 200	1 000	*24132CAME4
	270	109	2.1	1 040 000	1 760 000	1 200	—	1 000	24132CE4
	290	80	3	1 140 000	1 320 000	2 200	2 800	1 200	*22232CAME4
	290	80	3	910 000	1 320 000	2 000	—	1 200	22232CDE4
	290	104	3	1 370 000	1 770 000	1 500	2 200	1 000	*23232CAME4
	290	104	3	1 100 000	1 770 000	1 400	—	1 000	23232CE4
	340	114	4	1 700 000	1 900 000	1 400	2 200	1 100	*22332CAME4
	170	230	45	2	450 000	680 000	3 000	3 600	1 400
260		67	2.1	795 000	1 090 000	2 200	3 000	1 200	*23034CAME4
260		67	2.1	640 000	1 090 000	2 000	—	1 200	23034CDE4
260		90	2.1	1 030 000	1 520 000	1 600	2 400	1 000	*24034CAME4
260		90	2.1	825 000	1 520 000	1 500	—	1 000	24034CE4
280		88	2.1	1 180 000	1 570 000	1 800	2 600	1 000	*23134CAME4
280		88	2.1	940 000	1 570 000	1 500	—	1 000	23134CE4
280		109	2.1	1 280 000	1 770 000	1 200	2 200	1 000	*24134CAME4
280		109	2.1	1 080 000	1 860 000	1 100	—	1 000	24134CE4
310		86	4	1 240 000	1 500 000	2 000	2 600	1 100	*22234CAME4
310		86	4	990 000	1 500 000	1 800	—	1 100	22234CDE4
310		110	4	1 500 000	1 910 000	1 400	2 200	900	*23234CAME4
310		110	4	1 200 000	1 910 000	1 300	—	900	23234CE4
360		120	4	1 970 000	2 110 000	1 300	2 000	1 000	*22334CAME4

**Note** (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

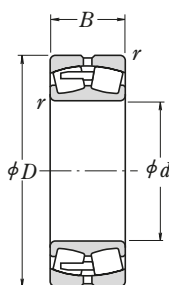
Designations  Tapered Bore <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)					Constant  $e$	Axial Load Factors			Mass (kg)  approx.
	$d_a$ min.	$d_a$ max.	$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
*23932CAMKE4	170	—	210	203	2	0.18	5.6	3.8	3.7	4.97
*23032CAMKE4	172	—	228	216	2	0.22	4.5	3.0	2.9	9.66
23032CDKE4	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
*24032CAMK30E4	172	—	228	212	2	0.30	3.4	2.3	2.2	12.7
24032CK30E4	172	177	228	212	2	0.30	3.4	2.3	2.2	12.7
*23132CAMKE4	172	—	258	234	2	0.30	3.4	2.3	2.2	20.3
23132CKE4	172	185	258	234	2	0.30	3.4	2.3	2.2	20.3
*24132CAMK30E4	172	—	258	229	2	0.39	2.6	1.7	1.7	25.4
24132CK30E4	172	179	258	229	2	0.39	2.6	1.7	1.7	25.4
*22232CAMKE4	174	—	276	255	2.5	0.26	3.8	2.6	2.5	23.1
22232CDKE4	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
*23232CAMKE4	174	—	276	245	2.5	0.34	2.9	2.0	1.9	30.5
23232CKE4	174	189	276	245	2.5	0.34	2.9	2.0	1.9	30.5
*22332CAMKE4	178	—	322	287	3	0.35	2.9	1.9	1.9	49.3
*23934CAMKE4	180	—	220	213	2	0.17	5.8	3.9	3.8	5.38
*23034CAMKE4	182	—	248	233	2	0.23	4.3	2.9	2.8	13
23034CDKE4	182	191	248	233	2	0.23	4.3	2.9	2.8	13
*24034CAMK30E4	182	—	248	228	2	0.31	3.2	2.2	2.1	17.3
24034CK30E4	182	188	248	228	2	0.31	3.2	2.2	2.1	17.3
*23134CAMKE4	182	—	268	245	2	0.29	3.5	2.3	2.3	21.8
23134CKE4	182	194	268	245	2	0.29	3.5	2.3	2.3	21.8
*24134CAMK30E4	182	—	268	239	2	0.38	2.7	1.8	1.7	26.6
24134CK30E4	182	190	268	239	2	0.37	2.7	1.8	1.8	26.6
*22234CAMKE4	188	—	292	270	3	0.26	3.8	2.6	2.5	28.8
22234CDKE4	188	206	292	270	3	0.26	3.8	2.6	2.5	28.8
*23234CAMKE4	188	—	292	261	3	0.35	2.9	1.9	1.9	36.4
23234CKE4	188	201	292	261	3	0.34	2.9	2.0	1.9	36.4
*22334CAMKE4	188	—	342	304	3	0.35	2.9	1.9	1.9	57.9

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to 0.10 $C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C352 and C358.

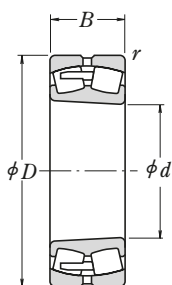


# ■ SPHERICAL ROLLER BEARINGS

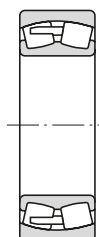
**Bore Diameter 180 – 190 mm**



Cylindrical Bore



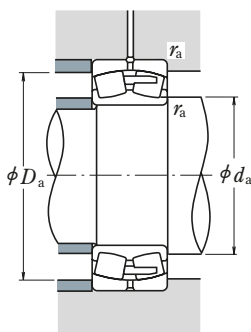
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
180	250	52	2	590 000	890 000	2 600	3 000	1 200	*23936CAME4
	280	74	2.1	935 000	1 270 000	2 000	2 800	1 200	*23036CAME4
	280	74	2.1	750 000	1 270 000	1 900	—	1 200	23036CDE4
	280	100	2.1	1 210 000	1 750 000	1 500	2 200	950	*24036CAME4
	280	100	2.1	965 000	1 750 000	1 400	—	950	24036CE4
	300	96	3	1 320 000	1 760 000	1 700	2 200	900	*23136CAME4
	300	96	3	1 050 000	1 760 000	1 400	—	900	23136CE4
	300	118	3	1 490 000	2 040 000	1 100	2 000	900	*24136CAME4
	300	118	3	1 190 000	2 040 000	1 000	—	900	24136CE4
	320	86	4	1 280 000	1 540 000	2 000	2 600	1 100	*22236CAME4
	320	86	4	1 020 000	1 540 000	1 800	—	1 100	22236CDE4
	320	112	4	1 620 000	2 110 000	1 300	2 000	850	*23236CAME4
	320	112	4	1 300 000	2 110 000	1 200	—	850	23236CE4
	380	126	4	2 170 000	2 340 000	1 200	2 000	950	*22336CAME4
	190	260	52	2	575 000	875 000	2 600	3 000	1 200
290		75	2.1	970 000	1 350 000	2 000	2 600	1 100	*23038CAME4
290		100	2.1	1 220 000	1 840 000	1 400	2 200	900	*24038CAME4
290		100	2.1	975 000	1 840 000	1 400	—	900	24038CE4
320		104	3	1 480 000	2 020 000	1 600	2 200	850	*23138CAME4
320		104	3	1 190 000	2 020 000	1 300	—	850	23138CE4
320		128	3	1 710 000	2 330 000	1 000	1 900	850	*24138CAME4
320		128	3	1 370 000	2 330 000	950	—	850	24138CE4
340		92	4	1 420 000	1 730 000	1 800	2 400	1 000	*22238CAME4
340		120	4	1 800 000	2 350 000	1 200	1 900	800	*23238CAME4
340		120	4	1 440 000	2 350 000	1 100	—	800	23238CE4
400		132	5	2 370 000	2 590 000	1 200	1 900	900	*22338CAME4

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$		$r_a$		$e$	$Y_2$	$Y_3$	
	min.	max.	max.	min.	max.					approx.
*23936CAMKE4	190	—	240	230	2	0.18	5.5	3.7	3.6	7.64
*23036CAMKE4	192	—	268	249	2	0.24	4.2	2.8	2.8	17.1
23036CDKE4	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
*24036CAMK30E4	192	—	268	245	2	0.32	3.1	2.1	2.0	22.7
24036CK30E4	192	200	268	245	2	0.32	3.1	2.1	2.0	22.7
*23136CAMKE4	194	—	286	260	2.5	0.31	3.3	2.2	2.2	27.5
23136CKE4	194	206	286	260	2.5	0.30	3.4	2.3	2.2	27.5
*24136CAMK30E4	194	—	286	255	2.5	0.37	2.7	1.8	1.8	33.1
24136CK30E4	194	202	286	255	2.5	0.37	2.7	1.8	1.8	33.1
*22236CAMKE4	198	—	302	278	3	0.26	3.9	2.6	2.6	30.2
22236CDKE4	198	212	302	278	3	0.26	3.9	2.6	2.6	30.2
*23236CAMKE4	198	—	302	274	3	0.35	2.9	1.9	1.9	38.9
23236CKE4	198	211	302	274	3	0.33	3.0	2.0	2.0	38.9
*22336CAMKE4	198	—	362	322	3	0.34	2.9	2.0	1.9	67
*23938CAMKE4	200	—	250	240	2	0.18	5.7	3.8	3.7	8.03
*23038CAMKE4	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
*24038CAMK30E4	202	—	278	253	2	0.32	3.1	2.1	2.0	24
24038CK30E4	202	210	278	253	2	0.31	3.2	2.2	2.1	24
*23138CAMKE4	204	—	306	276	2.5	0.31	3.2	2.2	2.1	34.5
23138CKE4	204	219	306	276	2.5	0.31	3.3	2.2	2.2	34.5
*24138CAMK30E4	204	—	306	269	2.5	0.40	2.5	1.7	1.6	41.5
24138CK30E4	204	211	306	269	2.5	0.40	2.5	1.7	1.6	41.5
*22238CAMKE4	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
*23238CAMKE4	208	—	322	288	3	0.35	2.8	1.9	1.9	47.6
23238CKE4	208	222	322	288	3	0.35	2.9	1.9	1.9	47.6
*22338CAMKE4	212	—	378	338	4	0.34	2.9	2.0	1.9	77.6

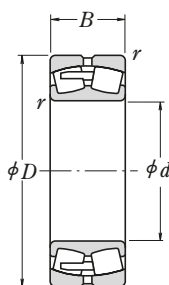
**Remarks**

- Bearings denoted by an asterisk (\*) are NSKHPs bearings; they come standard with an oil groove and holes.
- The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPs bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
- For the dimensions of adapters and withdrawal sleeves, refer to Pages C352 and C358.

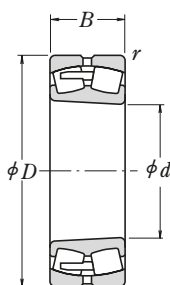


# ■ SPHERICAL ROLLER BEARINGS

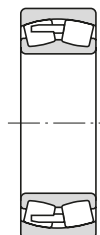
**Bore Diameter 200 – 220 mm**



Cylindrical Bore



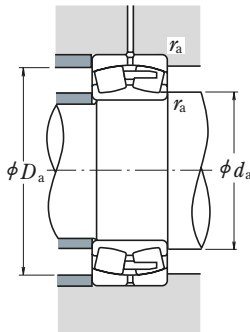
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
200	280	60	2.1	710 000	1 060 000	2 400	2 600	1 100	*23940CAME4
	310	82	2.1	1 180 000	1 700 000	1 800	2 400	1 000	*23040CAME4
	310	109	2.1	1 420 000	2 120 000	1 300	2 000	850	*24040CAME4
	310	109	2.1	1 140 000	2 120 000	1 300	—	850	24040CE4
	340	112	3	1 700 000	2 330 000	1 500	2 000	800	*23140CAME4
	340	112	3	1 360 000	2 330 000	1 200	—	800	23140CE4
	340	140	3	1 960 000	2 660 000	950	1 800	800	*24140CAME4
	340	140	3	1 570 000	2 670 000	900	—	800	24140CE4
	360	98	4	1 620 000	2 010 000	1 700	2 200	950	*22240CAME4
	360	128	4	2 070 000	2 750 000	1 100	1 800	750	*23240CAME4
	360	128	4	1 660 000	2 750 000	1 000	—	750	23240CE4
	420	138	5	2 500 000	2 990 000	1 100	1 700	850	*22340CAME4
	300	60	2.1	785 000	1 240 000	2 200	2 600	1 000	*23944CAME4
	340	90	3	1 360 000	1 980 000	1 600	2 200	950	*23044CAME4
	340	118	3	1 640 000	2 490 000	1 200	1 900	750	*24044CAME4
220	340	118	3	1 360 000	2 600 000	1 100	—	750	24044CE4
	370	120	4	1 960 000	2 710 000	1 300	1 800	710	*23144CAME4
	370	120	4	1 570 000	2 710 000	1 100	—	710	23144CE4
	370	150	4	2 250 000	3 200 000	850	1 600	710	*24144CAME4
	370	150	4	1 800 000	3 200 000	750	—	710	24144CE4
	400	108	4	1 960 000	2 430 000	1 500	2 000	850	*22244CAME4
	400	144	4	2 520 000	3 400 000	1 000	1 600	670	*23244CAME4
	400	144	4	2 020 000	3 400 000	850	—	670	23244CE4
	460	145	5	2 940 000	3 400 000	950	1 600	750	*22344CAME4

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

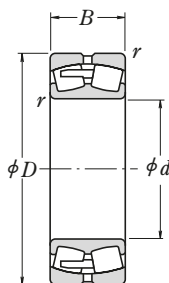
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore <sup>(1)</sup>	$d_a$		$D_a$		$r_a$	$e$	$Y_2$	$Y_3$	$Y_0$	approx.
	min.	max.	max.	min.	max.					
*23940CAMKE4	212	—	268	258	2	0.20	5.1	3.4	3.3	11
*23040CAMKE4	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
*24040CAMK30E4	212	—	298	271	2	0.33	3.0	2.0	2.0	30.4
24040CK30E4	212	223	298	271	2	0.32	3.1	2.1	2.0	30.4
*23140CAMKE4	214	—	326	293	2.5	0.32	3.2	2.1	2.1	42.7
23140CKE4	214	232	326	293	2.5	0.31	3.2	2.2	2.1	42.7
*24140CAMK30E4	214	—	326	290	2.5	0.39	2.5	1.7	1.7	51.3
24140CK30E4	214	226	326	290	2.5	0.39	2.6	1.8	1.7	51.3
*22240CAMKE4	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
*23240CAMKE4	218	—	342	307	3	0.35	2.9	1.9	1.9	57.1
23240CKE4	218	237	342	307	3	0.34	2.9	2.0	1.9	57.1
*22340CAMKE4	222	—	398	352	4	0.34	2.9	2.0	1.9	92.6
*23944CAMKE4	232	—	288	278	2	0.18	5.7	3.8	3.7	12.2
*23044CAMKE4	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
*24044CAMK30E4	234	—	326	296	2.5	0.32	3.2	2.1	2.1	40.5
24044CK30E4	234	244	326	296	2.5	0.31	3.2	2.1	2.1	40.5
*23144CAMKE4	238	—	352	320	3	0.31	3.3	2.2	2.2	53
23144CKE4	238	254	352	320	3	0.30	3.3	2.2	2.2	53
*24144CAMK30E4	238	—	352	313	3	0.39	2.6	1.7	1.7	66.7
24144CK30E4	238	248	352	313	3	0.39	2.6	1.7	1.7	66.7
*22244CAMKE4	238	—	382	348	3	0.27	3.7	2.5	2.4	59
*23244CAMKE4	238	—	382	337	3	0.36	2.8	1.9	1.8	80.4
23244CKE4	238	260	382	337	3	0.35	2.9	1.9	1.9	80.4
*22344CAMKE4	242	—	438	391	4	0.33	3.0	2.0	2.0	116

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C353 and C359.

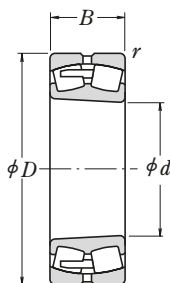


# ■ SPHERICAL ROLLER BEARINGS

**Bore Diameter 240 – 280 mm**



Cylindrical Bore



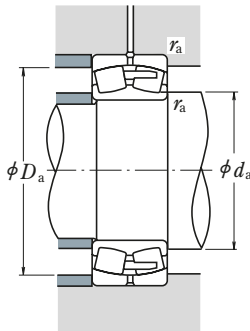
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )			Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Thermal Reference Speed	Limiting Speeds		Cylindrical Bore
						Mechanical	Grease		
240	320	60	2.1	795 000	1 300 000	1 900	2 600	950	*23948CAME4
	360	92	3	1 450 000	2 140 000	1 500	2 200	850	*23048CAME4
	360	118	3	1 730 000	2 730 000	1 100	1 800	710	*24048CAME4
	360	118	3	1 390 000	2 730 000	1 000	—	710	24048CE4
	400	128	4	2 230 000	3 100 000	1 200	1 700	670	*23148CAME4
	400	128	4	1 790 000	3 100 000	1 000	—	670	23148CE4
	400	160	4	2 660 000	3 800 000	750	1 500	670	*24148CAME4
	400	160	4	2 130 000	3 800 000	670	—	670	24148CE4
	440	120	4	2 340 000	2 890 000	1 400	1 800	750	*22248CAME4
	440	160	4	3 050 000	4 050 000	850	1 500	630	*23248CAME4
	500	155	5	3 250 000	3 800 000	850	1 500	670	*22348CAME4
	260	360	75	2.1	1 170 000	1 870 000	1 800	2 200	850
400		104	4	1 780 000	2 580 000	1 300	1 900	800	*23052CAME4
400		140	4	2 270 000	3 500 000	950	1 600	630	*24052CAME4
440		144	4	2 700 000	3 750 000	1 100	1 500	600	*23152CAME4
440		180	4	3 200 000	4 700 000	630	1 300	600	*24152CAME4
480		130	5	2 720 000	3 400 000	1 200	1 700	670	*22252CAME4
480		174	5	3 400 000	4 550 000	800	1 400	560	*23252CAME4
540		165	6	3 900 000	4 600 000	750	1 400	630	*22352CAME4
380		75	2.1	1 160 000	1 950 000	1 600	2 000	800	*23956CAME4
420		106	4	1 930 000	2 950 000	1 200	1 800	710	*23056CAME4
420		140	4	2 350 000	3 800 000	850	1 500	600	*24056CAME4
280		460	146	5	2 790 000	4 000 000	1 000	1 500	560
	460	180	5	3 300 000	5 000 000	600	1 300	560	*24156CAME4
	500	130	5	2 850 000	3 650 000	1 100	1 600	630	*22256CAME4
	500	176	5	3 600 000	4 900 000	750	1 300	530	*23256CAME4
	580	175	6	4 350 000	5 150 000	670	1 300	560	*22356CAME4
	580	175	6	4 350 000	5 150 000	670	1 300	560	

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

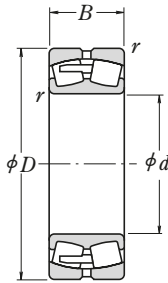
Designations  Tapered Bore <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)					Constant  $e$	Axial Load Factors			Mass (kg)  approx.
	$d_a$ min.	$d_a$ max.	$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
*23948CAMKE4	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
*23048CAMKE4	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
*24048CAMK30E4	254	—	346	317	2.5	0.30	3.4	2.3	2.2	43.4
24048CK30E4	254	265	346	317	2.5	0.29	3.4	2.3	2.2	43.4
*23148CAMKE4	258	—	382	347	3	0.31	3.3	2.2	2.2	66.9
23148CKE4	258	275	382	347	3	0.30	3.3	2.2	2.2	66.9
*24148CAMK30E4	258	—	382	341	3	0.38	2.7	1.8	1.8	79.5
24148CK30E4	258	268	382	341	3	0.38	2.7	1.8	1.8	79.5
*22248CAMKE4	258	—	422	383	3	0.27	3.7	2.5	2.4	80.2
*23248CAMKE4	258	—	422	372	3	0.37	2.7	1.8	1.8	106
*22348CAMKE4	262	—	478	423	4	0.32	3.2	2.1	2.1	147
*23952CAMKE4	272	—	348	333	2	0.19	5.4	3.6	3.5	23
*23052CAMKE4	278	—	382	356	3	0.25	4.1	2.7	2.7	46.6
*24052CAMK30E4	278	—	382	348	3	0.32	3.1	2.1	2.1	62.6
*23152CAMKE4	278	—	422	380	3	0.32	3.2	2.1	2.1	88.2
*24152CAMK30E4	278	—	422	371	3	0.39	2.6	1.7	1.7	109
*22252CAMKE4	282	—	458	418	4	0.27	3.7	2.5	2.5	104
*23252CAMKE4	282	—	458	406	4	0.37	2.7	1.8	1.8	137
*22352CAMKE4	288	—	512	462	5	0.32	3.2	2.1	2.1	180
*23956CAMKE4	292	—	368	351	2	0.18	5.7	3.8	3.8	24.5
*23056CAMKE4	298	—	402	377	3	0.24	4.2	2.8	2.7	50.5
*24056CAMK30E4	298	—	402	369	3	0.31	3.3	2.2	2.2	66.4
*23156CAMKE4	302	—	438	400	4	0.30	3.3	2.2	2.2	94.3
*24156CAMK30E4	302	—	438	392	4	0.37	2.7	1.8	1.8	115
*22256CAMKE4	302	—	478	439	4	0.25	4.0	2.7	2.6	110
*23256CAMKE4	302	—	478	425	4	0.35	2.9	1.9	1.9	147
*22356CAMKE4	308	—	552	496	5	0.31	3.2	2.1	2.1	221

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C353 and C359.

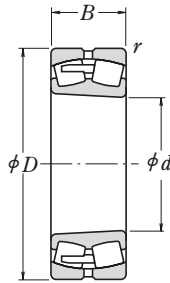


# SPHERICAL ROLLER BEARINGS

**Bore Diameter 300 – 380 mm**



Cylindrical Bore



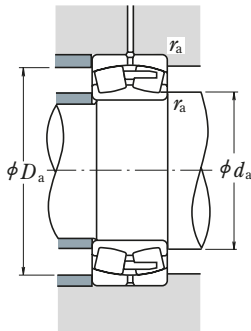
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
300	420	90	3	1 540 000	2 490 000	1 500	1 800	710	*23960CAME4
	460	118	4	2 400 000	3 700 000	1 100	1 600	670	*23060CAME4
	460	160	4	2 890 000	4 600 000	800	1 400	530	*24060CAME4
	500	160	5	3 350 000	4 800 000	900	1 400	500	*23160CAME4
	500	200	5	3 900 000	5 800 000	530	1 200	500	*24160CAME4
	540	140	5	3 250 000	4 250 000	1 000	1 500	600	*22260CAME4
	540	192	5	4 250 000	5 900 000	670	1 200	480	*23260CAME4
	320	440	90	3	1 620 000	2 750 000	1 400	1 700	670
480	121	4	2 450 000	3 850 000	1 000	1 600	630	*23064CAME4	
480	160	4	3 050 000	5 050 000	710	1 300	500	*24064CAME4	
540	176	5	3 850 000	5 500 000	800	1 300	480	*23164CAME4	
540	218	5	4 400 000	6 650 000	480	1 100	480	*24164CAME4	
580	150	5	3 750 000	4 850 000	950	1 400	530	*22264CAME4	
580	208	5	4 850 000	6 900 000	600	1 100	450	*23264CAME4	
340	460	90	3	1 670 000	2 840 000	1 300	1 700	630	*23968CAME4
	520	133	5	2 850 000	4 400 000	950	1 500	560	*23068CAME4
	520	180	5	3 650 000	6 050 000	670	1 200	480	*24068CAME4
	580	190	5	4 500 000	6 600 000	710	1 200	430	*23168CAME4
	580	243	5	5 300 000	7 900 000	450	1 000	430	*24168CAME4
	620	224	6	4 400 000	7 800 000	480	—	400	23268CAME4
360	480	90	3	1 730 000	3 050 000	1 200	1 700	600	*23972CAME4
	540	134	5	2 990 000	4 700 000	900	1 400	530	*23072CAME4
	540	180	5	3 650 000	6 100 000	630	1 200	450	*24072CAME4
	600	192	5	4 800 000	7 100 000	670	1 100	400	*23172CAME4
	600	243	5	5 250 000	8 000 000	430	1 000	400	*24172CAME4
	650	232	6	4 800 000	8 550 000	450	—	380	23272CAME4
380	520	106	4	2 340 000	4 100 000	1 100	1 500	530	*23976CAME4
	560	135	5	3 150 000	5 100 000	850	1 400	530	*23076CAME4
	560	180	5	3 850 000	6 600 000	600	1 200	430	*24076CAME4
	620	194	5	4 000 000	7 600 000	530	—	400	23176CAME4
	620	243	5	4 350 000	8 450 000	360	—	400	24176CAME4
	680	240	6	5 150 000	9 200 000	430	—	360	23276CAME4

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

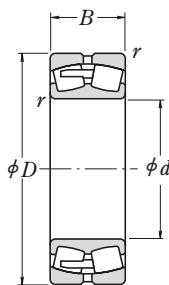
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore <sup>(1)</sup>	$d_a$		$D_a$		$r_a$	$e$	$Y_2$	$Y_3$	$Y_0$	approx.
	min.	max.	max.	min.	max.					
*23960CAMKE4	314	—	406	386	2.5	0.19	5.2	3.5	3.4	38.2
*23060CAMKE4	318	—	442	413	3	0.24	4.2	2.8	2.7	70.5
*24060CAMK30E4	318	—	442	400	3	0.32	3.1	2.1	2.0	93.6
*23160CAMKE4	322	—	478	433	4	0.31	3.3	2.2	2.2	125
*24160CAMK30E4	322	—	478	423	4	0.38	2.6	1.8	1.7	152
*22260CAMKE4	322	—	518	473	4	0.25	4.0	2.7	2.6	139
*23260CAMKE4	322	—	518	458	4	0.35	2.9	1.9	1.9	189
*23964CAMKE4	334	—	426	406	2.5	0.18	5.5	3.7	3.6	40.6
*23064CAMKE4	338	—	462	432	3	0.24	4.2	2.8	2.8	75.6
*24064CAMK30E4	338	—	462	422	3	0.31	3.3	2.2	2.2	99.7
*23164CAMKE4	342	—	518	466	4	0.31	3.2	2.1	2.1	162
*24164CAMK30E4	342	—	518	456	4	0.39	2.6	1.7	1.7	196
*22264CAMKE4	342	—	558	508	4	0.26	3.9	2.6	2.6	174
*23264CAMKE4	342	—	558	488	4	0.36	2.8	1.9	1.8	239
*23968CAMKE4	354	—	446	427	2.5	0.18	5.7	3.8	3.7	42.4
*23068CAMKE4	362	—	498	465	4	0.24	4.2	2.8	2.8	101
*24068CAMK30E4	362	—	498	454	4	0.32	3.2	2.1	2.1	135
*23168CAMKE4	362	—	558	499	4	0.31	3.2	2.1	2.1	206
*24168CAMK30E4	362	—	558	489	4	0.40	2.5	1.7	1.7	257
23268CAMKE4	368	—	592	521	5	0.36	2.8	1.9	1.8	295
*23972CAMKE4	374	—	466	447	2.5	0.17	6.0	4.1	4.0	44.7
*23072CAMKE4	382	—	518	485	4	0.24	4.2	2.8	2.8	106
*24072CAMK30E4	382	—	518	476	4	0.32	3.2	2.1	2.1	139
*23172CAMKE4	382	—	578	520	4	0.31	3.2	2.2	2.1	217
*24172CAMK30E4	382	—	578	507	4	0.40	2.5	1.7	1.7	264
23272CAMKE4	388	—	622	549	5	0.36	2.8	1.9	1.8	342
*23976CAMKE4	398	—	502	482	3	0.18	5.5	3.7	3.6	65.4
*23076CAMKE4	402	—	538	506	4	0.22	4.5	3.0	3.0	113
*24076CAMK30E4	402	—	538	496	4	0.29	3.4	2.3	2.3	148
23176CAMKE4	402	—	598	540	4	0.30	3.3	2.2	2.2	229
24176CAMK30E4	402	—	598	529	4	0.38	2.6	1.8	1.7	275
23276CAMKE4	408	—	652	578	5	0.35	2.9	1.9	1.9	372

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as 0.05 to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C354 and C360.

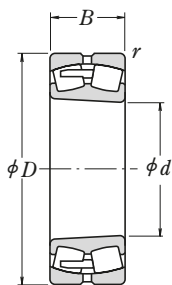


# ■ SPHERICAL ROLLER BEARINGS

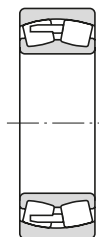
**Bore Diameter 400 – 460 mm**



Cylindrical Bore



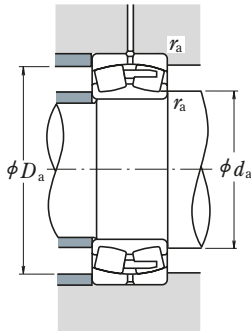
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
<b>400</b>	540	106	4	2 370 000	4 250 000	1 000	1 400	530	* <b>23980CAME4</b> * <b>23080CAME4</b> * <b>24080CAME4</b>
	600	148	5	3 700 000	5 900 000	800	1 300	480	
	600	200	5	4 500 000	7 600 000	560	1 100	400	
	650	200	6	4 150 000	7 900 000	500	—	380	<b>23180CAME4</b> <b>24180CAME4</b> <b>23280CAME4</b>
	650	250	6	4 950 000	10 100 000	320	—	380	
	720	256	6	5 800 000	10 400 000	380	—	340	
	560	106	4	2 340 000	4 250 000	1 000	1 400	500	* <b>23984CAME4</b> * <b>23084CAME4</b> * <b>24084CAME4</b>
	620	150	5	2 910 000	5 850 000	670	—	450	
	620	200	5	3 750 000	8 100 000	480	—	380	
	700	224	6	5 000 000	9 400 000	480	—	340	<b>23184CAME4</b> <b>24184CAME4</b> <b>23284CAME4</b>
<b>420</b>	700	280	6	6 000 000	12 000 000	280	—	340	
	760	272	7.5	6 450 000	11 700 000	360	—	320	
	600	118	4	2 190 000	4 800 000	630	—	450	<b>23988CAME4</b> <b>23088CAME4</b> <b>24088CAME4</b>
	650	157	6	3 150 000	6 350 000	630	—	430	
	650	212	6	4 150 000	9 100 000	450	—	360	
	720	226	6	5 300 000	10 300 000	430	—	320	<b>23188CAME4</b> <b>24188CAME4</b> <b>23288CAME4</b>
	720	280	6	6 000 000	12 100 000	280	—	320	
	790	280	7.5	6 900 000	12 800 000	340	—	300	
	620	118	4	2 220 000	4 950 000	600	—	430	<b>23992CAME4</b> <b>23092CAME4</b> <b>24092CAME4</b>
	680	163	6	3 450 000	7 100 000	600	—	400	
	680	218	6	4 500 000	9 950 000	430	—	340	
<b>460</b>	760	240	7.5	5 700 000	10 900 000	430	—	300	<b>23192CAME4</b> <b>24192CAME4</b> <b>23292CAME4</b>
	760	300	7.5	6 300 000	12 400 000	280	—	300	
	830	296	7.5	7 350 000	13 700 000	320	—	280	

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

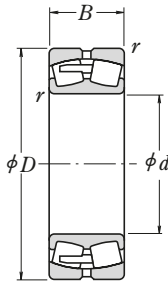
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$	$r_a$			$e$	$Y_2$	$Y_3$	
Tapered Bore <sup>(1)</sup>	min.	max.	max.	min.	max.					approx.
*23980CAMKE4	418	—	522	501	3	0.18	5.7	3.9	3.8	69.1
*23080CAMKE4	422	—	578	540	4	0.23	4.4	3.0	2.9	146
*24080CAMK30E4	422	—	578	527	4	0.31	3.3	2.2	2.2	193
23180CAMKE4	428	—	622	569	5	0.29	3.4	2.3	2.3	257
24180CAMK30E4	428	—	622	551	5	0.37	2.7	1.8	1.8	316
23280CAMKE4	428	—	692	610	5	0.36	2.8	1.9	1.9	449
*23984CAMKE4	438	—	542	521	3	0.17	6.0	4.0	3.9	71.6
23084CAMKE4	442	—	598	562	4	0.23	4.3	2.9	2.8	151
24084CAMK30E4	442	—	598	549	4	0.31	3.2	2.2	2.1	199
23184CAMKE4	448	—	672	607	5	0.31	3.3	2.2	2.2	341
24184CAMK30E4	448	—	672	598	5	0.38	2.6	1.8	1.7	421
23284CAMKE4	456	—	724	644	6	0.35	2.9	1.9	1.9	534
23988CAMKE4	458	—	582	555	3	0.18	5.7	3.9	3.8	96.3
23088CAMKE4	468	—	622	587	5	0.23	4.3	2.9	2.8	173
24088CAMK30E4	468	—	622	576	5	0.31	3.2	2.1	2.1	237
23188CAMKE4	468	—	692	627	5	0.3	3.3	2.2	2.2	360
24188CAMK30E4	468	—	692	617	5	0.37	2.7	1.8	1.8	433
23288CAMKE4	476	—	754	669	6	0.35	2.9	1.9	1.9	594
23992CAMKE4	478	—	602	575	3	0.17	5.9	4.0	3.9	100
23092CAMKE4	488	—	652	615	5	0.22	4.6	3.1	3.0	201
24092CAMK30E4	488	—	652	604	5	0.29	3.4	2.3	2.3	266
23192CAMKE4	496	—	724	661	6	0.31	3.3	2.2	2.2	423
24192CAMK30E4	496	—	724	646	6	0.39	2.6	1.7	1.7	512
23292CAMKE4	496	—	794	702	6	0.37	2.8	1.9	1.8	691

- Remarks**
- Bearings denoted by an asterisk (\*) are NSKHPS bearings; they come standard with an oil groove and holes.
  - The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.  
In this case, light loads are defined as  $\leq 0.05C_r$ , normal loads as  $0.05$  to  $0.10C_r$ , and heavy loads as  $> 0.10C_r$ .
  - For the dimensions of adapters and withdrawal sleeves, refer to Pages C354 – C355 and C360 – C361.

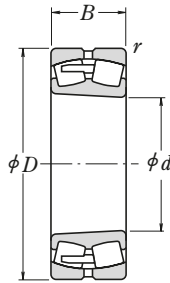


# ■ SPHERICAL ROLLER BEARINGS

**Bore Diameter 480 – 560 mm**



Cylindrical Bore



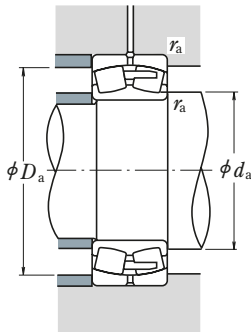
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Thermal Reference Speed	Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
<b>480</b>	650	128	5	2 580 000	5 850 000	560	—	400	<b>23996CAME4</b> <b>23096CAME4</b> <b>24096CAME4</b>
	700	165	6	3 800 000	7 950 000	560	—	400	
	700	218	6	4 600 000	10 200 000	400	—	320	
	790	248	7.5	6 050 000	11 700 000	400	—	300	<b>23196CAME4</b> <b>24196CAME4</b> <b>23296CAME4</b>
	790	308	7.5	7 150 000	14 600 000	240	—	300	
	870	310	7.5	7 850 000	14 400 000	300	—	260	
	870	310	7.5	7 850 000	14 400 000	300	—	260	<b>239/500CAME4</b> <b>230/500CAME4</b> <b>240/500CAME4</b>
	720	167	6	3 750 000	8 100 000	530	—	380	
	720	218	6	4 450 000	9 900 000	400	—	300	
<b>500</b>	830	264	7.5	6 850 000	13 400 000	360	—	280	<b>231/500CAME4</b> <b>241/500CAME4</b> <b>232/500CAME4</b>
	830	325	7.5	8 000 000	16 000 000	220	—	280	
	920	336	7.5	9 000 000	16 600 000	280	—	260	
	710	136	5	2 930 000	6 800 000	500	—	360	<b>239/530CAME4</b> <b>230/530CAME4</b> <b>240/530CAME4</b>
	780	185	6	4 400 000	9 200 000	500	—	340	
	780	250	6	5 400 000	11 800 000	360	—	280	
	870	272	7.5	7 150 000	14 100 000	340	—	260	<b>231/530CAME4</b> <b>241/530CAME4</b> <b>232/530CAME4</b>
	870	335	7.5	8 500 000	17 500 000	200	—	260	
	980	355	9.5	10 100 000	18 800 000	260	—	240	
<b>560</b>	750	140	5	3 100 000	7 250 000	480	—	340	<b>239/560CAME4</b> <b>230/560CAME4</b> <b>240/560CAME4</b>
	820	195	6	5 000 000	10 700 000	450	—	320	
	820	258	6	5 950 000	13 300 000	340	—	260	
	920	280	7.5	7 850 000	15 500 000	320	—	240	<b>231/560CAME4</b> <b>241/560CAME4</b> <b>232/560CAME4</b>
	920	355	7.5	9 400 000	19 600 000	190	—	240	
	1 030	365	9.5	10 900 000	20 500 000	240	—	220	

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

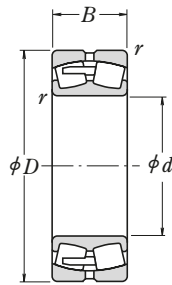
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$	$r_a$			$e$	$Y_2$	$Y_3$	
	min.	max.	max.	min.	max.					
Tapered Bore <sup>(1)</sup>										approx.
23996CAMKE4	502	—	628	602	4	0.18	5.7	3.8	3.7	121
23096CAMKE4	508	—	672	633	5	0.22	4.6	3.1	3.0	211
24096CAMK30E4	508	—	672	625	5	0.30	3.4	2.3	2.2	270
23196CAMKE4	516	—	754	688	6	0.31	3.3	2.2	2.2	475
24196CAMK30E4	516	—	754	670	6	0.39	2.6	1.7	1.7	567
23296CAMKE4	516	—	834	733	6	0.37	2.8	1.9	1.8	795
239/500CAMKE4	522	—	648	622	4	0.17	6.0	4.0	3.9	124
230/500CAMKE4	528	—	692	655	5	0.21	4.8	3.2	3.1	220
240/500CAMK30E4	528	—	692	643	5	0.30	3.4	2.3	2.2	276
231/500CAMKE4	536	—	794	720	6	0.31	3.2	2.2	2.1	567
241/500CAMK30E4	536	—	794	703	6	0.39	2.6	1.7	1.7	666
232/500CAMKE4	536	—	884	773	6	0.38	2.7	1.8	1.8	969
239/530CAMKE4	552	—	688	659	4	0.17	6.0	4.0	3.9	149
230/530CAMKE4	558	—	752	706	5	0.22	4.6	3.1	3.0	298
240/530CAMK30E4	558	—	752	690	5	0.31	3.3	2.2	2.2	390
231/530CAMKE4	566	—	834	758	6	0.30	3.3	2.2	2.2	628
241/530CAMK30E4	566	—	834	740	6	0.38	2.6	1.8	1.7	773
232/530CAMKE4	574	—	936	824	8	0.38	2.7	1.8	1.7	1 170
239/560CAMKE4	582	—	728	697	4	0.16	6.1	4.1	4.0	172
230/560CAMKE4	588	—	792	742	5	0.22	4.5	3.0	2.9	344
240/560CAMK30E4	588	—	792	729	5	0.30	3.3	2.2	2.2	440
231/560CAMKE4	596	—	884	804	6	0.30	3.4	2.3	2.2	727
241/560CAMK30E4	596	—	884	782	6	0.39	2.6	1.8	1.7	886
232/560CAMKE4	604	—	986	870	8	0.36	2.8	1.9	1.8	1 320

**Remark** For the dimensions of adapters and withdrawal sleeves, refer to Pages C355 and C361.

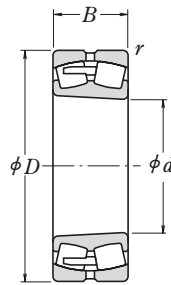


# SPHERICAL ROLLER BEARINGS

**Bore Diameter 600 – 750 mm**



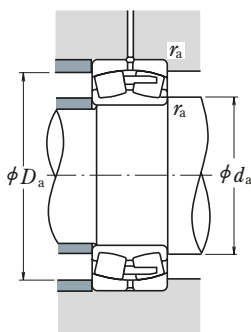
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )			Bearing
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	Thermal Reference Speed	Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
<b>600</b>	800	150	5	3 450 000	8 100 000	450	—	320	<b>239/600CAME4</b> <b>230/600CAME4</b> <b>240/600CAME4</b>
	870	200	6	5 450 000	12 200 000	400	—	300	
	870	272	6	6 600 000	15 100 000	300	—	240	
	980	300	7.5	8 750 000	17 500 000	280	—	220	<b>231/600CAME4</b> <b>241/600CAME4</b> <b>232/600CAME4</b>
	980	375	7.5	10 400 000	21 900 000	170	—	220	
	1 090	388	9.5	12 700 000	24 900 000	200	—	200	
<b>630</b>	850	165	6	4 000 000	9 350 000	400	—	300	<b>239/630CAME4</b> <b>230/630CAME4</b> <b>240/630CAME4</b>
	920	212	7.5	5 900 000	12 700 000	400	—	280	
	920	290	7.5	7 550 000	17 700 000	280	—	220	
	1 030	315	7.5	9 600 000	19 400 000	260	—	200	<b>231/630CAME4</b> <b>241/630CAME4</b> <b>232/630CAME4</b>
	1 030	400	7.5	11 300 000	23 900 000	160	—	200	
	1 150	412	12	13 400 000	25 600 000	200	—	180	
<b>670</b>	900	170	6	4 350 000	10 300 000	380	—	260	<b>239/670CAME4</b> <b>230/670CAME4</b> <b>240/670CAME4</b>
	980	230	7.5	6 850 000	15 000 000	360	—	240	
	980	308	7.5	8 450 000	19 500 000	260	—	200	
	1 090	336	7.5	10 600 000	21 600 000	240	—	190	<b>231/670CAME4</b> <b>241/670CAME4</b> <b>232/670CAME4</b>
	1 090	412	7.5	12 400 000	26 500 000	150	—	190	
	1 220	438	12	14 900 000	28 700 000	180	—	170	
<b>710</b>	950	180	6	4 800 000	11 700 000	360	—	240	<b>239/710CAME4</b> <b>230/710CAME4</b> <b>240/710CAME4</b>
	1 030	236	7.5	7 100 000	15 800 000	340	—	240	
	1 030	315	7.5	8 850 000	20 700 000	240	—	190	
	1 150	438	9.5	13 900 000	30 500 000	130	—	170	<b>241/710CAME4</b> <b>232/710CAME4</b>
	1 280	450	12	15 700 000	30 500 000	170	—	160	
<b>750</b>	1 000	185	6	5 250 000	12 800 000	320	—	220	<b>239/750CAME4</b> <b>230/750CAME4</b> <b>240/750CAME4</b> <b>232/750CAME4</b>
	1 090	250	7.5	7 750 000	17 200 000	320	—	220	
	1 090	335	7.5	10 100 000	24 000 000	220	—	180	
	1 360	475	15	17 700 000	35 500 000	150	—	140	

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

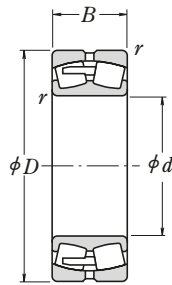
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Designations  Tapered Bore <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)					Constant  $e$	Axial Load Factors			Mass (kg)  approx.
	$d_a$ min.	$d_a$ max.	$D_a$ max.	$d_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
<b>239/600CAMKE4</b>	622	—	778	745	4	0.17	5.9	3.9	3.9	205
<b>230/600CAMKE4</b>	628	—	842	794	5	0.21	4.8	3.3	3.2	389
<b>240/600CAMK30E4</b>	628	—	842	772	5	0.30	3.3	2.2	2.2	529
<b>231/600CAMKE4</b>	636	—	944	856	6	0.30	3.4	2.3	2.2	898
<b>241/600CAMK30E4</b>	636	—	944	836	6	0.39	2.6	1.8	1.7	1 050
<b>232/600CAMKE4</b>	644	—	1 046	923	8	0.36	2.8	1.9	1.8	1 590
<b>239/630CAMKE4</b>	658	—	822	786	5	0.18	5.6	3.8	3.7	259
<b>230/630CAMKE4</b>	666	—	884	835	6	0.22	4.7	3.1	3.1	468
<b>240/630CAMK30E4</b>	666	—	884	815	6	0.30	3.3	2.2	2.2	637
<b>231/630CAMKE4</b>	666	—	994	900	6	0.30	3.4	2.3	2.2	1 040
<b>241/630CAMK30E4</b>	666	—	994	876	6	0.38	2.7	1.8	1.7	1 250
<b>232/630CAMKE4</b>	684	—	1 096	970	10	0.37	2.8	1.9	1.8	1 850
<b>239/670CAMKE4</b>	698	—	872	836	5	0.17	5.8	3.9	3.8	300
<b>230/670CAMKE4</b>	706	—	944	891	6	0.22	4.7	3.1	3.1	571
<b>240/670CAMK30E4</b>	706	—	944	868	6	0.30	3.3	2.2	2.2	773
<b>231/670CAMKE4</b>	706	—	1 054	952	6	0.30	3.3	2.2	2.2	1 230
<b>241/670CAMK30E4</b>	706	—	1 054	934	6	0.37	2.7	1.8	1.8	1 440
<b>232/670CAMKE4</b>	724	—	1 166	1 024	10	0.37	2.7	1.8	1.8	2 210
<b>239/710CAMKE4</b>	738	—	922	883	5	0.17	5.8	3.9	3.8	352
<b>230/710CAMKE4</b>	746	—	994	936	6	0.22	4.6	3.1	3.0	647
<b>240/710CAMK30E4</b>	746	—	994	916	6	0.29	3.4	2.3	2.2	861
<b>241/710CAMK30E4</b>	754	—	1 106	981	8	0.38	2.6	1.8	1.7	1 730
<b>232/710CAMKE4</b>	764	—	1 226	1 080	10	0.36	2.8	1.9	1.8	2 470
<b>239/750CAMKE4</b>	778	—	972	931	5	0.17	6.0	4.1	4.0	398
<b>230/750CAMKE4</b>	786	—	1 054	990	6	0.22	4.6	3.1	3.0	768
<b>240/750CAMK30E4</b>	786	—	1 054	969	6	0.29	3.4	2.3	2.2	1 030
<b>232/750CAMKE4</b>	814	—	1 296	1 148	12	0.36	2.8	1.9	1.8	2 980

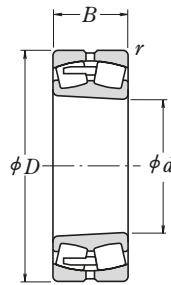


# SPHERICAL ROLLER BEARINGS

Bore Diameter 800 – 1400 mm



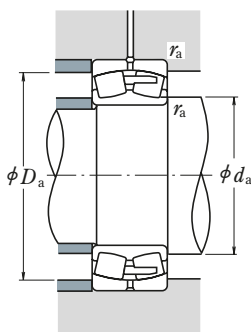
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min <sup>-1</sup> )			Bearing
$d$	$D$	$B$	$r$ min.	$C_r$	$C_{Or}$	Thermal Reference Speed	Limiting Speeds		Cylindrical Bore
							Mechanical	Grease	
<b>800</b>	1 060	195	6	5 600 000	13 700 000	300	—	220	<b>239/800CAME4</b>
	1 150	258	7.5	8 350 000	19 100 000	300	—	200	<b>230/800CAME4</b>
	1 150	345	7.5	10 900 000	26 300 000	200	—	160	<b>240/800CAME4</b>
	1 280	375	9.5	13 800 000	29 200 000	190	—	150	<b>231/800CAME4</b>
	1 420	488	15	20 300 000	41 000 000	130	—	130	<b>232/800CAME4</b>
<b>850</b>	1 120	200	6	6 100 000	15 200 000	280	—	190	<b>239/850CAME4</b>
	1 220	272	7.5	9 300 000	21 400 000	280	—	180	<b>230/850CAME4</b>
	1 220	365	7.5	11 600 000	28 300 000	190	—	150	<b>240/850CAME4</b>
	1 500	515	15	22 300 000	45 500 000	120	—	120	<b>232/850CAME4</b>
<b>900</b>	1 180	206	6	6 600 000	16 700 000	260	—	180	<b>239/900CAME4</b>
	1 280	280	7.5	9 850 000	22 800 000	260	—	160	<b>230/900CAME4</b>
	1 280	375	7.5	12 800 000	31 500 000	170	—	140	<b>240/900CAME4</b>
	1 580	515	15	23 400 000	47 500 000	120	—	110	<b>232/900CAME4</b>
<b>950</b>	1 250	224	7.5	7 600 000	19 900 000	240	—	160	<b>239/950CAME4</b>
	1 360	300	7.5	11 300 000	26 500 000	240	—	150	<b>230/950CAME4</b>
	1 360	412	7.5	14 500 000	36 500 000	160	—	120	<b>240/950CAME4</b>
	1 660	530	15	24 700 000	50 500 000	110	—	100	<b>232/950CAME4</b>
<b>1 000</b>	1 320	236	7.5	8 200 000	21 700 000	220	—	150	<b>239/1000CAME4</b>
	1 420	308	7.5	11 900 000	28 100 000	220	—	140	<b>230/1000CAME4</b>
	1 420	412	7.5	15 300 000	38 500 000	150	—	110	<b>240/1000CAME4</b>
<b>1 060</b>	1 400	250	7.5	9 300 000	24 400 000	200	—	130	<b>239/1060CAME4</b>
	1 500	325	9.5	13 000 000	31 500 000	200	—	120	<b>230/1060CAME4</b>
	1 500	438	9.5	16 800 000	43 000 000	140	—	100	<b>240/1060CAME4</b>
<b>1 120</b>	1 580	345	9.5	15 400 000	38 000 000	180	—	110	<b>230/1120CAME4</b>
	1 580	462	9.5	18 700 000	49 500 000	120	—	95	<b>240/1120CAME4</b>
<b>1 180</b>	1 660	475	9.5	20 200 000	52 500 000	120	—	85	<b>240/1180CAME4</b>
<b>1 250</b>	1 750	500	9.5	21 000 000	59 500 000	110	—	75	<b>240/1250CAME4</b>
<b>1 320</b>	1 850	530	12	22 600 000	63 500 000	100	—	67	<b>240/1320CAME4</b>
<b>1 400</b>	1 950	545	12	24 500 000	65 000 000	95	—	60	<b>240/1400CAME4</b>

**Note** <sup>(1)</sup> Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore <sup>(1)</sup>	$d_a$		$D_a$		$r_a$	$e$	$Y_2$	$Y_3$	$Y_0$	approx.
	min.	max.	max.	min.	max.					
<b>239/800CAMKE4</b>	828	—	1 032	987	5	0.17	6.0	4.0	3.9	462
<b>230/800CAMKE4</b>	836	—	1 114	1 045	6	0.21	4.7	3.2	3.1	870
<b>240/800CAMK30E4</b>	836	—	1 114	1 029	6	0.27	3.7	2.5	2.5	1 130
<b>231/800CAMKE4</b>	844	—	1 236	1 127	8	0.28	3.6	2.4	2.3	1 870
<b>232/800CAMKE4</b>	864	—	1 356	1 208	12	0.35	2.8	1.9	1.9	3 250
<b>239/850CAMKE4</b>	878	—	1 092	1 046	5	0.16	6.2	4.2	4.1	523
<b>230/850CAMKE4</b>	886	—	1 184	1 109	6	0.21	4.8	3.2	3.1	1 020
<b>240/850CAMK30E4</b>	886	—	1 184	1 093	6	0.28	3.6	2.4	2.4	1 350
<b>232/850CAMKE4</b>	914	—	1 436	1 274	12	0.35	2.8	1.9	1.9	3 890
<b>239/900CAMKE4</b>	928	—	1 152	1 103	5	0.16	6.4	4.3	4.2	591
<b>230/900CAMKE4</b>	936	—	1 244	1 169	6	0.20	4.9	3.3	3.2	1 160
<b>240/900CAMK30E4</b>	936	—	1 244	1 147	6	0.28	3.6	2.4	2.4	1 520
<b>232/900CAMKE4</b>	964	—	1 516	1 354	12	0.33	3.0	2.0	2.0	4 300
<b>239/950CAMKE4</b>	986	—	1 214	1 169	6	0.16	6.3	4.2	4.1	732
<b>230/950CAMKE4</b>	986	—	1 324	1 241	6	0.21	4.8	3.2	3.2	1 400
<b>240/950CAMK30E4</b>	986	—	1 324	1 219	6	0.28	3.6	2.4	2.3	1 880
<b>232/950CAMKE4</b>	1 014	—	1 596	1 428	12	0.32	3.1	2.1	2.1	4 800
<b>239/1000CAMKE4</b>	1 036	—	1 284	1 229	6	0.16	6.4	4.3	4.2	881
<b>230/1000CAMKE4</b>	1 036	—	1 384	1 298	6	0.20	4.9	3.3	3.2	1 560
<b>240/1000CAMK30E4</b>	1 036	—	1 384	1 275	6	0.27	3.7	2.5	2.4	2 010
<b>239/1060CAMKE4</b>	1 096	—	1 364	1 302	6	0.16	6.1	4.1	4.0	1 030
<b>230/1060CAMKE4</b>	1 104	—	1 456	1 368	8	0.21	4.9	3.3	3.2	1 790
<b>240/1060CAMK30E4</b>	1 104	—	1 456	1 346	8	0.28	3.6	2.4	2.4	2 410
<b>230/1120CAMKE4</b>	1 164	—	1 536	1 444	8	0.20	5.0	3.4	3.3	2 120
<b>240/1120CAMK30E4</b>	1 164	—	1 536	1 421	8	0.27	3.7	2.5	2.5	2 790
<b>240/1180CAMK30E4</b>	1 224	—	1 616	1 494	8	0.27	3.7	2.5	2.4	3 180
<b>240/1250CAMK30E4</b>	1 294	—	1 706	1 579	8	0.25	4.0	2.7	2.6	3 700
<b>240/1320CAMK30E4</b>	1 374	—	1 796	1 656	10	0.26	3.9	2.6	2.6	4 400
<b>240/1400CAMK30E4</b>	1 454	—	1 896	1 767	10	0.25	4.0	2.7	2.6	4 900





# 8. THRUST BALL BEARINGS

**INTRODUCTION** ..... C 296

**BEARING TABLES**

**SINGLE-DIRECTION THRUST BALL BARINGS**

With Flat Seat, Aligning Seat, or Aligning Seat Washer

Bore Diameter 10 – 360 mm ..... C 298

**DOUBLE-DIRECTION THRUST BALL BEARINGS**

With Flat Seat, Aligning Seat, or Aligning Seat Washer

Bore Diameter 10 – 190 mm ..... C 306



## DESIGN, TYPES, AND FEATURES

### THRUST BALL BEARINGS

Thrust ball bearings are classified into those with flat seats or aligning seats, depending on the shape of the outer ring seat (housing washer). They can sustain axial loads but no radial loads.

Available Series of thrust ball bearings available are shown in Table 1.

For single-direction thrust ball bearings, pressed-steel cages and machined-brass cages are usually used as shown in Table 2. The cages in double-direction thrust ball bearings are the same as those in single-direction thrust ball bearings of the same Diameter Series.

The basic load ratings listed in the bearing tables are based on the standard cage type shown in Table 2. If the type of cage is different for bearings with the same number, the number of balls may vary; in such cases, the load rating will differ from that listed in the bearing tables.

**Table 1 Series of Thrust Ball Bearings**

	W/Flat Seat	W/Aligning Seat	W/Aligning Seat Washer
Single- Direction	511	—	—
	512	532	532U
	513	533	533U
	514	534	534U
Double- Direction	522	542	542U
	523	543	543U
	524	544	544U

**Table 2 Standard Cages for Thrust Ball Bearings**

Pressed Steel	Machined Brass
51100 – 51152X 51200 – 51236X 51305 – 51336X	51156X – 51172X 51238X – 51272X 51338X – 51340X
51405 – 51418X 53200 – 53236X 53305 – 53336X 53405 – 53418X	51420X – 51436X 53238X – 53272X 53338X – 53340X 53420X – 53436X

## TOLERANCES AND RUNNING ACCURACY

**THRUST BALL BEARINGS** ..... Table 7.6 (Pages A140 to A142)

## RECOMMENDED FITS

**THRUST BALL BEARINGS** ..... Table 8.4 (Pages A164)  
Table 8.6 (Pages A165)

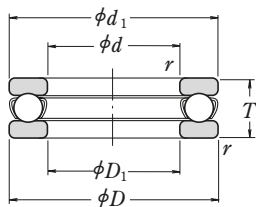
## MINIMUM AXIAL LOAD

Be sure to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.

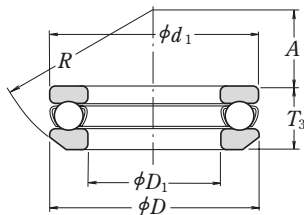


# SINGLE-DIRECTION THRUST BALL BEARINGS

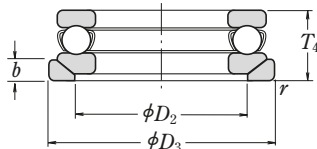
Bore Diameter 10 – 50 mm



With Flat Seat

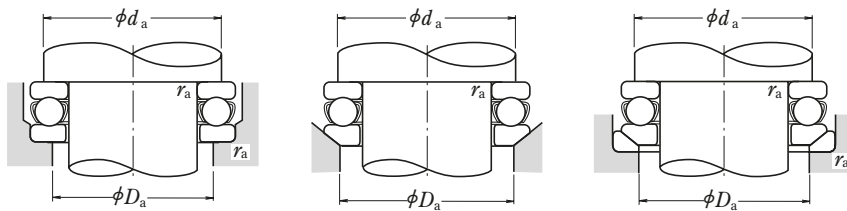


With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>T</i>	<i>T</i> <sub>3</sub>	<i>T</i> <sub>4</sub>	<i>r</i> min.	<i>C</i> <sub>a</sub>	<i>C</i> <sub>0a</sub>	Grease	Oil	With Flat Seat
<b>10</b>	24	9	—	—	0.3	10 100	14 000	6 700	10 000	<b>51100</b>
	26	11	11.6	13	0.6	12 800	17 100	6 000	9 000	<b>51200</b>
<b>12</b>	26	9	—	—	0.3	10 400	15 400	6 700	10 000	<b>51101</b>
	28	11	11.4	13	0.6	13 300	19 000	5 600	8 500	<b>51201</b>
<b>15</b>	28	9	—	—	0.3	10 600	16 800	6 300	9 500	<b>51102</b>
	32	12	13.3	15	0.6	16 700	24 800	5 000	7 500	<b>51202</b>
<b>17</b>	30	9	—	—	0.3	11 400	19 500	6 000	9 000	<b>51103</b>
	35	12	13.2	15	0.6	17 300	27 300	4 800	7 500	<b>51203</b>
<b>20</b>	35	10	—	—	0.3	15 100	26 600	5 300	8 000	<b>51104</b>
	40	14	14.7	17	0.6	22 500	37 500	4 300	6 300	<b>51204</b>
<b>25</b>	42	11	—	—	0.6	19 700	37 000	4 800	7 100	<b>51105</b>
	47	15	16.7	19	0.6	28 000	50 500	3 800	5 600	<b>51205</b>
	52	18	19.8	22	1	36 000	61 500	3 200	5 000	<b>51305</b>
	60	24	26.4	29	1	56 000	89 500	2 600	4 000	<b>51405</b>
<b>30</b>	47	11	—	—	0.6	20 600	42 000	4 300	6 700	<b>51106</b>
	52	16	17.8	20	0.6	29 500	58 000	3 400	5 300	<b>51206</b>
	60	21	22.6	25	1	43 000	78 500	2 800	4 300	<b>51306</b>
	70	28	30.1	33	1	73 000	126 000	2 200	3 400	<b>51406</b>
<b>35</b>	52	12	—	—	0.6	22 100	49 500	4 000	6 000	<b>51107</b>
	62	18	19.9	22	1	39 500	78 000	3 000	4 500	<b>51207</b>
	68	24	25.6	28	1	56 000	105 000	2 400	3 800	<b>51307</b>
	80	32	34	37	1.1	87 500	155 000	2 000	3 000	<b>51407</b>
<b>40</b>	60	13	—	—	0.6	27 100	63 000	3 600	5 300	<b>51108</b>
	68	19	20.3	23	1	47 500	98 500	2 800	4 300	<b>51208</b>
	78	26	28.5	31	1	70 000	135 000	2 200	3 400	<b>51308</b>
	90	36	38.2	42	1.1	103 000	188 000	1 700	2 600	<b>51408</b>
<b>45</b>	65	14	—	—	0.6	28 100	69 000	3 400	5 000	<b>51109</b>
	73	20	21.3	24	1	48 000	105 000	2 600	4 000	<b>51209</b>
	85	28	30.1	33	1	80 500	163 000	2 000	3 000	<b>51309</b>
	100	39	42.4	46	1.1	128 000	246 000	1 600	2 400	<b>51409</b>
<b>50</b>	70	14	—	—	0.6	29 000	75 500	3 200	4 800	<b>51110</b>
	78	22	23.5	26	1	49 000	111 000	2 400	3 600	<b>51210</b>
	95	31	34.3	37	1.1	97 500	202 000	1 800	2 800	<b>51310</b>
	110	43	45.6	50	1.5	147 000	288 000	1 400	2 200	<b>51410</b>

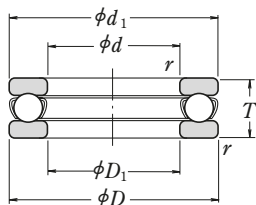


Designations		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
With Aligning Seat	With Aligning Seat Washer	$d_1$	$D_1$	$D_2$	$D_3$	$b$	$A$	$R$	$d_a$ min.	$D_a$ max.	$r_a$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	24	11	—	—	—	—	—	18	16	0.3	0.019	—	—
<b>53200</b>	<b>53200 U</b>	26	12	18	28	3.5	8.5	22	20	16	0.6	0.028	0.029	0.036
—	—	26	13	—	—	—	—	—	20	18	0.3	0.021	—	—
<b>53201</b>	<b>53201 U</b>	28	14	20	30	3.5	11.5	25	22	18	0.6	0.031	0.031	0.039
—	—	28	16	—	—	—	—	—	23	20	0.3	0.023	—	—
<b>53202</b>	<b>53202 U</b>	32	17	24	35	4	12	28	25	22	0.6	0.043	0.048	0.059
—	—	30	18	—	—	—	—	—	25	22	0.3	0.025	—	—
<b>53203</b>	<b>53203 U</b>	35	19	26	38	4	16	32	28	24	0.6	0.050	0.055	0.069
—	—	35	21	—	—	—	—	—	29	26	0.3	0.037	—	—
<b>53204</b>	<b>53204 U</b>	40	22	30	42	5	18	36	32	28	0.6	0.077	0.080	0.096
—	—	42	26	—	—	—	—	—	35	32	0.6	0.056	—	—
<b>53205</b>	<b>53205 U</b>	47	27	36	50	5.5	19	40	38	34	0.6	0.111	0.123	0.151
<b>53305</b>	<b>53305 U</b>	52	27	38	55	6	21	45	41	36	1	0.169	0.182	0.224
<b>53405</b>	<b>53405 U</b>	60	27	42	62	8	19	50	46	39	1	0.334	0.353	0.426
—	—	47	32	—	—	—	—	—	40	37	0.6	0.064	—	—
<b>53206</b>	<b>53206 U</b>	52	32	42	55	5.5	22	45	43	39	0.6	0.137	0.154	0.183
<b>53306</b>	<b>53306 U</b>	60	32	45	62	7	22	50	48	42	1	0.267	0.28	0.336
<b>53406</b>	<b>53406 U</b>	70	32	50	75	9	20	56	54	46	1	0.519	0.535	0.666
—	—	52	37	—	—	—	—	—	45	42	0.6	0.081	—	—
<b>53207</b>	<b>53207 U</b>	62	37	48	65	7	24	50	51	46	1	0.21	0.231	0.292
<b>53307</b>	<b>53307 U</b>	68	37	52	72	7.5	24	56	55	48	1	0.386	0.403	0.488
<b>53407</b>	<b>53407 U</b>	80	37	58	85	10	23	64	62	53	1	0.769	0.785	0.967
—	—	60	42	—	—	—	—	—	52	48	0.6	0.12	—	—
<b>53208</b>	<b>53208 U</b>	68	42	55	72	7	28.5	56	57	51	1	0.27	0.289	0.355
<b>53308</b>	<b>53308 U</b>	78	42	60	82	8.5	28	64	63	55	1	0.536	0.581	0.704
<b>53408</b>	<b>53408 U</b>	90	42	65	95	12	26	72	70	60	1	1.1	1.12	1.38
—	—	65	47	—	—	—	—	—	57	53	0.6	0.143	—	—
<b>53209</b>	<b>53209 U</b>	73	47	60	78	7.5	26	56	62	56	1	0.31	0.333	0.419
<b>53309</b>	<b>53309 U</b>	85	47	65	90	10	25	64	69	61	1	0.672	0.702	0.888
<b>53409</b>	<b>53409 U</b>	100	47	72	105	12.5	29	80	78	67	1	1.46	1.53	1.87
—	—	70	52	—	—	—	—	—	62	58	0.6	0.153	—	—
<b>53210</b>	<b>53210 U</b>	78	52	62	82	7.5	32.5	64	67	61	1	0.378	0.404	0.504
<b>53310</b>	<b>53310 U</b>	95	52	72	100	11	28	72	77	68	1	0.931	1.01	1.27
<b>53410</b>	<b>53410 U</b>	110	52	80	115	14	35	90	86	74	1.5	1.94	1.98	2.41

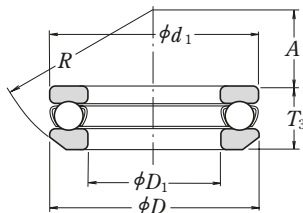


# SINGLE-DIRECTION THRUST BALL BEARINGS

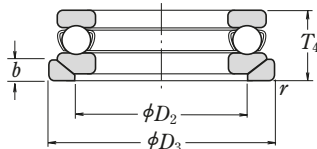
Bore Diameter 55 – 100 mm



With Flat Seat



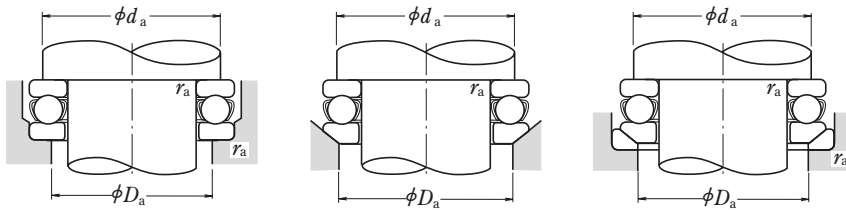
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>T</i>	<i>T</i> <sub>3</sub>	<i>T</i> <sub>4</sub>	<i>r</i> min.	<i>C</i> <sub>a</sub>	<i>C</i> <sub>0a</sub>	Grease	Oil	With Flat Seat
55	78	16	—	—	0.6	35 000	93 000	2 800	4 300	51111
	90	25	27.3	30	1	70 000	159 000	2 200	3 200	51211
	105	35	39.3	42	1.1	115 000	244 000	1 600	2 400	51311
	120	48	50.5	55	1.5	181 000	350 000	1 300	1 900	51411
60	85	17	—	—	1	41 500	113 000	2 600	4 000	51112
	95	26	28	31	1	71 500	169 000	2 000	3 000	51212
	110	35	38.3	42	1.1	119 000	263 000	1 600	2 400	51312
	130	51	54	58	1.5	202 000	395 000	1 200	1 800	51412
65	90	18	—	—	1	42 000	117 000	2 400	3 800	51113
	100	27	28.7	32	1	75 500	189 000	1 900	2 800	51213
	115	36	39.4	43	1.1	123 000	282 000	1 500	2 400	51313
	140	56	60.2	65	2	234 000	495 000	1 100	1 700	51413
70	95	18	—	—	1	43 500	127 000	2 400	3 600	51114
	105	27	28.8	32	1	74 000	189 000	1 900	2 800	51214
	125	40	44.2	48	1.1	137 000	315 000	1 400	2 000	51314
	150	60	63.6	69	2	252 000	555 000	1 000	1 500	51414
75	100	19	—	—	1	43 500	131 000	2 200	3 400	51115
	110	27	28.3	32	1	78 000	209 000	1 800	2 800	51215
	135	44	48.1	52	1.5	159 000	365 000	1 300	1 900	51315
	160	65	69	75	2	254 000	560 000	950	1 400	51415
80	105	19	—	—	1	45 000	141 000	2 200	3 400	51116
	115	28	29.5	33	1	79 000	218 000	1 800	2 600	51216
	140	44	47.6	52	1.5	164 000	395 000	1 300	1 900	51316
	170	68	72.2	78	2.1	272 000	620 000	900	1 300	51416
85	110	19	—	—	1	46 500	150 000	2 200	3 200	51117
	125	31	33.1	37	1	96 000	264 000	1 600	2 400	51217
	150	49	53.1	58	1.5	207 000	490 000	1 100	1 700	51317
	180	72	77	83	2.1	310 000	755 000	850	1 300	51417X
90	120	22	—	—	1	60 000	190 000	1 900	3 000	51118
	135	35	38.5	42	1.1	114 000	310 000	1 400	2 200	51218
	155	50	54.6	59	1.5	214 000	525 000	1 100	1 700	51318
	190	77	81.2	88	2.1	330 000	825 000	800	1 200	51418X
100	135	25	—	—	1	86 000	268 000	1 700	2 600	51120
	150	38	40.9	45	1.1	135 000	375 000	1 300	2 000	51220
	170	55	59.2	64	1.5	239 000	595 000	1 000	1 500	51320
	210	85	90	98	3	370 000	985 000	710	1 100	51420X

**Note** (1) The outside diameter  $d_1$  of shaft washers for bearing designations with an X is smaller than the outside diameter  $D$  of the housing washers.

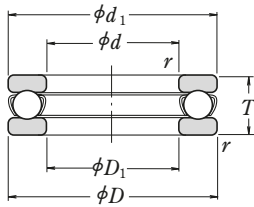


Designations <sup>(1)</sup>		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
With Aligning Seat	With Aligning Seat Washer	$d_1$	$D_1$	$D_2$	$D_3$	$b$	$A$	$R$	$d_a$ min.	$D_a$ max.	$r_a$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	78	57	—	—	—	—	—	69	64	0.6	0.227	—	—
<b>53211</b>	<b>53211 U</b>	90	57	72	95	9	35	72	76	69	1	0.599	0.656	0.819
<b>53311</b>	<b>53311 U</b>	105	57	80	110	11.5	30	80	85	75	1	1.31	1.45	1.78
<b>53411</b>	<b>53411 U</b>	120	57	88	125	15.5	28	90	94	81	1.5	2.58	2.59	3.16
—	—	85	62	—	—	—	—	—	75	70	1	0.281	—	—
<b>53212</b>	<b>53212 U</b>	95	62	78	100	9	32.5	72	81	74	1	0.673	0.731	0.897
<b>53312</b>	<b>53312 U</b>	110	62	85	115	11.5	41	90	90	80	1	1.4	1.51	1.83
<b>53412</b>	<b>53412 U</b>	130	62	95	135	16	34	100	102	88	1.5	3.16	3.2	3.91
—	—	90	67	—	—	—	—	—	80	75	1	0.324	—	—
<b>53213</b>	<b>53213 U</b>	100	67	82	105	9	40	80	86	79	1	0.756	0.812	0.989
<b>53313</b>	<b>53313 U</b>	115	67	90	120	12.5	38.5	90	95	85	1	1.54	1.67	2.04
<b>53413</b>	<b>53413 U</b>	140	68	100	145	17.5	40	112	110	95	2	4.1	4.22	5.13
—	—	95	72	—	—	—	—	—	85	80	1	0.346	—	—
<b>53214</b>	<b>53214 U</b>	105	72	88	110	9	38	80	91	84	1	0.793	0.866	1.05
<b>53314</b>	<b>53314 U</b>	125	72	98	130	13	43	100	103	92	1	2.0	2.2	2.64
<b>53414</b>	<b>53414 U</b>	150	73	110	155	19.5	34	112	118	102	2	5.05	5.12	6.21
—	—	100	77	—	—	—	—	—	90	85	1	0.389	—	—
<b>53215</b>	<b>53215 U</b>	110	77	92	115	9.5	49	90	96	89	1	0.845	1.27	1.11
<b>53315</b>	<b>53315 U</b>	135	77	105	140	15	37	100	111	99	1.5	2.6	2.8	3.42
<b>53415</b>	<b>53415 U</b>	160	78	115	165	21	42	125	125	110	2	6.15	6.23	7.58
—	—	105	82	—	—	—	—	—	95	90	1	0.417	—	—
<b>53216</b>	<b>53216 U</b>	115	82	98	120	10	46	90	101	94	1	0.931	1.01	1.23
<b>53316</b>	<b>53316 U</b>	140	82	110	145	15	50	112	116	104	1.5	2.74	2.94	3.55
<b>53416</b>	<b>53416 U</b>	170	83	125	175	22	36	125	133	117	2	7.21	7.33	8.9
—	—	110	87	—	—	—	—	—	100	95	1	0.44	—	—
<b>53217</b>	<b>53217 U</b>	125	88	105	130	11	52	100	109	101	1	1.22	1.35	1.63
<b>53317</b>	<b>53317 U</b>	150	88	115	155	17.5	43	112	124	111	1.5	3.57	3.78	4.67
<b>53417 X</b>	<b>53417 XU</b>	177	88	130	185	23	47	140	141	124	2	8.51	8.72	10.4
—	—	120	92	—	—	—	—	—	108	102	1	0.646	—	—
<b>53218</b>	<b>53218 U</b>	135	93	110	140	13.5	45	100	117	108	1	1.69	1.89	2.38
<b>53318</b>	<b>53318 U</b>	155	93	120	160	18	40	112	129	116	1.5	3.83	4.11	5.09
<b>53418 X</b>	<b>53418 XU</b>	187	93	140	195	25.5	40	140	149	131	2	10.2	10.3	12.4
—	—	135	102	—	—	—	—	—	121	114	1	0.96	—	—
<b>53220</b>	<b>53220 U</b>	150	103	125	155	14	52	112	130	120	1	2.25	2.49	3.03
<b>53320</b>	<b>53320 U</b>	170	103	135	175	18	46	125	142	128	1.5	4.98	5.31	6.37
<b>53420 X</b>	<b>53420 XU</b>	205	103	155	220	27	50	160	165	145	2.5	14.8	15	18.1

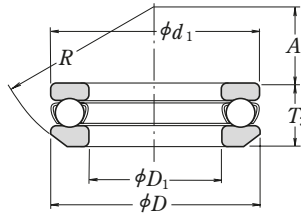


# SINGLE-DIRECTION THRUST BALL BEARINGS

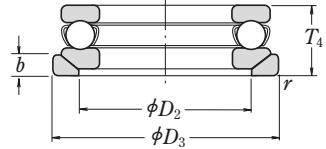
Bore Diameter 110 – 190 mm



With Flat Seat



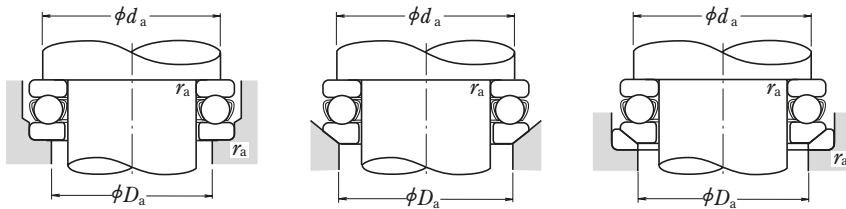
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
<i>d</i>	<i>D</i>	<i>T</i>	<i>T</i> <sub>3</sub>	<i>T</i> <sub>4</sub>	<i>r</i> min.	<i>C</i> <sub>a</sub>	<i>C</i> <sub>0a</sub>	Grease	Oil	With Flat Seat
<b>110</b>	145	25	—	—	1	88 000	288 000	1 700	2 400	<b>51122</b>
	160	38	40.2	45	1.1	136 000	395 000	1 300	1 900	<b>51222</b>
	190	63	67.2	72	2	282 000	755 000	900	1 300	<b>51322X</b>
	230	95	99.7	109	3	415 000	1 150 000	630	950	<b>51422X</b>
<b>120</b>	155	25	—	—	1	90 000	310 000	1 600	2 400	<b>51124</b>
	170	39	40.8	46	1.1	141 000	430 000	1 200	1 800	<b>51224</b>
	210	70	74.1	80	2.1	330 000	930 000	800	1 200	<b>51324X</b>
	250	102	107.3	118	4	480 000	1 400 000	600	900	<b>51424X</b>
<b>130</b>	170	30	—	—	1	105 000	350 000	1 400	2 000	<b>51126</b>
	190	45	47.9	53	1.5	183 000	550 000	1 100	1 600	<b>51226X</b>
	225	75	80.3	86	2.1	350 000	1 030 000	750	1 100	<b>51326X</b>
	270	110	115.2	128	4	525 000	1 590 000	530	800	<b>51426X</b>
<b>140</b>	180	31	—	—	1	107 000	375 000	1 300	2 000	<b>51128X</b>
	200	46	48.6	55	1.5	186 000	575 000	1 000	1 500	<b>51228X</b>
	240	80	84.9	92	2.1	370 000	1 130 000	670	1 000	<b>51328X</b>
	280	112	117	131	4	550 000	1 750 000	530	800	<b>51428X</b>
<b>150</b>	190	31	—	—	1	110 000	400 000	1 300	1 900	<b>51130X</b>
	215	50	53.3	60	1.5	238 000	735 000	950	1 400	<b>51230X</b>
	250	80	83.7	92	2.1	380 000	1 200 000	670	1 000	<b>51330X</b>
	300	120	125.9	140	4	620 000	2 010 000	480	710	<b>51430X</b>
<b>160</b>	200	31	—	—	1	113 000	425 000	1 200	1 900	<b>51132X</b>
	225	51	54.7	61	1.5	249 000	805 000	900	1 400	<b>51232X</b>
	270	87	91.7	100	3	475 000	1 570 000	600	900	<b>51332X</b>
	320	130	135.3	150	5	650 000	2 210 000	450	670	<b>51432X</b>
<b>170</b>	215	34	—	—	1.1	135 000	510 000	1 100	1 700	<b>51134X</b>
	240	55	58.7	65	1.5	280 000	915 000	850	1 300	<b>51234X</b>
	280	87	91.3	100	3	465 000	1 570 000	600	900	<b>51334X</b>
	340	135	141	156	5	715 000	2 480 000	430	630	<b>51434X</b>
<b>180</b>	225	34	—	—	1.1	136 000	530 000	1 100	1 700	<b>51136X</b>
	250	56	58.2	66	1.5	284 000	955 000	800	1 200	<b>51236X</b>
	300	95	99.3	109	3	480 000	1 680 000	560	850	<b>51336X</b>
	360	140	148.3	164	5	750 000	2 730 000	400	600	<b>51436X</b>
<b>190</b>	240	37	—	—	1.1	172 000	655 000	1 000	1 600	<b>51138X</b>
	270	62	65.7	73	2	320 000	1 110 000	750	1 100	<b>51238X</b>
	320	105	111	121	4	550 000	1 960 000	500	750	<b>51338X</b>

**Note** <sup>(1)</sup> The outside diameter *d*<sub>1</sub> of shaft washers for bearing designations with an X is smaller than the outside diameter *D* of the housing washers.

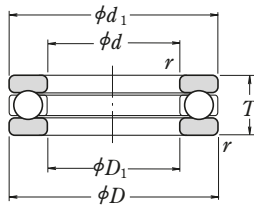


Designations <sup>(1)</sup>		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
With Aligning Seat	With Aligning Seat Washer	$d_1$	$D_1$	$D_2$	$D_3$	$b$	$A$	$R$	$d_a$ min.	$D_a$ max.	$r_a$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	145	112	—	—	—	—	—	131	124	1	1.04	—	—
<b>53222</b>	<b>53222 U</b>	160	113	135	165	14	65	125	140	130	1	2.42	2.65	3.2
<b>53322 X</b>	<b>53322 XU</b>	187	113	150	195	20.5	51	140	158	142	2	7.19	7.55	9.1
<b>53422 X</b>	<b>53422 XU</b>	225	113	170	240	29	59	180	181	159	2.5	20	20.5	24.3
—	—	155	122	—	—	—	—	—	141	134	1	1.12	—	—
<b>53224</b>	<b>53224 U</b>	170	123	145	175	15	61	125	150	140	1	2.7	2.94	3.58
<b>53324 X</b>	<b>53324 XU</b>	205	123	165	220	22	63	160	173	157	2	9.7	10.1	12.4
<b>53424 X</b>	<b>53424 XU</b>	245	123	185	260	32	70	200	196	174	3	26.2	26.5	31.3
—	—	170	132	—	—	—	—	—	154	146	1	1.68	—	—
<b>53226 X</b>	<b>53226 XU</b>	187	133	160	195	17	67	140	166	154	1.5	3.95	4.35	5.33
<b>53326 X</b>	<b>53326 XU</b>	220	134	177	235	26	53	160	186	169	2	12.1	12.7	15.8
<b>53426 X</b>	<b>53426 XU</b>	265	134	200	280	38	58	200	212	188	3	32.3	32.4	38.8
—	—	178	142	—	—	—	—	—	164	156	1	1.83	—	—
<b>53228 X</b>	<b>53228 XU</b>	197	143	170	210	17	87	160	176	164	1.5	4.3	4.74	5.89
<b>53328 X</b>	<b>53328 XU</b>	235	144	190	250	26	68	180	199	181	2	14.2	16.3	19.5
<b>53428 X</b>	<b>53428 XU</b>	275	144	206	290	38	83	225	222	198	3	34.7	34.8	41.4
—	—	188	152	—	—	—	—	—	174	166	1	1.95	—	—
<b>53230 X</b>	<b>53230 XU</b>	212	153	180	225	20.5	79	160	189	176	1.5	5.52	6.09	7.82
<b>53330 X</b>	<b>53330 XU</b>	245	154	200	260	26	89.5	200	209	191	2	15	17.3	20.5
<b>53430 X</b>	<b>53430 XU</b>	295	154	225	310	41	69	225	238	212	3	43.5	43.8	51.9
—	—	198	162	—	—	—	—	—	184	176	1	2.07	—	—
<b>53232 X</b>	<b>53232 XU</b>	222	163	190	235	21	74	160	199	186	1.5	6.04	6.78	8.7
<b>53332 X</b>	<b>53332 XU</b>	265	164	215	280	29	77	200	225	205	2.5	19.6	22.3	26.7
<b>53432 X</b>	<b>53432 XU</b>	315	164	240	330	41.5	84	250	254	226	4	52.7	52.9	62
—	—	213	172	—	—	—	—	—	197	188	1	2.72	—	—
<b>53234 X</b>	<b>53234 XU</b>	237	173	200	250	21.5	91	180	212	198	1.5	7.41	8.21	10.5
<b>53334 X</b>	<b>53334 XU</b>	275	174	220	290	29	105	225	235	215	2.5	20.3	23.2	28
<b>53434 X</b>	<b>53434 XU</b>	335	174	255	350	46	74	250	269	241	4	61.2	61.3	73
—	—	222	183	—	—	—	—	—	207	198	1	2.79	—	—
<b>53236 X</b>	<b>53236 XU</b>	247	183	210	260	21.5	112	200	222	208	1.5	7.94	8.57	10.8
<b>53336 X</b>	<b>53336 XU</b>	295	184	240	310	32	91	225	251	229	2.5	25.9	29.2	34.9
<b>53436 X</b>	<b>53436 XU</b>	355	184	270	370	46.5	97	280	285	255	4	70.5	72.1	84.9
—	—	237	193	—	—	—	—	—	220	210	1	3.6	—	—
<b>53238 X</b>	<b>53238 XU</b>	267	194	230	280	23	98	200	238	222	2	11.8	12.9	15.7
<b>53338 X</b>	<b>53338 XU</b>	315	195	255	330	33	104	250	266	244	3	36.5	38.1	44.7

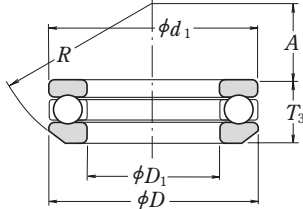


# ■ SINGLE-DIRECTION THRUST BALL BEARINGS

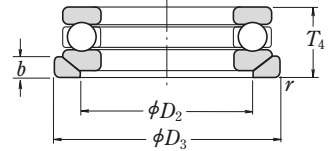
Bore Diameter 200 – 360 mm



With Flat Seat



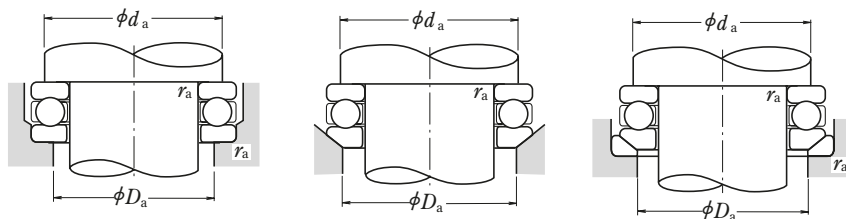
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing
$d$	$D$	$T$	$T_3$	$T_4$	$r_{\min.}$	$C_a$	$C_{0a}$	Grease	Oil	With Flat Seat
<b>200</b>	250	37	—	—	1.1	173 000	675 000	1 000	1 500	<b>51140 X</b>
	280	62	65.3	74	2	315 000	1 110 000	710	1 100	<b>51240 X</b>
	340	110	118.4	130	4	600 000	2 220 000	480	710	<b>51340 X</b>
<b>220</b>	270	37	—	—	1.1	179 000	740 000	950	1 500	<b>51144 X</b>
	300	63	65.6	75	2	325 000	1 210 000	670	1 000	<b>51244 X</b>
<b>240</b>	300	45	—	—	1.5	229 000	935 000	850	1 200	<b>51148 X</b>
	340	78	81.6	92	2.1	420 000	1 650 000	560	850	<b>51248 X</b>
<b>260</b>	320	45	—	—	1.5	233 000	990 000	800	1 200	<b>51152 X</b>
	360	79	82.8	93	2.1	435 000	1 800 000	560	850	<b>51252 X</b>
<b>280</b>	350	53	—	—	1.5	315 000	1 310 000	710	1 000	<b>51156 X</b>
	380	80	85	94	2.1	450 000	1 950 000	530	800	<b>51256 X</b>
<b>300</b>	380	62	—	—	2	360 000	1 560 000	600	900	<b>51160 X</b>
	420	95	100.5	112	3	540 000	2 410 000	450	670	<b>51260 X</b>
<b>320</b>	400	63	—	—	2	365 000	1 660 000	600	900	<b>51164 X</b>
	440	95	100.5	112	3	585 000	2 680 000	450	670	<b>51264 X</b>
<b>340</b>	420	64	—	—	2	375 000	1 760 000	560	850	<b>51168 X</b>
	460	96	100.3	113	3	595 000	2 800 000	430	630	<b>51268 X</b>
<b>360</b>	440	65	—	—	2	385 000	1 860 000	560	800	<b>51172 X</b>
	500	110	116.7	130	4	705 000	3 500 000	380	560	<b>51272 X</b>

**Note** (1) The outside diameter  $d_1$  of shaft washers for bearing designations with an X is smaller than the outside diameter  $D$  of the housing washers.

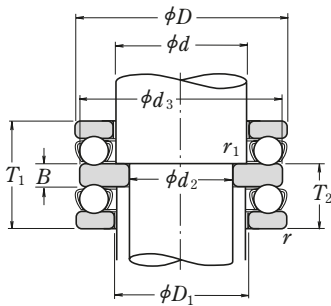


Designations <sup>(1)</sup>		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
With Aligning Seat	With Aligning Seat Washer	$d_1$	$D_1$	$D_2$	$D_3$	$b$	$A$	$R$	$d_a$ min.	$D_a$ max.	$r_a$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	247	203	—	—	—	—	—	230	220	1	3.75	—	—
<b>53240 X</b>	<b>53240 XU</b>	277	204	240	290	23	125	225	248	232	2	12.3	13.4	16.1
<b>53340 X</b>	<b>53340 XU</b>	335	205	270	350	38	92	250	282	258	3	43.6	46.2	54.8
—	—	267	223	—	—	—	—	—	250	240	1	4.09	—	—
<b>53244 X</b>	<b>53244 XU</b>	297	224	260	310	25	118	225	268	252	2	13.6	14.9	18
—	—	297	243	—	—	—	—	—	276	264	1.5	6.55	—	—
<b>53248 X</b>	<b>53248 XU</b>	335	244	290	350	30	122	250	299	281	2	23.7	25.6	30.7
—	—	317	263	—	—	—	—	—	296	284	1.5	7.01	—	—
<b>53252 X</b>	<b>53252 XU</b>	355	264	305	370	30	152	280	319	301	2	25.1	27.3	33.2
—	—	347	283	—	—	—	—	—	322	308	1.5	12	—	—
<b>53256 X</b>	<b>53256 XU</b>	375	284	325	390	31	143	280	339	321	2	27.1	30.3	37
—	—	376	304	—	—	—	—	—	348	332	2	17.2	—	—
<b>53260 X</b>	<b>53260 XU</b>	415	304	360	430	34	164	320	371	349	2.5	43.5	47.7	56.1
—	—	396	324	—	—	—	—	—	368	352	2	18.6	—	—
<b>53264 X</b>	<b>53264 XU</b>	435	325	380	450	36	157	320	391	369	2.5	45	49.9	59.4
—	—	416	344	—	—	—	—	—	388	372	2	19.9	—	—
<b>53268 X</b>	<b>53268 XU</b>	455	345	400	470	36	199	360	411	389	2.5	47.9	52.7	62
—	—	436	364	—	—	—	—	—	408	392	2	21.5	—	—
<b>53272 X</b>	<b>53272 XU</b>	495	365	430	510	43	172	360	442	418	3	68.8	76.3	90.9

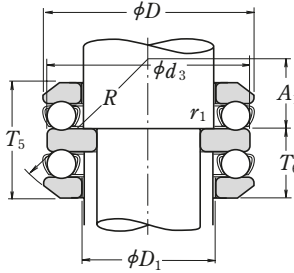


# DOUBLE-DIRECTION THRUST BALL BEARINGS

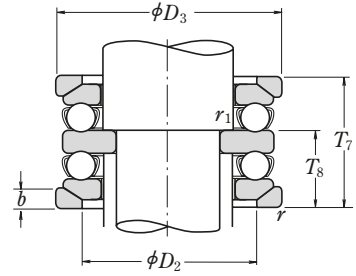
Bore Diameter 10 – 55 mm



With Flat Seat

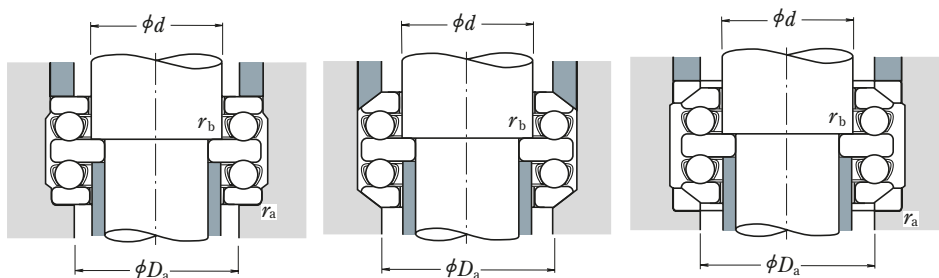


With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing	
<i>d</i> <sub>2</sub>	<i>d</i>	<i>D</i>	<i>T</i> <sub>1</sub>	<i>T</i> <sub>5</sub>	<i>T</i> <sub>7</sub>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>a</sub>	<i>C</i> <sub>0a</sub>	Grease	Oil	With Flat Seat	With Aligning Seat
10	15	32	22	24.6	28	0.6	0.3	16 700	24 800	4 800	7 100	52202	54202
	25	60	45	49.8	55	1	0.6	22 500	37 500	4 000	6 000	52204	54204
20	25	47	28	31.4	36	0.6	0.3	56 000	89 500	2 400	3 600	52405	54405
	25	52	34	37.6	42	1	0.3	28 000	50 500	3 400	5 300	52205	54205
	30	70	52	56.2	62	1	0.6	36 000	61 500	3 000	4 500	52305	54305
25	30	60	38	41.2	46	1	0.3	73 000	126 000	2 200	3 200	52406	54406
	30	60	38	41.2	46	1	0.3	29 500	58 000	3 200	5 000	52206	54206
	35	80	59	63	69	1.1	0.6	43 000	78 500	2 600	4 000	52306	54306
30	35	62	34	37.8	42	1	0.3	87 500	155 000	1 800	2 800	52407	54407
	35	68	44	47.2	52	1	0.3	29 500	58 000	3 200	5 000	52206	54206
	40	68	36	38.6	44	1	0.6	43 000	78 500	2 600	4 000	52306	54306
	40	78	49	54	59	1	0.6	87 500	155 000	1 800	2 800	52407	54407
35	40	78	49	54	59	1	0.6	70 000	135 000	2 000	3 000	52308	54308
	40	90	65	69.4	77	1.1	0.6	103 000	188 000	1 700	2 400	52408	54408
	45	73	37	39.6	45	1	0.6	48 000	105 000	2 400	3 600	52209	54209
	45	85	52	56.2	62	1	0.6	80 500	163 000	1 900	2 800	52309	54309
40	45	100	72	78.8	86	1.1	0.6	128 000	246 000	1 500	2 200	52409	54409
	50	78	39	42	47	1	0.6	49 000	111 000	2 400	3 400	52210	54210
	50	95	58	64.6	70	1.1	0.6	97 500	202 000	1 700	2 600	52310	54310
	50	110	78	83.2	92	1.5	0.6	147 000	288 000	1 400	2 000	52410	54410
45	55	90	45	49.6	55	1	0.6	70 000	159 000	2 000	3 000	52211	54211
	55	105	64	72.6	78	1.1	0.6	115 000	244 000	1 500	2 400	52311	54311
	55	120	87	92	101	1.5	0.6	181 000	350 000	1 200	1 800	52411	54411
50	60	95	46	50	56	1	0.6	71 500	169 000	1 900	3 000	52212	54212
	60	110	64	70.6	78	1.1	0.6	119 000	263 000	1 500	2 200	52312	54312
	60	130	93	99	107	1.5	0.6	202 000	395 000	1 100	1 700	52412	54412
	65	140	101	109.4	119	2	1	234 000	495 000	1 000	1 600	52413	54413
55	65	100	47	50.4	57	1	0.6	75 500	189 000	1 900	2 800	52213	54213
	65	115	65	71.8	79	1.1	0.6	123 000	282 000	1 500	2 200	52313	54313
	70	105	47	50.6	57	1	1	74 000	189 000	1 800	2 800	52214	54214
	70	125	72	80.4	88	1.1	1	137 000	315 000	1 300	2 000	52314	54314
	70	150	107	114.2	125	2	1	252 000	555 000	1 000	1 500	52414	54414

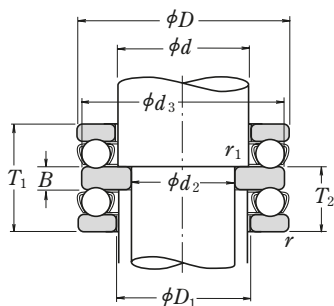


Designations  With Aligning Seat Washer	Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
	$d_3$	$D_1$	$D_2$	$D_3$	$T_2$	$T_6$	$T_8$	$B$	$b$	$A_1$	$R$	$D_a$ max.	$r_a$ max.	$r_b$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
<b>54202 U</b>	32	17	24	35	13.5	14.8	16.5	5	4	10.5	28	24	0.6	0.3	0.081	0.090	0.113
<b>54204 U</b>	40	22	30	42	16	16.7	19	6	5	16	36	30	0.6	0.3	0.148	0.151	0.185
<b>54405 U</b>	60	27	42	62	28	30.4	33	11	8	15	50	42	1	0.6	0.641	0.68	0.825
<b>54205 U</b>	47	27	36	50	17.5	19.2	21.5	7	5.5	16.5	40	36	0.6	0.3	0.213	0.236	0.293
<b>54305 U</b>	52	27	38	55	21	22.8	25	8	6	18	45	38	1	0.3	0.324	0.35	0.434
<b>54406 U</b>	70	32	50	75	32	34.1	37	12	9	16	56	50	1	0.6	0.978	1.01	1.27
<b>54206 U</b>	52	32	42	55	18	19.8	22	7	5.5	20	45	42	0.6	0.3	0.254	0.288	0.345
<b>54306 U</b>	60	32	45	62	23.5	25.1	27.5	9	7	19.5	50	45	1	0.3	0.483	0.511	0.621
<b>54407 U</b>	80	37	58	85	36.5	38.5	41.5	14	10	18.5	64	58	1	0.6	1.43	1.47	1.83
<b>54207 U</b>	62	37	48	65	21	22.9	25	8	7	21	50	48	1	0.3	0.406	0.447	0.57
<b>54307 U</b>	68	37	52	72	27	28.6	31	10	7.5	21	56	52	1	0.3	0.71	0.744	0.915
<b>54208 U</b>	68	42	55	72	22.5	23.8	26.5	9	7	25	56	55	1	0.6	0.543	0.581	0.713
<b>54308 U</b>	78	42	60	82	30.5	33	35.5	12	8.5	23.5	64	60	1	0.6	1.04	1.13	1.38
<b>54408 U</b>	90	42	65	95	40	42.2	46	15	12	22	72	65	1	0.6	1.98	2.02	2.54
<b>54209 U</b>	73	47	60	78	23	24.3	27	9	7.5	23	56	60	1	0.6	0.606	0.652	0.823
<b>54309 U</b>	85	47	65	90	32	34.1	37	12	10	21	64	65	1	0.6	1.28	1.34	1.71
<b>54409 U</b>	100	47	72	105	44.5	47.9	51.5	17	12.5	23.5	80	72	1	0.6	2.71	2.85	3.53
<b>54210 U</b>	78	52	62	82	24	25.5	28	9	7.5	30.5	64	62	1	0.6	0.697	0.75	0.949
<b>54310 U</b>	95	52	72	100	36	39.3	42	14	11	23	72	72	1	0.6	1.78	1.94	2.46
<b>54410 U</b>	110	52	80	115	48	50.6	55	18	14	30	90	80	1.5	0.6	3.51	3.59	4.45
<b>54211 U</b>	90	57	72	95	27.5	29.8	32.5	10	9	32.5	72	72	1	0.6	1.11	1.22	1.55
<b>54311 U</b>	105	57	80	110	39.5	43.8	46.5	15	11.5	25.5	80	80	1	0.6	2.43	2.7	3.35
<b>54411 U</b>	120	57	88	125	53.5	56	60.5	20	15.5	22.5	90	88	1.5	0.6	4.66	4.68	5.82
<b>54212 U</b>	95	62	78	100	28	30	33	10	9	30.5	72	78	1	0.6	1.22	1.33	1.66
<b>54312 U</b>	110	62	85	115	39.5	42.8	46.5	15	11.5	36.5	90	85	1	0.6	2.59	2.82	3.45
<b>54412 U</b>	130	62	95	135	57	60	64	21	16	28	100	95	1.5	0.6	5.74	5.82	7.24
<b>54413 U</b>	140	68	100	145	62	66.2	71	23	17.5	34	112	100	2	1	7.41	7.66	9.47
<b>54213 U</b>	100	67	82	105	28.5	30.2	33.5	10	9	38.5	80	82	1	0.6	1.34	1.45	1.81
<b>54313 U</b>	115	67	90	120	40	43.4	47	15	12.5	34.5	90	90	1	0.6	2.8	3.06	3.8
<b>54214 U</b>	105	72	88	110	28.5	30.3	33.5	10	9	36.5	80	88	1	1	1.44	1.59	1.95
<b>54314 U</b>	125	72	98	130	44	48.2	52	16	13	39	100	98	1	1	3.67	4.07	4.95
<b>54414 U</b>	150	73	110	155	65.5	69.1	74.5	24	19.5	28.5	112	110	2	1	8.99	9.12	11.3

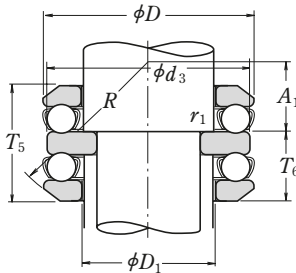


# DOUBLE-DIRECTION THRUST BALL BEARINGS

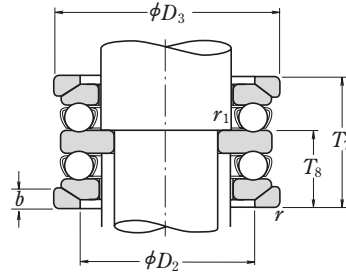
Bore Diameter 60 – 130 mm



With Flat Seat



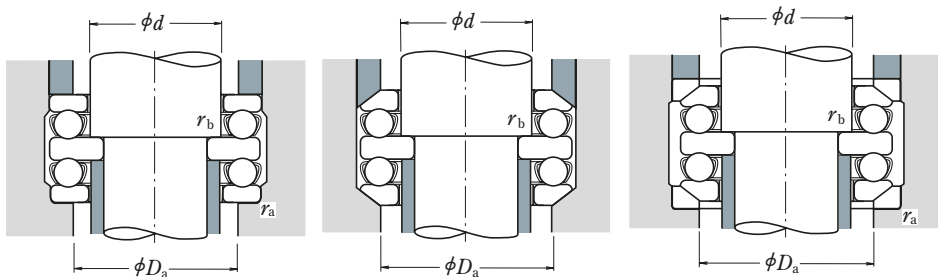
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing Designations <sup>(1)</sup>	
$d_2$	$d$	$D$	$T_1$	$T_5$	$T_7$	$r$ min.	$r_1$ min.	$C_a$	$C_{0a}$	Grease	Oil	With Flat Seat	With Aligning Seat
<b>60</b>	75	110	47	49.6	57	1	1	78 000	209 000	1 800	2 600	<b>52215</b>	<b>54215</b>
	75	135	79	87.2	95	1.5	1	159 000	365 000	1 200	1 800	<b>52315</b>	<b>54315</b>
	75	160	115	123	135	2	1	254 000	560 000	900	1 400	<b>52415</b>	<b>54415</b>
<b>65</b>	80	115	48	51	58	1	1	79 000	218 000	1 700	2 600	<b>52216</b>	<b>54216</b>
	80	140	79	86.2	95	1.5	1	164 000	395 000	1 200	1 800	<b>52316</b>	<b>54316</b>
	80	170	120	128.4	140	2.1	1	272 000	620 000	850	1 300	<b>52416</b>	<b>54416</b>
	85	180	128	138	150	2.1	1.1	310 000	755 000	800	1 200	<b>52417 X</b>	<b>54417 X</b>
<b>70</b>	85	125	55	59.2	67	1	1	96 000	264 000	1 500	2 200	<b>52217</b>	<b>54217</b>
	85	150	87	95.2	105	1.5	1	207 000	490 000	1 100	1 600	<b>52317</b>	<b>54317</b>
	90	190	135	143.4	157	2.1	1.1	330 000	825 000	750	1 100	<b>52418 X</b>	<b>54418 X</b>
<b>75</b>	90	135	62	69	76	1.1	1	114 000	310 000	1 400	2 000	<b>52218</b>	<b>54218</b>
	90	155	88	97.2	106	1.5	1	214 000	525 000	1 100	1 600	<b>52318</b>	<b>54318</b>
<b>80</b>	100	210	150	160	176	3	1.1	370 000	985 000	670	1 000	<b>52420 X</b>	<b>54420 X</b>
<b>85</b>	100	150	67	72.8	81	1.1	1	135 000	375 000	1 300	1 900	<b>52220</b>	<b>54220</b>
	100	170	97	105.4	115	1.5	1	239 000	595 000	950	1 500	<b>52320</b>	<b>54320</b>
<b>90</b>	110	230	166	—	—	3	1.1	415 000	1 150 000	600	900	<b>52422 X</b>	—
<b>95</b>	110	160	67	71.4	81	1.1	1	136 000	395 000	1 200	1 800	<b>52222</b>	<b>54222</b>
	110	190	110	118.4	128	2	1	282 000	755 000	850	1 300	<b>52322 X</b>	<b>54322 X</b>
	120	250	177	—	—	4	1.5	515 000	1 540 000	560	850	<b>52424 X</b>	—
<b>100</b>	120	170	68	71.6	82	1.1	1.1	141 000	430 000	1 200	1 800	<b>52224</b>	<b>54224</b>
	120	210	123	131.2	143	2.1	1.1	330 000	930 000	750	1 100	<b>52324 X</b>	<b>54324 X</b>
	130	270	192	—	—	4	1.5	525 000	1 590 000	530	800	<b>52426 X</b>	—
<b>110</b>	130	190	80	85.8	96	1.5	1.1	183 000	550 000	1 000	1 500	<b>52226 X</b>	<b>54226 X</b>
	130	225	130	—	—	2.1	1.1	350 000	1 030 000	710	1 100	<b>52326 X</b>	—
	140	280	196	—	—	4	1.5	550 000	1 750 000	500	750	<b>52428 X</b>	—
<b>120</b>	140	200	81	86.2	99	1.5	1.1	186 000	575 000	1 000	1 500	<b>52228 X</b>	<b>54228 X</b>
	140	240	140	—	—	2.1	1.1	370 000	1 130 000	670	1 000	<b>52328 X</b>	—
	150	300	209	—	—	4	2	620 000	2 010 000	480	710	<b>52430 X</b>	—
<b>130</b>	150	215	89	95.6	109	1.5	1.1	238 000	735 000	900	1 300	<b>52230 X</b>	<b>54230 X</b>
	150	250	140	—	—	2.1	1.1	380 000	1 200 000	630	950	<b>52330 X</b>	—
	160	320	226	—	—	5	2	650 000	2 210 000	430	630	<b>52432 X</b>	—

**Note** <sup>(1)</sup> The outside diameter  $d_3$  of central washers for bearing designations with an X is smaller than the outside diameter  $D$  of the housing washers.

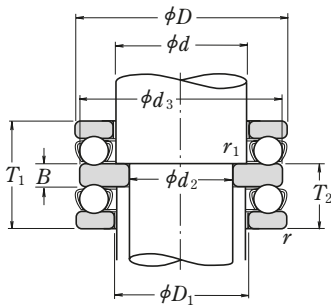


	Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
	$d_3$	$D_1$	$D_2$	$D_3$	$T_2$	$T_6$	$T_8$	$B$	$b$	$A_1$	$R$	$D_a$ max.	$r_a$ max.	$r_b$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
<b>54215 U</b>	110	77	92	115	28.5	29.8	33.5	10	9.5	47.5	90	92	1	1	1.54	1.66	2.06
<b>54315 U</b>	135	77	105	140	48.5	52.6	56.5	18	15	32.5	100	105	1.5	1	4.74	5.14	6.38
<b>54415 U</b>	160	78	115	165	70.5	74.5	80.5	26	21	36.5	125	115	2	1	10.8	11	13.7
<b>54216 U</b>	115	82	98	120	29	30.5	34	10	10	45	90	98	1	1	1.66	1.78	2.21
<b>54316 U</b>	140	82	110	145	48.5	52.1	56.5	18	15	45.5	112	110	1.5	1	4.99	5.39	6.61
<b>54416 U</b>	170	83	125	175	73.5	77.7	83.5	27	22	30.5	125	125	2	1	12.6	12.8	16
<b>54417 XU</b>	179.5	88	130	185	78.5	83.5	89.5	29	23	40.5	140	130	2	1	15.4	15.8	19.5
<b>54217 U</b>	125	88	105	130	33.5	35.6	39.5	12	11	49.5	100	105	1	1	2.26	2.45	3.02
<b>54317 U</b>	150	88	115	155	53	57.1	62	19	17.5	39	112	115	1.5	1	6.38	6.8	10.5
<b>54418 XU</b>	189.5	93	140	195	82.5	86.7	93.5	30	25.5	34.5	140	140	2	1	17.5	18.1	22.5
<b>54218 U</b>	135	93	110	140	38	41.5	45	14	13.5	42	100	110	1	1	3.09	3.42	4.39
<b>54318 U</b>	155	93	120	160	53.5	58.1	62.5	19	18	36.5	112	120	1.5	1	6.79	7.33	9.29
<b>54420 XU</b>	209.5	103	155	220	91.5	96.5	104.5	33	27	43.5	160	155	2.5	1	26.8	27.2	33.4
<b>54220 U</b>	150	103	125	155	41	43.9	48	15	14	49	112	125	1	1	4.08	4.54	5.64
<b>54320 U</b>	170	103	135	175	59	63.2	68	21	18	42	125	135	1.5	1	8.82	9.47	11.6
—	229	113	—	—	101.5	—	—	37	—	—	—	159	2.5	1	35.6	—	—
<b>54222 U</b>	160	113	135	165	41	43.2	48	15	14	62	125	135	1	1	4.39	4.83	5.94
<b>54322 XU</b>	189.5	113	150	195	67	71.2	76	24	20.5	47	140	150	2	1	12.7	13.5	16.6
—	249	123	—	—	108.5	—	—	40	—	—	—	174	3	1.5	47.6	—	—
<b>54224 U</b>	170	123	145	175	41.5	43.3	48.5	15	15	58.5	125	145	1	1	4.92	5.4	6.68
<b>54324 XU</b>	209.5	123	165	220	75	79.1	85	27	22	58	160	165	2	1	17.6	16.4	22.9
—	269	134	—	—	117	—	—	42	—	—	—	188	3	1.5	57.8	—	—
<b>54226 XU</b>	189.5	133	160	195	49	51.9	57	18	17	63	140	160	1.5	1	7.43	8.24	10.2
—	224	134	—	—	80	—	—	30	—	—	—	169	2	1	21.5	—	—
—	279	144	—	—	120	—	—	44	—	—	—	198	3	1.5	62.4	—	—
<b>54228 XU</b>	199.5	143	170	210	49.5	52.1	58.5	18	17	83.5	160	170	1.5	1	8.01	8.87	11.2
—	239	144	—	—	85.5	—	—	31	—	—	—	181	2	1	24.8	—	—
—	299	153	—	—	127.5	—	—	46	—	—	—	212	3	2	77.8	—	—
<b>54230 XU</b>	214.5	153	180	225	54.5	57.8	64.5	20	20.5	74.5	160	180	1.5	1	10.4	11.5	15
—	249	154	—	—	85.5	—	—	31	—	—	—	191	2	1	30.3	—	—
—	319	164	—	—	138	—	—	50	—	—	—	226	4	2	93.6	—	—

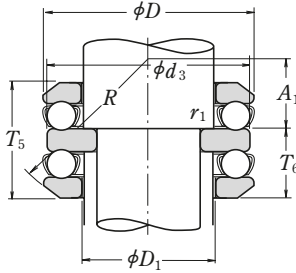


# DOUBLE-DIRECTION THRUST BALL BEARINGS

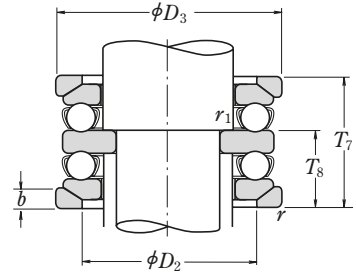
Bore Diameter 135 – 190 mm



With Flat Seat



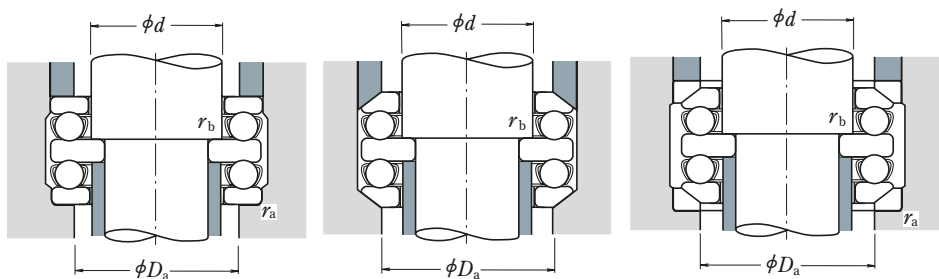
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )		Bearing Designations <sup>(1)</sup>	
$d_2$	$d$	$D$	$T_1$	$T_5$	$T_7$	$r$ min.	$r_1$ min.	$C_a$	$C_{0a}$	Grease	Oil	With Flat Seat	With Aligning Seat
<b>135</b>	170	340	236	—	—	5	2.1	715 000	2 480 000	400	600	<b>52434 X</b>	—
<b>140</b>	160	225	90	97.4	110	1.5	1.1	249 000	805 000	850	1 300	<b>52232 X 54232 X</b>	
	160	270	153	—	—	3	1.1	475 000	1 570 000	600	900	<b>52332 X</b>	—
	180	360	245	—	—	5	3	750 000	2 730 000	380	560	<b>52436 X</b>	—
<b>150</b>	170	240	97	104.4	117	1.5	1.1	280 000	915 000	800	1 200	<b>52234 X 54234 X</b>	
	170	280	153	—	—	3	1.1	465 000	1 570 000	560	850	<b>52334 X</b>	—
	180	250	98	102.4	118	1.5	2	284 000	955 000	800	1 200	<b>52236 X 54236 X</b>	
	180	300	165	—	—	3	2	480 000	1 680 000	530	800	<b>52336 X</b>	—
<b>160</b>	190	270	109	116.4	131	2	2	320 000	1 110 000	710	1 100	<b>52238 X 54238 X</b>	
	190	320	183	—	—	4	2	550 000	1 960 000	480	710	<b>52338 X</b>	—
<b>170</b>	200	280	109	115.6	133	2	2	315 000	1 110 000	710	1 000	<b>52240 X 54240 X</b>	
	200	340	192	—	—	4	2	600 000	2 220 000	450	670	<b>52340 X</b>	—
<b>190</b>	220	300	110	115.2	134	2	2	325 000	1 210 000	670	1 000	<b>52244 X 54244 X</b>	

**Note** <sup>(1)</sup> The outside diameter  $d_3$  of central washers for bearing designations with an X is smaller than the outside diameter  $D$  of the housing washers.



With Aligning Seat Washer	Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
	$d_3$	$D_1$	$D_2$	$D_3$	$T_2$	$T_6$	$T_8$	$B$	$b$	$A_1$	$R$	$D_a$ max.	$r_a$ max.	$r_b$ max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	339	174	—	—	143	—	—	50	—	—	—	240	4	2	110	—	—
<b>54232 XU</b>	224.5	163	190	235	55	58.7	65	20	21	70	160	190	1.5	1	11.2	12.7	16.5
—	269	164	—	—	93	—	—	33	—	—	—	205	2.5	1	35.1	—	—
—	359	184	—	—	148.5	—	—	52	—	—	—	254	4	2.5	126	—	—
<b>54234 XU</b>	239.5	173	200	250	59	62.7	69	21	21.5	87	180	200	1.5	1	13.6	15.2	19.8
—	279	174	—	—	93	—	—	33	—	—	—	215	2.5	1	40.8	—	—
<b>54236 XU</b>	249	183	210	260	59.5	61.7	69.5	21	21.5	108.5	200	210	1.5	2	14.8	16.1	20.6
—	299	184	—	—	101	—	—	37	—	—	—	229	2.5	2.5	46.3	—	—
<b>54238 XU</b>	269	194	230	280	66.5	70.2	77.5	24	23	93.5	200	230	2	2	22.1	22.2	29.8
—	319	195	—	—	111.5	—	—	40	—	—	—	244	3	2	113	—	—
<b>54240 XU</b>	279	204	240	290	66.5	69.8	78.5	24	23	120.5	225	240	2	2	23.1	23.2	30.6
—	339	205	—	—	117	—	—	42	—	—	—	258	3	2	78.4	—	—
<b>54244 XU</b>	299	224	260	310	67	69.6	79	24	25	114	225	260	2	2	25.2	27.8	34.1





9. THRUST CYLINDRICAL ROLLER BEARINGS

INTRODUCTION ..... C 314

BEARING TABLES

THRUST CYLINDRICAL ROLLER BEARINGS

Bore Diameter 35mm – 320mm ..... C 316



DESIGN, TYPES, AND FEATURES

THRUST CYLINDRICAL ROLLER BEARINGS

These are thrust bearings containing cylindrical rollers. They can sustain only axial loads but are suitable for heavy loads and feature high axial rigidity.  
Machined brass cages are used with this bearing type.

TOLERANCES AND RUNNING ACCURACY

THRUST CYLINDRICAL ROLLER BEARINGS  
..... According to Table 7.6 (Pages A140 to A142)

RECOMMENDED FITS

THRUST CYLINDRICAL ROLLER BEARINGS.....Table 8.4 (Pages A164)  
Table 8.6 (Pages A165)



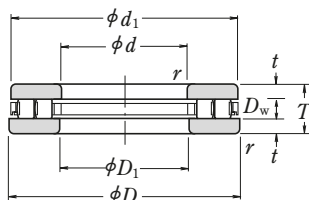
## MINIMUM AXIAL LOAD

Be sure to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please contact NSK.

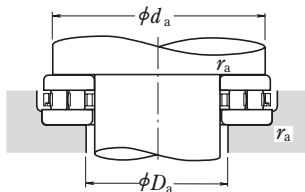


# THRUST CYLINDRICAL ROLLER BEARINGS

Bore Diameter 35 – 130 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>	Grease	Oil
<b>35</b>	80	32	1.1	95 500	247 000	1 000	3 000
<b>40</b>	78	22	1	63 000	194 000	1 200	3 600
<b>45</b>	65	14	0.6	33 000	100 000	1 700	5 000
	85	24	1	71 000	233 000	1 100	3 400
<b>50</b>	110	27	1.1	139 000	470 000	900	2 800
	95	27	1.1	113 000	350 000	1 000	3 000
<b>55</b>	105	30	1.1	134 000	450 000	900	2 600
<b>60</b>	95	26	1	99 000	325 000	1 000	3 000
	110	30	1.1	139 000	480 000	850	2 600
<b>65</b>	100	27	1	110 000	325 000	950	2 800
	115	30	1.1	145 000	515 000	850	2 600
<b>70</b>	150	36	2	259 000	935 000	670	2 000
	125	34	1.1	191 000	635 000	750	2 200
<b>75</b>	100	19	1	63 500	221 000	1 100	3 400
	135	36	1.5	209 000	735 000	710	2 200
<b>80</b>	115	28	1	120 000	420 000	900	2 600
	140	36	1.5	208 000	740 000	710	2 000
<b>85</b>	110	19	1	75 000	298 000	1 100	3 200
	125	31	1	151 000	485 000	800	2 400
	150	39	1.5	257 000	995 000	630	1 900
<b>90</b>	120	22	1	96 000	370 000	950	3 000
	155	39	1.5	250 000	885 000	630	1 900
<b>100</b>	170	42	1.5	292 000	1 110 000	560	1 700
<b>110</b>	160	38	1.1	228 000	855 000	630	1 900
	190	48	2	390 000	1 490 000	500	1 500
<b>120</b>	170	39	1.1	233 000	895 000	600	1 800
	210	54	2.1	505 000	1 930 000	450	1 400
<b>130</b>	190	45	1.5	300 000	1 090 000	530	1 600
	225	58	2.1	585 000	2 370 000	430	1 300
	270	85	4	895 000	3 300 000	320	950



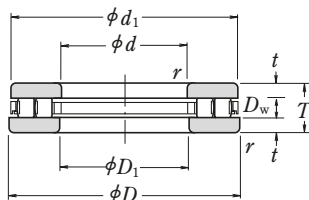
Bearing Designation	Dimensions (mm)				Abutment and Fillet Dimensions (mm)			Mass (kg)
	$d_1$	$D_1$	$D_w$	$t$	$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>35 TMP 14</b>	80	37	12	10	71	46	1	0.97
<b>40 TMP 93</b>	78	42	8	7	71	48	1	0.525
<b>45 TMP 11</b>	65	47	6	4	60	49	0.6	0.144
<b>45 TMP 93</b>	85	47	8	8	78	53	1	0.665
<b>50 TMP 74</b>	109	52	11	8	100	61	1	1.52
<b>50 TMP 93</b>	93	52	11	8	89	57	1	0.94
<b>55 TMP 93</b>	105	55.2	11	9.5	98	63	1	1.28
<b>60 TMP 12</b>	95	62	10	8	88	67	1	0.735
<b>60 TMP 93</b>	110	62	11	9.5	103	68	1	1.36
<b>65 TMP 12</b>	100	67	12.5	7.25	93	71	1	0.805
<b>65 TMP 93</b>	115	65.2	11	9.5	108	73	1	1.44
<b>70 TMP 74</b>	149	72	15	10.5	137	84	2	3.8
<b>70 TMP 93</b>	125	72	14	10	117	78	1	1.95
<b>75 TMP 11</b>	100	77	8	5.5	96	79	1	0.41
<b>75 TMP 93</b>	135	77	14	11	125	84	1.5	2.42
<b>80 TMP 12</b>	115	82	11	8.5	109	86	1	1.02
<b>80 TMP 93</b>	138	82	14	11	130	91	1.5	2.54
<b>85 TMP 11</b>	110	87	7.5	5.75	105	89	1	0.46
<b>85 TMP 12</b>	125	88	14	8.5	118	92	1	1.36
<b>85 TMP 93</b>	148	87	14	12.5	140	95	1.5	3.2
<b>90 TMP 11</b>	119	91.5	9	6.5	114	95	1	0.725
<b>90 TMP 93</b>	155	90.2	16	11.5	144	101	1.5	3.3
<b>100 TMP 93</b>	170	103	16	13	159	110	1.5	4.25
<b>110 TMP 12</b>	160	113	15	11.5	150	119	1	2.66
<b>110 TMP 93</b>	190	113	19	14.5	179	120	2	6.15
<b>120 TMP 12</b>	170	123	15	12	160	129	1	2.93
<b>120 TMP 93</b>	210	123	22	16	199	129	2	8.55
<b>130 TMP 12</b>	187	133	19	13	177	142	1.5	4.5
<b>130 TMP 93</b>	225	133	22	18	214	140	2	10.4
<b>130 TMP 94</b>	270	133	32	26.5	254	150	3	26.2

**Remark** For cylindrical roller thrust bearings not listed above, please contact NSK.

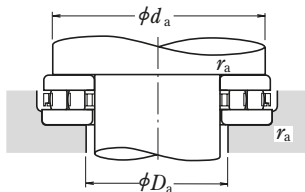


# THRUST CYLINDRICAL ROLLER BEARINGS

Bore Diameter 140 – 320 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
<i>d</i>	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>	Grease	Oil
<b>140</b>	200	46	2	285 000	1 120 000	500	1 500
	240	60	2.1	610 000	2 360 000	400	1 200
	280	85	4	990 000	3 800 000	300	900
<b>150</b>	215	50	2	375 000	1 500 000	480	1 400
	250	60	2.1	635 000	2 510 000	400	1 200
<b>160</b>	200	31	1	173 000	815 000	630	1 900
	270	67	3	745 000	3 150 000	360	1 100
<b>170</b>	240	55	1.5	485 000	1 960 000	430	1 300
	280	67	3	800 000	3 500 000	340	1 000
<b>180</b>	300	73	3	1 000 000	4 000 000	320	950
	360	109	5	1 640 000	6 200 000	240	710
<b>190</b>	270	62	3	705 000	2 630 000	360	1 100
	320	78	4	1 080 000	4 500 000	300	900
<b>200</b>	250	37	1.1	365 000	1 690 000	500	1 500
	340	85	4	1 180 000	5 150 000	280	800
<b>220</b>	270	37	1.1	385 000	1 860 000	480	1 500
	300	63	2	770 000	3 100 000	340	1 000
<b>240</b>	300	45	1.5	435 000	2 160 000	400	1 200
	340	78	2.1	965 000	4 100 000	280	850
<b>260</b>	320	45	1.5	460 000	2 350 000	400	1 200
	360	79	2.1	995 000	4 350 000	280	850
<b>280</b>	350	53	1.5	545 000	2 800 000	340	1 000
	380	80	2.1	1 050 000	4 750 000	260	800
<b>300</b>	380	62	2	795 000	4 000 000	300	900
	420	95	3	1 390 000	6 250 000	220	670
<b>320</b>	400	63	2	820 000	4 250 000	300	900
	440	95	3	1 420 000	6 550 000	220	670



Bearing Designation	Dimensions (mm)				Abutment and Fillet Dimensions (mm)			Mass (kg)
	$d_1$	$D_1$	$D_w$	$t$	$d_a$ min.	$D_a$ max.	$r_a$ max.	
<b>140 TMP 12</b>	197	143	17	14.5	188	153	2	4.85
<b>140 TMP 93</b>	240	143	25	17.5	226	154	2	12.2
<b>140 TMP 94</b>	280	143	32	26.5	262	158	3	27.5
<b>150 TMP 12</b>	215	153	19	15.5	202	163	2	6.15
<b>150 TMP 93</b>	250	153	25	17.5	236	165	2	12.8
<b>160 TMP 11</b>	200	162	11	10	191	168	1	2.21
<b>160 TMP 93</b>	265	164	25	21	255	173	2.5	16.9
<b>170 TMP 12</b>	237	173	22	16.5	227	182	1.5	8.2
<b>170 TMP 93</b>	280	173	25	21	265	183	2.5	17.7
<b>180 TMP 93</b>	300	185	32	20.5	284	194	2.5	22.5
<b>180 TMP 94</b>	354	189	45	32	335	205	4	58.2
<b>190 TMP 12</b>	266	195	30	16	255	200	2.5	11.8
<b>190 TMP 93</b>	320	195	32	23	303	205	3	27.6
<b>200 TMP 11</b>	247	203	17	10	242	207	1	4.1
<b>200 TMP 93</b>	340	205	32	26.5	322	218	3	34.5
<b>220 TMP 11</b>	267	223	17	10	262	227	1	4.5
<b>220 TMP 12</b>	297	224	30	16.5	287	232	2	13.5
<b>240 TMP 11</b>	297	243	18	13.5	288	251	1.5	7.2
<b>240 TMP 12</b>	335	244	32	23	322	258	2	23.3
<b>260 TMP 11</b>	317	263	18	13.5	308	272	1.5	7.75
<b>260 TMP 12</b>	355	264	32	23.5	342	276	2	25.2
<b>280 TMP 11</b>	347	283	20	16.5	335	294	1.5	11.6
<b>280 TMP 12</b>	375	284	32	24	362	296	2	27.2
<b>300 TMP 11</b>	376	304	25	18.5	365	315	2	16.7
<b>300 TMP 12</b>	415	304	38	28.5	398	322	2.5	42
<b>320 TMP 11</b>	396	324	25	19	385	335	2	18
<b>320 TMP 12</b>	435	325	38	28.5	418	340	2.5	44.5

**Remark** For cylindrical roller thrust bearings not listed above, please contact NSK.





10. THRUST TAPERED ROLLER BEARINGS

INTRODUCTION ..... C 322

BEARING TABLES

THRUST TAPERED ROLLER BEARINGS

Bore Diameter 101.600mm – 600mm ..... C 324



DESIGN, TYPES, AND FEATURES

THRUST TAPERED ROLLER BEARINGS

These thrust bearings containing tapered rollers come in two types. TT bearings, which have a rib on the housing washer, can accurately guide the shaft in the radial direction, while TTF bearings, which have no rib on the housing washer, can tolerate some eccentricity during operation.



Fig. 1 TT and TTF Base Structure

TOLERANCES AND RUNNING ACCURACY

THRUST TAPERED ROLLER BEARINGS ..... Table 7.7 (Page A144)

RECOMMENDED FITS

THRUST TAPERED ROLLER BEARINGS ..... Table 8.4 (Page A164)  
Table 8.6 (Page A165)

For Inch Series tapered roller thrust bearings, please contact NSK.

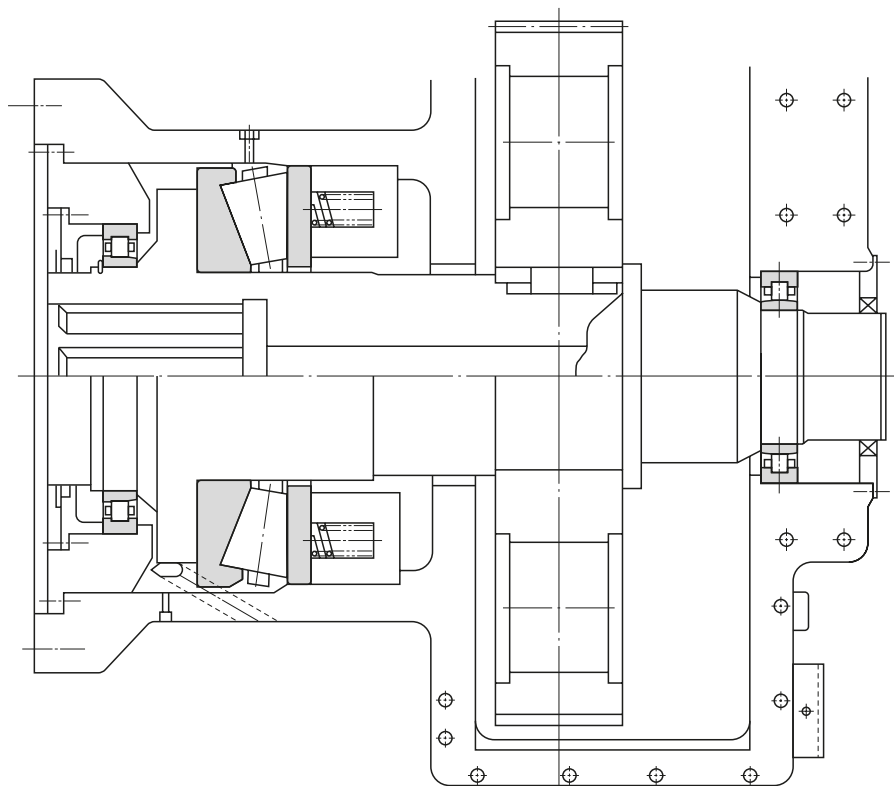
MINIMUM AXIAL LOAD

Be sure to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please contact NSK.

USAGE EXAMPLE

A typical structure of a heavy-duty Extruder is shown in Figure 2.





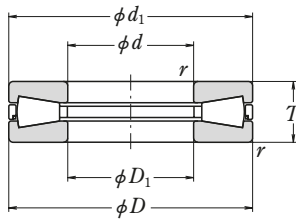
**Fig. 2 Thrust Tapered Roller Bearings in a Heavy-Duty Extruder**



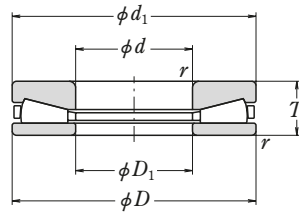
# THRUST TAPERED ROLLER BEARINGS

## TT, TTF Types

Bores Diameter 101.600 – 168.275 mm



TT



TTF

<i>d</i>	Boundary Dimensions (mm/inch)			Basic Load Ratings (kN)	
	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>
<b>101.600</b> 4.0000	215.900 8.5000	46.038 1.8125	3.3	710	2 900
<b>111.760</b> 4.4000	223.520 8.8000	55.880 2.2000	3.3	790	2 920
<b>114.300</b> 4.5000	250.825 9.8750	53.975 2.1250	4.0	970	4 100
<b>127.000</b> 5.0000	266.700 10.5000	58.738 2.3125	4.8	1 040	4 350
	266.700 10.5000	58.738 2.3125	4.8	1 030	4 500
<b>128.575</b> 5.0620	265.100 10.4370	63.500 2.5000	6.4	1 040	4 350
<b>130</b>	250	70	2.1	1 100	4 100
<b>135</b> <b>150</b>	245 300	65 90	2.1 5	855 1 470	3 100 6 300
<b>152.400</b> 6.0000	317.500 12.5000	69.850 2.7500	6.4	1 470	6 300
	317.500 12.5000	69.850 2.7500	6.4	1 550	6 700
<b>165.100</b> 6.5000	311.150 12.2500	88.900 3.5000	6.4	1 560	5 250
<b>168.275</b> 6.6250	304.800 12.0000	69.850 2.7500	6.4	1 230	5 000

Bearing Designation	Dimensions (mm)		Corner Radius of Shaft or Housing $r_a$ max.	Mass (kg)  approx.
	$D_1$	$d_1$		
<b>*101TT2151</b>	103.200	214.300	3.3	8.9
<b>*111TT2251</b>	113.300	221.900	3.3	11.2
<b>*114TT2551</b>	114.500	250.825	4.0	14.4
<b>*127TT2551</b>	128.600	265.100	4.8	17.3
<b>*127TTF2651</b>	128.600	265.100	4.8	17.3
<b>*128TT2651</b>	128.900	265.100	6.4	18.2
<b>130TTF2501</b>	130.3	250	2	17
<b>135TT2401</b> <b>150TTF3001</b>	135.3 152	245 306	2 4	14.5 34.2
<b>*152TTF3151</b>	152.700	315.900	6.4	28.9
<b>*152TT3152</b>	152.400	317.500	6.4	28.9
<b>*165TT3151</b>	165.400	311.150	6.4	33
<b>*168TTF3051</b>	169.000	302.500	6.4	24.1

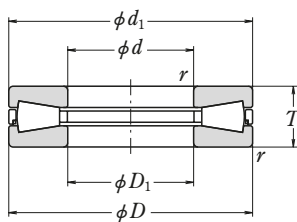
**Note** \* Bearings marked with \* are Inch Series bearings.



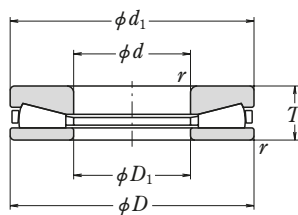
# THRUST TAPERED ROLLER BEARINGS

TT, TTF Types

Bore Diameter 170 – 241.300 mm



TT



TTF

<i>d</i>	Boundary Dimensions (mm/inch)			Basic Load Ratings (kN)	
	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>
<b>170</b>	320	100	5	1 650	5 550
<b>174.625</b> 6.8750	358.775 14.1250	82.550 3.2500	6.4	1 740	7 400
	358.775 14.1250	82.550 3.2500	6.4	1 740	7 400
<b>177.800</b> 7.0000	368.300 14.5000	82.550 3.2500	8.0	1 900	8 250
<b>203.200</b> 8.0000	419.100 16.5000	92.075 3.6250	9.7	2 530	11 300
	419.100 16.5000	92.075 3.6250	9.7	2 530	11 300
	419.100 16.5000	120.650 4.7500	9.7	2 530	11 300
	419.100 16.5000	120.650 4.7500	9.7	2 530	11 300
<b>206.375</b> 8.1250	419.100 16.5000	120.370 4.7390	C10	2 590	11 700
<b>228.600</b> 9.0000	482.600 19.0000	104.775 4.1250	11.2	3 350	16 400
	482.600 19.0000	104.775 4.1250	11.2	3 350	16 400
<b>234.950</b> 9.2500	546.100 21.5000	127.000 5.0000	15.9	4 600	21 400
<b>241</b>	404	110	4	2 200	8 650
<b>241.300</b> 9.5000	496.888 19.5625	129.000 5.0787	C8	3 450	16 700

Bearing Designation	Dimensions (mm)		Corner Radius of Shaft or Housing $r_a$ max.	Mass (kg)  approx.
	$D_1$	$d_1$		
<b>170TT3201</b>	170.5	320	4	39.3
<b>*174TT3551</b>	174.625	358.775	6.4	43.3
<b>*174TTF3551</b>	174.625	358.775	6.4	43.3
<b>*177TT3651</b>	180.400	365.800	8.0	45.9
<b>*203TT4151</b>	205.600	416.700	9.7	66.1
<b>*203TTF4153A</b>	203.200	419.100	9.7	66.1
<b>*203TT4152</b>	205.600	416.700	9.7	86.6
<b>*203TTF4152</b>	205.600	416.700	9.7	86.6
<b>*206TT4151</b>	206.375	419.100	6	85.5
<b>*228TT4851</b>	228.900	482.600	11.2	101
<b>*228TTF4851</b>	230.600	480.600	11.2	101
<b>*234TT5451</b>	237.000	544.000	15.9	165
<b>241TTF4002</b>	241	404	3	61.8
<b>*241TT4952</b>	241.300	496.888	5	130

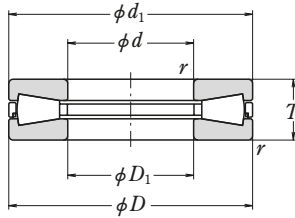
**Note** \* Bearings marked with \* are Inch Series bearings.



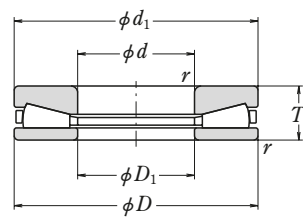
# **THRUST TAPERED ROLLER BEARINGS**

## **TT, TTF Types**

**Bore Diameter 254.000 – 600 mm**

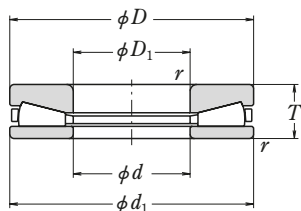


TT



TTF

<i>d</i>	Boundary Dimensions (mm/inch)			Basic Load Ratings (kN)	
	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>
<b>254.000</b> 10.0000	539.750 21.2500	117.475 4.6250	11.2	3 950	18 600
<b>260</b>	360	75	2.1	1 110	4 650
<b>273.050</b> 10.7500	552.450 21.7500	133.350 5.2500	C8	4 400	20 700
<b>279.400</b> 11.0000	603.250 23.7500	136.525 5.3750	11.2	5 400	25 200
<b>330</b>	440	85	3	1 300	6 300
<b>340</b>	460	96	3	1 690	7 750
<b>350</b>	460	85	2	1 370	6 600
<b>360</b>	470	85	4	1 440	6 950
	600	120	4	3 700	20 100
<b>380</b>	550	110	4	2 760	12 100
<b>406.400</b> 16.0000	711.200 28.0000	146.050 5.7500	9.7	5 900	28 600
	838.200 33.0000	177.800 7.0000	12.7	8 950	46 500
<b>431.800</b> 17.0000	863.600 34.0000	228.600 9.0000	10.4	15 100	69 500
<b>440</b>	600	105	4	2 720	13 900
<b>450</b>	570	100	3	2 170	10 500
<b>460</b>	580	90	3	1 890	9 550
<b>500</b>	630	82	3	2 020	11 600
<b>508</b>	730.25	120.65	6	4 900	26 100
<b>508.000</b> 20.0000	990.600 39.0000	196.850 7.7500	12.7	12 000	65 000
<b>558</b>	780	120	9.5	4 800	25 500
<b>558.800</b> 22.0000	1 066.800 42.0000	285.750 11.2500	10.4	21 100	94 500
<b>560</b>	670	85	3	1 950	10 700
<b>600</b>	710	86	3	1 900	10 700



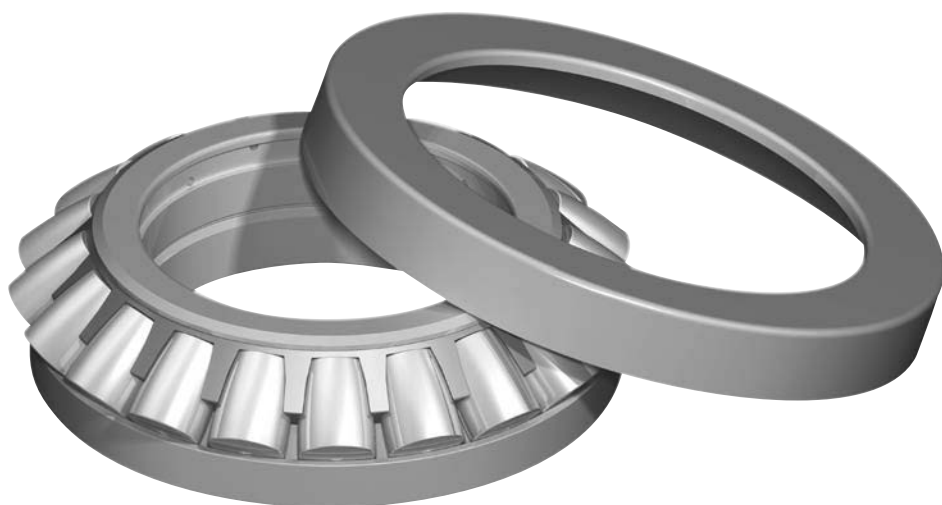
TTF-1

Bearing Designation	Dimensions (mm)		Corner Radius of Shaft or Housing $r_a$ max.	Mass (kg)
	$D_1$	$d_1$		approx.
<b>*254TTF5351</b>	254.000	539.750	11.2	142
<b>260TTF3601</b>	260.3	360	2	24.8
<b>*273TT5551</b>	273.050	552.450	5	164
<b>*279TT6051</b>	279.700	603.250	11.2	208
<b>330TTF4401</b>	331	440	2.5	38.5
<b>340TTF4603</b>	340	460	2.5	49.2
<b>350TTF4602A<sup>(1)</sup></b>	351	450	2	40.4
<b>360TTF4701</b>	360.4	470	3	41.4
<b>360TTF6201</b>	366	620	3	148
<b>380TTF5501</b>	381	550	3	92.9
<b>*406TT7151</b>	406.800	711.200	9.7	266
<b>*406TT8351</b>	406.800	837.800	12.7	510
<b>*431TTF8651</b>	435.000	862.000	10.4	683
<b>440TTF6001</b>	440	600	3	93.3
<b>450TTF5701</b>	455	569	2.5	65.4
<b>460TTF5801</b>	465	579	2.5	60
<b>500TTF6301</b>	505	628	2.5	64.3
<b>508TT7301</b>	509	730.25	5	177
<b>*508TT9951</b>	508.000	990.600	12.7	760
<b>558TT7801</b>	558	780	8	190
<b>*558TTF1051</b>	561.980	1 065.219	10.4	1 260
<b>560TTF6701</b>	565	668	2.5	61.4
<b>600TTF7101</b>	604	710	2.5	66.2

**Note** \* Bearings marked with \* are Inch Series bearings.

<sup>(1)</sup> For this bearing, dimensional designations are defined by Figure TTF-1.





# 11. THRUST SPHERICAL ROLLER BEARINGS

INTRODUCTION ..... C 332

BEARING TABLES

THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 60mm – 500mm ..... C 334



### DESIGN, TYPES, AND FEATURES

#### THRUST SPHERICAL ROLLER BEARINGS

These thrust bearings containing convex rollers have self-aligning capabilities and are free of any influence from mounting error or shaft deflection. E-type bearings (suffixed with E in the bearing tables) with pressed cages are available for high load applications.

Machined-brass cages are recommended for horizontal shafts or high-speed applications; please contact NSK for details.

Since there are several places where lubrication is difficult, such as the area between the roller heads and inner ring rib, the sliding surfaces between cage and guide sleeve, etc., oil lubrication should be used, even at low speeds.

Machined-brass cages are used in standard bearings of this type.

### TOLERANCES AND RUNNING ACCURACY

**THRUST SPHERICAL ROLLER BEARINGS** .....Table 7.8 (Pages A145)

### RECOMMENDED FITS

**THRUST SPHERICAL ROLLER BEARINGS** .....Table 8.4 (Pages A164)  
Table 8.6 (Pages A165)



## **DIMENSIONS RELATED TO MOUNTING**

Dimensions related to mounting of thrust spherical roller bearings are listed in the bearing tables.

If the bearing load is heavy, design the shaft shoulder with ample strength to provide sufficient support for the shaft washer.

## **PERMISSIBLE MISALIGNMENT**

The permissible misalignment of thrust spherical roller bearings varies depending on size, but it is approximately 0.018 to 0.036 radian (1° to 2°) with average loads.

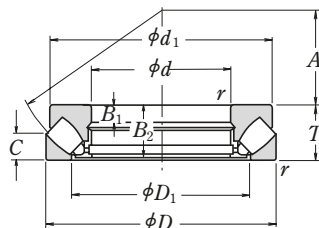
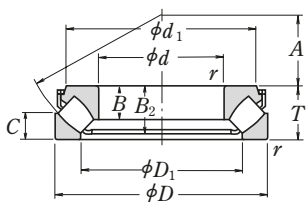
## **MINIMUM AXIAL LOAD**

Be sure to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.



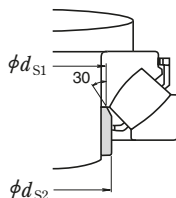
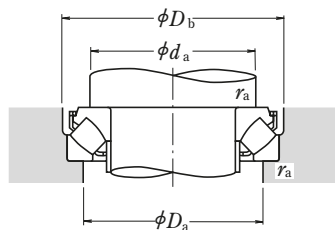
# THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 60 – 200 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> ) Oil	Bearing Designation
<i>d</i>	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>		
<b>60</b>	130	42	1.5	330 000	885 000	2 600	<b>29412 E</b>
<b>65</b>	140	45	2	405 000	1 100 000	2 400	<b>29413 E</b>
<b>70</b>	150	48	2	450 000	1 240 000	2 400	<b>29414 E</b>
<b>75</b>	160	51	2	515 000	1 430 000	2 200	<b>29415 E</b>
<b>80</b>	170	54	2.1	575 000	1 600 000	2 000	<b>29416 E</b>
<b>85</b>	150	39	1.5	330 000	1 040 000	2 400	<b>29317 E</b>
	180	58	2.1	630 000	1 760 000	1 900	<b>29417 E</b>
<b>90</b>	155	39	1.5	350 000	1 080 000	2 200	<b>29318 E</b>
	190	60	2.1	695 000	1 950 000	1 800	<b>29418 E</b>
<b>100</b>	170	42	1.5	410 000	1 280 000	2 000	<b>29320 E</b>
	210	67	3	840 000	2 400 000	1 600	<b>29420 E</b>
<b>110</b>	190	48	2	530 000	1 710 000	1 800	<b>29322 E</b>
	230	73	3	1 010 000	2 930 000	1 500	<b>29422 E</b>
<b>120</b>	210	54	2.1	645 000	2 100 000	1 600	<b>29324 E</b>
	250	78	4	1 160 000	3 400 000	1 400	<b>29424 E</b>
<b>130</b>	225	58	2.1	740 000	2 450 000	1 500	<b>29326 E</b>
	270	85	4	1 330 000	3 900 000	1 200	<b>29426 E</b>
<b>140</b>	240	60	2.1	840 000	2 810 000	1 400	<b>29328 E</b>
	280	85	4	1 370 000	4 200 000	1 200	<b>29428 E</b>
<b>150</b>	250	60	2.1	870 000	2 900 000	1 400	<b>29330 E</b>
	300	90	4	1 580 000	4 900 000	1 100	<b>29430 E</b>
<b>160</b>	270	67	3	1 010 000	3 400 000	1 300	<b>29332 E</b>
	320	95	5	1 740 000	5 400 000	1 100	<b>29432 E</b>
<b>170</b>	280	67	3	1 050 000	3 500 000	1 200	<b>29334 E</b>
	340	103	5	1 680 000	5 800 000	1 000	<b>29434</b>
<b>180</b>	300	73	3	1 230 000	4 200 000	1 100	<b>29336 E</b>
	360	109	5	1 870 000	6 500 000	900	<b>29436</b>
<b>190</b>	320	78	4	1 370 000	4 700 000	1 100	<b>29338 E</b>
	380	115	5	2 100 000	7 450 000	850	<b>29438</b>
<b>200</b>	280	48	2	540 000	2 310 000	1 500	<b>29240</b>
	340	85	4	1 570 000	5 450 000	1 000	<b>29340 E</b>
	400	122	5	2 290 000	8 150 000	800	<b>29440</b>

**Note** (1) For heavy load applications, ensure that the  $d_a$  value chosen is large enough to support the shaft washer rib.

**Dynamic Equivalent Load**

$$P = 1.2F_r + F_a$$

**Static Equivalent Load**

$$P_0 = 2.8F_r + F_a$$

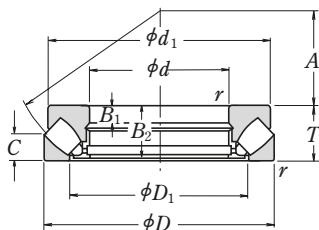
However,  $F_r/F_a \leq 0.55$  must be satisfied.

Dimensions (mm)						Spacer Sleeve Dimensions (mm)		Abutment and Fillet Dimensions (mm)				Mass (kg)
$d_1$	$D_1$	$B, B_1$	$B_2$	$C$	$A$	$d_{S1}$ max.	$d_{S2}$ max.	$d_a^{(1)}$ min.	$D_a$ max.	$D_b$ min.	$r_a$ max.	approx.
114.5	89	27	38	20	38	67	67	90	108	133	1.5	2.55
121.5	93	29.5	40.5	22	42	72	72	100	115	143	2	3.2
131.5	102	31	43	24	44	78	78	105	125	153	2	3.9
138	107	33.5	46	25	47	83	83	115	132	163	2	4.65
148	114.5	35	48.5	27	50	89	89	120	140	173	2	5.55
134.5	112	24.5	35.5	19	50	91	91	115	135	153	1.5	2.7
156.5	124	37	51.5	28	54	95	95	130	150	183	2	6.55
139.5	118	24.5	35	19	52	97	97	120	140	158	1.5	2.83
165.5	129.5	39	54.5	29	56	100	100	135	157	193	2	7.55
152	128	26.2	38	20.8	58	107	107	130	150	173	1.5	3.6
185	144	43	59.5	33	62	111	111	150	175	214	2.5	10.3
169.5	142.5	30.3	43.5	24	64	117	117	145	165	193	2	5.25
200	157	47	64.5	36	69	121	129	165	190	234	2.5	13.3
187.5	156.5	34	48.5	27	70	130	130	160	180	214	2	7.3
215	171	50.5	69.5	38	74	132	142	180	205	254	3	16.6
203.5	168.5	37	53.5	28	76	141	143	170	195	229	2	8.95
235	185	54	74.5	42	81	143	153	195	225	275	3	21.1
216.5	179	38.5	54	30	82	148	154	185	205	244	2	10.4
244.5	195.5	54	74.5	42	86	153	162	205	235	285	3	22.2
224	190	38	54.5	29	87	158	163	195	215	254	2	10.8
266	209	58	81	44	92	164	175	220	250	306	3	27.3
243	203	42	60	33	92	169	176	210	235	275	2.5	14.3
278	224.5	60.5	84.5	46	99	175	189	230	265	326	4	32.1
252	214.5	42.2	60.5	32	96	178	188	220	245	285	2.5	14.8
310	243	37	99	50	104	—	—	245	285	—	4	43.5
270	227	46	65.5	36	103	189	195	235	260	306	2.5	19
330	255	39	105	52	110	—	—	260	300	—	4	52
288.5	244	49	69	38	110	200	211	250	275	326	3	23
345	271	41	111	55	117	—	—	275	320	—	4	60
266	236	15	46	24	108	—	—	235	255	—	2	8.55
306.5	257	53.5	75	41	116	211	224	265	295	346	3	28.5
365	280	43	117	59	122	—	—	290	335	—	4	69



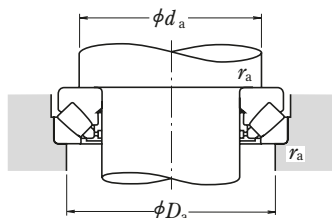
# THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 220 – 420 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> ) Oil	Bearing Designation
<i>d</i>	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C<sub>a</sub></i>	<i>C<sub>0a</sub></i>		
<b>220</b>	300	48	2	560 000	2 500 000	1 400	<b>29244</b>
	360	85	4	1 340 000	5 200 000	950	<b>29344</b>
	420	122	6	2 350 000	8 650 000	800	<b>29444</b>
<b>240</b>	340	60	2.1	800 000	3 450 000	1 200	<b>29248</b>
	380	85	4	1 360 000	5 400 000	950	<b>29348</b>
	440	122	6	2 420 000	9 100 000	750	<b>29448</b>
<b>260</b>	360	60	2.1	855 000	3 850 000	1 200	<b>29252</b>
	420	95	5	1 700 000	6 800 000	800	<b>29352</b>
	480	132	6	2 820 000	10 700 000	710	<b>29452</b>
<b>280</b>	380	60	2.1	885 000	4 100 000	1 100	<b>29256</b>
	440	95	5	1 830 000	7 650 000	800	<b>29356</b>
	520	145	6	3 400 000	13 100 000	630	<b>29456</b>
	520	145	6	3 950 000	14 900 000	630	<b>29456 EM</b>
<b>300</b>	420	73	3	1 160 000	5 150 000	950	<b>29260</b>
	480	109	5	2 190 000	9 100 000	710	<b>29360</b>
	540	145	6	3 500 000	13 700 000	630	<b>29460</b>
<b>320</b>	440	73	3	1 190 000	5 450 000	950	<b>29264</b>
	500	109	5	2 230 000	9 400 000	670	<b>29364</b>
	580	155	7.5	3 650 000	14 600 000	560	<b>29464</b>
<b>340</b>	460	73	3	1 230 000	5 750 000	900	<b>29268</b>
	540	122	5	2 640 000	11 200 000	630	<b>29368</b>
	620	170	7.5	4 400 000	17 400 000	530	<b>29468</b>
<b>360</b>	500	85	4	1 550 000	7 300 000	800	<b>29272</b>
	560	122	5	2 670 000	11 500 000	600	<b>29372</b>
	640	170	7.5	4 200 000	17 200 000	500	<b>29472</b>
	640	170	7.5	5 450 000	20 400 000	500	<b>29472 EM</b>
<b>380</b>	520	85	4	1 620 000	7 800 000	800	<b>29276</b>
	600	132	6	3 300 000	14 500 000	560	<b>29376</b>
	670	175	7.5	4 800 000	19 500 000	480	<b>29476</b>
<b>400</b>	540	85	4	1 640 000	8 000 000	750	<b>29280</b>
	620	132	6	3 250 000	14 500 000	530	<b>29380</b>
	710	185	7.5	5 400 000	22 100 000	450	<b>29480</b>
<b>420</b>	580	95	5	2 010 000	9 800 000	670	<b>29284</b>
	650	140	6	3 500 000	15 700 000	500	<b>29384</b>
	730	185	7.5	5 650 000	23 500 000	450	<b>29484</b>

**Note** <sup>(1)</sup> For heavy load applications, ensure that the *d<sub>a</sub>* value chosen is large enough to support the shaft washer rib.

**Dynamic Equivalent Load**

$$P = 1.2F_r + F_a$$

**Static Equivalent Load**

$$P_0 = 2.8F_r + F_a$$

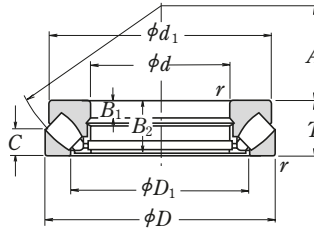
However,  $F_r/F_a \leq 0.55$  must be satisfied.

Dimensions (mm)						Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_1$	$D_1$	$B_1$	$B_2$	$C$	$A$	$d_a^{(1)}$ min.	$D_a$ max.	$r_a$ max.	approx.
285	254	15	46	24	117	260	275	2	9.2
335	280	29	81	41	125	285	315	3	33
385	308	43	117	58	132	310	355	5	74
325	283	19	57	30	130	285	305	2	16.5
355	300	29	81	41	135	300	330	3	35.5
405	326	43	117	59	142	330	375	5	79
345	302	19	57	30	139	305	325	2	18
390	329	32	91	45	148	330	365	4	48.5
445	357	48	127	64	154	360	405	5	105
365	323	19	57	30	150	325	345	2	19
410	348	32	91	46	158	350	390	4	52.5
480	384	52	140	68	166	390	440	5	132
480	380	52	140	70	166	410	445	5	134
400	353	21	69	38	162	355	380	2.5	30
450	379	37	105	50	168	380	420	4	74
500	402	52	140	70	175	410	460	5	140
420	372	21	69	38	172	375	400	2.5	32.5
470	399	37	105	53	180	400	440	4	77
555	436	55	149	75	191	435	495	6	175
440	395	21	69	37	183	395	420	2.5	33.5
510	428	41	117	59	192	430	470	4	103
590	462	61	164	82	201	465	530	6	218
480	423	25	81	44	194	420	455	3	51
525	448	41	117	59	202	450	495	4	107
610	480	61	164	82	210	485	550	6	228
580	474	61	164	83	210	495	550	6	220
496	441	27	81	42	202	440	475	3	52
568	477	44	127	63	216	480	525	5	140
640	504	63	168	85	230	510	575	6	254
517	460	27	81	42	212	460	490	3	55
590	494	44	127	64	225	500	550	5	150
680	536	67	178	89	236	540	610	6	306
553	489	30	91	46	225	490	525	4	72
620	520	48	135	68	235	525	575	5	170
700	556	67	178	89	244	560	630	6	323



# THRUST SPHERICAL ROLLER BEARINGS

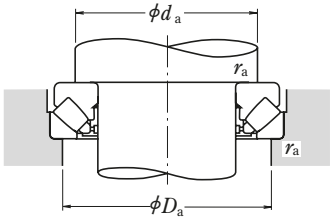
Bore Diameter 440 – 500 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> ) Oil	Bearing Designation
<i>d</i>	<i>D</i>	<i>T</i>	<i>r</i> min.	<i>C</i> <sub>a</sub>	<i>C</i> <sub>0a</sub>		
<b>440</b>	600	95	5	2 030 000	10 100 000	670	<b>29288</b>
	680	145	6	3 750 000	16 700 000	480	<b>29388</b>
	780	206	9.5	6 550 000	27 200 000	400	<b>29488</b>
	780	206	9.5	8 000 000	31 500 000	400	<b>29488 EM</b>
<b>460</b>	620	95	5	2 060 000	10 300 000	670	<b>29292</b>
	710	150	6	4 100 000	18 400 000	450	<b>29392</b>
	800	206	9.5	6 750 000	28 600 000	380	<b>29492</b>
<b>480</b>	650	103	5	2 370 000	12 100 000	600	<b>29296</b>
	730	150	6	4 150 000	19 000 000	450	<b>29396</b>
	850	224	9.5	7 200 000	31 000 000	360	<b>29496</b>
<b>500</b>	670	103	5	2 390 000	12 400 000	600	<b>292/500</b>
	750	150	6	4 350 000	20 400 000	450	<b>293/500</b>
	870	224	9.5	7 850 000	33 000 000	340	<b>294/500</b>

**Note** <sup>(1)</sup> For heavy load applications, ensure that the *d*<sub>a</sub> value chosen is large enough to support the shaft washer rib.





Dynamic Equivalent Load

$P = 1.2F_r + F_a$

Static Equivalent Load

$P_0 = 2.8F_r + F_a$

However,  $F_r/F_a \leq 0.55$  must be satisfied.

Dimensions (mm)						Abutment and Fillet Dimensions (mm)			Mass (kg)
$d_1$	$D_1$	$B_1$	$B_2$	$C$	$A$	$d_a^{(1)}$ min.	$D_a$ max.	$r_a$ max.	approx.
575	508	30	91	49	235	510	545	4	77
645	548	49	140	70	245	550	600	5	190
745	588	74	199	100	260	595	670	8	407
710	577	74	199	101	257	605	675	8	402
592	530	30	91	46	245	530	570	4	80
666	567	51	144	72	257	575	630	5	210
765	608	74	199	100	272	615	690	8	420
624	556	33	99	55	259	555	595	4	97
690	590	51	144	72	270	595	650	5	215
810	638	81	216	108	280	645	730	8	545
645	574	33	99	55	268	575	615	4	100
715	611	51	144	74	280	615	670	5	220
830	661	81	216	107	290	670	750	8	560





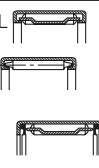
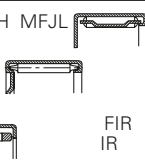



















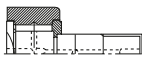
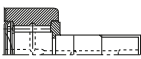







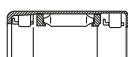


## 12. NEEDLE ROLLER BEARINGS

### DESIGN AND TYPES

Needle roller bearings come in various types and designs.  
NSK Needle Roller Bearings CAT. No. E1419 lists bearings shown in Table 1. Please refer to this catalog and contact NSK regarding bearing selection.

**Table 1 Types of Needle Roller Bearings**

Cage & Needle Roller Assemblies	FWJ FWF WJ WJ		FBN, FBNP WJC FWJC											
Drawn Cup Needle Roller Bearings	FJ, FJH J, JH F, FH B, BH FJT, FJTT MFJT FJLT, FJLTT MFJLT		MFJ, MFJH MJ, MJH MF, MFH M, MH FJP JP	  FIR IR	  Y YH									
Solid Needle Roller Bearings	RNA 48 RNA 49 RNA 59 RNA 69 HJ		RLM			RNA...TT		Cone						
Thrust Needle Roller Bearings Thrust Raceway Washers	FNTA NTA		FB		FTRA TRA		FTRB TRB		FTRC TRC		FTRD TRD		FTRE TRE	
Needle Rollers	A Type (Please refer to B350 page) T Type		F Type		P Type		C Type		M Type					
Cam Followers Roller Followers	FCR FCJ CR		FCRS FCJS CRS		FYCR FYCJ YCR		FYCRS FYCJS YCRS							
Needle Roller Bearings for Universal Joints	ZY		NSA											
Drawn Cup Roller Clutches	RC		FC		RCB		FCB							



## 13. BALL BEARING UNITS

### DESIGN AND TYPES

Ball bearing units come in various designs and types.  
Please refer to the catalogs below for more detailed information:

Ball Bearing Units CAT.No. E1154  
Steel Series Ball Bearing Units CAT.No. E1232  
Ball Bearing Units With Ductile Cast Iron Housings CAT.No. E1233  
Triple-Sealed Bearings for Ball Bearing Units CAT.No. E1234  
Stainless Series Ball Bearings Units CAT.No. E1235  
Ball Bearing Units Handbook CAT.No. E1155





## 14. PLUMMER BLOCKS

### DESIGN, TYPES, AND FEATURES

Plummer blocks come in numerous types and sizes.

SN 5  
SN 6  
SN 30  
SN 31  
SN 2  
SN 3  
SN 2C  
SN 3C



These types are the most common. Models SN30 and SN31 are for medium loads.

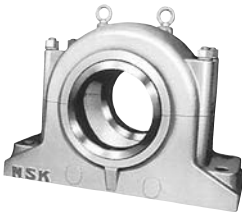
Types SN2C and SN3C have different bore diameters on both sides.

SG 5



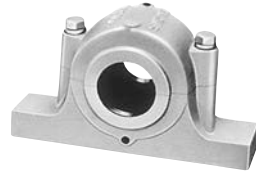
Dustproof plummer blocks have a combination of oil seals, labyrinth seals, and oil groove seals; therefore, they are suitable for environments with dust or other foreign matter.

SD31TS  
SD32TS



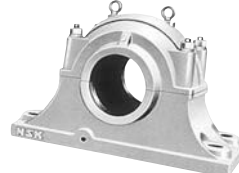
These types feature labyrinth seals, making them suitable for high-speed applications.

SN 5B  
SN 6B  
SN 30B  
SN 31B  
SN 2B  
SN 3B  
SN 2BC  
SN 3BC



These types have the same dimensions as types SN5 and SN6. To increase the bearing box strength, no material is removed from the top or bottom of the base, so mounting holes can be drilled anywhere.

SD 30S  
SD 31S  
SD 5  
SD 6  
SD 2  
SD 3  
SD 2C  
SD 3C



These types are large and made for heavy loads. Standard models have double seals and four mounting bolt holes. Types SD2C and SD3C feature different bore diameters on both sides.



V · C

Single-piece plummer blocks (integrated roller bearing units) have higher rigidity and precision than split plummer blocks.





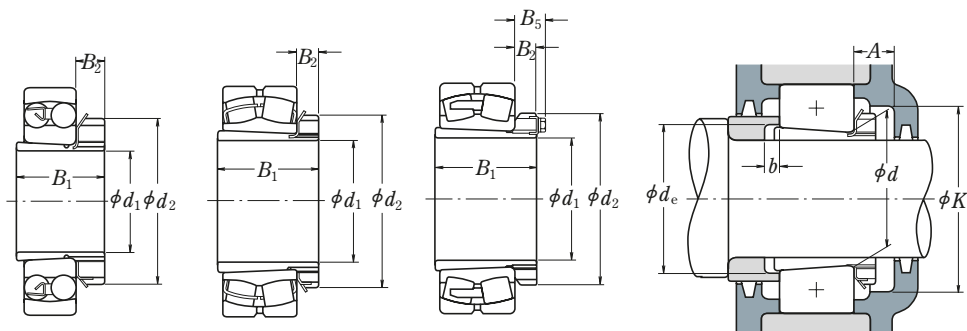
# 15. ACCESSORIES FOR ROLLING BEARINGS

<b>ADAPTERS</b>	
<b>FOR ROLLING BEARINGS</b>	Shaft Diameter 17 – 470mm..... C 348
<b>WITHDRAWAL SLEEVES</b>	
<b>FOR ROLLING BEARINGS</b>	Shaft Diameter 35 – 480mm..... C 356
<b>NUTS FOR ROLLING BEARINGS</b>	..... C 362
<b>STOPPERS FOR ROLLING BEARINGS</b>	..... C 367
<b>LOCK-WASHERS FOR ROLLING BEARINGS</b>	..... C 368



# ADAPTERS FOR ROLLING BEARINGS

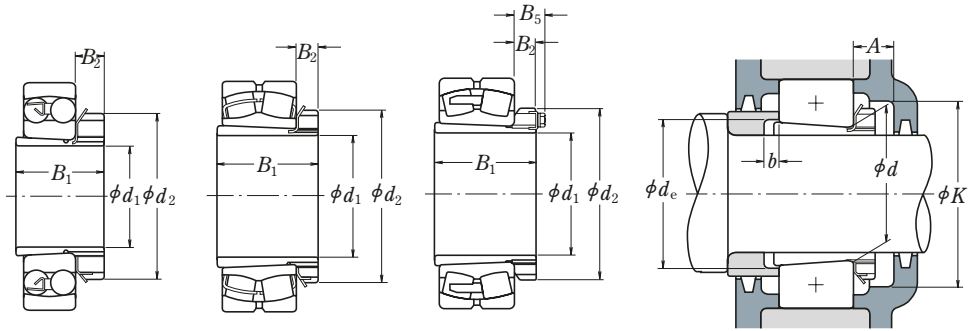
Shaft Diameter 17 – 40 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings		Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
				$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
17	20	1204K	+ H 204X	24	32	7	—	A 204X	14	39	23	5	0.045
	20	2204K	+ H 304X	28	32	7	—	A 304X	14	39	24	5	0.045
	20	1304K	+ H 304X	28	32	7	—	A 304X	14	39	24	8	0.045
	20	2304K	+ H2304X	31	32	7	—	A2304X	14	39	24	5	0.050
20	25	1205K	+ H 205X	26	38	8	—	A 205X	15	45	28	5	0.065
	25	2205K	+ H 305X	29	38	8	—	A 305X	15	45	29	5	0.075
	25	1305K	+ H 305X	29	38	8	—	A 305X	15	45	29	6	0.075
	25	21305C DKE4	+ H 305X	29	38	8	—	A 305X	15	45	29	6	0.075
	25	2305K	+ H2305X	35	38	8	—	A2305X	15	45	29	5	0.090
	25	2305K	+ H2305X	35	38	8	—	A2305X	15	45	29	5	0.090
25	30	1206K	+ H 206X	27	45	8	—	A 206X	15	50	33	5	0.10
	30	2206K	+ H 306X	31	45	8	—	A 306X	15	50	34	5	0.11
	30	1306K	+ H 306X	31	45	8	—	A 306X	15	50	34	6	0.11
	30	21306C DKE4	+ H 306X	31	45	8	—	A 306X	15	50	34	6	0.11
	30	2306K	+ H2306X	38	45	8	—	A2306X	15	50	35	5	0.125
	30	2306K	+ H2306X	38	45	8	—	A2306X	15	50	35	5	0.125
30	35	1207K	+ H 207X	29	52	9	—	A 207X	17	58	38	5	0.125
	35	2207K	+ H 307X	35	52	9	—	A 307X	17	58	39	5	0.145
	35	1307K	+ H 307X	35	52	9	—	A 307X	17	58	39	7	0.145
	35	21307C DKE4	+ H 307X	35	52	9	—	A 307X	17	58	39	7	0.145
	35	2307K	+ H2307X	43	52	9	—	A2307X	17	58	40	5	0.16
	35	2307K	+ H2307X	43	52	9	—	A2307X	17	58	40	5	0.16
35	40	1208K	+ H 208X	31	58	10	—	A 208X	17	65	44	5	0.175
	40	2208K	+ H 308X	36	58	10	—	A 308X	17	65	44	5	0.19
	40	1308K	+ H 308X	36	58	10	—	A 308X	17	65	44	5	0.19
	40	21308E AKE4	+ H 308X	36	58	10	—	A 308X	17	65	44	5	0.19
	40	2308K	+ H2308X	46	58	10	—	A2308X	17	65	45	5	0.225
	40	22308E AKE4	+ H2308X	46	58	10	—	A2308X	17	65	45	5	0.225
40	45	1209K	+ H 209X	33	65	11	—	A 209X	17	72	49	5	0.225
	45	2209K	+ H 309X	39	65	11	—	A 309X	17	72	49	8	0.26
	45	1309K	+ H 309X	39	65	11	—	A 309X	17	72	49	5	0.26
	45	21309E AKE4	+ H 309X	39	65	11	—	A 309X	17	72	49	5	0.26
	45	2309K	+ H2309X	50	65	11	—	A2309X	17	72	50	5	0.30
	45	22309E AKE4	+ H2309X	50	65	11	—	A2309X	17	72	50	5	0.30

**Remark** Suffix X represents adapter sleeves with narrow slits for which washers with straight tabs should be used.

## Shaft Diameter 45 – 60 mm



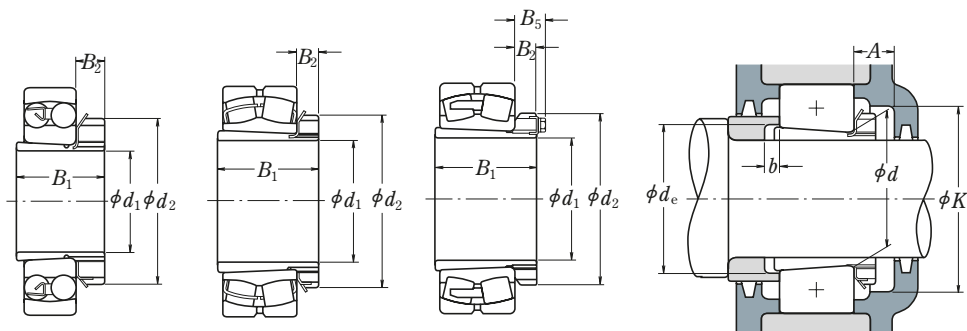
Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation		Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg) approx.
				$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
45	50	1210K	+ H 210X	35	70	12	—	A 210X	19	76	53	5	0.275
	50	2210K	+ H 310X	42	70	12	—	A 310X	19	76	54	10	0.30
	50	1310K	+ H 310X	42	70	12	—	A 310X	19	76	54	5	0.30
	50	21310E AKE4	+ H 310X	42	70	12	—	A 310X	19	76	54	5	0.30
	50	2310K	+ H2310X	55	70	12	—	A2310X	19	76	56	5	0.35
	50	22310E AKE4	+ H2310X	55	70	12	—	A2310X	19	76	56	5	0.35
	55	1211K	+ H 211X	37	75	12	—	A 211X	19	85	60	6	0.305
	55	2211K	+ H 311X	45	75	12	—	A 311X	19	85	60	11	0.35
	55	22211E AKE4	+ H 311X	45	75	12	—	A 311X	19	85	60	11	0.35
50	55	1311K	+ H 311X	45	75	12	—	A 311X	19	85	60	6	0.35
	55	21311E AKE4	+ H 311X	45	75	12	—	A 311X	19	85	60	6	0.35
	55	2311K	+ H2311X	59	75	12	—	A2311X	19	85	61	6	0.40
	55	22311E AKE4	+ H2311X	59	75	12	—	A2311X	19	85	61	6	0.40
	60	1212K	+ H 212X	38	80	13	—	A 212X	20	90	64	5	0.365
	60	2212K	+ H 312X	47	80	13	—	A 312X	20	90	65	9	0.40
55	60	22212E AKE4	+ H 312X	47	80	13	—	A 312X	20	90	65	9	0.40
	60	1312K	+ H 312X	47	80	13	—	A 312X	20	90	65	5	0.40
	60	21312E AKE4	+ H 312X	47	80	13	—	A 312X	20	90	65	5	0.40
	60	2312K	+ H2312X	62	80	13	—	A2312X	20	90	66	5	0.45
	60	22312E AKE4	+ H2312X	62	80	13	—	A2312X	20	90	66	5	0.45
	65	1213K	+ H 213X	40	85	14	—	A 213X	21	96	70	5	0.40
60	65	2213K	+ H 313X	50	85	14	—	A 313X	21	96	70	8	0.45
	65	22213E AKE4	+ H 313X	50	85	14	—	A 313X	21	96	70	8	0.45
	65	1313K	+ H 313X	50	85	14	—	A 313X	21	96	70	5	0.45
	65	21313E AKE4	+ H 313X	50	85	14	—	A 313X	21	96	70	5	0.45
	65	2313K	+ H2313X	65	85	14	—	A2313X	21	96	72	5	0.55
	65	22313E AKE4	+ H2313X	65	85	14	—	A2313X	21	96	72	5	0.55
	70	22214E AKE4	+ H 314X	52	92	14	—	A 314X	21	96	70	8	0.65
	70	21314E AKE4	+ H 314X	52	92	14	—	A 314X	21	96	70	5	0.65
	70	22314E AKE4	+ H2314X	68	92	14	—	A2314X	21	96	72	5	0.80

**Remark** Suffix X represents adapter sleeves with narrow slits for which washers with straight tabs should be used.



# ADAPTERS FOR ROLLING BEARINGS

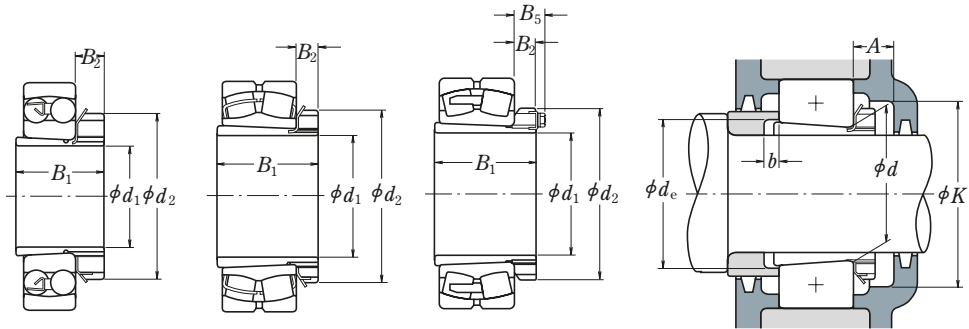
Shaft Diameter 65 – 80 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
			$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
65	75	1215K + H 215X	43	98	15	—	A 215X	23	110	80	5	0.70
	75	2215K + H 315X	55	98	15	—	A 315X	23	110	80	12	0.85
	75	22215E AKE4 + H 315X	55	98	15	—	A 315X	23	110	80	12	0.85
	75	1315K + H 315X	55	98	15	—	A 315X	23	110	80	5	0.85
	75	21315E AKE4 + H 315X	55	98	15	—	A 315X	23	110	80	5	0.85
	75	2315K + H2315X	73	98	15	—	A2315X	23	110	82	5	1.05
	75	22215E AKE4 + H2315X	73	98	15	—	A2315X	23	110	82	5	1.05
	80	1216K + H 216X	46	105	17	—	A 216X	25	120	85	5	0.85
	80	2216K + H 316X	59	105	17	—	A 316X	25	120	86	12	1.05
70	80	22216E AKE4 + H 316X	59	105	17	—	A 316X	25	120	86	12	1.05
	80	1316K + H 316X	59	105	17	—	A 316X	25	120	86	5	1.05
	80	21316E AKE4 + H 316X	59	105	17	—	A 316X	25	120	86	5	1.05
	80	2316K + H2316X	78	105	17	—	A2316X	25	120	87	5	1.3
	80	22216E AKE4 + H2316X	78	105	17	—	A2316X	25	120	87	5	1.3
	85	1217K + H 217X	50	110	18	—	A 217X	27	128	90	6	1.0
	85	2217K + H 317X	63	110	18	—	A 317X	27	128	91	12	1.2
	85	22217E AKE4 + H 317X	63	110	18	—	A 317X	27	128	91	12	1.2
	85	1317K + H 317X	63	110	18	—	A 317X	27	128	91	6	1.2
75	85	21317E AKE4 + H 317X	63	110	18	—	A 317X	27	128	91	6	1.2
	85	2317K + H2317X	82	110	18	—	A2317X	27	128	94	6	1.45
	85	22217E AKE4 + H2317X	82	110	18	—	A2317X	27	128	94	6	1.45
	90	1218K + H 218X	52	120	18	—	A 218X	28	139	95	6	1.15
	90	2218K + H 318X	65	120	18	—	A 318X	28	139	96	10	1.4
	90	22218E AKE4 + H 318X	65	120	18	—	A 318X	28	139	96	10	1.4
	90	1318K + H 318X	65	120	18	—	A 318X	28	139	96	6	1.4
	90	21318E AKE4 + H 318X	65	120	18	—	A 318X	28	139	96	6	1.4
	90	2318K + H2318X	86	120	18	—	A2318X	28	139	99	6	1.7
80	90	23218C KE4 + H2318X	86	120	18	—	A2318X	28	139	99	6	1.7
	90	22318E AKE4 + H2318X	86	120	18	—	A2318X	28	139	99	6	1.7

**Remark** Suffix X represents adapter sleeves with narrow slits for which washers with straight tabs should be used.

## Shaft Diameter 85 – 115 mm



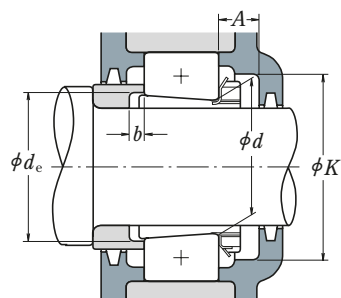
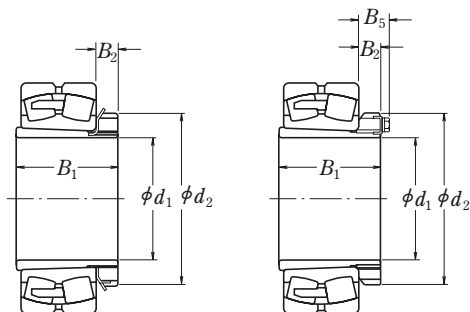
Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings		Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
				$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
85	95	1219K	+ H 219X	55	125	19	—	A 219X	29	145	101	7	1.35
	95	2219K	+ H 319X	68	125	19	—	A 319X	29	145	102	9	1.55
	95	22219E AKE4	+ H 319X	68	125	19	—	A 319X	29	145	102	9	1.55
	95	1319K	+ H 319X	68	125	19	—	A 319X	29	145	102	7	1.55
	95	21319C KE4	+ H 319X	68	125	19	—	A 319X	29	145	102	7	1.55
	95	2319K	+ H2319X	90	125	19	—	A2319X	29	145	105	7	1.9
	95	22319E AKE4	+ H2319X	90	125	19	—	A2319X	29	145	105	7	1.9
	95	22319E AKE4	+ H2319X	90	125	19	—	A2319X	29	145	105	7	1.9
90	100	1220K	+ H 220X	58	130	20	—	A 220X	30	150	106	7	1.45
	100	2220K	+ H 320X	71	130	20	—	A 320X	30	150	107	8	1.7
	100	22220E AKE4	+ H 320X	71	130	20	—	A 320X	30	150	107	8	1.7
	100	1320K	+ H 320X	71	130	20	—	A 320X	30	150	107	7	1.7
	100	21320C KE4	+ H 320X	71	130	20	—	A 320X	30	150	107	7	1.7
	100	2320K	+ H2320X	97	130	20	—	A2320X	30	150	110	7	2.15
	100	23220C KE4	+ H2320X	97	130	20	—	A2320X	30	150	110	7	2.15
	100	22320E AKE4	+ H2320X	97	130	20	—	A2320X	30	150	110	7	2.15
100	110	23122C KE4	+ H3122X	81	145	21	—	A3122X	32	170	117	7	2.25
	110	1222K	+ H 222X	63	145	21	—	A 222X	32	170	116	7	1.95
	110	2222K	+ H 322X	77	145	21	—	A 322X	32	170	117	6	2.3
	110	22222E AKE4	+ H 322X	77	145	21	—	A 322X	32	170	117	6	2.3
	110	1322K	+ H 322X	77	145	21	—	A 322X	32	170	117	9	2.3
	110	2322K	+ H2322X	105	145	21	—	A2322X	32	170	121	7	2.75
	110	23222C KE4	+ H2322X	105	145	21	—	A2322X	32	170	121	17	2.75
	110	22322E AKE4	+ H2322X	105	145	21	—	A2322X	32	170	121	7	2.75
110	120	23024C DKE4	+ H3024	72	145	22	—	A 3024	33	180	127	7	1.95
	120	23124C KE4	+ H3124	88	155	22	—	A 3124	33	180	128	7	2.65
	120	22224E AKE4	+ H3124	88	155	22	—	A 3124	33	180	128	11	2.65
	120	23224C KE4	+ H2324	112	155	22	—	A 2324	33	180	131	17	3.2
115	120	22324E AKE4	+ H2324	112	155	22	—	A 2324	33	180	131	7	3.2
	130	23026C DKE4	+ H3026	80	155	23	—	A 3026	34	190	137	8	2.85
	130	23126C KE4	+ H3126	92	165	23	—	A 3126	34	190	138	8	3.65
	130	22226E AKE4	+ H3126	92	165	23	—	A 3126	34	190	138	8	3.65
	130	23226C KE4	+ H2326	121	165	23	—	A 2326	34	190	142	21	4.6
	130	22326C KE4	+ H2326	121	165	23	—	A 2326	34	190	142	8	4.6
	130	22326C KE4	+ H2326	121	165	23	—	A 2326	34	190	142	8	4.6
	130	22326C KE4	+ H2326	121	165	23	—	A 2326	34	190	142	8	4.6

**Remark** Suffix X represents adapter sleeves with narrow slits for which washers with straight tabs should be used.



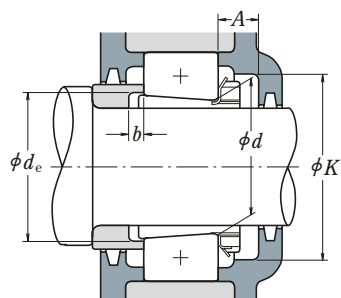
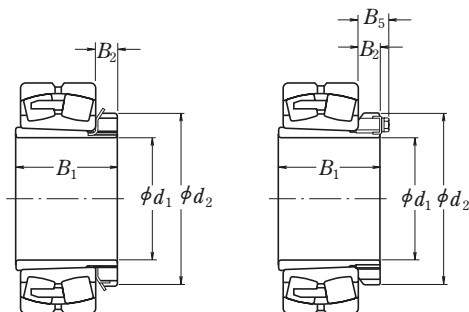
# ADAPTERS FOR ROLLING BEARINGS

Shaft Diameter 125 – 170 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
			$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
125	140	23028C DKE4 + <b>H3028</b>	82	165	24	—	A 3028	36	205	147	8	3.15
	140	23128C KE4 + <b>H3128</b>	97	180	24	—	A 3128	36	205	149	8	4.35
	140	22228C DKE4 + <b>H3128</b>	97	180	24	—	A 3128	36	205	149	8	4.35
	140	23228C KE4 + <b>H2328</b>	131	180	24	—	A 2328	36	205	152	22	5.55
	140	22228C KE4 + <b>H2328</b>	131	180	24	—	A 2328	36	205	152	8	5.55
	140	22230C DKE4 + <b>H3030</b>	87	180	26	—	A 3030	37	220	158	8	3.9
135	150	23130C KE4 + <b>H3130</b>	111	195	26	—	A 3130	37	220	160	8	5.5
	150	22230C DKE4 + <b>H3130</b>	111	195	26	—	A 3130	37	220	160	15	5.5
	150	23230C KE4 + <b>H2330</b>	139	195	26	—	A 2330	37	220	163	20	6.6
	150	22230C AKE4 + <b>H2330</b>	139	195	26	—	A 2330	37	220	163	8	6.6
	150	23932C AKE4 + <b>H3932</b>	78	190	28	—	A 3932	39	205	168	8	4.64
	150	23032C DKE4 + <b>H3032</b>	93	190	28	—	A 3032	39	230	168	8	5.2
140	160	23132C KE4 + <b>H3132</b>	119	210	28	—	A 3132	39	230	170	8	7.65
	160	22232C DKE4 + <b>H3132</b>	119	210	28	—	A 3132	39	230	170	14	7.65
	160	23232C KE4 + <b>H2332</b>	147	210	28	—	A 2332	39	230	174	18	9.15
	160	22232C AKE4 + <b>H2332</b>	147	210	28	—	A 2332	39	230	174	8	9.15
	160	23934B CAKE4 + <b>H3934</b>	79	200	29	—	A 3934	40	215	179	8	5.07
	160	23034C DKE4 + <b>H3034</b>	101	200	29	—	A 3034	40	250	179	8	6.0
150	170	23134C KE4 + <b>H3134</b>	122	220	29	—	A 3134	40	250	180	8	8.4
	170	22234C DKE4 + <b>H3134</b>	122	220	29	—	A 3134	40	250	180	10	8.4
	170	23234C KE4 + <b>H2334</b>	154	220	29	—	A 2334	40	250	185	18	10
	170	22234C AKE4 + <b>H2334</b>	154	220	29	—	A 2334	40	250	185	8	10
	170	23936C AKE4 + <b>H3936</b>	87	210	30	—	A 3936	41	230	189	8	5.87
	170	23036C DKE4 + <b>H3036</b>	109	210	30	—	A 3036	41	260	189	8	6.85
160	180	23136C KE4 + <b>H3136</b>	131	230	30	—	A 3136	41	260	191	8	9.5
	180	22236C DKE4 + <b>H3136</b>	131	230	30	—	A 3136	41	260	191	18	9.5
	180	23236C KE4 + <b>H2336</b>	161	230	30	—	A 2336	41	260	195	22	11.5
	180	22236C AKE4 + <b>H2336</b>	161	230	30	—	A 2336	41	260	195	8	11.5
	180	23938C AKE4 + <b>H3938</b>	89	220	31	—	A 3938	43	240	199	9	6.35
	180	23038C AKE4 + <b>H3038</b>	112	220	31	—	A 3038	43	270	199	9	7.45
170	190	23138C KE4 + <b>H3138</b>	141	240	31	—	A 3138	43	270	202	9	11
	190	22238C AKE4 + <b>H3138</b>	141	240	31	—	A 3138	43	270	202	21	11
	190	23238C KE4 + <b>H2338</b>	169	240	31	—	A 2338	43	270	206	21	12.5
	190	22238C AKE4 + <b>H2338</b>	169	240	31	—	A 2338	43	270	206	9	12.5

## Shaft Diameter 180 – 260 mm

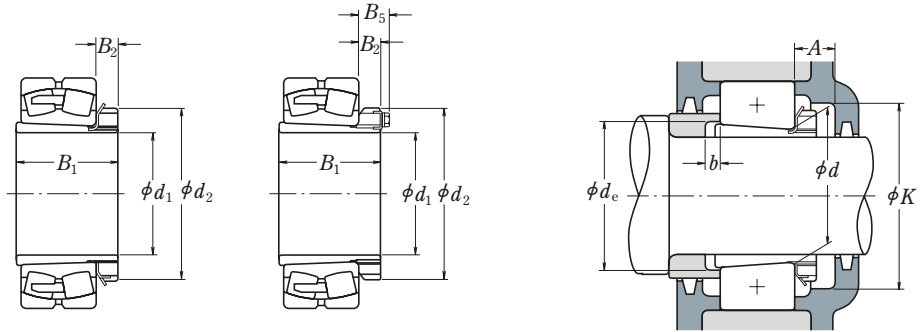


Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
			$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
180	200	23940C AKE4 + <b>H 3940</b>	98	240	32	—	A 3940	46	260	210	10	8.0
	200	23040C AKE4 + <b>H 3040</b>	120	240	32	—	A 3040	46	280	210	10	9.2
	200	23140C KE4 + <b>H 3140</b>	150	250	32	—	A 3140	46	280	212	10	12
	200	22240C AKE4 + <b>H 3140</b>	150	250	32	—	A 3140	46	280	212	24	12
	200	23240C KE4 + <b>H 2340</b>	176	250	32	—	A 2340	46	280	216	20	14
	200	22340C AKE4 + <b>H 2340</b>	176	250	32	—	A 2340	46	280	216	10	14
	220	23944C AKE4 + <b>H 3944</b>	96	260	30	41	A 3944	55	280	231	10	8.32
	220	23044C AKE4 + <b>H 3044</b>	128	260	30	41	A 3044	55	320	231	12	10.5
	220	23144C KE4 + <b>H 3144</b>	158	280	32	44	A 3144	55	320	233	10	14.5
200	220	22244C AKE4 + <b>H 3144</b>	158	280	32	44	A 3144	55	320	233	22	14.5
	220	23244C KE4 + <b>H 2344</b>	183	280	32	44	A 2344	55	320	236	11	16.5
	220	22344C AKE4 + <b>H 2344</b>	183	280	32	44	A 2344	55	320	236	10	16.5
	240	23948C AKE4 + <b>H 3948</b>	101	290	34	46	A 3948	60	300	251	11	11.2
	240	23048C AKE4 + <b>H 3048</b>	133	290	34	46	A 3048	60	340	251	11	13
	240	23148C KE4 + <b>H 3148</b>	169	300	34	46	A 3148	60	340	254	11	17.5
	240	22248C AKE4 + <b>H 3148</b>	169	300	34	46	A 3148	60	340	254	19	17.5
	240	23248C AKE4 + <b>H 2348</b>	196	300	34	46	A 2348	60	340	257	6	19.5
	240	22348C AKE4 + <b>H 2348</b>	196	300	34	46	A 2348	60	340	257	11	19.5
220	260	23952C AKE4 + <b>H 3952</b>	116	310	34	46	A 3952	60	330	272	11	13.4
	260	23052C AKE4 + <b>H 3052</b>	147	310	34	46	A 3052	60	370	272	13	15.5
	260	23152C AKE4 + <b>H 3152</b>	187	330	36	49	A 3152	60	370	276	11	22
	260	22252C AKE4 + <b>H 3152</b>	187	330	36	49	A 3152	60	370	276	25	22
	260	23252C AKE4 + <b>H 2352</b>	208	330	36	49	A 2352	60	370	278	2	24
	260	22352C AKE4 + <b>H 2352</b>	208	330	36	49	A 2352	60	370	278	11	24
	280	23956C AKE4 + <b>H 3956</b>	121	330	38	50	A 3956	65	350	292	12	15.5
	280	23056C AKE4 + <b>H 3056</b>	152	330	38	50	A 3056	65	390	292	12	17.5
	280	23156C AKE4 + <b>H 3156</b>	192	350	38	51	A 3156	65	390	296	12	24.5
240	280	22256C AKE4 + <b>H 3156</b>	192	350	38	51	A 3156	65	390	296	28	24.5
	280	23256C AKE4 + <b>H 2356</b>	221	350	38	51	A 2356	65	390	299	11	28
	280	22356C AKE4 + <b>H 2356</b>	221	350	38	51	A 2356	65	390	299	12	28
	280	22356C AKE4 + <b>H 2356</b>	221	350	38	51	A 2356	65	390	299	12	28



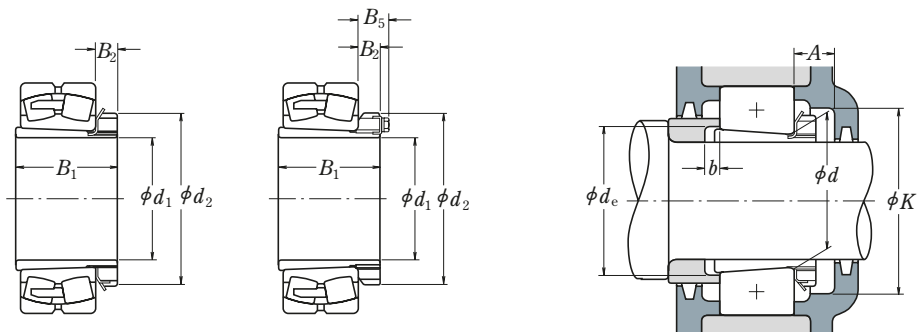
# ADAPTERS FOR ROLLING BEARINGS

Shaft Diameter 280 – 410 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
			$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
280	300	23960CAKE4 + <b>H3960</b>	140	360	42	54	A3960	69	380	313	12	20.7
	300	23060CAKE4 + <b>H3060</b>	168	360	42	54	A3060	69	430	313	12	23
	300	23160CAKE4 + <b>H3160</b>	208	380	40	53	A3160	69	430	317	12	30
	300	22260CAKE4 + <b>H3160</b>	208	380	40	53	A3160	69	430	317	32	30
	300	23260CAKE4 + <b>H3260</b>	240	380	40	53	A3260	69	430	321	12	34
	300	23260CAKE4 + <b>H3260</b>	240	380	40	53	A3260	69	430	321	12	34
300	320	23964CAKE4 + <b>H3964</b>	140	380	42	55	A3964	72	400	334	13	21.8
	320	23064CAKE4 + <b>H3064</b>	171	380	42	55	A3064	72	450	334	13	24.5
	320	23164CAKE4 + <b>H3164</b>	226	400	42	56	A3164	72	450	339	13	35
	320	22264CAKE4 + <b>H3164</b>	226	400	42	56	A3164	72	450	339	39	35
	320	23264CAKE4 + <b>H3264</b>	258	400	42	56	A3264	72	450	343	13	39.5
	320	23264CAKE4 + <b>H3264</b>	258	400	42	56	A3264	72	450	343	13	39.5
320	340	23968CAKE4 + <b>H3968</b>	144	400	45	58	A3968	75	430	354	14	24.6
	340	23068CAKE4 + <b>H3068</b>	187	400	45	58	A3068	75	490	355	14	28.5
	340	23168CAKE4 + <b>H3168</b>	254	440	55	72	A3168	75	490	360	14	49.5
	340	23268CAKE4 + <b>H3268</b>	288	440	55	72	A3268	75	490	364	14	54.5
340	360	23972CAKE4 + <b>H3972</b>	144	420	45	58	A3972	75	450	374	14	25.7
	360	23072CAKE4 + <b>H3072</b>	188	420	45	58	A3072	75	510	375	14	30.5
	360	23172CAKE4 + <b>H3172</b>	259	460	58	75	A3172	75	510	380	14	54
	360	23272CAKE4 + <b>H3272</b>	299	460	58	75	A3272	75	510	385	14	60.5
360	380	23976CAKE4 + <b>H3976</b>	164	450	48	62	A3976	82	480	396	15	31.9
	380	23076CAKE4 + <b>H3076</b>	193	450	48	62	A3076	82	540	396	15	36
	380	23176CAKE4 + <b>H3176</b>	264	490	60	77	A3176	82	540	401	15	61.5
	380	23276CAKE4 + <b>H3276</b>	310	490	60	77	A3276	82	540	405	15	69.5
380	400	23980CAKE4 + <b>H3980</b>	168	470	52	66	A3980	86	500	417	15	35.2
	400	23080CAKE4 + <b>H3080</b>	210	470	52	66	A3080	86	580	417	15	41.5
	400	23180CAKE4 + <b>H3180</b>	272	520	62	82	A3180	86	580	421	15	70.5
	400	23280CAKE4 + <b>H3280</b>	328	520	62	82	A3280	86	580	427	15	81
400	420	23984CAKE4 + <b>H3984</b>	168	490	52	66	A3984	86	520	437	16	36.6
	420	23084CAKE4 + <b>H3084</b>	212	490	52	66	A3084	86	600	437	16	43.5
	420	23184CAKE4 + <b>H3184</b>	304	540	70	90	A3184	86	600	443	16	84
	420	23284CAKE4 + <b>H3284</b>	352	540	70	90	A3284	86	600	448	16	94
410	440	23988CAKE4 + <b>H3988</b>	189	520	60	77	A3988	99	550	458	17	58.6
	440	23088CAKE4 + <b>H3088</b>	228	520	60	77	A3088	99	620	458	17	65
	440	23188CAKE4 + <b>H3188</b>	307	560	70	90	A3188	99	620	464	17	104
	440	23288CAKE4 + <b>H3288</b>	361	560	70	90	A3288	99	620	469	17	118

## Shaft Diameter 430 – 470 mm

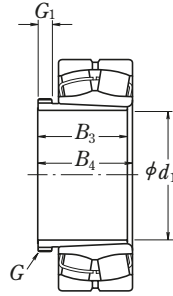


Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Dimensions (mm)				Adapter Sleeve Designation	Abutment Dimensions (mm)				Mass (kg)  approx.
			$B_1$	$d_2$	$B_2$	$B_5$		$A$ min.	$K$ min.	$d_e$ min.	$b$ min.	
<b>430</b>	460	23992C AKE4 + <b>H 3992</b>	189	540	60	77	A 3992	99	570	478	17	62
	460	23092C AKE4 + <b>H 3092</b>	234	540	60	77	A 3092	99	650	478	17	69.5
	460	23192C AKE4 + <b>H 3192</b>	326	580	75	95	A 3192	99	650	485	17	116
	460	23292C AKE4 + <b>H 3292</b>	382	580	75	95	A 3292	99	650	491	17	132
<b>450</b>	480	23996C AKE4 + <b>H 3996</b>	200	560	60	77	A 3996	99	600	499	18	67.5
	480	23096C AKE4 + <b>H 3096</b>	237	560	60	77	A 3096	99	690	499	18	73.5
	480	23196C AKE4 + <b>H 3196</b>	335	620	75	95	A 3196	99	690	505	18	133
	480	23296C AKE4 + <b>H 3296</b>	397	620	75	95	A 3296	99	690	512	18	152
<b>470</b>	500	239/500C AKE4 + <b>H 39/500</b>	208	580	68	85	A 39/500	109	620	519	18	74.6
	500	230/500C AKE4 + <b>H 30/500</b>	247	580	68	85	A 30/500	109	700	519	18	82
	500	231/500C AKE4 + <b>H 31/500</b>	356	630	80	100	A 31/500	109	700	527	18	143
	500	232/500C AKE4 + <b>H 32/500</b>	428	630	80	100	A 32/500	109	700	534	18	166



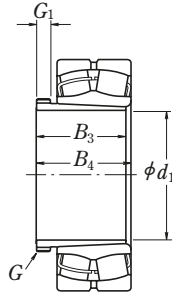
# WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 35 – 85 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
<b>35</b>	40	21308EAKE4 + <b>AH 308</b>	M 45 × 1.5	29	6	32	0.09
	40	22308EAKE4 + <b>AH 2308</b>	M 45 × 1.5	40	7	43	0.13
	45	21309EAKE4 + <b>AH 309</b>	M 50 × 1.5	31	6	34	0.11
<b>40</b>	45	22309EAKE4 + <b>AH 2309</b>	M 50 × 1.5	44	7	47	0.165
<b>45</b>	50	21310EAKE4 + <b>AHX 310</b>	M 55 × 2	35	7	38	0.16
	50	22310EAKE4 + <b>AHX 2310</b>	M 55 × 2	50	9	53	0.235
<b>50</b>	55	22211EAKE4 + <b>AHX 311</b>	M 60 × 2	37	7	40	0.19
	55	21311EAKE4 + <b>AHX 311</b>	M 60 × 2	37	7	40	0.19
	55	22311EAKE4 + <b>AHX 2311</b>	M 60 × 2	54	10	57	0.285
<b>55</b>	60	22212EAKE4 + <b>AHX 312</b>	M 65 × 2	40	8	43	0.215
	60	21312EAKE4 + <b>AHX 312</b>	M 65 × 2	40	8	43	0.215
	60	22312EAKE4 + <b>AHX 2312</b>	M 65 × 2	58	11	61	0.34
<b>60</b>	65	22213EAKE4 + <b>AH 313</b>	M 75 × 2	42	8	45	0.255
	65	21313EAKE4 + <b>AH 313</b>	M 75 × 2	42	8	45	0.255
	65	22313EAKE4 + <b>AH 2313</b>	M 75 × 2	61	12	64	0.395
<b>65</b>	70	22214EAKE4 + <b>AH 314</b>	M 80 × 2	43	8	47	0.28
	70	21314EAKE4 + <b>AH 314</b>	M 80 × 2	43	8	47	0.28
	70	22314EAKE4 + <b>AHX 2314</b>	M 80 × 2	64	12	68	0.53
<b>70</b>	75	22215EAKE4 + <b>AH 315</b>	M 85 × 2	45	8	49	0.315
	75	21315EAKE4 + <b>AH 315</b>	M 85 × 2	45	8	49	0.315
	75	22315EAKE4 + <b>AHX 2315</b>	M 85 × 2	68	12	72	0.605
<b>75</b>	80	22216EAKE4 + <b>AH 316</b>	M 90 × 2	48	8	52	0.365
	80	21316EAKE4 + <b>AH 316</b>	M 90 × 2	48	8	52	0.365
	80	22316EAKE4 + <b>AHX 2316</b>	M 90 × 2	71	12	75	0.665
<b>80</b>	85	22217EAKE4 + <b>AHX 317</b>	M 95 × 2	52	9	56	0.48
	85	21317EAKE4 + <b>AHX 317</b>	M 95 × 2	52	9	56	0.48
	85	22317EAKE4 + <b>AHX 2317</b>	M 95 × 2	74	13	78	0.745
<b>85</b>	90	22218EAKE4 + <b>AHX 318</b>	M 100 × 2	53	9	57	0.52
	90	21318EAKE4 + <b>AHX 318</b>	M 100 × 2	53	9	57	0.52
	90	23218CKE4 + <b>AHX 3218</b>	M 100 × 2	63	10	67	0.58
	90	22318EAKE4 + <b>AHX 2318</b>	M 100 × 2	79	14	83	0.845

## Shaft Diameter 90 – 135 mm

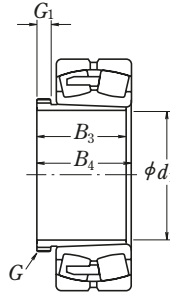


Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
<b>90</b>	95	22219EAKE4 + <b>AHX 319</b>	M 105 × 2	57	10	61	0.595
	95	21319CKE4 + <b>AHX 319</b>	M 105 × 2	57	10	61	0.595
	95	22319EAKE4 + <b>AHX 2319</b>	M 105 × 2	85	16	89	0.89
<b>95</b>	100	21320CKE4 + <b>AHX 3120</b>	M 110 × 2	64	11	68	0.70
	100	22220EAKE4 + <b>AHX 320</b>	M 110 × 2	59	10	63	0.66
	100	21320CKE4 + <b>AHX 320</b>	M 110 × 2	59	10	63	0.66
	100	23220CKE4 + <b>AHX 3220</b>	M 110 × 2	73	11	77	0.77
	100	22320EAKE4 + <b>AHX 2320</b>	M 110 × 2	90	16	94	1.0
	100	22320EAKE4 + <b>AHX 2320</b>	M 110 × 2	90	16	94	1.0
<b>105</b>	110	23122CKE4 + <b>AHX 3122</b>	M 120 × 2	68	11	72	0.76
	110	22222EAKE4 + <b>AHX 3122</b>	M 120 × 2	68	11	72	0.76
	110	24122CK30E4 + <b>AH 24122</b>	M 115 × 2	82	13	91	0.73
	110	23222CKE4 + <b>AHX 3222</b>	M 125 × 2	82	11	86	1.04
	110	22322EAKE4 + <b>AHX 2322</b>	M 125 × 2	98	16	102	1.35
	110	22322EAKE4 + <b>AHX 2322</b>	M 125 × 2	98	16	102	1.35
<b>115</b>	120	23024CDKE4 + <b>AHX 3024</b>	M 130 × 2	60	13	64	0.75
	120	24024CK30E4 + <b>AH 24024</b>	M 125 × 2	73	13	82	0.70
	120	23124CKE4 + <b>AHX 3124</b>	M 130 × 2	75	12	79	0.95
	120	22224EAKE4 + <b>AHX 3124</b>	M 130 × 2	75	12	79	0.95
	120	24124CK30E4 + <b>AH 24124</b>	M 130 × 2	93	13	102	1.02
	120	23224CKE4 + <b>AHX 3224</b>	M 135 × 2	90	13	94	1.3
<b>125</b>	120	22324EAKE4 + <b>AHX 2324</b>	M 135 × 2	105	17	109	1.6
	130	23026CDKE4 + <b>AHX 3026</b>	M 140 × 2	67	14	71	0.95
	130	24026CK30E4 + <b>AH 24026</b>	M 135 × 2	83	14	93	0.89
	130	23126CKE4 + <b>AHX 3126</b>	M 140 × 2	78	12	82	1.08
	130	22226EAKE4 + <b>AHX 3126</b>	M 140 × 2	78	12	82	1.08
	130	24126CK30E4 + <b>AH 24126</b>	M 140 × 2	94	14	104	1.14
<b>135</b>	130	23226CKE4 + <b>AHX 3226</b>	M 145 × 2	98	15	102	1.58
	130	22326CKE4 + <b>AHX 2326</b>	M 145 × 2	115	19	119	1.97
	140	23028CDKE4 + <b>AHX 3028</b>	M 150 × 2	68	14	73	1.01
	140	24028CK30E4 + <b>AH 24028</b>	M 145 × 2	83	14	93	0.96
	140	23128CKE4 + <b>AHX 3128</b>	M 150 × 2	83	14	88	1.28
	140	22228CDKE4 + <b>AHX 3128</b>	M 150 × 2	83	14	88	1.28
<b>140</b>	140	24128CK30E4 + <b>AH 24128</b>	M 150 × 2	99	14	109	1.3
	140	23228CKE4 + <b>AHX 3228</b>	M 155 × 3	104	15	109	1.84
	140	22328CKE4 + <b>AHX 2328</b>	M 155 × 3	125	20	130	2.33
	140	22328CKE4 + <b>AHX 2328</b>	M 155 × 3	125	20	130	2.33
	140	22328CKE4 + <b>AHX 2328</b>	M 155 × 3	125	20	130	2.33
	140	22328CKE4 + <b>AHX 2328</b>	M 155 × 3	125	20	130	2.33



# WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

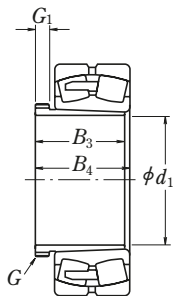
Shaft Diameter 145 – 180 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
<b>145</b>	150	23030CDKE4 + <b>AHX 3030</b>	M 160 × 3	72	15	77	1.15
	150	24030CK30E4 + <b>AH 24030</b>	M 155 × 3	90	15	101	1.11
	150	23130CKE4 + <b>AHX 3130</b>	M 165 × 3	96	15	101	1.79
	150	22230CDKE4 + <b>AHX 3130</b>	M 165 × 3	96	15	101	1.79
	150	24130CK30E4 + <b>AH 24130</b>	M 160 × 3	115	15	126	1.63
	150	23230CKE4 + <b>AHX 3230</b>	M 165 × 3	114	17	119	2.22
	150	22330CAKE4 + <b>AHX 2330</b>	M 165 × 3	135	24	140	2.82
<b>150</b>	160	23032CDKE4 + <b>AH 3032</b>	M 170 × 3	77	16	82	2.05
	160	24032CK30E4 + <b>AH 24032</b>	M 170 × 3	95	15	106	2.28
	160	23132CKE4 + <b>AH 3132</b>	M 180 × 3	103	16	108	3.2
	160	22232CDKE4 + <b>AH 3132</b>	M 180 × 3	103	16	108	3.2
	160	24132CK30E4 + <b>AH 24132</b>	M 170 × 3	124	15	135	3.03
	160	23232CKE4 + <b>AH 3232</b>	M 180 × 3	124	20	130	4.1
	160	22332CAKE4 + <b>AH 2332</b>	M 180 × 3	140	24	146	4.7
<b>160</b>	170	23034CDKE4 + <b>AH 3034</b>	M 180 × 3	85	17	90	2.45
	170	24034CK30E4 + <b>AH 24034</b>	M 180 × 3	106	16	117	2.74
	170	23134CKE4 + <b>AH 3134</b>	M 190 × 3	104	16	109	3.4
	170	22234CDKE4 + <b>AH 3134</b>	M 190 × 3	104	16	109	3.4
	170	24134CK30E4 + <b>AH 24134</b>	M 180 × 3	125	16	136	3.26
	170	23234CKE4 + <b>AH 3234</b>	M 190 × 3	134	24	140	4.8
	170	22334CAKE4 + <b>AH 2334</b>	M 190 × 3	146	24	152	5.25
<b>170</b>	180	23036CDKE4 + <b>AH 3036</b>	M 190 × 3	92	17	98	2.8
	180	24036CK30E4 + <b>AH 24036</b>	M 190 × 3	116	16	127	3.19
	180	23136CKE4 + <b>AH 3136</b>	M 200 × 3	116	19	122	4.2
	180	24136CK30E4 + <b>AH 24136</b>	M 190 × 3	134	16	145	3.74
	180	22236CDKE4 + <b>AH 2236</b>	M 200 × 3	105	17	110	3.75
	180	23236CKE4 + <b>AH 3236</b>	M 200 × 3	140	24	146	5.3
	180	22336CAKE4 + <b>AH 2336</b>	M 200 × 3	154	26	160	5.85
<b>180</b>	190	23038CAKE4 + <b>AH 3038</b>	Tr 205 × 4	96	18	102	3.35
	190	24038CK30E4 + <b>AH 24038</b>	M 200 × 3	118	18	131	3.47
	190	23138CKE4 + <b>AH 3138</b>	Tr 210 × 4	125	20	131	4.9
	190	24138CK30E4 + <b>AH 24138</b>	M 200 × 3	146	18	159	4.38
	190	22238CAKE4 + <b>AH 2238</b>	Tr 210 × 4	112	18	117	4.25
	190	23238CKE4 + <b>AH 3238</b>	Tr 210 × 4	145	25	152	5.9
	190	22338CAKE4 + <b>AH 2338</b>	Tr 210 × 4	160	26	167	6.65



## Shaft Diameter 190 – 260 mm

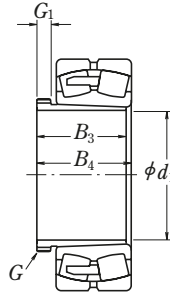


Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
<b>190</b>	200	23040CAKE4 + AH <b>3040</b>	Tr 215 × 4	102	19	108	3.8
	200	24040CK30E4 + AH <b>24040</b>	Tr 210 × 4	127	18	140	3.92
	200	23140CKE4 + AH <b>3140</b>	Tr 220 × 4	134	21	140	5.5
	200	24140CK30E4 + AH <b>24140</b>	Tr 210 × 4	158	18	171	5.0
	200	22240CAKE4 + AH <b>2240</b>	Tr 220 × 4	118	19	123	4.7
	200	23240CKE4 + AH <b>3240</b>	Tr 220 × 4	153	25	160	6.7
<b>200</b>	200	22340CAKE4 + AH <b>2340</b>	Tr 220 × 4	170	30	177	7.55
	220	23044CAKE4 + AH <b>3044</b>	Tr 235 × 4	111	20	117	7.4
	220	24044CK30E4 + AH <b>24044</b>	Tr 230 × 4	138	20	152	8.23
	220	23144CKE4 + AH <b>3144</b>	Tr 240 × 4	145	23	151	10.5
	220	24144CK30E4 + AH <b>24144</b>	Tr 230 × 4	170	20	184	10.3
	220	22244CAKE4 + AH <b>2244</b>	Tr 240 × 4	130	20	136	9.1
	220	23244CKE4 + AH <b>2344</b>	Tr 240 × 4	181	30	189	13.5
	220	22344CAKE4 + AH <b>2344</b>	Tr 240 × 4	181	30	189	13.5
	240	23048CAKE4 + AH <b>3048</b>	Tr 260 × 4	116	21	123	8.75
	240	24048CK30E4 + AH <b>24048</b>	Tr 250 × 4	138	20	153	9.0
<b>220</b>	240	23148CKE4 + AH <b>3148</b>	Tr 260 × 4	154	25	161	12
	240	24148CK30E4 + AH <b>24148</b>	Tr 260 × 4	180	20	195	12.6
	240	22248CAKE4 + AH <b>2248</b>	Tr 260 × 4	144	21	150	11
	240	23248CAKE4 + AH <b>2348</b>	Tr 260 × 4	189	30	197	15.5
	240	22348CAKE4 + AH <b>2348</b>	Tr 260 × 4	189	30	197	15.5
	260	23052CAKE4 + AH <b>3052</b>	Tr 280 × 4	128	23	135	10.5
	260	24052CAK30E4 + AH <b>24052</b>	Tr 270 × 4	162	22	178	11.7
	260	23152CAKE4 + AH <b>3152</b>	Tr 290 × 4	172	26	179	16
<b>240</b>	260	24152CAK30E4 + AH <b>24152</b>	Tr 280 × 4	202	22	218	15.5
	260	22252CAKE4 + AH <b>2252</b>	Tr 290 × 4	155	23	161	14
	260	23252CAKE4 + AH <b>2352</b>	Tr 290 × 4	205	30	213	19.5
	260	22352CAKE4 + AH <b>2352</b>	Tr 290 × 4	205	30	213	19.5
	280	23056CAKE4 + AH <b>3056</b>	Tr 300 × 4	131	24	139	12
	280	24056CAK30E4 + AH <b>24056</b>	Tr 290 × 4	162	22	179	12.6
	280	23156CAKE4 + AH <b>3156</b>	Tr 310 × 5	175	28	183	17.5
	280	24156CAK30E4 + AH <b>24156</b>	Tr 300 × 4	202	22	219	16.8
<b>260</b>	280	22256CAKE4 + AH <b>2256</b>	Tr 310 × 5	155	24	163	15
	280	23256CAKE4 + AH <b>2356</b>	Tr 310 × 5	212	30	220	21.5
	280	22356CAKE4 + AH <b>2356</b>	Tr 310 × 5	212	30	220	21.5



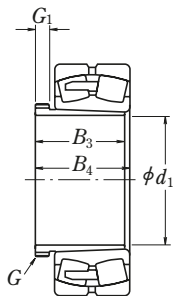
# WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 280 – 380 mm



Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
280	300	23060CAKE4 + AH 3060	Tr 320 × 5	145	26	153	14.5
	300	24060CAK30E4 + AH 24060	Tr 310 × 5	184	24	202	15.5
	300	23160CAKE4 + AH 3160	Tr 330 × 5	192	30	200	21
	300	24160CAK30E4 + AH 24160	Tr 320 × 5	224	24	242	20.3
	300	22260CAKE4 + AH 2260	Tr 330 × 5	170	26	178	18
	300	23260CAKE4 + AH 3260	Tr 330 × 5	228	34	236	20
	320	23064CAKE4 + AH 3064	Tr 345 × 5	149	27	157	16
	320	24064CAK30E4 + AH 24064	Tr 330 × 5	184	24	202	16.4
	320	23164CAKE4 + AH 3164	Tr 350 × 5	209	31	217	24.5
300	320	24164CAK30E4 + AH 24164	Tr 340 × 5	242	24	260	23.5
	320	23264CAKE4 + AH 3264	Tr 350 × 5	246	36	254	25
	340	23068CAKE4 + AH 3068	Tr 365 × 5	162	28	171	19.5
	340	24068CAK30E4 + AH 24068	Tr 360 × 5	206	26	225	21.2
	340	23168CAKE4 + AH 3168	Tr 370 × 5	225	33	234	29
	340	24168CAK30E4 + AH 24168	Tr 360 × 5	269	26	288	28.3
	340	23268CAKE4 + AH 3268	Tr 370 × 5	264	38	273	35.5
	360	23072CAKE4 + AH 3072	Tr 385 × 5	167	30	176	21
	360	24072CAK30E4 + AH 24072	Tr 380 × 5	206	26	226	22.5
320	360	23172CAKE4 + AH 3172	Tr 400 × 5	229	35	238	33
	360	24172CAK30E4 + AH 24172	Tr 380 × 5	269	26	289	30
	360	23272CAKE4 + AH 3272	Tr 400 × 5	274	40	283	41.5
	380	23076CAKE4 + AH 3076	Tr 410 × 5	170	31	180	23.5
	380	24076CAK30E4 + AH 24076	Tr 400 × 5	208	28	228	24.1
	380	23176CAKE4 + AH 3176	Tr 420 × 5	232	36	242	35.5
	380	24176CAK30E4 + AH 24176	Tr 400 × 5	271	28	291	32.1
	380	23276CAKE4 + AH 3276	Tr 420 × 5	284	42	294	45.5
	400	23080CAKE4 + AH 3080	Tr 430 × 5	183	33	193	27.5
340	400	24080CAK30E4 + AH 24080	Tr 420 × 5	228	28	248	28
	400	23180CAKE4 + AH 3180	Tr 440 × 5	240	38	250	39.5
	400	24180CAK30E4 + AH 24180	Tr 420 × 5	278	28	298	34.8
	400	23280CAKE4 + AH 3280	Tr 440 × 5	302	44	312	51.5

## Shaft Diameter 400 – 480 mm

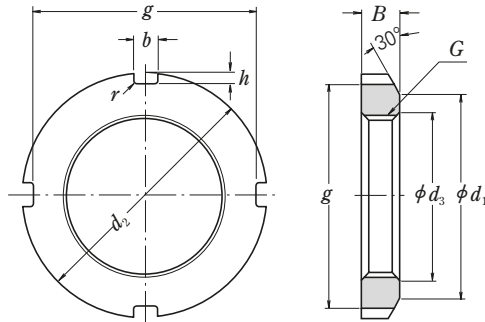


Shaft Diameter (mm) $d_1$	Nominal Bore Dia. (mm) $d$	Designation  Applicable Bearings	Screw Threads  $G$	Dimensions (mm)			Mass (kg)  approx.
				$B_3$	$G_1$	$B_4$	
<b>400</b>	420	23084CAKE4 + <b>AH 3084</b>	Tr 450 × 5	186	34	196	29
	420	24084CAK30E4 + <b>AH 24084</b>	Tr 440 × 5	230	30	252	29.8
	420	23184CAKE4 + <b>AH 3184</b>	Tr 460 × 5	266	40	276	46.5
	420	24184CAK30E4 + <b>AH 24184</b>	Tr 440 × 5	310	30	332	41.4
	420	23284CAKE4 + <b>AH 3284</b>	Tr 460 × 5	321	46	331	59
	420	23188CAKE4 + <b>AHX 3188</b>	Tr 480 × 5	270	42	281	50
<b>420</b>	440	23088CAKE4 + <b>AHX 3088</b>	Tr 470 × 5	194	35	205	42
	440	24088CAK30E4 + <b>AH 24088</b>	Tr 460 × 5	242	30	264	33
	440	23188CAKE4 + <b>AHX 3188</b>	Tr 480 × 5	270	42	281	50
	440	24188CAK30E4 + <b>AH 24188</b>	Tr 460 × 5	310	30	332	43.5
	440	23288CAKE4 + <b>AHX 3288</b>	Tr 480 × 5	330	48	341	64
	440	23192CAKE4 + <b>AHX 3192</b>	Tr 510 × 6	285	43	296	58
<b>440</b>	460	23092CAKE4 + <b>AHX 3092</b>	Tr 490 × 5	202	37	213	46
	460	24092CAK30E4 + <b>AH 24092</b>	Tr 480 × 5	250	32	273	35.9
	460	23192CAKE4 + <b>AHX 3192</b>	Tr 510 × 6	285	43	296	58
	460	24192CAK30E4 + <b>AH 24192</b>	Tr 480 × 5	332	32	355	49.7
	460	23292CAKE4 + <b>AHX 3292</b>	Tr 510 × 6	349	50	360	74.5
	460	23196CAKE4 + <b>AHX 3196</b>	Tr 530 × 6	295	45	307	63
<b>460</b>	480	23096CAKE4 + <b>AHX 3096</b>	Tr 520 × 6	205	38	217	51
	480	24096CAK30E4 + <b>AH 24096</b>	Tr 500 × 5	250	32	273	37.5
	480	23196CAKE4 + <b>AHX 3196</b>	Tr 530 × 6	295	45	307	63
	480	24196CAK30E4 + <b>AH 24196</b>	Tr 500 × 5	340	32	363	53
	480	23296CAKE4 + <b>AHX 3296</b>	Tr 530 × 6	364	52	376	82
	480	23196CAKE4 + <b>AHX 3196</b>	Tr 530 × 6	295	45	307	63
<b>480</b>	500	230/500CAKE4 + <b>AHX 30/500</b>	Tr 540 × 6	209	40	221	54.5
	500	240/500CAK30E4 + <b>AH 240/500</b>	Tr 530 × 6	253	35	276	41.9
	500	231/500CAKE4 + <b>AHX 31/500</b>	Tr 550 × 6	313	47	325	71
	500	241/500CAK30E4 + <b>AH 241/500</b>	Tr 530 × 6	360	35	383	61.2
	500	232/500CAKE4 + <b>AHX 32/500</b>	Tr 550 × 6	393	54	405	94.5
	500	231/500CAKE4 + <b>AHX 31/500</b>	Tr 550 × 6	313	47	325	71



# ■ NUTS FOR ROLLING BEARINGS

(For Adapters and Shafts)



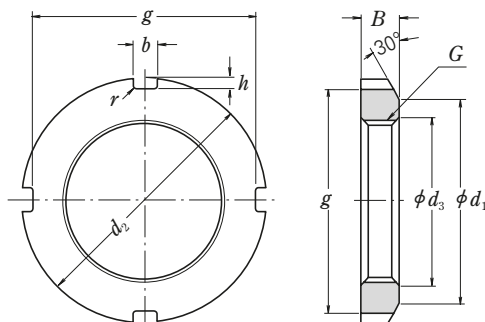
Nut with Washer

Units : mm

Designation	Nut Series AN										Reference		
	Screw Threads <i>G</i>	Basic Dimensions								Mass (kg) approx.	Adapter (1) Sleeve Bore Dia. Numbers	Washer Designation	Shaft Dia.
		<i>d</i> <sub>2</sub>	<i>d</i> <sub>1</sub>	<i>g</i>	<i>b</i>	<i>h</i>	<i>d</i> <sub>3</sub>	<i>B</i>	<i>r</i> max.				
<b>AN 02</b>	M 15×1	25	21	21	4	2	15.5	5	0.4	0.010	—	<b>AW 02 X</b>	15
<b>AN 03</b>	M 17×1	28	24	24	4	2	17.5	5	0.4	0.013	—	<b>AW 03 X</b>	17
<b>AN 04</b>	M 20×1	32	26	28	4	2	20.5	6	0.4	0.019	04	<b>AW 04 X</b>	20
<b>AN 05</b>	M 25×1.5	38	32	34	5	2	25.8	7	0.4	0.025	05	<b>AW 05 X</b>	25
<b>AN 06</b>	M 30×1.5	45	38	41	5	2	30.8	7	0.4	0.043	06	<b>AW 06 X</b>	30
<b>AN 07</b>	M 35×1.5	52	44	48	5	2	35.8	8	0.4	0.053	07	<b>AW 07 X</b>	35
<b>AN 08</b>	M 40×1.5	58	50	53	6	2.5	40.8	9	0.5	0.085	08	<b>AW 08 X</b>	40
<b>AN 09</b>	M 45×1.5	65	56	60	6	2.5	45.8	10	0.5	0.119	09	<b>AW 09 X</b>	45
<b>AN 10</b>	M 50×1.5	70	61	65	6	2.5	50.8	11	0.5	0.148	10	<b>AW 10 X</b>	50
<b>AN 11</b>	M 55×2	75	67	69	7	3	56	11	0.5	0.158	11	<b>AW 11 X</b>	55
<b>AN 12</b>	M 60×2	80	73	74	7	3	61	11	0.5	0.174	12	<b>AW 12 X</b>	60
<b>AN 13</b>	M 65×2	85	79	79	7	3	66	12	0.5	0.203	13	<b>AW 13 X</b>	65
<b>AN 14</b>	M 70×2	92	85	85	8	3.5	71	12	0.5	0.242	14	<b>AW 14 X</b>	70
<b>AN 15</b>	M 75×2	98	90	91	8	3.5	76	13	0.5	0.287	15	<b>AW 15 X</b>	75
<b>AN 16</b>	M 80×2	105	95	98	8	3.5	81	15	0.6	0.395	16	<b>AW 16 X</b>	80
<b>AN 17</b>	M 85×2	110	102	103	8	3.5	86	16	0.6	0.45	17	<b>AW 17 X</b>	85
<b>AN 18</b>	M 90×2	120	108	112	10	4	91	16	0.6	0.555	18	<b>AW 18 X</b>	90
<b>AN 19</b>	M 95×2	125	113	117	10	4	96	17	0.6	0.66	19	<b>AW 19 X</b>	95
<b>AN 20</b>	M 100×2	130	120	122	10	4	101	18	0.6	0.70	20	<b>AW 20 X</b>	100
<b>AN 21</b>	M 105×2	140	126	130	12	5	106	18	0.7	0.845	21	<b>AW 21 X</b>	105
<b>AN 22</b>	M 110×2	145	133	135	12	5	111	19	0.7	0.965	22	<b>AW 22 X</b>	110
<b>AN 23</b>	M 115×2	150	137	140	12	5	116	19	0.7	1.01	—	<b>AW 23</b>	115
<b>AN 24</b>	M 120×2	155	138	145	12	5	121	20	0.7	1.08	24	<b>AW 24</b>	120
<b>AN 25</b>	M 125×2	160	148	150	12	5	126	21	0.7	1.19	—	<b>AW 25</b>	125

**Note** (1) Applicable to adapter sleeves in Series A31, A2, A3, or A23.

**Remark** The basic design and dimensions of screw threads are in accordance with JIS B 0205.



Nut with Washer

Units : mm

Designation	Nut Series AN										Reference		
	Screw Threads	Basic Dimensions								Mass (kg) approx.	Adapter <sup>(1)</sup> Sleeve Bore Dia. Numbers	Washer Designation	Shaft Dia.
		$d_2$	$d_1$	$g$	$b$	$h$	$d_3$	$B$	$r$ max.				
<b>AN 26</b>	M 130×2	165	149	155	12	5	131	21	0.7	1.25	26	<b>AW 26</b>	130
<b>AN 27</b>	M 135×2	175	160	163	14	6	136	22	0.7	1.55	—	<b>AW 27</b>	135
<b>AN 28</b>	M 140×2	180	160	168	14	6	141	22	0.7	1.56	28	<b>AW 28</b>	140
<b>AN 29</b>	M 145×2	190	172	178	14	6	146	24	0.7	2.0	—	<b>AW 29</b>	145
<b>AN 30</b>	M 150×2	195	171	183	14	6	151	24	0.7	2.03	30	<b>AW 30</b>	150
<b>AN 31</b>	M 155×3	200	182	186	16	7	156.5	25	0.7	2.21	—	—	—
<b>AN 32</b>	M 160×3	210	182	196	16	7	161.5	25	0.7	2.59	32	<b>AW 32</b>	160
<b>AN 33</b>	M 165×3	210	193	196	16	7	166.5	26	0.7	2.43	—	—	—
<b>AN 34</b>	M 170×3	220	193	206	16	7	171.5	26	0.7	2.8	34	<b>AW 34</b>	170
<b>AN 36</b>	M 180×3	230	203	214	18	8	181.5	27	0.7	3.05	36	<b>AW 36</b>	180
<b>AN 38</b>	M 190×3	240	214	224	18	8	191.5	28	0.7	3.4	38	<b>AW 38</b>	190
<b>AN 40</b>	M 200×3	250	226	234	18	8	201.5	29	0.7	3.7	40	<b>AW 40</b>	200

Nut Series ANL

<b>ANL 24</b>	M 120×2	145	133	135	12	5	121	20	0.7	0.78	24	<b>AWL 24</b>	120
<b>ANL 26</b>	M 130×2	155	143	145	12	5	131	21	0.7	0.88	26	<b>AWL 26</b>	130
<b>ANL 28</b>	M 140×2	165	151	153	14	6	141	22	0.7	0.99	28	<b>AWL 28</b>	140
<b>ANL 30</b>	M 150×2	180	164	168	14	6	151	24	0.7	1.38	30	<b>AWL 30</b>	150
<b>ANL 32</b>	M 160×3	190	174	176	16	7	161.5	25	0.7	1.56	32	<b>AWL 32</b>	160
<b>ANL 34</b>	M 170×3	200	184	186	16	7	171.5	26	0.7	1.72	34	<b>AWL 34</b>	170
<b>ANL 36</b>	M 180×3	210	192	194	18	8	181.5	27	0.7	1.95	36	<b>AWL 36</b>	180
<b>ANL 38</b>	M 190×3	220	202	204	18	8	191.5	28	0.7	2.08	38	<b>AWL 38</b>	190
<b>ANL 40</b>	M 200×3	240	218	224	18	8	201.5	29	0.7	2.98	40	<b>AWL 40</b>	200

**Note** <sup>(1)</sup> Series AN is applicable to adapter sleeves in Series A31 or A23.

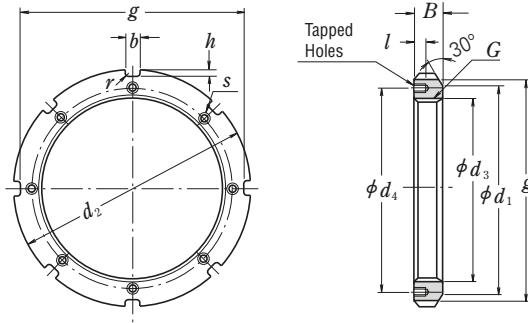
Series ANL is applicable to adapter sleeves in Series A30.

**Remark** The basic design and dimensions of screw threads are in accordance with JIS B 0205.



# ■ NUTS FOR ROLLING BEARINGS

(For Adapters and Shafts)



Nut With Stopper

Units : mm

Designation	Nut Series AN													Reference			
	Screw Threads <i>G</i>	Basic Dimensions								Tapped Holes			Mass (kg) approx.	Adapter (°) Sleeve Bore Dia. Numbers	Stopper Designation	Shaft Dia.	
		<i>d</i> <sub>2</sub>	<i>d</i> <sub>1</sub>	<i>g</i>	<i>b</i>	<i>h</i>	<i>d</i> <sub>3</sub>	<i>B</i>	<i>r</i> max.	<i>l</i>	Screw Threads ( <i>S</i> )	<i>d</i> <sub>4</sub>					
AN 44	Tr 220×4	280	250	260	20	10	222	32	0.8	15	M 8×1.25	238	5.2	44	AL 44	220	
AN 48	Tr 240×4	300	270	280	20	10	242	34	0.8	15	M 8×1.25	258	5.95	48	AL 44	240	
AN 52	Tr 260×4	330	300	306	24	12	262	36	0.8	18	M 10×1.5	281	8.05	52	AL 52	260	
AN 56	Tr 280×4	350	320	326	24	12	282	38	0.8	18	M 10×1.5	301	9.05	56	AL 52	280	
AN 60	Tr 300×4	380	340	356	24	12	302	40	0.8	18	M 10×1.5	326	11.8	60	AL 60	300	
AN 64	Tr 320×5	400	360	376	24	12	322.5	42	0.8	18	M 10×1.5	345	13.1	64	AL 64	320	
AN 68	Tr 340×5	440	400	410	28	15	342.5	55	1	21	M 12×1.75	372	23.1	68	AL 68	340	
AN 72	Tr 360×5	460	420	430	28	15	362.5	58	1	21	M 12×1.75	392	25.1	72	AL 68	360	
AN 76	Tr 380×5	490	450	454	32	18	382.5	60	1	21	M 12×1.75	414	31	76	AL 76	380	
AN 80	Tr 400×5	520	470	484	32	18	402.5	62	1	27	M 16×2	439	37	80	AL 80	400	
AN 84	Tr 420×5	540	490	504	32	18	422.5	70	1	27	M 16×2	459	43.5	84	AL 80	420	
AN 88	Tr 440×5	560	510	520	36	20	442.5	70	1	27	M 16×2	477	45	88	AL 88	440	
AN 92	Tr 460×5	580	540	540	36	20	462.5	75	1	27	M 16×2	497	50.5	92	AL 88	460	
AN 96	Tr 480×5	620	560	580	36	20	482.5	75	1	27	M 16×2	527	62	96	AL 96	480	
AN 100	Tr 500×5	630	580	584	40	23	502.5	80	1	27	M 16×2	539	63.5	/500	AL 100	500	

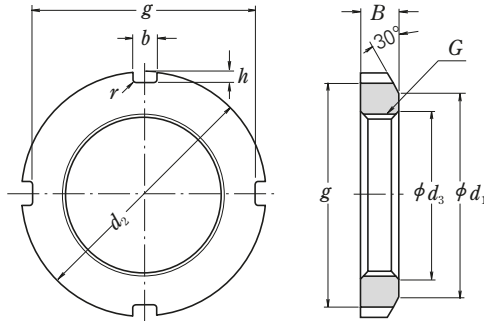
Nut Series ANL

ANL 44	Tr 220×4	260	242	242	20	9	222	30	0.8	12	M 6×1	229	3.1	44	ALL 44	220
ANL 48	Tr 240×4	290	270	270	20	10	242	34	0.8	15	M 8×1.25	253	5.15	48	ALL 48	240
ANL 52	Tr 260×4	310	290	290	20	10	262	34	0.8	15	M 8×1.25	273	5.65	52	ALL 48	260
ANL 56	Tr 280×4	330	310	310	24	10	282	38	0.8	15	M 8×1.25	293	6.8	56	ALL 56	280
ANL 60	Tr 300×4	360	336	336	24	12	302	42	0.8	15	M 8×1.25	316	9.6	60	ALL 60	300
ANL 64	Tr 320×5	380	356	356	24	12	322.5	42	0.8	15	M 8×1.25	335	9.95	64	ALL 64	320
ANL 68	Tr 340×5	400	376	376	24	12	342.5	45	1	15	M 8×1.25	355	11.7	68	ALL 64	340
ANL 72	Tr 360×5	420	394	394	28	13	362.5	45	1	15	M 8×1.25	374	12	72	ALL 72	360
ANL 76	Tr 380×5	450	422	422	28	14	382.5	48	1	18	M 10×1.5	398	14.9	76	ALL 76	380
ANL 80	Tr 400×5	470	442	442	28	14	402.5	52	1	18	M 10×1.5	418	16.9	80	ALL 76	400
ANL 84	Tr 420×5	490	462	462	32	14	422.5	52	1	18	M 10×1.5	438	17.4	84	ALL 84	420
ANL 88	Tr 440×5	520	490	490	32	15	442.5	60	1	21	M 12×1.75	462	26.2	88	ALL 88	440
ANL 92	Tr 460×5	540	510	510	32	15	462.5	60	1	21	M 12×1.75	482	28	92	ALL 88	460
ANL 96	Tr 480×5	560	530	530	36	15	482.5	60	1	21	M 12×1.75	502	29.5	96	ALL 96	480
ANL 100	Tr 500×5	580	550	550	36	15	502.5	68	1	21	M 12×1.75	522	33.5	/500	ALL 96	500

**Note** (°) Series AN is applicable to adapter sleeves in Series A31, A32, and A23. Series ANL is applicable to adapter sleeves in Series A30.

**Remarks** 1. The basic design and dimensions of screw threads are in accordance with JIS B 0216.  
2. The basic design and dimensions of threads in tapped holes are in accordance with JIS B 0205.

## (For Withdrawal Sleeves)



Units : mm

Designation	Nut Series HN										Reference			
	Screw Threads G	Basic Dimensions								Mass (kg) approx.	Withdrawal Sleeve Designations			
		$d_2$	$d_1$	$g$	$b$	$h$	$d_3$	$B$	$r_{\max.}$		AH 31	AH 22	AH 32	AH 23
HN 42	Tr 210×4	270	238	250	20	10	212	30	0.8	4.75	AH 3138	AH 2238	AH 3238	AH 2338
HN 44	Tr 220×4	280	250	260	20	10	222	32	0.8	5.35	AH 3140	AH 2240	AH 3240	AH 2340
HN 48	Tr 240×4	300	270	280	20	10	242	34	0.8	6.2	AH 3144	AH 2244	—	AH 2344
HN 52	Tr 260×4	330	300	306	24	12	262	36	0.8	8.55	AH 3148	AH 2248	—	AH 2348
HN 58	Tr 290×4	370	330	346	24	12	292	40	0.8	11.8	AH 3152	AH 2252	—	AH 2352
HN 62	Tr 310×5	390	350	366	24	12	312.5	42	0.8	13.4	AH 3156	AH 2256	—	AH 2356
HN 66	Tr 330×5	420	380	390	28	15	332.5	52	1	20.4	AH 3160	AH 2260	AH 3260	—
HN 70	Tr 350×5	450	410	420	28	15	352.5	55	1	25.2	AH 3164	AH 2264	AH 3264	—
HN 74	Tr 370×5	470	430	440	28	15	372.5	58	1	28.2	AH 3168	—	AH 3268	—
HN 80	Tr 400×5	520	470	484	32	18	402.5	62	1	40	AH 3172	—	AH 3272	—
HN 84	Tr 420×5	540	490	504	32	18	422.5	70	1	46.9	AH 3176	—	AH 3276	—
HN 88	Tr 440×5	560	510	520	36	20	442.5	70	1	48.5	AH 3180	—	AH 3280	—
HN 92	Tr 460×5	580	540	540	36	20	462.5	75	1	55	AH 3184	—	AH 3284	—
HN 96	Tr 480×5	620	560	580	36	20	482.5	75	1	67	AHX 3188	—	AHX 3288	—
HN 102	Tr 510×6	650	590	604	40	23	513	80	1	75	AHX 3192	—	AHX 3292	—
HN 106	Tr 530×6	670	610	624	40	23	533	80	1	78	AHX 3196	—	AHX 3296	—
HN 110	Tr 550×6	700	640	654	40	23	553	80	1	92.5	AHX 31/500	—	AHX 32/500	—
Nut Series HNL											AH 30	AH 2		
HNL41	Tr 205×4	250	232	234	18	8	207	30	0.8	3.45	AH 3038	AH 238		
HNL43	Tr 215×4	260	242	242	20	9	217	30	0.8	3.7	AH 3040	AH 240		
HNL47	Tr 235×4	280	262	262	20	9	237	34	0.8	4.6	AH 3044	AH 244		
HNL52	Tr 260×4	310	290	290	20	10	262	34	0.8	5.8	AH 3048	AH 248		
HNL56	Tr 280×4	330	310	310	24	10	282	38	0.8	6.7	AH 3052	AH 252		
HNL60	Tr 300×4	360	336	336	24	12	302	42	0.8	9.6	AH 3056	AH 256		
HNL64	Tr 320×5	380	356	356	24	12	322.5	42	1	10.3	AH 3060	—		
HNL69	Tr 345×5	410	384	384	28	13	347.5	45	1	11.5	AH 3064	—		
HNL73	Tr 365×5	430	404	404	28	13	367.5	48	1	14.2	AH 3068	—		
HNL77	Tr 385×5	450	422	422	28	14	387.5	48	1	15	AH 3072	—		
HNL82	Tr 410×5	480	452	452	32	14	412.5	52	1	19	AH 3076	—		
HNL86	Tr 430×5	500	472	472	32	14	432.5	52	1	19.8	AH 3080	—		
HNL90	Tr 450×5	520	490	490	32	15	452.5	60	1	23.8	AH 3084	—		
HNL94	Tr 470×5	540	510	510	32	15	472.5	60	1	25	AHX 3088	—		
HNL98	Tr 490×5	580	550	550	36	15	492.5	60	1	34	AHX 3092	—		
HNL 104	Tr 520×6	600	570	570	36	15	523	68	1	37	AHX 3096	—		
HNL 108	Tr 540×6	630	590	590	40	20	543	68	1	43.5	AHX 30/500	—		

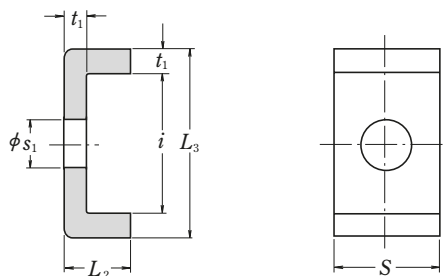
- Remarks**
1. The basic design and dimensions of screw threads are in accordance with JIS B 0216.
  2. There may be more notches in the nut than shown in the above figure.



# NUTS FOR ROLLING BEARINGS

(Combination of Withdrawal Sleeves and Nuts)

Designation	Reference						
	Withdrawal Sleeve Designations						
	AH 30	AH 31	AH 2	AH 22	AH 32	AH 3	AH 23
AN 09	—	—	AH 208	—	—	AH 308	AH 2308
AN 10	—	—	AH 209	—	—	AH 309	AH 2309
AN 11	—	—	AH 210	—	—	AHX 310	AHX 2310
AN 12	—	—	AH 211	—	—	AHX 311	AHX 2311
AN 13	—	—	AH 212	—	—	AHX 312	AHX 2312
AN 14	—	—	—	—	—	—	—
AN 15	—	—	AH 213	—	—	AH 313	AH 2313
AN 16	—	—	AH 214	—	—	AH 314	AHX 2314
AN 17	—	—	AH 215	—	—	AH 315	AHX 2315
AN 18	—	—	AH 216	—	—	AH 316	AHX 2316
AN 19	—	—	AH 217	—	—	AHX 317	AHX 2317
AN 20	—	—	AH 218	—	AHX 3218	AHX 318	AHX 2318
AN 21	—	—	AH 219	—	—	AHX 319	AHX 2319
AN 22	—	—	AH 220	—	AHX 3220	AHX 320	AHX 2320
AN 23	—	—	AH 221	—	—	AHX 321	—
AN 24	—	AHX 3122	AH 222	—	—	AHX 322	—
AN 25	—	—	—	—	AHX 3222	—	AHX 2322
AN 26	AHX 3024	AHX 3124	AH 224	—	—	AHX 324	—
AN 27	—	—	—	—	AHX 3224	—	AHX 2324
AN 28	AHX 3026	AHX 3126	AH 226	—	—	AHX 326	—
AN 29	—	—	—	—	AHX 3226	—	AHX 2326
AN 30	AHX 3028	AHX 3128	AH 228	—	—	AHX 328	—
AN 31	—	—	—	—	AHX 3228	—	AHX 2328
AN 32	AHX 3030	—	AH 230	—	—	—	—
AN 33	—	AHX 3130	—	—	AHX 3230	AHX 330	AHX 2330
AN 34	AH 3032	—	AH 232	—	—	—	—
AN 36	AH 3034	AH 3132	AH 234	—	AH 3232	AH 332	AH 2332
AN 38	AH 3036	AH 3134	AH 236	—	AH 3234	AH 334	AH 2334
AN 40	—	AH 3136	—	AH 2236	AH 3236	—	AH 2336



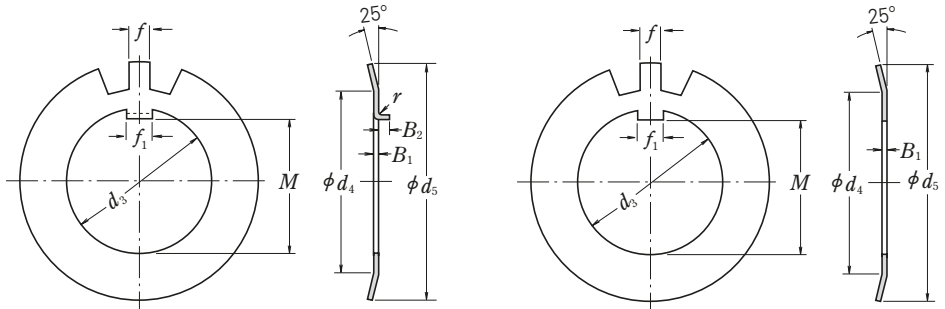
Units : mm

Designation	Stopper Series AL							Reference
	Basic Dimensions						Mass (kg) per 100 pcs approx.	Nut Designations
	$t_1$	$S$	$L_2$	$s_1$	$i$	$L_3$		
AL 44	4	20	12	9	22.5	30.5	2.6	AN 44, AN 48 AN 52, AN 56 AN 60
AL 52	4	24	12	12	25.5	33.5	3.4	
AL 60	4	24	12	12	30.5	38.5	3.8	
AL 64	5	24	15	12	31	41	5.35	AN 64 AN 68, AN 72 AN 76
AL 68	5	28	15	14	38	48	6.65	
AL 76	5	32	15	14	40	50	7.95	
AL 80	5	32	15	18	45	55	8.2	AN 80, AN 84 AN 88, AN 92 AN 96 AN 100
AL 88	5	36	15	18	43	53	9.0	
AL 96	5	36	15	18	53	63	10.4	
AL 100	5	40	15	18	45	55	10.5	

Stopper Series ALL								
ALL 44	4	20	12	7	13.5	21.5	2.12	ANL 44 ANL 48, ANL 52 ANL 56
ALL 48	4	20	12	9	17.5	25.5	2.29	
ALL 56	4	24	12	9	17.5	25.5	2.92	
ALL 60	4	24	12	9	20.5	28.5	3.15	ANL 60 ANL 64, ANL 68 ANL 72
ALL 64	5	24	15	9	21	31	4.55	
ALL 72	5	28	15	9	20	30	5.05	
ALL 76	5	28	15	12	24	34	5.3	ANL 76, ANL 80 ANL 84 ANL 88, ANL 92 ANL 96, ANL 100
ALL 84	5	32	15	12	24	34	6.1	
ALL 88	5	32	15	14	28	38	6.45	
ALL 96	5	36	15	14	28	38	7.3	



# LOCK-WASHERS FOR ROLLING BEARINGS



Bent-Tab

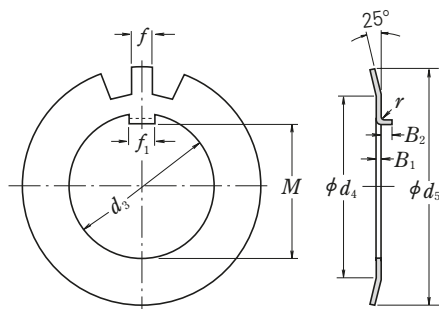
Straight-Tab

Units : mm

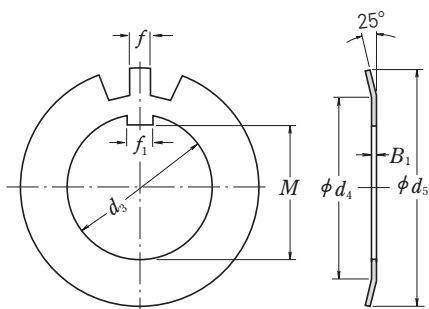
Designation		Lock-Washer Series AW											Reference		
		Basic Dimensions									No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter (1) Sleeve Bore Dia. Numbers	Nut Designation	Shaft Dia.
Bent-Tab	Straight-Tab	$d_3$	$M$	$f_1$	$B_1$	$f$	$d_4$	$d_5$	Bent-Tab $r$	Bent-Tab $B_2$					
AW 02	AW 02 X	15	13.5	4	1	4	21	28	1	2.5	13	0.253	—	AN 02	15
AW 03	AW 03 X	17	15.5	4	1	4	24	32	1	2.5	13	0.315	—	AN 03	17
AW 04	AW 04 X	20	18.5	4	1	4	26	36	1	2.5	13	0.35	04	AN 04	20
AW 05	AW 05 X	25	23	5	1.2	5	32	42	1	2.5	13	0.64	05	AN 05	25
AW 06	AW 06 X	30	27.5	5	1.2	5	38	49	1	2.5	13	0.78	06	AN 06	30
AW 07	AW 07 X	35	32.5	6	1.2	5	44	57	1	2.5	15	1.04	07	AN 07	35
AW 08	AW 08 X	40	37.5	6	1.2	6	50	62	1	2.5	15	1.23	08	AN 08	40
AW 09	AW 09 X	45	42.5	6	1.2	6	56	69	1	2.5	17	1.52	09	AN 09	45
AW 10	AW 10 X	50	47.5	6	1.2	6	61	74	1	2.5	17	1.6	10	AN 10	50
AW 11	AW 11 X	55	52.5	8	1.2	7	67	81	1	4	17	1.96	11	AN 11	55
AW 12	AW 12 X	60	57.5	8	1.5	7	73	86	1.2	4	17	2.53	12	AN 12	60
AW 13	AW 13 X	65	62.5	8	1.5	7	79	92	1.2	4	19	2.9	13	AN 13	65
AW 14	AW 14 X	70	66.5	8	1.5	8	85	98	1.2	4	19	3.35	14	AN 14	70
AW 15	AW 15 X	75	71.5	8	1.5	8	90	104	1.2	4	19	3.55	15	AN 15	75
AW 16	AW 16 X	80	76.5	10	1.8	8	95	112	1.2	4	19	4.65	16	AN 16	80
AW 17	AW 17 X	85	81.5	10	1.8	8	102	119	1.2	4	19	5.25	17	AN 17	85
AW 18	AW 18 X	90	86.5	10	1.8	10	108	126	1.2	4	19	6.25	18	AN 18	90
AW 19	AW 19 X	95	91.5	10	1.8	10	113	133	1.2	4	19	6.7	19	AN 19	95
AW 20	AW 20 X	100	96.5	12	1.8	10	120	142	1.2	6	19	7.65	20	AN 20	100
AW 21	AW 21 X	105	100.5	12	1.8	12	126	145	1.2	6	19	8.25	21	AN 21	105
AW 22	AW 22 X	110	105.5	12	1.8	12	133	154	1.2	6	19	9.4	22	AN 22	110
AW 23	AW 23 X	115	110.5	12	2	12	137	159	1.5	6	19	10.8	—	AN 23	115
AW 24	AW 24 X	120	115	14	2	12	138	164	1.5	6	19	10.5	24	AN 24	120
AW 25	AW 25 X	125	120	14	2	12	148	170	1.5	6	19	11.8	—	AN 25	125

**Note** <sup>(1)</sup> Applicable to adapter sleeves in Series A31, A2, A3, and A23.

**Remark** Lock-washers with straight tabs must be used for adapter sleeves with narrow slits, while either type of lock-washer may be used for those with wide slits.



Bent-Tab



Straight-Tab

Units : mm

Designation		Lock-Washer Series AW											Reference		
		Basic Dimensions										No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter (1) Sleeve Bore Dia. Numbers	Nut Designation
Bent-Tab	Straight-Tab	$d_3$	$M$	$f_1$	$B_1$	$f$	$d_4$	$d_5$	Bent-Tab $r$	$B_2$					
AW 26	AW 26 X	130	125	14	2	12	149	175	1.5	6	19	11.3	26	AN 26	130
AW 27	AW 27 X	135	130	14	2	14	160	185	1.5	6	19	14.4	—	AN 27	135
AW 28	AW 28 X	140	135	16	2	14	160	192	1.5	8	19	14.2	28	AN 28	140
AW 29	AW 29 X	145	140	16	2	14	172	202	1.5	8	19	16.8	—	AN 29	145
AW 30	AW 30 X	150	145	16	2	14	171	205	1.5	8	19	15.9	30	AN 30	150
AW 31	AW 31 X	155	147.5	16	2.5	16	182	212	1.5	8	19	20.9	—	AN 31	155
AW 32	AW 32 X	160	154	18	2.5	16	182	217	1.5	8	19	22.2	32	AN 32	160
AW 33	AW 33 X	165	157.5	18	2.5	16	193	222	1.5	8	19	24.1	—	AN 33	165
AW 34	AW 34 X	170	164	18	2.5	16	193	232	1.5	8	19	24.7	34	AN 34	170
AW 36	AW 36 X	180	174	20	2.5	18	203	242	1.5	8	19	26.8	36	AN 36	180
AW 38	AW 38 X	190	184	20	2.5	18	214	252	1.5	8	19	27.8	38	AN 38	190
AW 40	AW 40 X	200	194	20	2.5	18	226	262	1.5	8	19	29.3	40	AN 40	200

Washer Series AWL

<b>AWL 24</b>	<b>AWL 24 X</b>	120	115	14	2	12	133	155	1.5	6	19	7.7	24	<b>ANL 24</b>	120
<b>AWL 26</b>	<b>AWL 26 X</b>	130	125	14	2	12	143	165	1.5	6	19	8.7	26	<b>ANL 26</b>	130
<b>AWL 28</b>	<b>AWL 28 X</b>	140	135	16	2	14	151	175	1.5	8	19	10.9	28	<b>ANL 28</b>	140
<b>AWL 30</b>	<b>AWL 30 X</b>	150	145	16	2	14	164	190	1.5	8	19	11.3	30	<b>ANL 30</b>	150
<b>AWL 32</b>	<b>AWL 32 X</b>	160	154	18	2.5	16	174	200	1.5	8	19	16.2	32	<b>ANL 32</b>	160
<b>AWL 34</b>	<b>AWL 34 X</b>	170	164	18	2.5	16	184	210	1.5	8	19	19	34	<b>ANL 34</b>	170
<b>AWL 36</b>	<b>AWL 36 X</b>	180	174	20	2.5	18	192	220	1.5	8	19	18	36	<b>ANL 36</b>	180
<b>AWL 38</b>	<b>AWL 38 X</b>	190	184	20	2.5	18	202	230	1.5	8	19	20.5	38	<b>ANL 38</b>	190
<b>AWL 40</b>	<b>AWL 40 X</b>	200	194	20	2.5	18	218	250	1.5	8	19	21.4	40	<b>ANL 40</b>	200

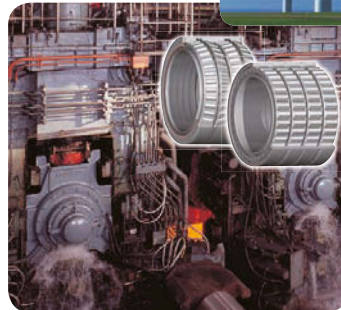
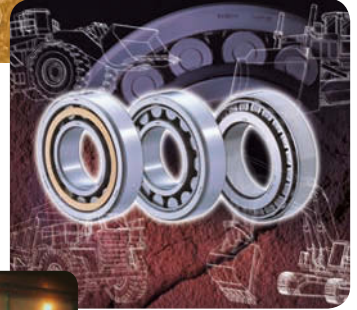
**Note** (1) Series AW is applicable to adapter sleeves in Series A31 and A23.

Series AWL is applicable to adapter sleeves in Series A30.

**Remark** Lock-washers with straight tabs must be used for adapter sleeves with narrow slits, while either type of lock-washer may be used for those with wide slits.



# INDUSTRY SOLUTIONS



(\*1)

(\*1)

## Part D

### INDUSTRY SOLUTIONS

1. AIR TURBINE BEARINGS FOR DENTAL HANDPIECES ..... D 004
2. PUMPS & COMPRESSORS ..... D 010
3. AGRICULTURAL MACHINERY ..... D 026
4. CONSTRUCTION MACHINERY ..... D 034
5. MINING MACHINERY ..... D 040
6. RAILWAY ROLLING STOCK ..... D 048
7. PAPERMAKING MACHINES ..... D 066
8. WIND POWER INDUSTRY ..... D 086
9. STEEL INDUSTRY ..... D 094

**Note** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

# Air Turbine Bearings for Dental Handpieces

Greatly improved corrosion resistance  
lengthens bearing replacement cycles.



**Features of Dental Handpiece Bearings** ..... D 006

**Formulation of Bearing Designations** ..... D 007

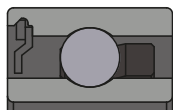
**Lineup** ..... D 008

## ■ Dental Handpiece Bearings

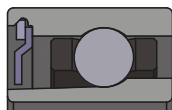
### Features of NSK Dental Handpiece Bearings

This bearing Series has been developed to cover the wide range of handpiece sizes and shapes used in the market (43 types in total).

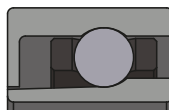
#### • Bearing Type



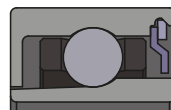
Deep groove



Angular

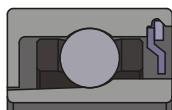


Integral  
angular

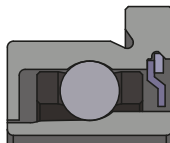


Integral  
shielded angular

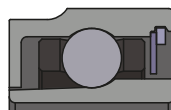
#### • Shape



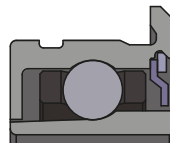
Straight



Flanged



Grooved



Special

### Long-Life Bearings With Highly Corrosion-Resistant ES1 Stainless Steel

NSK has developed a highly corrosion-resistant material called ES1 that is highly suitable for manufacturing dental handpiece bearings. ES1 has made it possible to improve the life of bearings significantly and assure highly effective sterilization with no cross contamination. ES1 offers corrosion resistance far superior to conventional SUS440C stainless steel bearings. Electrical and chemical tests of our anodic polarization measurement confirm that the current density (corrosion rate) in the passive state range of ES1 bearings is about one-tenth lower than conventional stainless steel bearings, demonstrating ES1's superior corrosion resistance.

### Ultra-High-Speed Rotation

To maintain ultra-high-speed rotation and the long rolling life of air turbine bearings, NSK makes continuous efforts to optimize the design and improve the precision of cage parts. As a result, we have been successful in maintaining stable rotation even at 500,000 rpm.

## Formulation of Bearing Designations

Please use the following example designation for an NSK standard dental handpiece bearing (Straight 100 Series) as a guide to select a bearing according to requirements such as bearing width, material, and lubricant.

**B3Z100X -H-20SN34 T52C ZS CG9 7A U438 CF1X**

(1) (2) (3) (4) (5) (6) (7) (8)

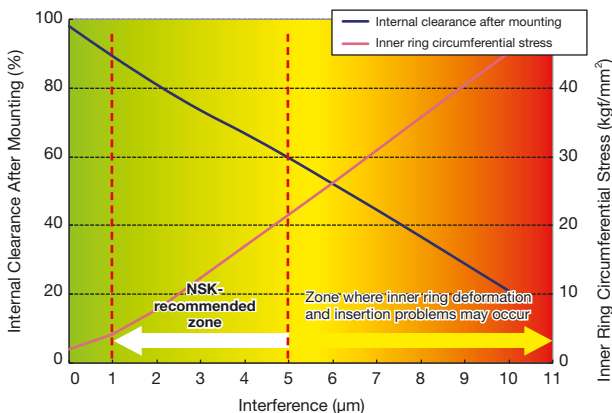
- (1) B3Z100X:** Model name indicating basic designation for air turbines
- (2) -H-20SN34:** Ceramic balls (-H-26: Optional stainless steel balls)
- (3) T52C:** Torlon® polyamide-imide cage  
C, J, P, etc.: Cage type
- (4) ZS:** Single shield
- (5) CG9:** RIC 0.008mm to 0.010mm (Recommended by NSK)
- (6) 7A:** Special tolerance class (ABEC7+ID: ABEC9)
- (7) U438:** Special specification for air turbine
- (8) CF1X:** Special oil (food grade) or **BF7N:** Special grease

## Importance of a Perfect Fitting

For optimal performance, bearings must be correctly fitted on the shaft and in the housing. To provide this performance, Class ABEC9 tolerance (from -0.0025 mm to 0 mm) is used for the inner ring bore of NSK bearings. NSK can supply bearings with two classifications of ring bore diameter tolerance (from -0.0025 to -0.00125 mm and from -0.00125 to 0 mm). This choice makes it easy to stabilize the bearing fitting. A stable fitting reduces air turbine vibrations, noise, and irregularities in the revolutions per minute, thereby assuring long life.

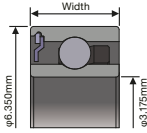
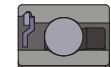
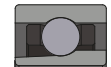
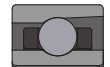
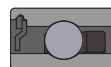

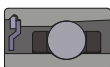
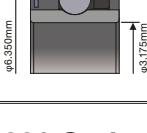

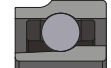
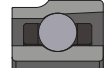
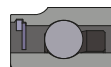
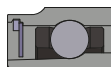
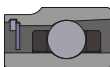
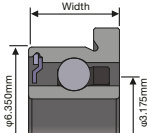






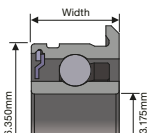



### • Shaft material: martensitic stainless steel (SUS400 family)

(Please contact NSK when using bearings for stainless steel shafts made of materials other than martensitic stainless steel.)



## Dental Handpiece Bearings

### Lineup


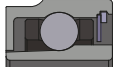
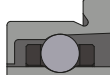
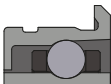
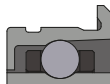
Bearing Series	Width	Deep Groove Bearing	Angular Contact Bearing	
			Inner Ring Counterbore	Outer Ring Counterbore
<b>100 Series</b> (Straight type) 	<b>2.380mm</b> (0.0937")			
		<b>B3Z-100X</b>	<b>BH3Z-101X</b>	<b>BH3Z-102X</b>
	<b>2.779mm</b> (0.1094")			
		<b>B3Z-100</b>	<b>BH3Z-101A</b>	<b>BH3Z-102A</b>
<b>150 Series</b> (Grooved type) 	<b>2.380mm</b> (0.0937")			
		<b>B3Z-150X</b>	<b>BH3Z-151X</b>	<b>BH3Z-152X</b>
	<b>2.779mm</b> (0.1094")			
		<b>B3Z-150</b>	<b>BH3Z-151A</b>	<b>BH3Z-152A</b>
<b>200 Series</b> (Flanged type) 	<b>2.380mm</b> (0.0937")			
		<b>FBC3Z-200X</b>	<b>FBH3Z-201X</b>	<b>FBH3Z-202X</b>
	<b>2.779mm</b> (0.1094")			
		<b>FBC3Z-200</b>	<b>FBH3Z-201A</b>	<b>FBH3Z-202A</b>
<b>250 Series</b> 	<b>2.779mm</b> (0.1094")			
		<b>FBC3Z-250</b>	<b>FBH3Z-251A</b>	<b>FBH3Z-252A</b>

### Standard Specifications

- Ceramic balls
- ABEC9(P2) grade tolerance is used for the inner ring bore diameter for maximum bearing performance. The tolerance of other parts is ABEC7(P4) grade.
- NSK can supply bearings with two classifications of the inner ring bore diameter tolerance (from -0.0025 to -0.00125, and from -0.00125 to 0mm).
- Custom laser markings are available upon request.
- Highly safe, low-viscosity CG1 oil is standard in NSK dental handpiece bearings. Bearings with BF7 grease are also available.

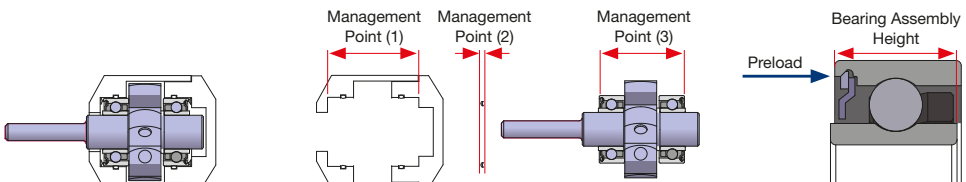
### Optional Specifications

- Stainless steel ball bearings are also available.
- Bearings with different widths for the outer ring and inner ring are also available.

Integral Bearing				
Inner Ring Counterbore		Outer Ring Counterbore		
				
BH3Z-103X		BH3Z-104X		
				
BH3Z-103A	BH3Z-103B	BH3Z-104A	BH3Z-104	
				
BH3Z-153X		BH3Z-154X		
				
BH3Z-153A	BH3Z-153B	BH3Z-154A	BH3Z-154	
				
FBH3Z-203X		FBH3Z-204X		
				
FBH3Z-203A	FBH3Z-203B	FBH3Z-204A	FBH3Z-204	
				
FBH3Z-253A	FBH3Z-253B	FBH3Z-254A	FBH3Z-254	

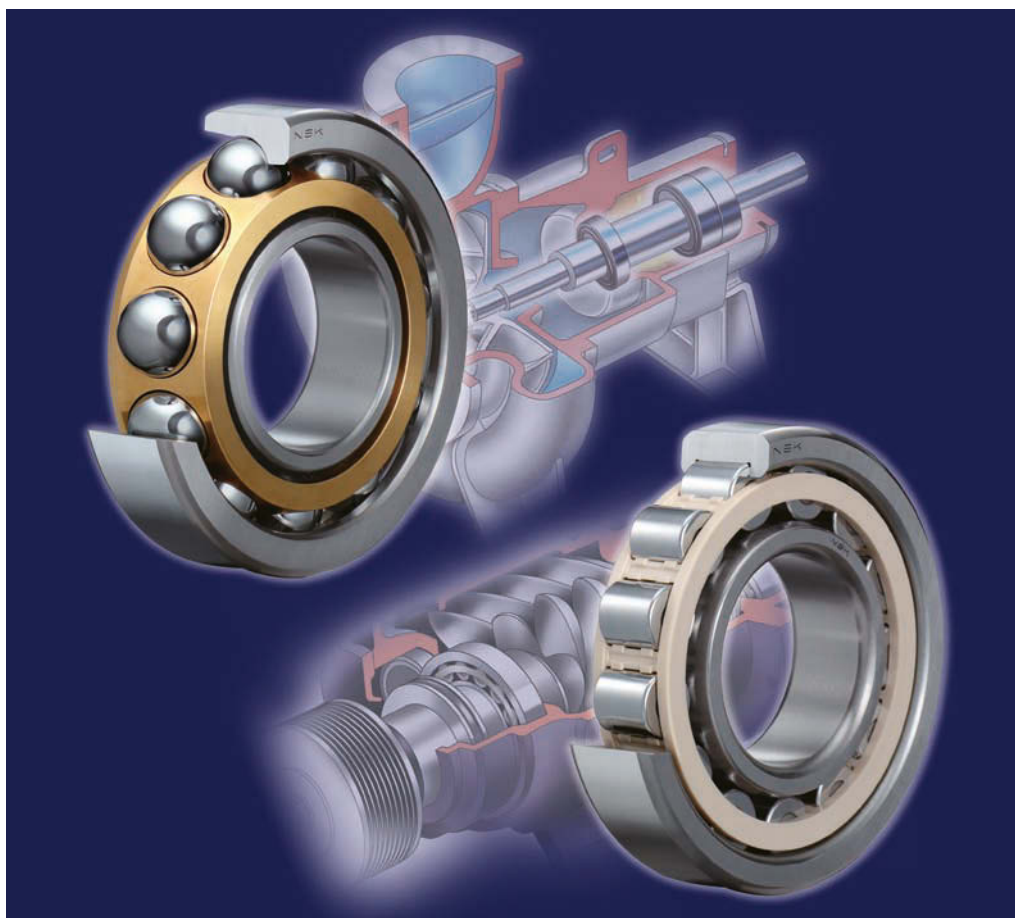
## Preload Stabilization

Stabilization of preload with a spring is extremely important for air turbine bearings. There are three management points ((1) to (3) below) for this task. Bearing assembly height is also a vital factor when applying preload. NSK can verify the configuration of your bearing assembly height to assure stable preloading.



# Bearings for Pumps & Compressors

High-performance, reliable bearings that deliver long life and energy-efficient operation.



## Bearings for Pumps

### Bearing Tables

#### NSKHPS™ / High Load Capacity Single-Row Angular Contact Ball Bearings

Bore Diameter 20 – 120 mm ..... D 015

#### High Load Capacity Double-Row Angular Contact Ball Bearings

Bore Diameter 25 – 65 mm ..... D 016

#### High Load Capacity Deep Groove Ball Bearings (Open)

Bore Diameter 15 – 60 mm ..... D 017

#### Creep-Free Bearings™

Bore Diameter 10 – 45 mm ..... D 018

## Bearings for Compressors

### Bearing Tables

#### High Load Capacity Cylindrical Roller Bearings (L-PPS Cage)

Bore Diameter 20 – 100 mm ..... D 022

#### NSKHPS™ Angular Contact Ball Bearings (L-PPS Cage)

Bore Diameter 12 – 80 mm ..... D 024

#### High-Speed Cylindrical Roller Bearings

Bore Diameter 25 – 50 mm ..... D 025

#### High-Speed Angular Contact Ball Bearings

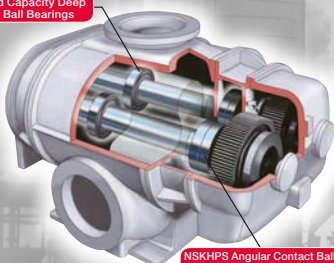
Bore Diameter 20 – 50 mm ..... D 025

# Bearings for Pumps

Advanced machined-brass cages provide strength and endurance. Optimized internal geometries allow efficient lubricant flow through the bearing.

## Vacuum Pumps

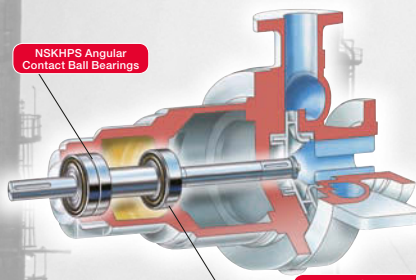
High Load Capacity Deep Groove Ball Bearings



NSKHPS Angular Contact Ball Bearings, or High Load Capacity Double-Row Angular Contact Ball Bearings

## Pumps for Petroleum and Chemicals

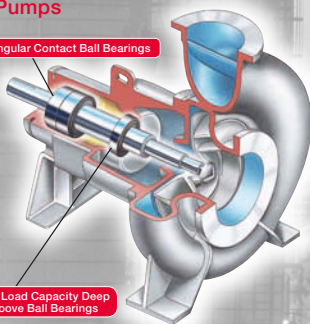
NSKHPS Angular Contact Ball Bearings



High Load Capacity Deep Groove Ball Bearings

## Slurry Pumps

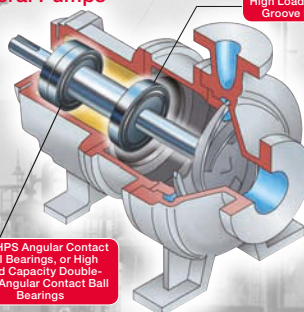
NSKHPS Angular Contact Ball Bearings



High Load Capacity Deep Groove Ball Bearings

## General Pumps

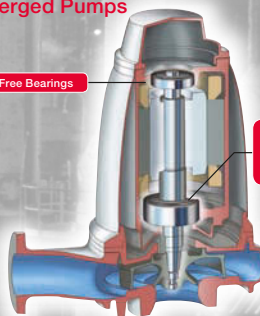
High Load Capacity Deep Groove Ball Bearings



NSKHPS Angular Contact Ball Bearings, or High Load Capacity Double-Row Angular Contact Ball Bearings

## Submerged Pumps

Creep-Free Bearings



NSKHPS Angular Contact Ball Bearings, or High Load Capacity Double-Row Angular Contact Ball Bearings

## Features of Bearings for Pumps



### NSKHPS™ / High Load Capacity Single-Row Angular Contact Ball Bearings

- High load capacity angular contact ball bearings with machined-brass cages.
- Improved bearing life (up to 90% longer) over conventional bearings reduces maintenance frequency and improves reliability.



### High Load Capacity Double-Row Angular Contact Ball Bearings

- High load capacity double-row angular contact ball bearings have advanced internal bearing geometry.
- Improved bearing life (up to 50% longer) over conventional bearings reduces maintenance frequency and improves reliability.



### High Load Capacity Deep Groove Ball Bearings (Open Type)

- Open high load capacity deep groove ball bearings with advanced internal bearing geometry.
- Improved bearing life (up to 70% longer) over conventional bearings reduces maintenance frequency and improves reliability.



### Creep-Free Bearings™

- Outer ring creep prevention is significantly improved with O-ring tension in the housing.
- Standard principal dimensions are maintained to eliminate the need for re-machining housings. These bearings are suitable for the free side of the motor in motor-integrated pumps.

## ■ Features of Bearings for Pumps

### NSKHPS™ / High Load Capacity Single-Row Angular Contact Ball Bearings

#### Applications

- Petroleum and Chemical industries (API standards<sup>\*1</sup>, etc.)
- Pulp and paper industry (ANSI standards<sup>\*2</sup>, etc.)

<sup>\*1</sup> Standards related to petroleum specified by the American Petroleum Institute

<sup>\*2</sup> Standards of industrial products in the U.S. specified by the American National Standards Institute

**High load capacity and outstanding lubrication performance enable reduced pump size and extended maintenance intervals.**

Compared to conventional bearings:

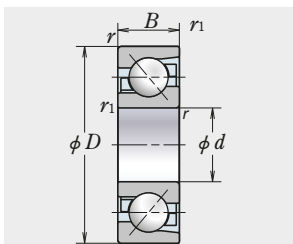
- Bearing life: 90% longer
- Maximum rotational speed: 20% faster
- Universal arrangement standard
- 40° contact angle

Axial Internal Clearance

in Combined ACBBs  
(Measured Clearance)

Unit:  $\mu\text{m}$

Nominal Bore Diameter $d$ (mm)		CNB		GA	
Over	Incl.	Min.	Max.	Min.	Max.
12	18	17	25	-2	6
18	30	20	28		
30	50	24	32		
50	80	29	41	-3	9



#### Bearing Designation

Example:

**7310 B EA MR SU GA**

Basic designation

Contact angle: 40°

Internal designation: High load capacity

Cage: Machined cage

Arrangement: Universal arrangement (single unit)

Internal clearance

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min <sup>-1</sup> )	
	<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> (min.)	<i>r</i> <sub>1</sub> (min.)	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>	Grease	Oil
*7304BEA	20	52	15	1.1	0.6	19 800	10 500	13 000	18 000
*7305BEA	25	62	17	1.1	0.6	27 200	14 900	10 000	15 000
*7206BEA	30	62	16	1	0.6	23 700	14 300	10 000	14 000
*7306BEA	30	72	19	1.1	0.6	36 500	20 600	9 000	13 000
*7207BEA	35	72	17	1.1	0.6	32 500	19 600	8 500	12 000
*7307BEA	35	80	21	1.5	1	40 500	24 400	8 000	11 000
*7208BEA	40	80	18	1.1	0.6	38 500	24 500	7 500	11 000
*7308BEA	40	90	23	1.5	1	53 000	33 000	7 100	10 000
*7209BEA	45	85	19	1.1	0.6	40 500	27 100	7 100	10 000
*7309BEA	45	100	25	1.5	1	62 500	39 500	6 300	9 000
*7210BEA	50	90	20	1.1	0.6	42 000	29 700	6 300	9 500
*7310BEA	50	110	27	2	1	78 000	50 500	5 600	8 000
*7211BEA	55	100	21	1.5	1	51 500	37 000	6 000	8 500
*7311BEA	55	120	29	2	1	89 000	58 500	5 000	7 500
*7212BEA	60	110	22	1.5	1	61 500	45 000	5 300	7 500
*7312BEA	60	130	31	2.1	1.1	102 000	68 500	4 800	6 700
*7213BEA	65	120	23	1.5	1	70 000	53 500	4 800	7 100
*7313BEA	65	140	33	2.1	1.1	114 000	77 000	4 300	6 300
*7214BEA	70	125	24	1.5	1	75 500	58 500	4 500	6 700
*7314BEA	70	150	35	2.1	1.1	124 000	87 500	4 000	6 000
*7215BEA	75	130	25	1.5	1	78 500	63 500	4 300	6 300
*7315BEA	75	160	37	2.1	1.1	134 000	98 500	3 800	5 600
*7216BEA	80	140	26	2	1	87 500	70 000	4 000	6 000
*7316BEA	80	170	39	2.1	1.1	144 000	110 000	3 600	5 300
7217BEA	85	150	28	2	1	96 000	81 500	3 800	5 600
7317BEA	85	180	41	3	1.1	157 000	133 000	3 400	5 000
7218BEA	90	160	30	2	1	109 000	93 500	3 600	5 300
7318BEA	90	190	43	3	1.1	169 000	146 000	3 200	4 500
7219BEA	95	170	32	2.1	1.1	123 000	107 000	3 400	5 000
7319BEA	95	200	45	3	1.1	180 000	160 000	3 000	4 500
7220BEA	100	180	34	2.1	1.1	136 000	122 000	3 200	4 500
7320BEA	100	215	47	3	1.1	202 000	187 000	2 800	4 000
7221BEA	105	190	36	2.1	1.1	148 000	133 000	3 000	4 500
7321BEA	105	225	49	3	1.1	213 000	203 000	2 600	4 000
7222BEA	110	200	38	2.1	1.1	154 000	144 000	2 800	4 300
7322BEA	110	240	50	3	1.1	226 000	226 000	2 600	3 800
7224BEA	120	215	40	2.1	1.1	179 000	177 000	2 600	3 800
7324BEA	120	260	55	3	1.1	238 000	250 000	2 200	3 400

**Remarks**

\*These NSKHS angular contact ball bearings feature ISO tolerance Class 5 running accuracy and ISO tolerance Class 6 dimensional accuracy.

Bearings without an asterisk are high load capacity angular contact ball bearings with P6 running accuracy and P6 dimensional accuracy.

## ■ Features of Bearings for Pumps

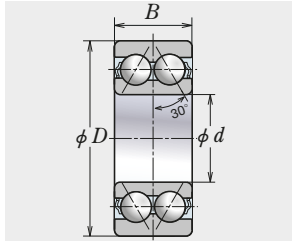
### High Load Capacity Double-Row Angular Contact Ball Bearings

- Applications
- Pulp and paper industry (ANSI standards, etc.)
  - Water/Sewage and Irrigation, etc.

Improved bearing life and thrust load capacity enable reduced pump size and extended maintenance intervals.

Compared to conventional bearings:

- Bearing life: 50% longer
- Thrust load capacity: Twice as high as conventional bearings
- Improved installation with advanced lead-in chamfer
- Class P6 as standard



#### Bearing Designation

Example:

**3309**

**F**

**CGXX**

Basic Designation

Contact angle: 30°

Radial internal clearance

Bearing Designation	Boundary Dimensions (mm)			Basic Load Ratings (N)	
	$d$	$D$	$B$	$C_r$ (dynamic)	$C_{0r}$ (static)
<b>3305F</b>	25	62	25.4	30 500	20 500
<b>3306F</b>	30	72	30.2	39 500	27 300
<b>3307F</b>	35	80	34.9	49 500	35 000
<b>3308F</b>	40	90	36.5	60 500	44 000
<b>3309F</b>	45	100	39.7	66 500	49 500
<b>3310F</b>	50	110	44.4	85 500	64 500
<b>3311F</b>	55	120	49.2	106 000	82 000
<b>3312F</b>	60	130	54	122 000	95 500
<b>3313F</b>	65	140	58.7	138 000	109 000

## High Load Capacity Deep Groove Ball Bearings (Open Type)

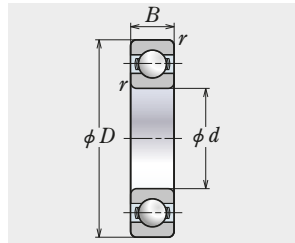
### Applications

- Petroleum and chemical industries (API standards, etc.)
- Pulp and paper industry (ANSI standards, etc.)
- Semiconductor and liquid crystal panels (vacuum pumps)

**High load capacity enables reduced pump size and extended maintenance intervals.**

Compared to conventional bearings:

- Bearing life: 70% longer



### Bearing Designation

Example:

**HR 6305 C3**

High load capacity

Basic designation

Internal clearance

Bearing Designation	Boundary Dimensions (mm)				Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$C_r$ (dynamic)	$C_{or}$ (static)
<b>HR 6202</b>	15	35	11	0.6	8 550	3 950
<b>HR 6302</b>	15	42	13	1.0	13 300	5 900
<b>HR 6203</b>	17	40	12	0.6	11 300	5 350
<b>HR 6303</b>	17	47	14	1.0	15 600	7 100
<b>HR 6304</b>	20	52	15	1.1	18 200	9 050
<b>HR 6205</b>	25	52	15	1.0	15 300	8 100
<b>HR 6305</b>	25	62	17	1.1	23 700	12 200
<b>HR 6206</b>	30	62	16	1.0	23 300	12 800
<b>HR 6306</b>	30	72	19	1.1	29 800	15 800
<b>HR 6207</b>	35	72	17	1.1	28 300	16 000
<b>HR 6307</b>	35	80	21	1.5	39 500	21 500
<b>HR 6208</b>	40	80	18	1.1	32 500	19 900
<b>HR 6308</b>	40	90	23	1.5	47 000	26 200
<b>HR 6209</b>	45	85	19	1.1	36 500	22 600
<b>HR 6309</b>	45	100	25	1.5	57 000	34 500
<b>HR 6210</b>	50	90	20	1.1	39 000	25 800
<b>HR 6310</b>	50	110	27	2.0	66 500	40 500
<b>HR 6211</b>	55	100	21	1.5	48 000	32 000
<b>HR 6311</b>	55	120	29	2.0	78 000	46 000
<b>HR 6212</b>	60	110	22	1.5	58 000	38 000

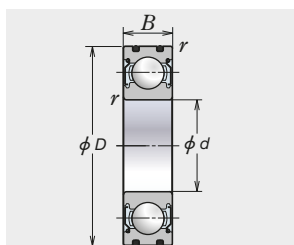
# ■ Features of Bearings for Pumps

## Creep-Free Bearings™

Applications • Water/Sewage and Irrigation, etc.

Outer ring creep prevention is significantly improved by O-ring tension in the housing. Standard principal dimensions are maintained to eliminate the need for re-machining housings, thereby reducing costs.

(Recommended fits: G6 or H7)



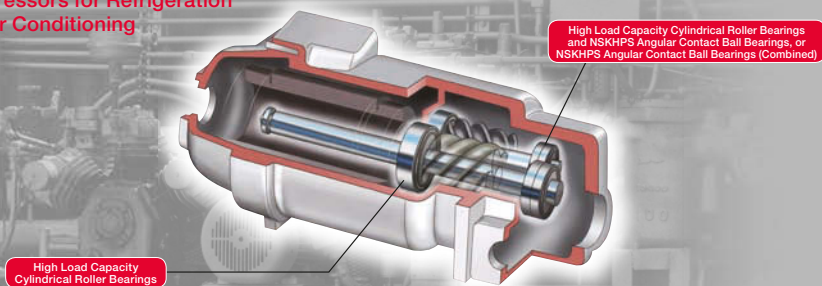
Bearing Designation	Boundary Dimensions (mm)				Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)
<b>6000</b>	10	26	8	0.3	4 550	1 970
<b>6200</b>	10	30	9	0.6	5 100	2 390
<b>6300</b>	10	35	11	0.6	8 100	3 450
<b>6001</b>	12	28	8	0.3	5 100	2 370
<b>6201</b>	12	32	10	0.6	6 800	3 050
<b>6301</b>	12	37	12	1.0	9 700	4 200
<b>6002</b>	15	32	9	0.3	5 600	2 830
<b>6202</b>	15	35	11	0.6	7 650	3 750
<b>6302</b>	15	42	13	1.0	11 400	5 450
<b>6003</b>	17	35	10	0.3	6 000	3 250
<b>6203</b>	17	40	12	0.6	9 550	4 800
<b>6303</b>	17	47	14	1.0	13 600	6 650
<b>6004</b>	20	42	12	0.6	9 400	5 000
<b>6204</b>	20	47	14	1.0	12 800	6 600
<b>6304</b>	20	52	15	1.1	15 900	7 900
<b>6005</b>	25	47	12	0.6	10 100	5 850
<b>6205</b>	25	52	15	1.0	14 000	7 850
<b>6305</b>	25	62	17	1.1	20 600	11 200
<b>6006</b>	30	55	13	1.0	13 200	8 300
<b>6206</b>	30	62	16	1.0	19 500	11 300
<b>6306</b>	30	72	19	1.1	26 700	15 000
<b>6007</b>	35	62	14	1.0	16 000	10 300
<b>6207</b>	35	72	17	1.1	25 700	15 300
<b>6307</b>	35	80	21	1.5	33 500	19 200
<b>6008</b>	40	68	15	1.0	16 800	11 500
<b>6208</b>	40	80	18	1.1	29 100	17 900
<b>6308</b>	40	90	23	1.5	40 500	24 000
<b>6009</b>	45	75	16	1.0	20 900	15 200
<b>6209</b>	45	85	19	1.1	31 500	20 400
<b>6309</b>	45	100	25	1.5	53 000	32 000



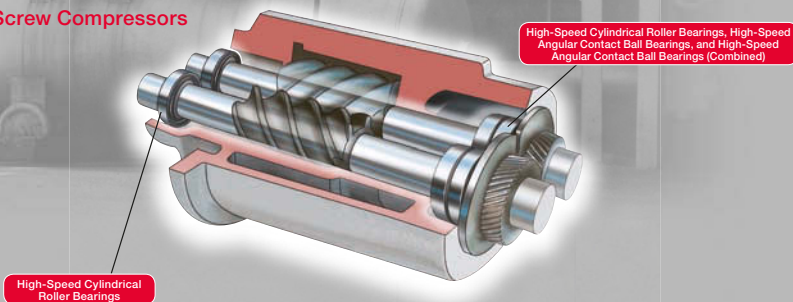
# Bearings for Compressors

L-PPS (Linear-Polyphenylene Sulfide) cages are chemically stable and resist wear better than steel or brass. Optimized internal geometries allow efficient lubricant flow through the bearing.

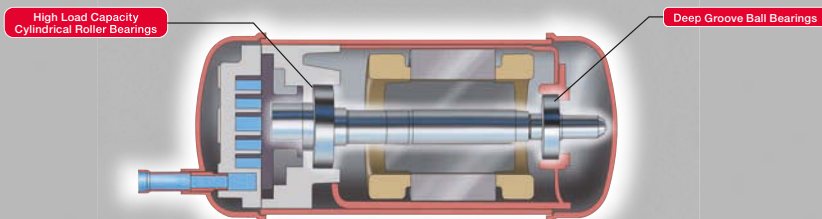
## Compressors for Refrigeration and Air Conditioning



## Oil-Free Screw Compressors



## Scroll Compressors



## Features of Bearings for Compressors



### High Load Capacity Cylindrical Roller Bearings (L-PPS Cage)

- High load capacity cylindrical roller bearings with high-performance L-PPS plastic cages.
- Heat-resistant L-PPS plastic cages deliver chemical stability that ensures strength with little to no deterioration, even in compressor oil, refrigeration machine oil, or ammonia refrigerant, while also providing excellent abrasion resistance.



### NSKHPS™ Angular Contact Ball Bearings (L-PPS cage)

- High load capacity angular contact ball bearings with high-performance L-PPS plastic cages.
- Improved bearing life (up to 90% longer) over conventional bearings reduces maintenance frequency and improves reliability.



### High-Speed Cylindrical Roller Bearings

- High-speed cylindrical roller bearings with outer ring guided machined-brass cages.
- Class P5 tolerances as standard ensure stable performance at high speeds.



### High-Speed Angular Contact Ball Bearings

- High-speed angular contact ball bearings with outer ring guided machined-brass cages.
- Class P5 tolerances as standard ensure stable performance at high speeds.

## ■ Features of Bearings for Compressors

### High Load Capacity Cylindrical Roller Bearings (L-PPS Cage)

#### Applications

- Refrigeration and air conditioning screw compressors
- Air and gas screw compressors

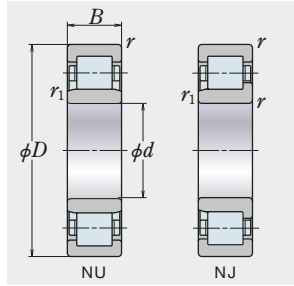
Outstanding load capacity and lubrication performance allow for reduced compressor size and extended maintenance intervals.



Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$r_1$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)
NU (NJ) 204ET7	20	47	14	1	0.6	25 700	22 600
NU (NJ) 304ET7	20	52	15	1.1	0.6	31 500	26 900
NU (NJ) 2204ET7	20	47	18	1	0.6	30 500	28 300
NU (NJ) 2304ET7	20	52	21	1.1	0.6	42 000	39 000
NU (NJ) 205ET7	25	52	15	1	0.6	29 300	27 700
NU (NJ) 305ET7	25	62	17	1.1	1.1	41 500	37 500
NU (NJ) 2205ET7	25	52	18	1	0.6	35 000	34 500
NU (NJ) 2305ET7	25	62	24	1.1	1.1	57 000	56 000
NU (NJ) 206ET7	30	62	16	1	0.6	39 000	37 500
NU (NJ) 306ET7	30	72	19	1.1	1.1	53 000	50 000
NU (NJ) 2206ET7	30	62	20	1	0.6	49 000	50 000
NU (NJ) 2306ET7	30	72	27	1.1	1.1	74 500	77 500
NU (NJ) 207ET7	35	72	17	1.1	0.6	50 500	50 000
NU (NJ) 307ET7	35	80	21	1.5	1.1	66 500	65 500
NU (NJ) 2207ET7	35	72	23	1.1	0.6	61 500	65 000
NU (NJ) 2307ET7	35	80	31	1.5	1.1	93 000	101 000
NU (NJ) 208ET7	40	80	18	1.1	1.1	55 500	55 500
NU (NJ) 308ET7	40	90	23	1.5	1.5	83 000	81 500
NU (NJ) 2208ET7	40	80	23	1.1	1.1	72 500	77 500
NU (NJ) 2308ET7	40	90	33	1.5	1.5	114 000	122 000
NU (NJ) 209ET7	45	85	19	1.1	1.1	63 000	66 500
NU (NJ) 309ET7	45	100	25	1.5	1.5	97 500	98 500
NU (NJ) 2209ET7	45	85	23	1.1	1.1	76 000	84 500
NU (NJ) 2309ET7	45	100	36	1.5	1.5	137 000	153 000
NU (NJ) 210ET7	50	90	20	1.1	1.1	69 000	76 500
NU (NJ) 310ET7	50	110	27	2	2	110 000	113 000
NU (NJ) 2210ET7	50	90	23	1.1	1.1	86 500	97 000
NU (NJ) 2310ET7	50	110	40	2	2	163 000	187 000
NU (NJ) 211ET7	55	100	21	1.5	1.1	86 500	98 500
NU (NJ) 311ET7	55	120	29	2	2	137 000	143 000
NU (NJ) 2211ET7	55	100	25	1.5	1.1	101 000	122 000

Radial Internal Clearance Unit:  $\mu\text{m}$ 

Nominal Bore Diameter $d$ (mm)		Interchangeable CN clearance		Non-interchangeable CC Clearance	
Over	Incl.	Min.	Max.	Min.	Max.
10	24	20	45	20	30
24	30	20	45	25	35
30	40	25	50	25	40
40	50	30	60	30	45
50	65	40	70	35	50
65	80	40	75	40	60
80	100	50	85	45	70



Bearing Designation

Example:

NU	310	E	T7	
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Type

Basic Designation

Internal designation: High load capacity

Cage: L-PPS cage

Clearance

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$r_1$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)
NU (NJ) 2311ET7	55	120	43	2	2	201 000	233 000
NU (NJ) 212ET7	60	110	22	1.5	1.5	97 500	107 000
NU (NJ) 312ET7	60	130	31	2.1	2.1	150 000	157 000
NU (NJ) 2212ET7	60	110	28	1.5	1.5	131 000	157 000
NU (NJ) 2312ET7	60	130	46	2.1	2.1	222 000	262 000
NU (NJ) 213ET7	65	120	23	1.5	1.5	108 000	119 000
NU (NJ) 313ET7	65	140	33	2.1	2.1	181 000	191 000
NU (NJ) 2213ET7	65	120	31	1.5	1.5	149 000	181 000
NU (NJ) 2313ET7	65	140	48	2.1	2.1	233 000	265 000
NU (NJ) 214ET7	70	125	24	1.5	1.5	119 000	137 000
NU (NJ) 314ET7	70	150	35	2.1	2.1	205 000	222 000
NU (NJ) 2214ET7	70	125	31	1.5	1.5	156 000	194 000
NU (NJ) 2314ET7	70	150	51	2.1	2.1	274 000	325 000
NU (NJ) 215ET7	75	130	25	1.5	1.5	130 000	156 000
NU (NJ) 315ET7	75	160	37	2.1	2.1	240 000	263 000
NU (NJ) 2215ET7	75	130	31	1.5	1.5	162 000	207 000
NU (NJ) 2315ET7	75	160	55	2.1	2.1	330 000	395 000
NU (NJ) 216ET7	80	140	26	2	2	139 000	167 000
NU (NJ) 316ET7	80	170	39	2.1	2.1	256 000	282 000
NU (NJ) 2216ET7	80	140	33	2	2	186 000	243 000
NU (NJ) 2316ET7	80	170	58	2.1	2.1	355 000	430 000
NU (NJ) 217ET7	85	150	28	2	2	167 000	199 000
NU (NJ) 2217ET7	85	150	36	2	2	217 000	279 000
NU (NJ) 2317ET7	85	180	60	3	3	395 000	485 000
NU (NJ) 218ET7	90	160	30	2	2	182 000	217 000
NU (NJ) 2218ET7	90	160	40	2	2	242 000	315 000
NU (NJ) 2318ET7	90	190	64	3	3	435 000	535 000
NU (NJ) 220ET7	100	180	34	2.1	2.1	310 000	305 000
NU (NJ) 320ET7	100	215	47	3	3	380 000	425 000
NU (NJ) 2220ET7	100	180	46	2.1	2.1	335 000	445 000
NU (NJ) 2320ET7	100	215	73	3	3	570 000	715 000

## ■ Features of Bearings for Compressors

### NSKHPS™ Angular Contact Ball Bearings (L-PPS Cage)

#### Applications

- Refrigeration and air conditioning screw compressors
- Air and gas screw compressors

Outstanding load capacity and lubrication performance allow for reduced compressor size and extended maintenance intervals.

Compared to conventional bearings:

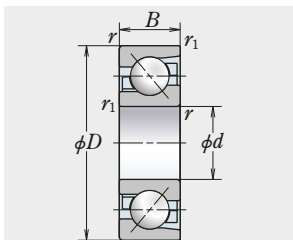
- Bearing life: up to 90% longer
- Maximum rotational speed: up to 20% faster
- Universal arrangement as standard
- 40° contact angle



#### Axial Internal Clearance

Unit:  $\mu\text{m}$

Nominal Bore Diameter $d$ (mm)		CNB		GA	
Over	Incl.	Min.	Max.	Min.	Max.
12	18	17	25	-2	6
18	30	20	28		
30	50	24	32		
60	80	29	41	-3	9



#### Bearing Designation

Example: **7310 B EA T7 SU CNB**

Basic Designation

Contact angle: 40°

Internal designation: High load capacity

Cage: L-PPS cage

Arrangement: Universal arrangement (single unit)

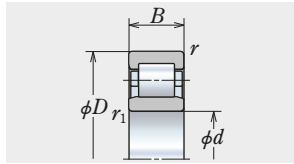
Internal clearance

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)		Maximum Rotational Speed (min <sup>-1</sup> )
	$d$	$D$	$B$	$r$ (min.)	$r_1$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)	
<b>7201BEA</b>	12	32	10	0.6	0.3	8 150	3 750	30 000
<b>7301BEA</b>	12	37	12	1	0.6	11 100	4 950	26 000
<b>7202BEA</b>	15	35	11	0.6	0.3	9 800	4 800	26 000
<b>7302BEA</b>	15	42	13	1	0.6	14 300	6 900	22 000
<b>7203BEA</b>	17	40	12	0.6	0.3	11 600	6 100	22 000
<b>7303BEA</b>	17	47	14	1	0.6	16 800	8 300	20 000
<b>7204BEA</b>	20	47	14	1	0.6	15 600	8 150	19 000
<b>7304BEA</b>	20	52	15	1.1	0.6	19 800	10 500	18 000
<b>7205BEA</b>	25	52	15	1	0.6	17 600	10 200	17 000
<b>7305BEA</b>	25	62	17	1.1	0.6	27 200	14 900	15 000
<b>7206BEA</b>	30	62	16	1	0.6	23 700	14 300	14 000
<b>7306BEA</b>	30	72	19	1.1	0.6	36 500	20 600	13 000
<b>7207BEA</b>	35	72	17	1.1	0.6	32 500	19 600	12 000
<b>7307BEA</b>	35	80	21	1.5	1	40 500	24 400	11 000
<b>7208BEA</b>	40	80	18	1.1	0.6	38 500	24 500	11 000
<b>7308BEA</b>	40	90	23	1.5	1	53 000	33 000	10 000
<b>7209BEA</b>	45	85	19	1.1	0.6	40 500	27 100	10 000
<b>7309BEA</b>	45	100	25	1.5	1	62 500	39 500	9 000
<b>7210BEA</b>	50	90	20	1.1	0.6	42 000	29 700	9 500
<b>7310BEA</b>	50	110	27	2	1	78 000	50 500	8 000
<b>7211BEA</b>	55	100	21	1.5	1	51 500	37 000	8 500
<b>7311BEA</b>	55	120	29	2	1	89 000	58 500	7 500
<b>7212BEA</b>	60	110	22	1.5	1	61 500	45 000	7 500
<b>7312BEA</b>	60	130	31	2.1	1.1	102 000	68 500	6 700
<b>7213BEA</b>	65	120	23	1.5	1	70 000	53 500	7 100
<b>7313BEA</b>	65	140	33	2.1	1.1	114 000	77 000	6 300
<b>7214BEA</b>	70	125	24	1.5	1	75 500	58 500	6 700
<b>7314BEA</b>	70	150	35	2.1	1.1	124 000	87 500	6 000
<b>7215BEA</b>	75	130	25	1.5	1	78 500	63 500	6 300
<b>7216BEA</b>	80	140	26	2	1	87 500	70 000	6 000

## High-Speed Cylindrical Roller Bearings

Applications • Air (oil-free) screw compressors

High-speed cylindrical roller bearings, adopting outer ring guided machined-brass cages.  **$d_{mn}$ : 1 300 000** (see Remarks 1 & 2) and bearing accuracy greater than Class P5 as standard.



Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$r_1$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)
NU205EMM	25	52	15	1	0.6	29 300	27 700
NU206EMM	30	62	16	1	0.6	39 000	37 500
NU207EMM	35	72	17	1.1	0.6	50 500	50 000
NU208EMM	40	80	18	1.1	1.1	55 500	55 500
NU209EMM	45	85	19	1.1	1.1	63 000	66 500
NU210EMM	50	90	20	1.1	1.1	69 000	76 500

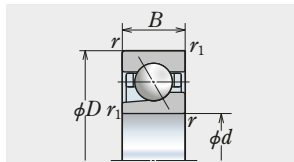
Remarks 1: Under general forced-lubrication conditions

2: Consult NSK regarding maximum rotational speed, which can vary according to service conditions and lubrication.

## High-Speed Angular Contact Ball Bearings

Applications • Air (oil-free) screw compressors

High-speed angular contact bearings with outer ring guided machined-brass cages.  **$d_{mn}$ : 1 300 000** (see Remarks 1 & 2) and bearing accuracy greater than Class P5 as standard.



Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)	
	$d$	$D$	$B$	$r$ (min.)	$r_1$ (min.)	$C_r$ (dynamic)	$C_{0r}$ (static)
20BA02A	20	47	14	1	0.6	13 600	7 550
25BA02A	25	52	15	1	0.6	15 400	9 500
30BA03B	30	72	19	1.5	0.6	31 500	19 000
35BA03B	35	80	21	1.5	0.6	39 000	24 000
40BA02A	40	80	18	1.5	0.6	34 500	24 100
45BA03A2	45	100	25	1.5	1	60 000	40 000
50BA03A1	50	110	27	1	2.5	70 000	47 500

Remarks 1: Under general forced-lubrication conditions

2: Consult NSK regarding maximum rotational speed, which can vary according to service conditions and lubrication.

# Bearings for Agricultural Machinery

High-performance bearings that provide high reliability and efficiency for agricultural equipment and machinery.



## Bearing Tables

**TM Series Sealed Deep Groove Ball Bearings** ..... D 032

# ■ Bearings for Agricultural Machinery

## Lineup



### Powertrain

Engine/Electrical Accessories



Plastic Pulley for  
Accessory & Timing Belts



Deep Groove Ball Bearings

### Drivetrain

Transmission/Differential Gear/Propeller Shaft



Needle Roller Bearings



Creep-Free Bearings™



HR Series Tapered Roller Bearings



Double-Row Angular  
Contact Ball Bearings



Thrust Ball Bearings



Long-Life Pinion Shaft  
With Cage and Rollers

Air Turbine  
Dental  
Handpieces

Pumps &  
Compressors

Agricultural  
Machinery

Construction  
Machinery

Mining  
Machinery

Railway  
Rolling Stock

Papermaking  
Machines

Wind Power  
Industry

Steel Industry

INDUSTRY  
SOLUTIONS



Water Pump Bearings



UR Bearings  
(Special Carbonitriding Heat-Treatment Technology)



NSKHPs™ Deep Groove Ball Bearings



TM Series  
Sealed Deep Groove Ball Bearings

## Other



Ball Bearing Units

## Implements



Agril Disc Hub

## Chassis

Wheel/Steering



NSKHPs™ Spherical  
Roller Bearings



Hub Unit Bearings (HUB 1)



Hi-TF Bearings



## High-Performance Standard NSKHPST™ Series Deep Groove Ball Bearings/Cylindrical Roller Bearings/Spherical Roller Bearings for Industrial Machinery



### Features

Compared with conventional bearings ...

Bearing Life  
**15%  
higher**

New Product  
Line-up  
**Wide range  
line-up**

The NSKHPST™ Series redefines the concept of standard bearings.

- Improved reliability  
Thanks to optimization of the bearing's internal design and improvement of processing technology, NSKHPS bearings feature up to 15% longer bearing life over conventional bearings. As a result, NSKHPS bearings reduce maintenance costs and facilitate the downscaling of related equipment.
- New product lineup  
Standard dimensions are the same as those for standard-size bearings. NSK has expanded the lineup of NSKHPS bearings to focus on a wide range of sizes with a high degree of versatility for generalpurpose applications.  
Please refer to Pages C020–C035 for the dimensions of NSKHPS deep groove ball bearings and Page D038 for more detailed information on NSKHPS cylindrical roller and spherical roller bearings.

## HR Series High-Load Bearings (Tapered Roller Bearings/Deep Groove Ball Bearings)

HR Series high-load bearings provide excellent performance in diverse applications.

### Features

- Higher load-carrying capacity and longer operating life.

Tapered roller bearings

An optimized cage design allows for larger rollers and higher roller count.

Deep groove ball bearings

Standard dimensions are identical to standard-size bearings and feature designs with optimized ball diameters and quantity.



## UR Bearings

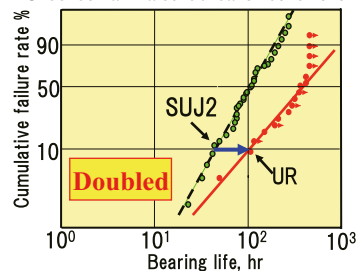
A special carbonitriding heat treatment (UR) through hardens bearing steel and enables long life.

### Features

- More than double the bearing life of standard bearings under harsh or contaminated lubrication conditions.
- Optional combinations with high-capacity Series enable further extended life.
- A wide range of products can receive the UR treatment since the treatment can be performed on regular bearing steel.



Under contaminated lubrication conditions



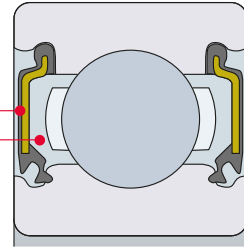
## TM Series Sealed Deep Groove Ball Bearings

The TM Series delivers longer operating life in contaminated environments by incorporating a special seal that prevents the entry of foreign particles and is especially effective in agricultural machinery and automobile transmission systems.



### Features

- Seal lip structure prevents entry of foreign matter while allowing entry of oil.
- Lower torque than conventional contact seal bearings.
- Sealed-in grease with a high affinity for gear oil aids initial lubrication.



### Bearing Series

TM302-TM314 / TM203-TM214

Major dimensions are the same as the Series 62 and Series 63 deep groove ball bearings.

## Long-Life Pinion Shaft With Cage and Rollers

These bearings have improved durability and reliability to achieve long service life under harsh operating conditions, such as prolonged continuous operation, by utilizing a pinion shaft with a cage and rollers as a single assembly.

### Features

- Special heat treatment and improved raceway surfaces more than double service life.

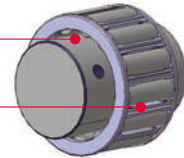
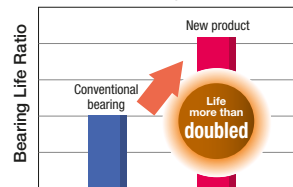
#### Pinion shaft

- Raceway polished to a mirror-smooth finish to ensure a sufficiently thick oil film.
- Special heat treatment applied to pinion shaft as a measure against contaminated-lubricant conditions.

#### Cage and rollers

- Roller running surface polished to a mirror-smooth finish to ensure a sufficiently thick oil film.
- Special heat treatment applied to rollers as a measure against contaminated-lubricant conditions.

Comparison of life test results for conventional and newly developed bearing



Corresponding size:  
Inscribed circle diameter up to 32 mm

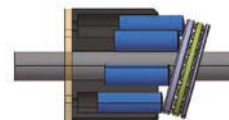
## HST Long-Life, High-Reliability Cage-Equipped Thrust Ball Bearings for Agricultural Machinery

These bearings contribute to the long life and reliability of agricultural machinery.

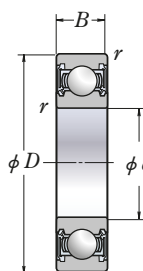
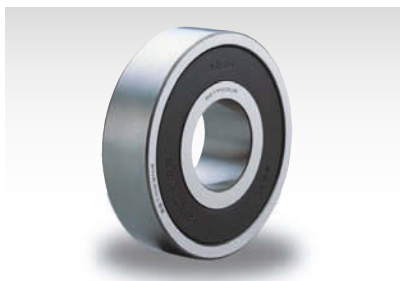
### Features

Over twice the life of conventional bearings through the use of special technology.

- Long-life technology  
EP steel, which is strong against subsurface fatigue, is used for the inner and outer ring. A special heat treatment is applied to the rings and balls to resist surface fatigue.
- High-reliability cage  
A plastic cage resistant to cage load is used to improve reliability.



# **■ TM Series Sealed Deep Groove Ball Bearings**



## **Bearing Designation**

Example:

**TM**    **205**    **C3**

TM Series

Basic designation

Internal clearance designation

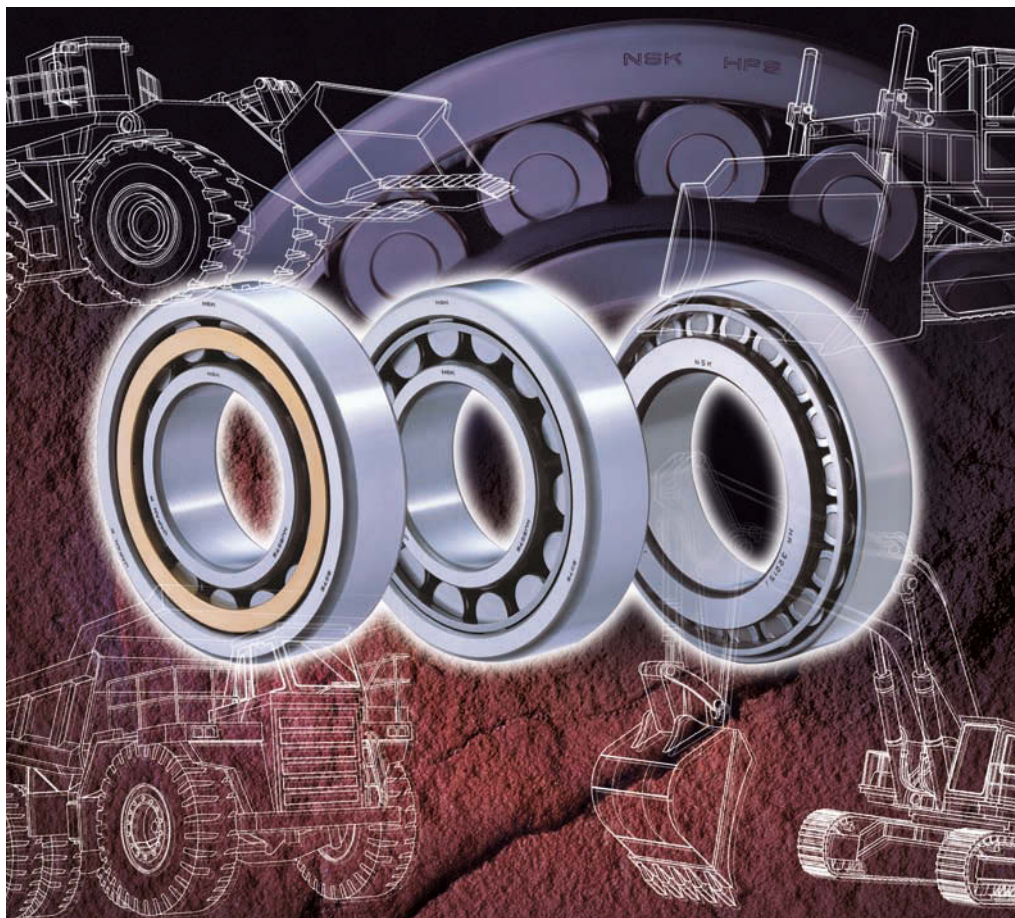
Bearing Designation	Boundary Dimensions (mm)			Basic Load Ratings (N)	
	<i>d</i>	<i>D</i>	<i>B</i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>
<b>TM203</b>	17	40	12	9 550	4 800
<b>TM303</b>	17	47	14	13 600	6 650
<b>TM204</b>	20	47	14	12 800	6 600
<b>TM304</b>	20	52	15	15 900	7 900
<b>TM2/22</b>	22	50	14	12 900	6 800
<b>TM3/22</b>	22	56	16	18 400	9 250
<b>TM205</b>	25	52	15	14 000	7 850
<b>TM305</b>	25	62	17	20 600	11 200
<b>TM2/28</b>	28	58	16	16 600	9 500
<b>TM3/28</b>	28	68	18	26 700	14 000
<b>TM206</b>	30	62	16	19 500	11 300
<b>TM306</b>	30	72	19	26 700	15 000
<b>TM2/32</b>	32	65	17	20 700	11 600
<b>TM3/32</b>	32	75	20	29 400	17 000
<b>TM207</b>	35	72	17	25 700	15 300
<b>TM307</b>	35	80	21	33 500	19 200
<b>TM208</b>	40	80	18	29 100	17 800
<b>TM308</b>	40	90	23	40 500	24 000
<b>TM209</b>	45	85	19	31 500	20 400
<b>TM309</b>	45	100	25	53 000	32 000
<b>TM210</b>	50	90	20	35 000	23 200
<b>TM310</b>	50	110	27	62 000	38 500
<b>TM211</b>	55	100	21	43 500	29 300
<b>TM311</b>	55	120	29	71 500	44 500
<b>TM212</b>	60	110	22	52 500	36 000
<b>TM312</b>	60	130	31	82 000	52 000
<b>TM213</b>	65	120	23	57 500	40 000
<b>TM313</b>	65	140	33	92 500	60 000
<b>TM214</b>	70	125	24	62 000	44 000
<b>TM314</b>	70	150	35	104 000	68 000

**Note** The maximum continuous operating temperature for standard nitrile rubber seals is 110 °C.



# Bearings for Construction Machinery

Tough bearings that provide long service life under harsh conditions reflect NSK's accumulated technological prowess.



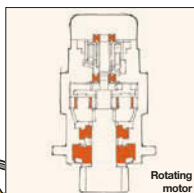
**Lineup** ..... D 036

# Bearing s for Construction Machinery

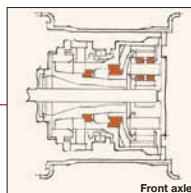
## Lineup

Bearings typically used:

- Tapered Roller Bearings
- Deep Groove Ball Bearings
- Needle Roller Bearings



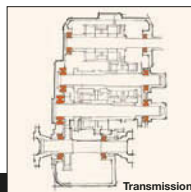
Rotating motor



Front axle

Bearings typically used:

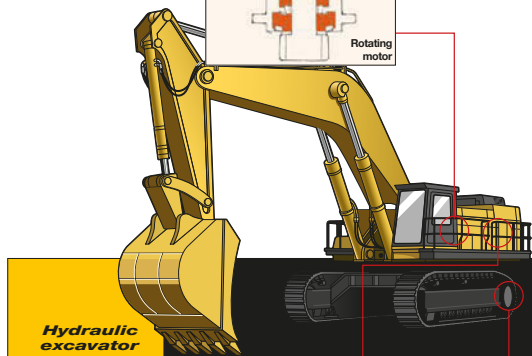
- Tapered Roller Bearings



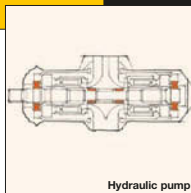
Transmission

Bearings typically used:

- Cylindrical Roller Bearings
- Tapered Roller Bearings
- Deep Groove Ball Bearings



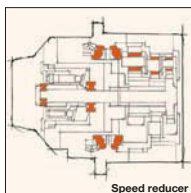
Hydraulic excavator



Hydraulic pump

Bearings typically used:

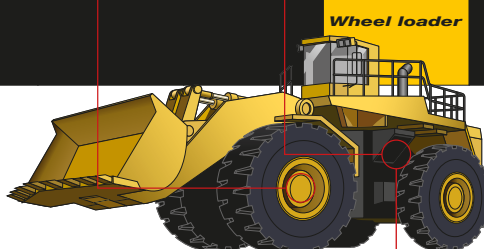
- Cylindrical Roller Bearings
- Needle Roller Bearings



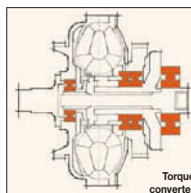
Speed reducer

Bearings typically used:

- Cylindrical Roller Bearings
- Angular Contact Ball Bearings
- Needle Roller Bearings



Wheel loader



Torque converter

Bearings typically used:

- Deep Groove Ball Bearings
- Angular Contact Ball Bearings



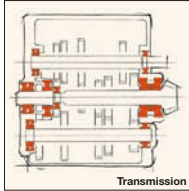
● NSKHPS™ Spherical Roller Bearings



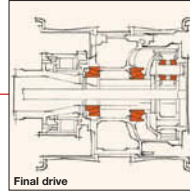
● NSKHPS™ Cylindrical Roller Bearings



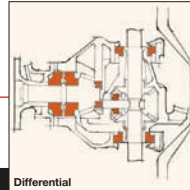
● HR Series Tapered Roller Bearings



Bearings typically used:  
● Cylindrical Roller Bearings  
● Tapered Roller Bearings  
● Spherical Roller Bearings



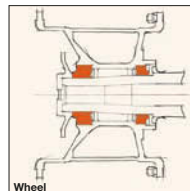
Bearings typically used:  
● Tapered Roller Bearings



Bearings typically used:  
● Cylindrical Roller Bearings  
● Tapered Roller Bearings

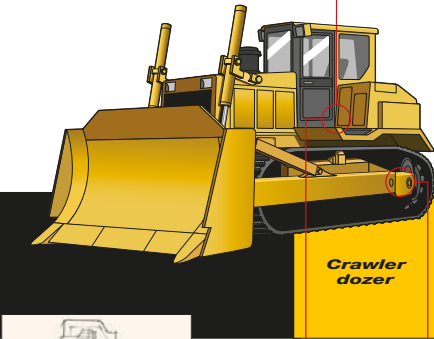
Differential

Off-highway truck

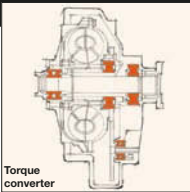


Bearings typically used:  
● Tapered Roller Bearings

Wheel

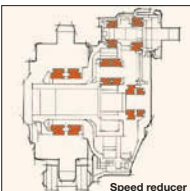


Crawler dozer



Torque converter

Bearings typically used:  
● Cylindrical Roller Bearings  
● Deep Groove Ball Bearings  
● Angular Contact Ball Bearings



Speed reducer

Bearings typically used:  
● Tapered Roller Bearings



● Hi-TF Bearings



● TM Series Sealed Deep Groove Ball Bearings



● Long-Life Pinion Shafts with Cage and Rollers

## ■ Bearings for Construction Machinery

### NSKHPS™ Spherical Roller Bearings

#### Features Compared to the conventional bearing :

Compared with conventional bearings ...

Bearing Life  
Maximum  
**2  
times**

working temp.  
up to  
**200 °C**

1. Improved reliability  
Bearing life is up to twice that of conventional bearings thanks to optimization of the bearing's internal design and improvement of processing technology.

2. High-temperature dimensional stabilizing treatment as standard  
NSK's proprietary heat treatment technology enables high temperature dimensional stabilization up to 200 °C.



### NSKHPS™ Cylindrical Roller Bearings

#### Features Compared to the conventional bearing :

Compared with conventional bearings ...

Bearing Life  
Maximum  
**60%  
higher**

New Product  
Line-up  
**Wide range  
line-up**

1. Improved reliability  
Bearing life is up to 60% longer compared to conventional bearings thanks to an optimized internal design and improvement of processing technology.

2. Wide product lineup  
NSK offers a wide lineup of NSKHPS bearings with four types of cages and a range of sizes for a high degree of versatility across general-purpose applications.

- Pressed-steel cage with high cost performance
- Highly reliable machined-brass cage
- Polyamide-resin cage with excellent heat resistance and chemical resistance.

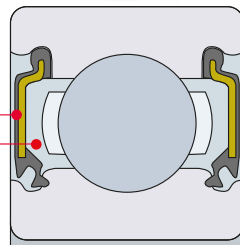
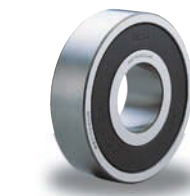


### TM Series Sealed Deep Groove Ball Bearings

The TM Series delivers longer operating life under contaminated environments by incorporating a special seal that prevents the entry of foreign particles and is especially effective in agricultural machinery and automobile transmission systems.

#### Features

- Seal lip structure prevents entry of foreign matter while allowing entry of oil.
- Lower torque than conventional contact seal bearings.
- Sealed-in grease with a high affinity for gear oil aids initial lubrication.



Bearing Series

TM302-TM314 / TM203-TM214

Major dimensions are identical to Series 62 and Series 63 deep groove ball bearings.

## HR Series Tapered Roller Bearings

HR Series high-load capacity, standard-sized tapered roller bearings offer boosted performance in diverse applications.

### Features

Optimized cage design allows increased size and number of rollers

Higher load-carrying capacity and longer operating life



## Long-Life Pinion Shafts With Cage and Rollers

These bearings have improved durability and reliability to achieve long service life under harsh operating conditions, such as extended continuous operation, by utilizing a pinion shaft with a cage and rollers as a single assembly.

### Features

Bearing Life  
Over  
**2x  
Longer**

#### Pinion shaft

- The raceway is polished to a mirror-smooth finish to ensure a sufficiently thick oil film.
- A special heat treatment is applied to the pinion shaft as a measure against contaminated-lubricant conditions.

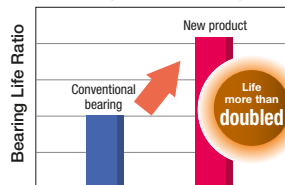
#### Cage and rollers

- The roller surface is polished to a mirror-smooth finish to ensure a sufficiently thick oil film.
- A special heat treatment is applied to the rollers as a measure against contaminated-lubricant conditions.



Corresponding size:  
Inscribed circle diameter up to 32 mm

Life Test Results for Conventional and Newly Developed Bearings



## Hi-TF Bearings

Bearings manufactured with NSK's Hi-TF material have been specifically designed for outstanding toughness under harsh operating conditions, surpassing even NSK's earlier TF bearings. Hi-TF bearings incorporate this new material and a new heat-treatment technology to provide long service life under contaminated lubrication conditions with superior resistance to wear, seizure, and heat. Hi-TF bearings meet the rigorous requirements of bearings now and into the future.

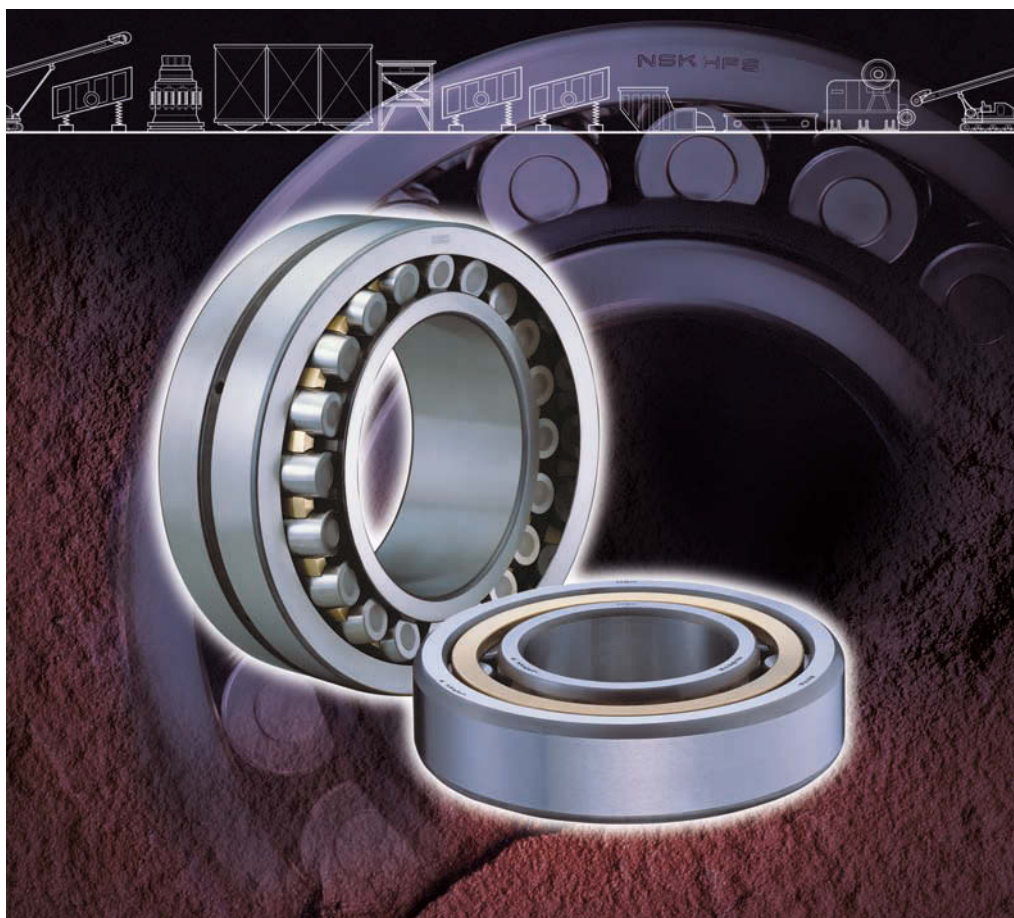
### Features

Longer bearing life even under harsh conditions with excellent resistance to wear, seizure, and heat



# Bearings for Mining Machinery

Tough bearings that offer longer service life under demanding mining conditions thanks to NSK's wealth of outstanding technologies.



## Bearing Tables

**CA-VS3 and CA-VS4 Series Super Long-Life Spherical Roller Bearings for Vibrating Equipment** ..... D 046

**EMM-VS Series Cylindrical Roller Bearings for Vibrating Equipment** ..... D 047

## ■ Bearings for Mining Machinery



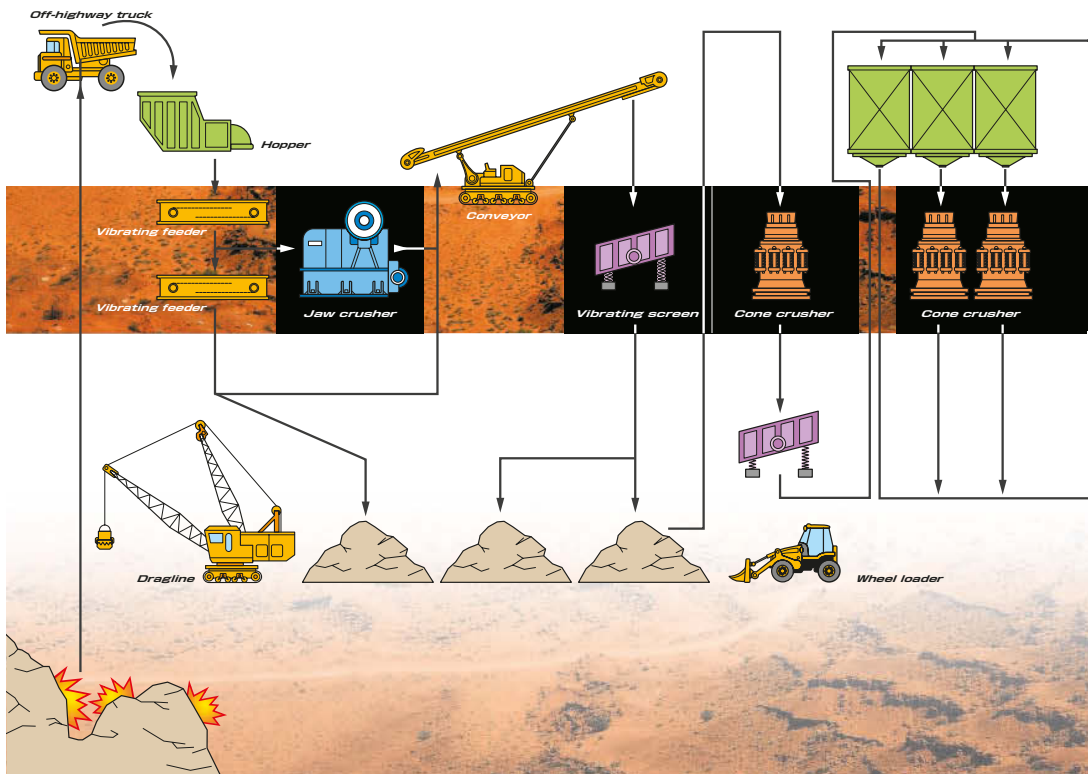
**Jaw Crusher**

Work material is crushed between two opposing jaw plates. One plate opens and shuts, crushing raw material against the stationary jaw plate.



**Cone Crusher**

Material is fed into the crusher cavity and processed by the eccentric rotating action of the inner cone against the outer cone. Work can be reduced to a diameter ranging from 50 mm to 100 mm.



**NSKHPS™ Spherical Roller Bearings**



**NSKHPS™ Cylindrical Roller Bearings**



**CA-VS3 and CA-VS4 Series Super-Long-Life Spherical Roller Bearings for Vibrating Equipment**



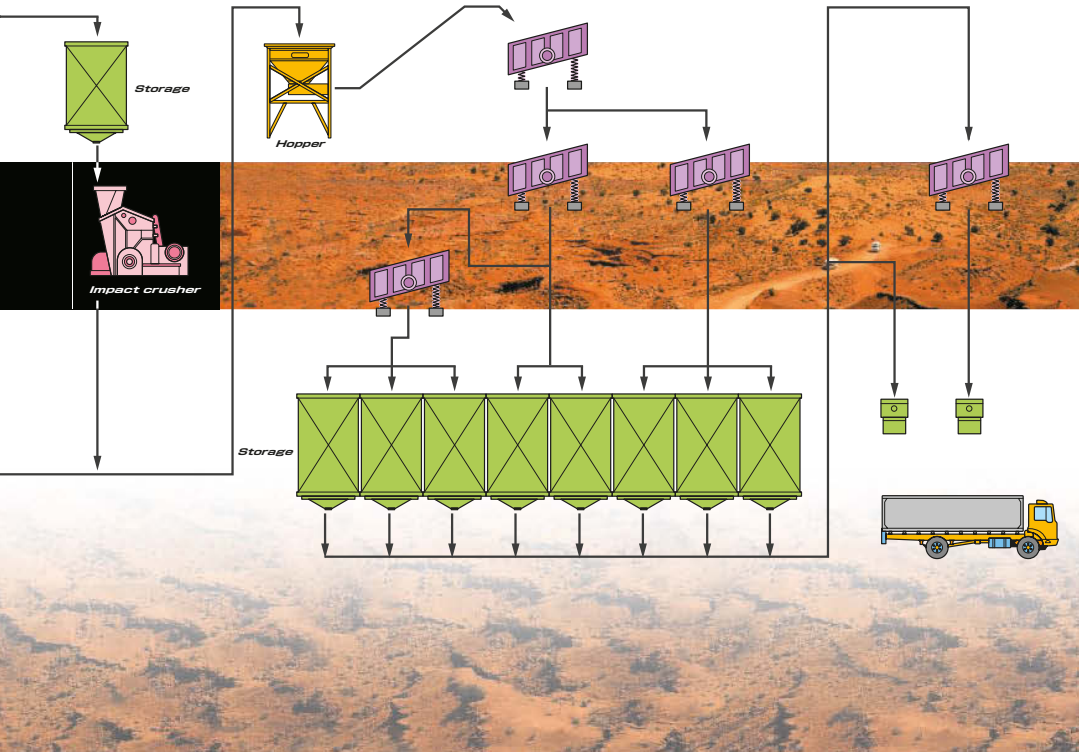
### Vibrating Screen

A vibrating screen consists of a case with a shaft and housing installed inside and springs supporting the case. Swing and rotation of the shaft is produced by the attached unbalanced weight, which generates vibration. This vibration sifts the material set on the screen on top of the case.



### Impact Crusher

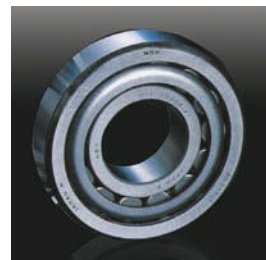
As indicated by its name, this machine crushes ore through impact. It steadily reduces the size of the crushed particles through sharp, repeated impacts with a rapidly spinning hammer, steel plate, or stick.



**EMM-VS Series Cylindrical  
Roller Bearings for Vibrating  
Equipment**



**Plummer Block**



**Hi-TF Bearings**

## ■ Bearings for Mining Machinery

### NSKHPS™ Spherical Roller Bearings

#### Features Compared to conventional bearings:

Compared with conventional bearings ...

Bearing life  
Maximum  
**2**  
times

working temp.  
up to  
**200 °C**

1. Improved reliability  
Bearing life has increased by a maximum of 2 times compared with that of conventional bearings by the optimization of the bearing's internal design and improvement of processing technology.

2. High-temperature dimensional stabilizing treatment as standard

NSK's proprietary heat treatment technology enables hightemperature dimensional stabilization up to 200 °C.



### NSKHPS™ Cylindrical Roller Bearings

#### Features Compared to conventional bearings:

Compared with conventional bearings ...

Bearing Life  
**60%**  
higher  
(maximum)

New Product  
Line-up  
**Wide range**  
line-up

1. Improved reliability  
Bearing life is up to 60% longer compared to conventional bearings thanks to optimization of the bearing's internal design and improvement of processing technology.

2. Wide product lineup  
NSK offers NSKHPS bearings with four types of cages featuring a range of sizes for a high degree of versatility across general-purpose applications:

- Pressed-steel cage with high cost-performance
- Highly reliable machined-brass cage
- Polyamide-resin cage with excellent heat and chemical resistance

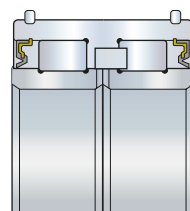


### Full Complement Cylindrical Roller Bearings for Crane Sheaves

These cylindrical roller bearings incorporate seals to prevent the entry of foreign matter.

#### Features

- Improved seals: Contact seals increase resistance to entry of foreign matter or water.
- High load capacity: Larger radial load and axial load capacity compared to conventional sheave bearings.
- Corrosion resistance: Phosphate surface treatment improves resistance to rust.
- Easier grease replenishment: Sealed bearing includes inner ring holes to facilitate grease replenishment.
- Fewer mounted components: With snap rings for the outer ring, fewer components are required around the bearing, making for a more cost-effective sheave.



## CA-VS Series Spherical Roller Bearings

Standard-sized CA Series bearings feature a machined brass cage and tough, wear-resistant capabilities ideal for heavy or shock load applications. NSK offers U15 and VS units specifically for vibrating screens, feeders, and other vibrating applications.

### Features

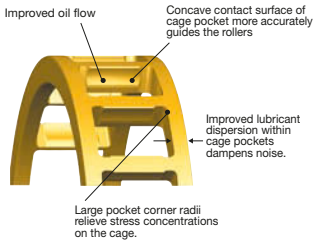
- Highly resistant to heavy or shock loads.
- Excellent self-aligning ability.
- Long service life for vibrating applications.
- Preventive measures against shaft deflection.

Easy installation



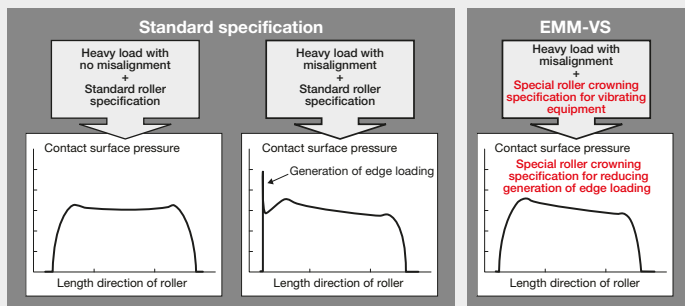
## EMM-VS Series Cylindrical Roller Bearings for Vibrating Equipment

### EMM Series: Outer Ring Guided Machined-Brass Cage



- Machined-brass cage (High strength, wear-resistant cage)
- Outer ring guided one-piece cage

### ■ Analysis of roller surface pressure

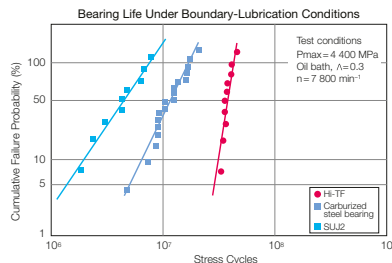
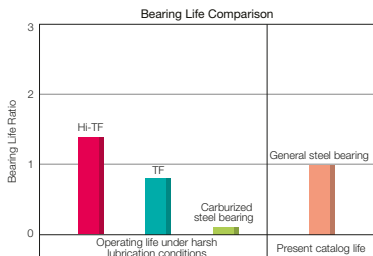


## Hi-TF Bearings

Bearings manufactured from NSK's Hi-TF material have been specifically designed for outstanding toughness under harsh operating conditions, surpassing even NSK's earlier TF bearings. Hi-TF bearings incorporate this new material and a new heat-treatment technology to provide long service life under contaminated lubrication conditions with superior resistance to wear, seizure, and heat. Hi-TF bearings meet the rigorous requirements of bearings now and into the future.

### Features

Achieves longer bearing life even under harsh conditions with excellent resistance to wear, seizure, and heat



## Plummer Blocks

Plummer block housings can be used with high-capacity spherical roller bearings or self-aligning ball bearings. They are manufactured from high-strength cast iron as standard but are also available in cast steel or spheroidal graphite cast iron.



## ■ Bearings for Mining Machinery

### CA-VS3 and CA-VS4 Series Super Long-Life Spherical Roller Bearings for Vibrating Equipment

Example: **223** **20** **CAM** **E4** **-VS3**

Bearing Series  
(Bearing type+width series+diameter series)

Bearing bore (Bore number)

Cage type

CAM: High load capacity machined-brass cage

- Bearings for vibrating equipment
- Special accuracy for vibrating equipment
- Special internal clearance for vibrating equipment

Outer ring with oil groove and oil hole (external features designation)

### Dimensional Tolerance and Radial Internal Clearance

NSK's VS3 and VS4 specifications stabilize load distribution by controlling the internal clearance and dimensional tolerance of the bearing.

■ The VS3 and VS4 Series meet U15 specifications (special tolerance for vibrating equipment) for CAVS Series self-aligning spherical roller bearings; however, to simplify the suffix and clarify the difference between the new and conventional Series, suffix U15 is omitted.

■ The numbers in VS3 and VS4 (3 and 4) refer to bearing internal clearance "C3U15" and "C4U15."

- The dimensional tolerance of a bearing is set at 1/2 relative to the outer diameter tolerance and internal diameter tolerance.
- The radial internal clearance is set at 2/3 relative to the standard.

Bearing Designation	Basic Load Ratings (kN)		Boundary Dimensions (mm)					Radial Clearance (Cylindrical Bore)	
	$C_r$	$C_{0r}$	$d$ (mm)	Boundary Diameter Tolerance ( $\mu$ m)	$D$ (mm)	Boundary Diameter Tolerance ( $\mu$ m)	$B$ (mm)	VS3( $\mu$ m)	VS4( $\mu$ m)
22308CAME4-VS ( )	152 000	129 000	40	0 -7	90	-5 -13	33	50 to 60	65 to 80
22309CAME4-VS ( )	185 000	167 000	45		100		36	60 to 75	85 to 100
22310CAME4-VS ( )	232 000	211 000	50	0 -9	110		40	75 to 90	100 to 120
22311CAME4-VS ( )	261 000	241 000	55		120		43		
22312CAME4-VS ( )	305 000	288 000	60		130	46	-5 -18	90 to 110	120 to 145
22313CAME4-VS ( )	330 000	315 000	65		140	48			
22314CAME4-VS ( )	380 000	370 000	70	150	51				
22315CAME4-VS ( )	425 000	415 000	75	160	55				
22316CAME4-VS ( )	485 000	480 000	80	0 -12	170	-5 -18	58	110 to 135	150 to 180
22317CAME4-VS ( )	520 000	510 000	85		180	60			
22318CAME4-VS ( )	605 000	595 000	90		190	64			
22319CAME4-VS ( )	655 000	675 000	95		200	67			
22320CAME4-VS ( )	750 000	785 000	100	0 -15	215	-10 -23	73	135 to 160	180 to 210
22322CAME4-VS ( )	925 000	980 000	110		240		80		
22324CAME4-VS ( )	1 060 000	1 120 000	120		260		86		
22326CAME4-VS ( )	1 240 000	1 350 000	130		280		93		
22328CAME4-VS ( )	1 450 000	1 590 000	140	0 -18	300	-13 -28	102	160 to 190	205 to 240
22330CAME4-VS ( )	1 530 000	1 690 000	150		320		108		
22332CAME4-VS ( )	1 700 000	1 900 000	160		340		114		
22334CAME4-VS ( )	1 970 000	2 110 000	170		360		120		
22336CAME4-VS ( )	2 170 000	2 340 000	180	380	126		200 to 240	260 to 310	
22338CAME4-VS ( )	2 370 000	2 590 000	190	400	132				220 to 260

**Remark** VS ( ): Replace the parentheses with the appropriate number (3 or 4) when ordering.

## EMM-VS Series Cylindrical Roller Bearings for Vibrating Equipment

Example:

**NU 23 08 EMM C3 (4) -VS**

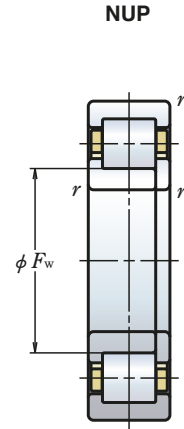
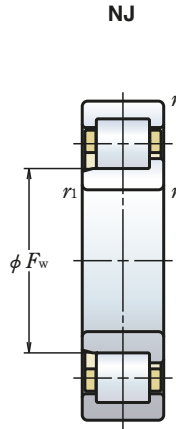
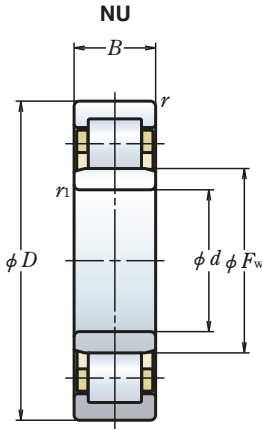
Bearing Type (NU,NJ,NUP)

Bearing Series

Bore Number

EMM-VS : Bearings for Vibrating Equipment

Internal Radial Clearance



Bearing Designations		Boundary Dimensions (mm)						Basic Load Ratings (N)	
		$d$	$D$	$B$	$r_{\min.}$	$r_{1\min.}$	$F_w$	$C_r$	$C_{0r}$
NU2308EMMC3-VS	NU2308EMMC4-VS	40	90	33	1.5	1.5	52	114 000	122 000
NU2309EMMC3-VS	NU2309EMMC4-VS	45	100	36	1.5	1.5	58.5	137 000	153 000
NU2310EMMC3-VS	NU2310EMMC4-VS	50	110	40	2	2	65	163 000	187 000
NU2311EMMC3-VS	NU2311EMMC4-VS	55	120	43	2	2	70.5	201 000	233 000
NU2312EMMC3-VS	NU2312EMMC4-VS	60	130	46	2	2	77	222 000	262 000
NU2313EMMC3-VS	NU2313EMMC4-VS	65	140	48	2.1	2.1	82.5	233 000	265 000
NU2314EMMC3-VS	NU2314EMMC4-VS	70	150	51	2.1	2.1	89	274 000	325 000
NU2315EMMC3-VS	NU2315EMMC4-VS	75	160	55	2.1	2.1	95	330 000	395 000
NU2316EMMC3-VS	NU2316EMMC4-VS	80	170	58	2.1	2.1	101	355 000	430 000
NU2317EMMC3-VS	NU2317EMMC4-VS	85	180	60	3	3	108	395 000	485 000
NU2318EMMC3-VS	NU2318EMMC4-VS	90	190	64	3	3	113.5	435 000	535 000
NU2319EMMC3-VS	NU2319EMMC4-VS	95	200	67	3	3	121.5	460 000	585 000
NU2320EMMC3-VS	NU2320EMMC4-VS	100	215	73	3	3	127.5	570 000	715 000
NU2322EMMC3-VS	NU2322EMMC4-VS	110	240	80	3	3	143	675 000	880 000
NU2324EMMC3-VS	NU2324EMMC4-VS	120	260	86	3	3	154	795 000	1 030 000

# Bearings for Railway Rolling Stock



## Bearing Tables

**Axle Bearings** ..... D 052

**Gearbox Bearings** ..... D 062

**Traction Motor Bearings** ..... D 064

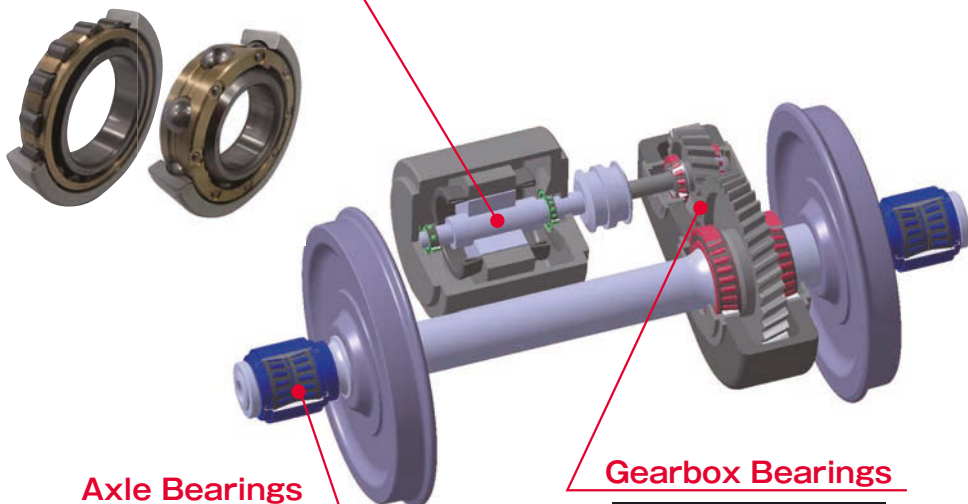
## ■ Bearings for Railway Rolling Stock

High reliability is essential for bearings for railway rolling stock.

There are three bearing types typically used in rolling stock: axle bearings, which carry the heavy weight of the rolling stock on shafts; traction motor bearings, which support the main shaft of the propulsion motor; and gearbox bearings, which transmit drive power from the traction motor to the axle shaft.

NSK supplies specifically designed bearings for each application.

### Traction Motor Bearings



### Axle Bearings



### Gearbox Bearings



Air Turbine  
Dental  
Handpieces

Pumps &  
Compressors

Agricultural  
Machinery

Construction  
Machinery

Mining  
Machinery

**Railway  
Rolling Stock**

Papermaking  
Machines

Wind Power  
Industry

Steel Industry

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## Axle Bearings

- NSK has developed various high-speed, lightweight, and low-maintenance axle bearings:
  - Sealed-Clean rotating end cap tapered roller bearings with grease lubrication
  - Sealed-Clean rotating end cap cylindrical roller bearings with grease lubrication
  - Open cylindrical roller bearings with oil bath or grease lubrication
  - Open tapered roller bearings with oil bath lubrication
- Axle bearings with sensors for higher reliability are also available.
- NSK is certified by the Association of American Railways (AAR). Please consult NSK for details.



## Gearbox Bearings

- NSK bearings have higher seizure resistance under high-speed rotation due to special designs.
- A high-toughness cage may be used in necessary applications.

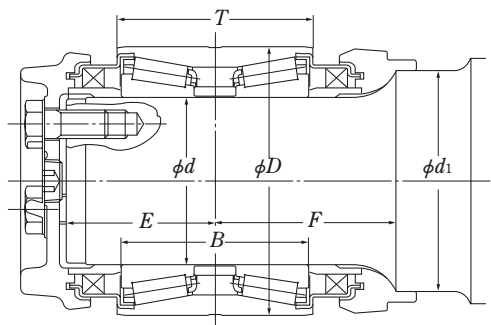


## Traction Motor Bearings

- Designed for high-speed, inverter-controlled traction motors thanks to a dimension-stabilizing treatment. Long-life grease is recommended.
- NSK offers two solutions to prevent electric current penetration (electrolytic corrosion):
  - Ceramic-insulated bearings
  - PPS-molded bearings
- High-capacity bearings are used in large traction motors in electric locomotives.

## ■ Axle Bearings

### Sealed-Clean Rotating End Cap Tapered Roller Bearings



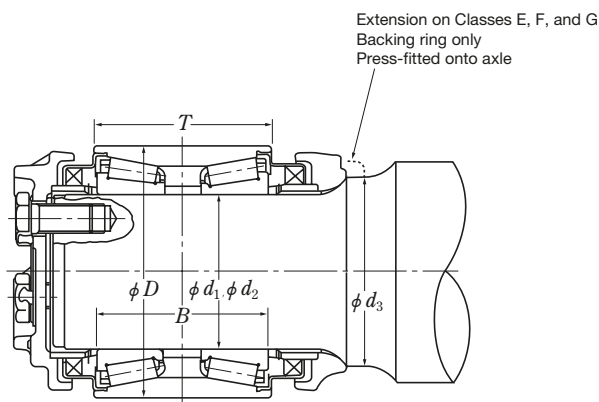
Bearing Designation	Dimensions (mm)				
	$d$	$D$	$T$	$B$	$d_1$
<b>J-908</b>	90	154	90	80	110
<b>J-318</b>	110	175	130	125	155
<b>J-910</b>	110	188	150	145	150
<b>J-901</b>	110	190	150	145	150
<b>J-905</b>	110	195	150	145	150
<b>J-909</b>	110	205	140	130	150
<b>J-902</b>	110	220	145	144	155
<b>J-900</b>	115	210	150	145	144
<b>J-319</b>	120	195	142	136	155
<b>J-904</b>	120	220	145	145	155
<b>J-355</b>	120	220	155	155	150
<b>J-907A</b>	120	220	155	150	149
<b>J-320</b>	130	208	152	146	165
<b>J-913</b>	130	220	155	155	160
<b>J-920</b>	130	220	155	155	171
<b>J-934</b>	130	230	160	150	149
<b>J-937</b>	130	230	160	150	160
<b>J-936B</b>	130	240	165	160	160
<b>J-943</b>	130	240	160	160	160
<b>J-921C</b>	150	250	185	179.5	185
<b>J-942</b>	185	280	160	155	225

<i>E</i>	<i>F</i>	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
55	80	297 000	480 000
105	135	470 000	940 000
100	120	605 000	1 110 000
100	120	605 000	1 110 000
100	120	650 000	1 180 000
85	105	745 000	1 270 000
112	110	690 000	1 090 000
98	117	710 000	1 250 000
113	135	645 000	1 290 000
120	117	750 000	1 250 000
125	100	845 000	1 530 000
146.5	117	780 000	1 310 000
115	139	660 000	1 350 000
168	100	765 000	1 410 000
115	140.7	820 000	1 550 000
146.5	117	915 000	1 670 000
149	117	915 000	1 670 000
203.5	117	1 040 000	1 800 000
90	101	1 040 000	1 800 000
122	133	915 000	1 700 000
—	115.5	915 000	1 900 000

# ■ Axle Bearings

## Sealed-Clean Rotating End Cap Tapered Roller Bearings

AAR No.22

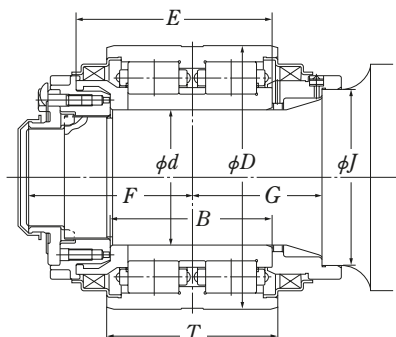


Class	Journal Size	Unit Number	Bearing Designations		$d_1$ (bearing) max.-min.	$d_2$ (axle) max.-min.
B	4 1/4 X 8	J-371	HM120848R	HM120817XDR	101.625-101.600 4.001-4.000	101.702-101.676 4.0040-4.0030
C	5 X 9	J-372	HM124646R	HM124618XDR	119.087-119.062 4.6885-4.6875	119.164-119.139 4.6915-4.6905
D	5 1/2 X 10	J-373	HM127446R	HM127415XDR	131.775-131.750 5.1880-5.1870	131.864-131.839 5.1915-5.1905
E	6 X 11	J-374	HM129848R	HM129814XDR	144.475-144.450 5.6880-5.6870	144.564-144.539 5.6915-5.6905
F	6 1/2 X12	J-375	HM133444R	HM133416XDR	157.175-157.150 6.1880-6.1870	157.264-157.239 6.1915-6.1905
G	7 X 12	J-376	HM136948R	HM136916XDR	177.812-177.787 7.0005-6.9995	177.902-177.876 7.0040-7.0030

Dimensions mm (upper line) / inches (lower line)				Basic Dynamic Load Rating N (lbf)	Basic Static Load Rating N (lbf)
<i>D</i>	<i>T</i>	<i>B</i>	<i>d</i> <sub>3</sub>		
165.100 6 1/2	114.300 4 1/2	106.362 4 3/16	127.000 5	415 000 (93 000)	775 000 (174 000)
195.262 7 11/16	142.875 5 5/8	136.525 5 3/8	149.225 5 7/8	585 000 (132 000)	1 140 000 (255 000)
207.962 8 3/16	152.600 6	146.050 5 3/4	161.925 6 3/8	635 000 (143 000)	1 250 000 (282 000)
220.662 8 11/16	163.512 6 7/16	155.575 6 1/8	178.613-178.562 7.032-7.030	665 000 (149 000)	1 350 000 (305 000)
252.412 9 15/16	184.150 7 1/4	177.800 7	191.313-191.262 7.532-7.530	905 000 (204 000)	1 840 000 (415 000)
276.225 10 7/8	185.725 7.312	180.075 7 1/8	203.251-203.200 8.002-8.000	1 010 000 (227 000)	2 170 000 (485 000)

## ■ Axle Bearings

### Sealed-Clean Rotating End Cap Cylindrical Roller Bearings



Bearing Designation	Dimensions (mm)								Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>	<i>J</i>	<i>E</i>	<i>F</i>	<i>G</i>		
<b>J-580A</b>	100	195	150	175	130	—	120	105	670 000	1 040 000
<b>J-447B</b>	110	220	160	154	170	—	135	140	875 000	1 370 000
<b>J-577</b>	110	220	170	182	140	210	128	112	875 000	1 370 000
<b>J-504</b>	120	195	140	134	155	176	135	132	545 000	915 000
<b>120JRF11</b>	120	215	146	146	—	—	—	—	830 000	1 350 000
<b>J-809</b>	120	220	145	145	155	171	145	117	700 000	1 120 000
<b>J-805</b>	120	220	155	157	150	190	113	100	765 000	1 250 000
<b>J-806</b>	120	220	160	172	160	200	128	112	765 000	1 250 000
<b>J-810A</b>	120	220	160	185.5	145	—	128	104	765 000	1 250 000
<b>J-811</b>	120	220	160	204	150	242	128	112	815 000	1 320 000
<b>J-817</b>	120	220	175	175	144	197	118	113	850 000	1 430 000
<b>J-605</b>	120	220	175	182	140	210	128	112	850 000	1 430 000
<b>J-803</b>	120	220	175	182	150	210	128	112	850 000	1 430 000
<b>J-594</b>	120	230	150	142	155	171	145	113	830 000	1 290 000
<b>J-574</b>	120	240	160	162	168	193	158	113	935 000	1 420 000
<b>J-574A</b>	120	240	160	162	168	196	120	125	935 000	1 420 000
<b>J-480B</b>	120	240	160	164	150	197	128	112	935 000	1 450 000
<b>J-556B</b>	120	240	170	180	168	218	130	125	1 020 000	1 580 000
<b>J-802</b>	120	240	170	182	150	205	128	112	1 020 000	1 580 000
<b>J130-20DR</b>	130	220	124	124	—	—	—	—	805 000	1 320 000
<b>J-814</b>	130	230	160	185.5	155	—	128	104	800 000	1 340 000
<b>J-816</b>	130	240	160	160	160	188	100	112	825 000	1 310 000
<b>J-807</b>	130	240	160	160	160	188	118	112	825 000	1 310 000
<b>J-801</b>	130	240	160	160	165	188	116	105	825 000	1 310 000
<b>J-589</b>	130	240	160	160	170	188	131	116	825 000	1 310 000
<b>J-567</b>	130	250	170	170	165	208	95	135	1 030 000	1 610 000
<b>J-578</b>	130	260	175	182	160	212.5	128	112	1 030 000	1 610 000
<b>J-555</b>	130	260	180	182	160	215	128	112	1 030 000	1 610 000
<b>160JRT02</b>	160	280	159	180	—	—	—	—	1 060 000	1 730 000

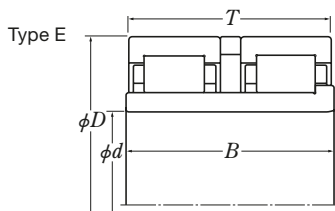
Air Turbine  
Dental  
HandpiecesPumps &  
CompressorsAgricultural  
MachineryConstruction  
MachineryMining  
MachineryRailway  
Rolling StockPapermaking  
MachinesWind Power  
Industry

Steel Industry

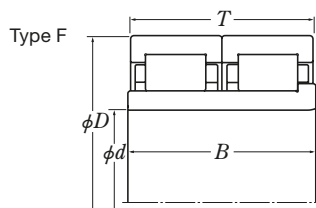
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## ■ Axle Bearings

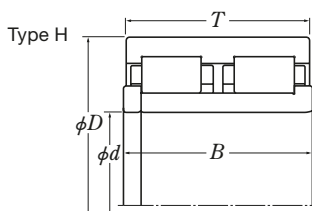
### Open Cylindrical Roller Bearings



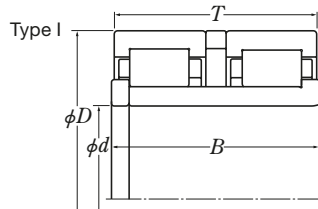
Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>85JRJ02</b>	85	150	120.0	125	365 000	585 000
<b>90JRJ01</b>	90	160	118.5	130	355 000	530 000
<b>110JRJ01</b>	110	200	150.0	160	625 000	995 000
<b>2J110-2</b>	110	220	180.0 (80×2)	190	875 000	1 370 000
<b>120JRJ01</b>	120	220	180.0	183	850 000	1 430 000
<b>2J120-1</b>	120	240	180.0 (80×2)	190	935 000	1 450 000
<b>2J120-3M</b>	120	240	180.0 (80×2)	180	935 000	1 450 000



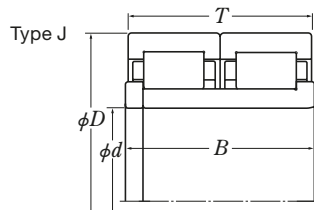
Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>2J110-1</b>	110	225	70×2	150	935 000	1 430 000
<b>120JRJ02A</b>	120	240	160	180	935 000	1 450 000



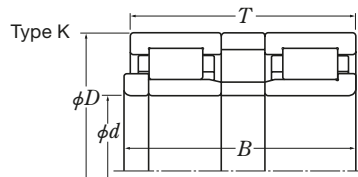
Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>JC14</b>	130	260	160	160	1 140 000	1 840 000



Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>95JRT02</b>	95	170	115	125	440 000	685 000
<b>95JRT01</b>	95	190	125	130	800 000	1 340 000
<b>2O100-1</b>	100	200	170	170	650 000	1 030 000
<b>2O110-1</b>	110	220	180	185	875 000	1 370 000
<b>120JRT04</b>	120	220	160	165	810 000	1 340 000
<b>2O120-11</b>	120	220	180	183	850 000	1 430 000
<b>JC34</b>	120	230	165	170	945 000	1 460 000
<b>120JRT01</b>	120	240	180	185	935 000	1 450 000
<b>2O120-4</b>	120	240	180	185	935 000	1 450 000
<b>JC38A</b>	125	235	165	170	945 000	1 470 000
<b>JC39A</b>	125	236	165	175.5	960 000	1 500 000
<b>130JRT08</b>	130	235	165	170	895 000	1 520 000
<b>2O130-7</b>	130	240	180	185	915 000	1 490 000
<b>130JRT01</b>	130	260	180	185	1 030 000	1 610 000
<b>2O130-6</b>	130	260	180	185	1 030 000	1 610 000
<b>JC37A</b>	130	265	166	166	1 140 000	1 700 000
<b>2O140-1</b>	140	250	155	160	865 000	1 480 000
<b>170JRT01</b>	170	340	230	230	1 660 000	2 760 000



Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>JC27X</b>	120	230	150	177	935 000	1 440 000
<b>JC400K</b>	120	230	150	177	885 000	1 340 000



Bearing Designation	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	<i>d</i>	<i>D</i>	<i>T</i>	<i>B</i>		
<b>J130-5/U130-5DB+KL38</b>	130	240	198 (80×2)	204	880 000	1 450 000



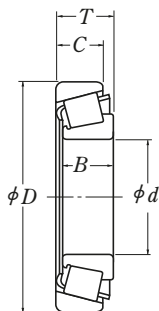
Air Turbine  
Dental  
HandpiecesPumps &  
CompressorsAgricultural  
MachineryConstruction  
MachineryMining  
MachineryRailway  
Rolling StockPapermaking  
MachinesWind Power  
Industry

Steel Industry

INDUSTRY  
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# Gearbox Bearings

## Tapered Roller Bearings



Bearing Designation	Dimensions (mm)					Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Application <sup>(1)</sup>
	d	D	T	B	C			
<b>QT30</b>	60	130	33.5	31	22	127 000	139 000	Gear (P)
<b>30312DQWAP6</b>	60	130	33.5	31	22	127 000	139 000	Gear (P)
<b>30313DQWAP6U1</b>	65	140	36	33	23	147 000	163 000	Gear (P)
<b>QT9</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>QT9A</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>QT9B-2</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>QT9F</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>QT9J</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>R70-25</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>30314DAQWAP6A</b>	70	150	38	35	25	165 000	185 000	Gear (P)
<b>30314QWAP6</b>	70	150	38	35	30	194 000	218 000	Gear (P)
<b>QT31</b>	70	150	40	37	27	172 000	198 000	Gear (P)
<b>QT7A</b>	75	160	40	37	27	189 000	224 000	Gear (P)
<b>30315DXQWAP6</b>	75	160	40	37	26	189 000	224 000	Gear (P)
<b>30315QWAP6</b>	75	160	40	37	31	209 000	233 000	Gear (P)
<b>R80-1</b>	80	170	42.5	39	28	196 000	222 000	Gear (P)
<b>QT4A</b>	80	170	42.5	39	28	208 000	241 000	Gear (P)
<b>30316QWAP6</b>	80	170	42.5	39	33	235 000	265 000	Gear (P)
<b>30317DQWAP6A</b>	85	180	44.5	41	29	233 000	269 000	Gear (P)
<b>30317QWAP6A</b>	85	180	44.5	41	34	262 000	300 000	Gear (P)
<b>QT18</b>	85	180	45.5	42	29	244 000	285 000	Gear (P)
<b>30328QWAP6</b>	140	300	67.75	62	53	600 000	740 000	Gear (G)
<b>QT1<sup>(2)</sup></b>	190	280	49	46	36.5	605 000	1 240 000	Gear (G)
<b>QT29<sup>(3)</sup></b>	193.675	282.575	50.800	47.625	36.512	360 000	600 000	Gear (G)
<b>QT26</b>	195	280	58	60	41	410 000	780 000	Gear (G)
<b>QT25</b>	200	280	51	48	41	410 000	780 000	Gear (G)
<b>32940QSA</b>	200	280	51	48	41	410 000	780 000	Gear (G)
<b>QT13<sup>(2)</sup></b>	200	290	49	46	36.5	625 000	1 330 000	Gear (G)
<b>QT27</b>	200	290	55	60	41	410 000	790 000	Gear (G)
<b>QT34A</b>	202	290	58	60	41	435 000	855 000	Gear (G)
<b>QT33</b>	205	283	51	48	41	415 000	795 000	Gear (G)
<b>QT38</b>	205	310	60	60	47	545 000	1 020 000	Gear (G)
<b>R205-1</b>	205	310	60	60	47	545 000	1 020 000	Gear (G)
<b>R205-4</b>	205	310	60	60	47	545 000	1 020 000	Gear (G)
<b>QT5</b>	210	320	70	66	56	665 000	1 180 000	Gear (G)
<b>QT35</b>	215	315	65	70	49	595 000	1 130 000	Gear (G)
<b>R215-3</b>	215	315	65	70	49	595 000	1 130 000	Gear (G)
<b>QT32</b>	218	315	65	70	49	595 000	1 130 000	Gear (G)
<b>32944QWASA</b>	220	300	51	48	41	425 000	855 000	Gear (G)
<b>32052Q</b>	260	400	87	82	71	1 130 000	2 020 000	Gear (G)

Notes <sup>(1)</sup> Gear (P): Pinion-side bearing of gear unit, Gear (G): Gear-side bearing of gear unit

<sup>(2)</sup> Double-row configuration

<sup>(3)</sup> Sizes have been converted to millimeters from inches.

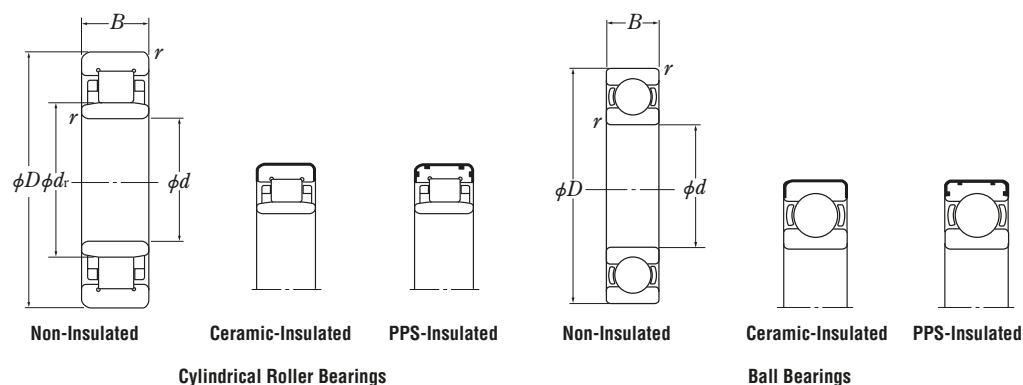
Air Turbine  
Dental  
HandpiecesPumps &  
CompressorsAgricultural  
MachineryConstruction  
MachineryMining  
MachineryRailway  
Rolling StockPapermaking  
MachinesWind Power  
Industry

Steel Industry

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# Traction Motor Bearings

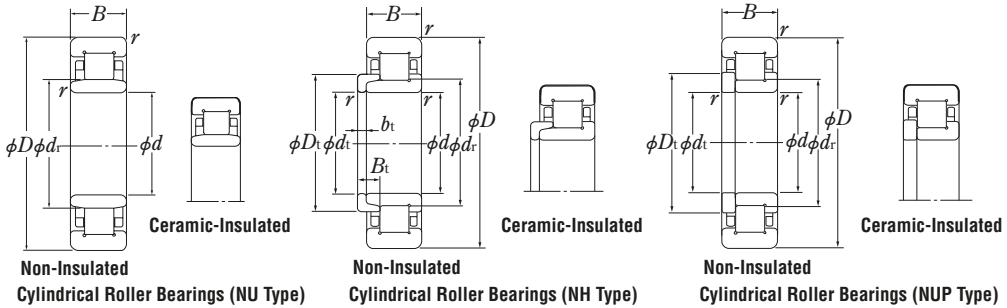
## Bearings for Electric Car Traction Motors



Loaded Side, Cylindrical Roller Bearing	Dimensions (mm)					Non-Loaded Side, Ball Bearing	Dimensions (mm)		
	<i>d</i>	<i>D</i>	<i>B</i>	<i>d<sub>r</sub></i>	<i>r</i> (min.)		<i>d</i>	<i>D</i>	<i>B</i>
<b>NU210E<sup>(1)</sup></b>	50	90	20	59.5	1.1	<b>6016</b>	80	125	22
<b>NU212</b>	60	110	22	73.5	1.5	<b>6310</b>	50	110	27
<b>NU312</b>	60	130	31	77.0	2.1	<b>6310</b>	50	110	27
<b>NU213</b>	65	120	23	79.6	1.5	<b>6310</b>	50	110	27
<b>NU313</b>	65	140	33	83.5	2.1	<b>6311</b>	55	120	29
<b>NU214</b>	70	125	24	84.5	1.5	<b>6310</b>	50	110	27
						<b>6311</b>	55	120	29
<b>NU314</b>	70	150	35	90.0	2.1	<b>6311</b>	55	120	29
<b>NU215</b>	75	130	25	88.5	1.5	<b>6311</b>	55	120	29
						<b>6312</b>	60	130	31
<b>NU315</b>	75	160	37	95.5	2.1	<b>6311</b>	55	120	29
						<b>6312</b>	60	130	31
						<b>6314</b>	70	150	35
<b>NU415</b>	75	190	45	104.5	3.0	<b>6313</b>	65	140	33
<b>NU216</b>	80	140	26	95.3	2.0	<b>6312</b>	60	130	31
<b>NU316</b>	80	170	39	103.0	2.1	<b>6312</b>	60	130	31
<b>NU416</b>	80	200	48	110.0	3.0	<b>6313</b>	65	140	33
<b>NU217</b>	85	150	28	101.8	2.0	<b>6217</b>	85	150	28
<b>NU218</b>	90	160	30	107.0	2.0	<b>6218</b>	90	160	30
<b>NU219</b>	95	170	32	113.5	2.1	<b>6219</b>	95	170	32

Note <sup>(1)</sup> E: High-Capacity

## Bearings for Electric Locomotive Traction Motors



## 2xx Series (Free End-Bearings)

Boundary Dimensions (mm)					Basic Designation	Internal Design <sup>(1)</sup>	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
$d$	$D$	$B$	$d_1$	$r$ (min.)				
120	215	40	143.5	2.1	<b>NU224</b> <b>NU226</b>	E	320 000	395 000
130	230	40	153.5	3.0		E	345 000	425 000

Note <sup>(1)</sup> E: High-capacity type

## 3xx Series (Free End-Bearings)

Boundary Dimensions (mm)					Basic Designation	Internal Design <sup>(1)</sup>	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
$d$	$D$	$B$	$d_1$	$r$ (min.)				
90	190	43	113.5	3	<b>NU318</b> <b>NU320</b> <b>NU322</b> <b>NU324</b> <b>NU326</b>	E	315 000	355 000
100	215	47	127.5	3		E	380 000	425 000
110	240	50	143.0	3		E	425 000	485 000
120	260	55	154.0	3		E	530 000	610 000
130	280	58	165.0	4		B	655 000	795 000
140	300	62	167.0	4	<b>NU328</b>	E	615 000	735 000
			180.0			E	665 000	795 000
			178.0			F	705 000	860 000
			193.0			E	760 000	920 000
150	320	65	193.0	4	<b>NU330</b>	EA	715 000	855 000
			190.5			J	800 000	985 000
			190.0			L	790 000	970 000
			204.0			E	860 000	1 050 000
160	340	68	204.0	4	<b>NU332</b> <b>NU336</b>	E	860 000	1 050 000
180	380	75	231.0	4		E	985 000	1 230 000

Note <sup>(1)</sup> E, EA: High-capacity type B, F, J, L: Special specification

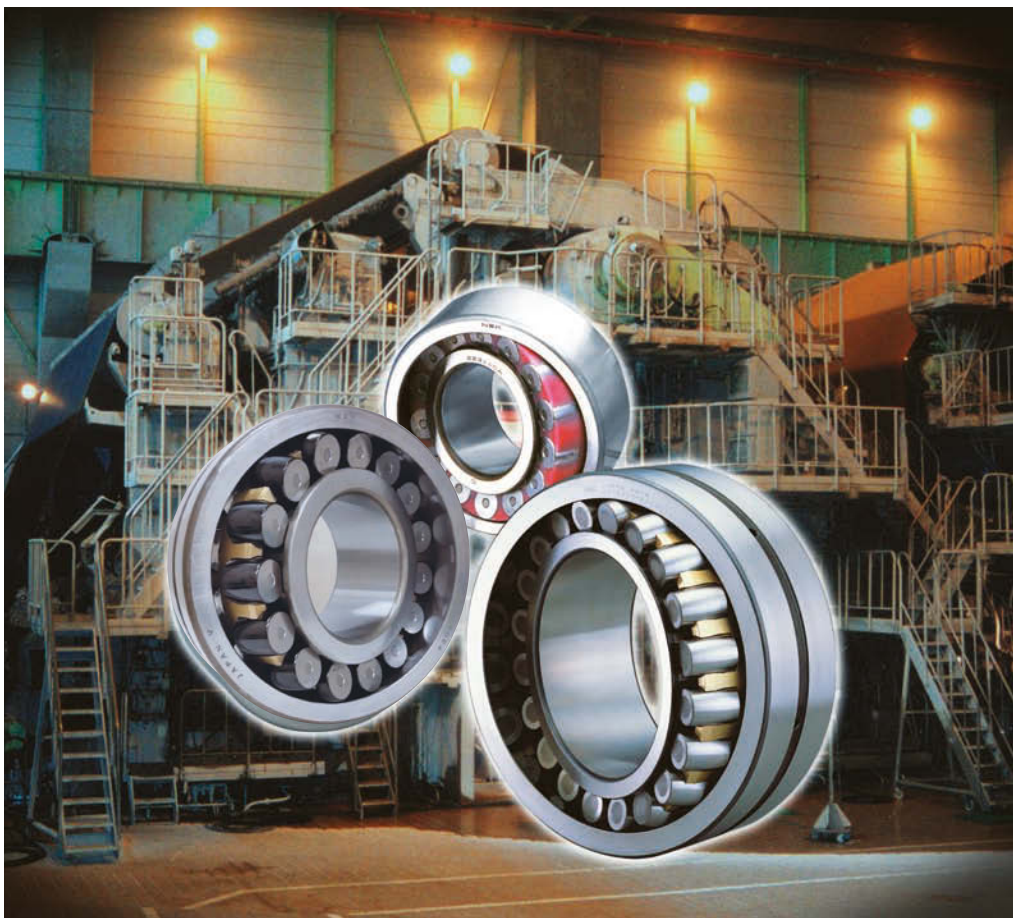
## 3xx Series (NH Type, NUP Type)

Dimensions (mm)								Basic Designation	Internal Design <sup>(1)</sup>	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
$d, d_1$	$D$	$B$	$d_1$	$D_1$	$B_1$	$b_1$	$r$ (min.)				
80	170	39	101.0	111.8	17.0	11.0	2.1	<b>NH316</b> <b>NH318</b>	E	256 000	282 000
90	190	43	115.0	125.0	21.0	12.0	3.0		—	240 000	265 000
90	190	43	113.5	124.2	18.5	—	3.0	<b>NUP318</b>	E	315 000	355 000
			115.0	125.0	—				B	240 000	265 000
			113.5	124.2	—				E	315 000	355 000
100	215	47	129.5	140.5	22.5	13.0	3.0	<b>NH320</b>	A	310 000	355 000
			129.5	140.5	22.5				B	310 000	355 000
			127.5	139.0	20.5				E	380 000	425 000
			143.0	155.0	22.0				E	425 000	485 000
110	240	50	143.0	155.0	22.0	14.0	3.0	<b>NH322</b> <b>NH324</b>	—	475 000	550 000
120	260	55	154.0	168.5	23.5	14.0	3.0		—	560 000	665 000
130	280	58	167.0	182.0	24.0	14.0	4.0	<b>NH326</b> <b>NH328</b>	E	615 000	735 000
			181.0	196.0	26.0	15.0	4.0		—	615 000	745 000

Note <sup>(1)</sup> E: High-capacity type A, B: Special specification

# Bearings for Papermaking Machines

Bearings featuring excellent durability under wet, dusty, and high-temperature environments resulting in longer life, higher limiting speed, and dramatically enhanced productivity.



## The Papermaking Process and Bearing Specifications ..... D 068

### Bearing Tables

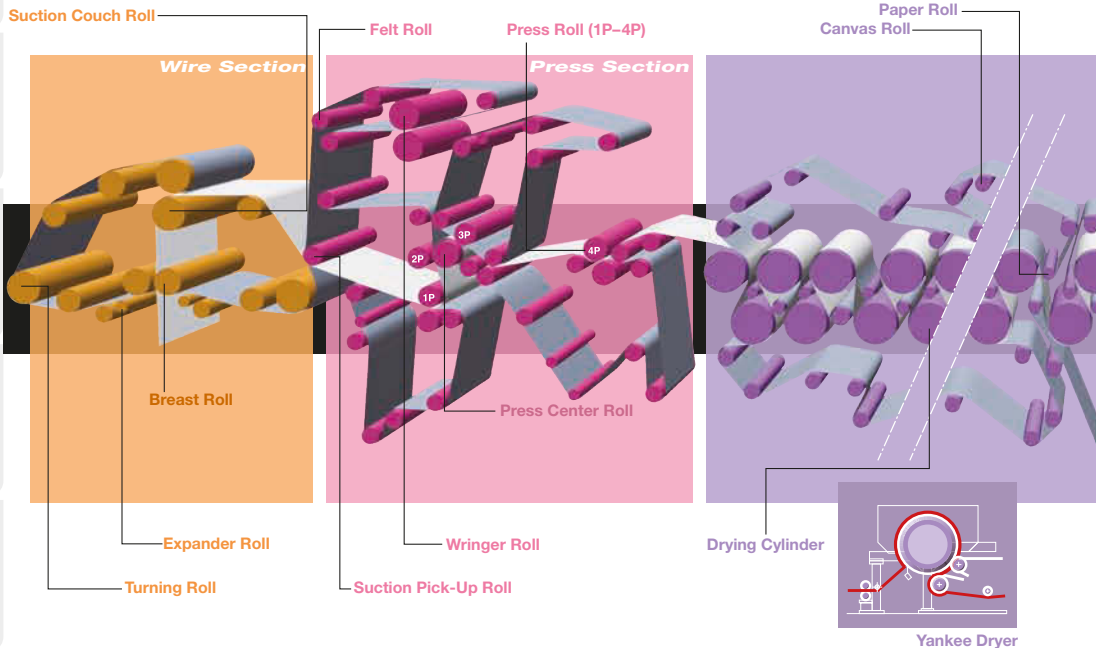
TL Series Spherical Roller Bearings ..... D 076

Molded-Oil™ Bearings ..... D 082

Triple Ring Bearings ..... D 084

# Bearings for Papermaking Machines

## The Papermaking Process and Bearing Specifications



### Molded-Oil™ Bearings

These bearings provide excellent performance without oil leakage in environments with moisture or paper dust.

Molded-Oil uses an optimized molding method and composition that enables high-speed operation, allows for easy handling, and is environmentally friendly.

Major applications: raw material conveyors, carrier rope sheaves, suction rolls



### Triple Ring Bearings

Easy-to-use, uniquely structured bearings that feature no creep, high precision, and long life.

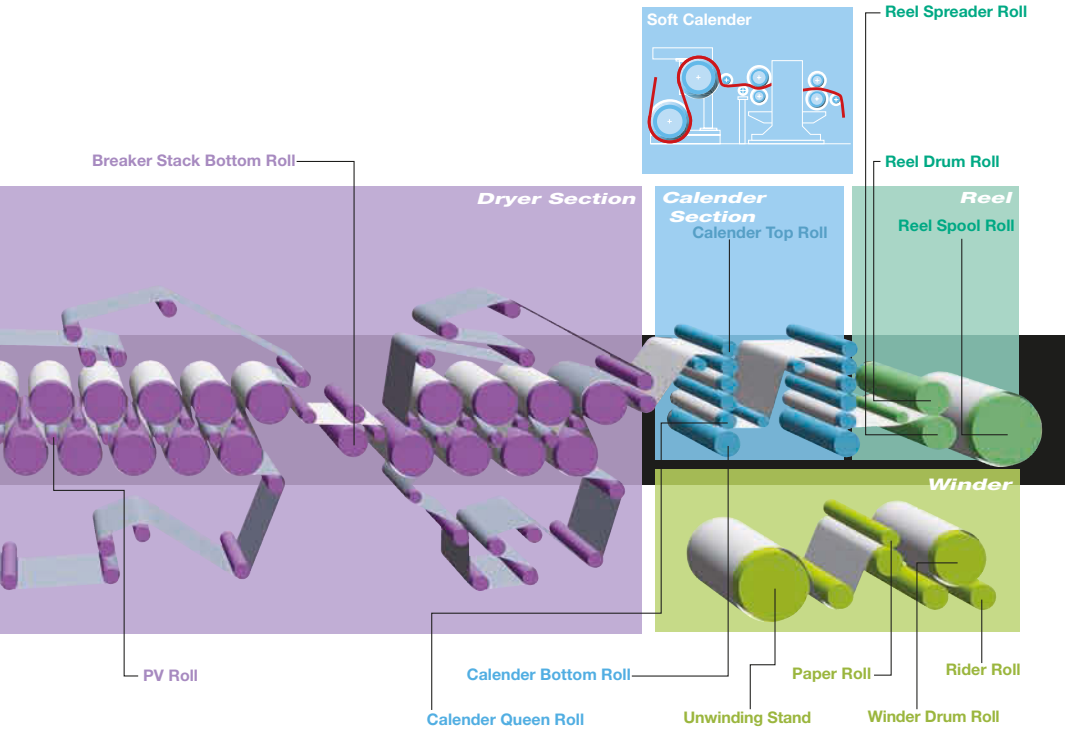
Major applications: press rolls, breaker stack rolls



### Smear-Resistant Spherical Roller Bearings

Bearings with improved anti-smearing performance through a DLC coating on the rolling elements.

Major applications: Inner side bearings for suction rolls, soft calendar rolls



#### CA Series Spherical Roller Bearings

Featuring superior radial load capacity, alignment, and excellent strength, these bearings are equipped with a machined cage and conform to high running accuracy requirements (ISO tolerance Class 5).

Major applications: large diameter rolls such as suction rolls, press rolls, calender rolls and reel drum rolls.



#### TL Series Spherical Roller Bearings

Ideal for high temperature equipment, these tough and long-life bearings resist inner ring fracture, boost productivity, and lower costs.

Major applications: Press Roll, Drying Roll, Canvas Roll, PV Roll, Calender Roll



#### Deep Groove Ball Bearings for High-Speed Expander Rolls

Special bearings that suppress friction torque and surface damage such as smearing.

## ■ Bearings for Papermaking Machines

### High-Performance Standard Bearings for Industrial Machinery

NSKHPS™ bearings redefine the standard.

The new NSKHPS Series fully incorporates the advantages of NSK's world-class design, materials, and manufacturing technologies into new products with greater strength and higher accuracy, setting a new standard for bearings.

#### NSKHPS™ Spherical Roller Bearings

##### Features

Compared with conventional bearings ...

Bearing Life  
**2  
Times  
Longer**  
(Max.)

Working  
Temperature  
up to  
**200 °C**

##### 1. Improved reliability

Bearing life is up to double that of conventional bearings through optimization of the bearing's internal design and improved processing technology.

As a result, NSKHPS bearings reduce maintenance costs and facilitate the downscaling of related equipment.

##### 2. High-temperature dimensional stabilizing treatment as standard

High-temperature dimensional stabilization up to 200 °C is achieved through the application of NSK's proprietary material heat treatment technology.

As a result, NSKHPS bearings can be used in a wide range of applications.

##### 3. Wide lineup

A wide range of bearings are available, including giant and wide-roll sizes.



Designations

Pages C266 to C287

#### NSKHPS™ Cylindrical Roller Bearings

##### Features

Compared with conventional bearings ...

Bearing Life  
**60%  
Longer**  
(maximum)

Wide  
Lineup

##### 1. Improved reliability

Bearing life is up to 60% longer compared to conventional bearings thanks to optimization of the bearing's internal design and improvement of processing technology.

##### 2. Wide product lineup

NSK offers NSKHPS bearings with four types of cages featuring a range of sizes for a high degree of versatility across general-purpose applications:

- Pressed-steel cage with high cost-performance
- Highly reliable machined-brass cage
- Polyamide-resin cage with excellent heat and chemical resistance



Designations

Pages C132 to C147

## TL Series Spherical Roller Bearings

Dryer rolls are generally used under high-temperature conditions that can lead to fracture of the bearing inner ring, which may result in work stoppage. NSK's TL Series bearings offer long life, sufficient strength to resist inner ring fractures, superior dimensional stability under high-temperature conditions, and long life due to superior hardness. These characteristics all contribute to greatly improved productivity.



### <Applications>

Used in all applications excluding drying/calender rolls and large-size bearings for press rolls.

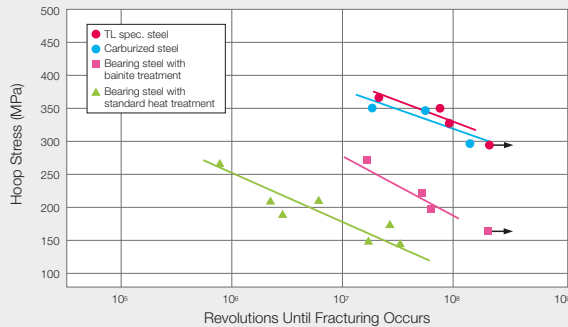
Designations

Pages D076 to D081

### Features

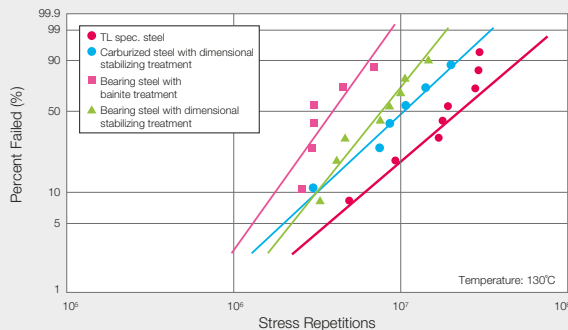
#### Enhanced inner ring strength

Adoption of special steel- and surface-hardening heat treatments developed by NSK dramatically enhance inner ring strength against increasing hoop stress caused by rising shaft temperature.



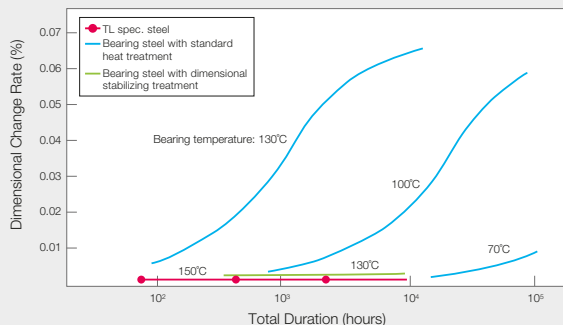
#### Longer life

Increased hardness of the raceway surface provides longer life when foreign debris is present.



#### Dimensional stability under high temperatures

Dimensional stability under high temperatures is standard. (Max. 200 °C)



# Bearings for Papermaking Machines

## Molded-Oil™ Bearings

Molded-Oil™ bearings are lubricated with NSK's own special oil-containing material. Molded-Oil consists of lubricating oil and a polyolefin resin with an affinity for oil. Oil slowly seeping from this material provides ample lubrication to the bearing for extended periods.

Designations Pages D082 and D083

CAT. No. E1216

### Features

#### Excellent performance in water- and dust-contaminated environments

Molded-Oil bearings are designed to prevent the entry of dust and liquids such as water, which can wash out the oil. Sealed types can be used in contaminated environments.

\*Water and dust dramatically accelerate bearing damage. In order to realize stable operation, we recommend using seals to prevent water and dust from getting in the bearing.

#### Optimal composition and molding methods enable high-speed operation

Optimization of composition and molding improves strength and enables high-speed operation.

#### Low torque

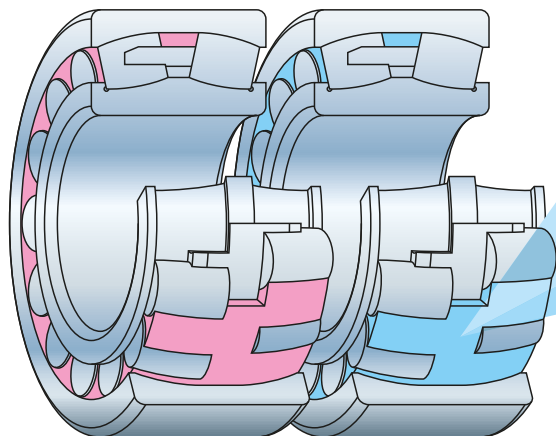
Packing the bearing with Molded-Oil after surface treatment allows for smooth rotation of rolling elements.

#### Environmentally friendly

Bearings are lubricated by small quantities of oil diffused by the Molded-Oil, consequently minimizing oil leakage.

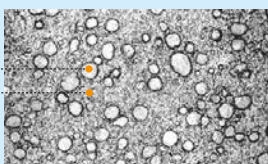
### <Applications>

Material processing equipment (conveyors, agitators), paper mill line equipment (support for wire part rolls), maintenance facilities (carrier rope sheave pulley), and carrier line equipment



For general use

For high-speed operation



Close-up of Molded-Oil™ 100 μm

#### Portion containing mostly lubricating oil

The lubricating oil is mineral oil-based.

#### Portion containing mostly polyolefin

Polyolefin is an environmentally sound material used for packaging food in supermarkets, replacing dioxin-generating vinyl chloride.

Note that this bearing has certain restrictions in regards to ambient operating temperatures and limiting speeds ( $d_m n$ ). Refer to the Molded-Oil bearings catalog (Cat. No. E1216) for details. See Page 3 of the same catalog for relevant handling precautions.

## Smear-Resistant Spherical Roller Bearings

Newly developed smear-resistant spherical roller bearings feature improved durability thanks to NSK's original DLC\* coating on the rolling contact surface of the rollers.



\*DLC: Hard coating mainly consisting of carbon (diamond-like carbon)

The phenomenon of smearing or micro-seizing caused by slippage between the raceway surface of the inner and outer rings and the roller surface may occur in bearings used under light load inside papermaking machinery and in applications with poor lubrication.

A DLC coating drastically improves anti-smearing performance.

Inner bore dimensions ranging from 80 mm to 240 mm

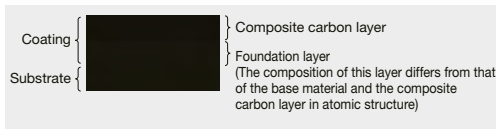
### <Applications>

- Inner side bearings for suction rolls in press section
- Bearings for soft calender rolls in calender section

### Features

NSK independently developed its DLC coating for bearings. Because the elastic modulus of the coating is close to that of the substrate base, the coating can better follow the elastic deformation of the base metal. The adhesion of the coating to the base metal is also improved, making it less likely to be removed even at high surface pressure.

#### Conventional DLC coating



#### NSK DLC coating

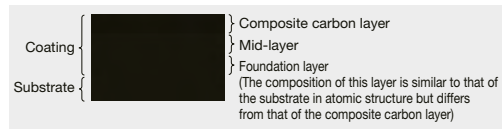


Fig. 1

### Twin-disc test

Two disc test pieces

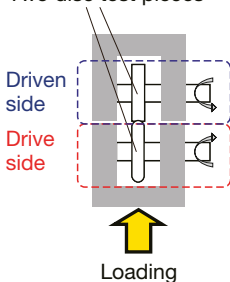
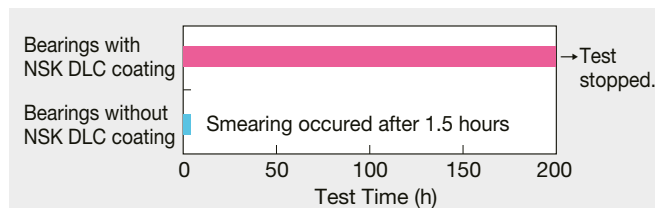


Fig. 2

A rolling-contact test was conducted under boundary lubrication conditions and sliding contact conditions in which the speeds of two disc test pieces were set differently. (Fig. 2)



## ■ Bearings for Papermaking Machines

### Triple Ring Bearings

Combination tapered roller bearings have typically been used for the outside of controlled crown rolls (CCR) and spherical roller bearings for the inside. Switching to high-precision, high load capacity triple ring bearings prevents creep, facilitates easier mounting, and extends operating life.

Designations

Page D084

#### Features

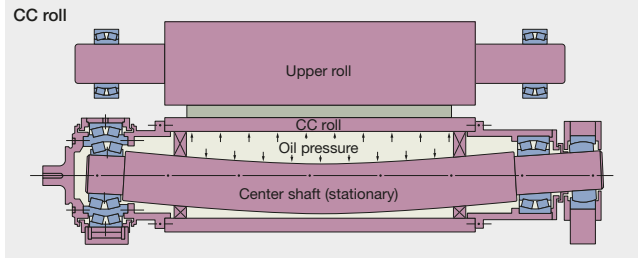
**High-load capacity design**

**Long life**  
(uses vacuum-melted, carburized steel)

**High precision**  
(dimensional and rotational precision)

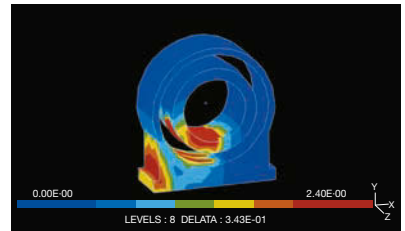
**Optimal inner ring design for lubrication**

**Lubrication hole and groove provided on inner and outer rings**



#### Finite element analysis of housing design for triple ring bearings.

Bearing load distribution is minimized by finite element method (FEM) analysis, thereby contributing to an optimized structural design of the housing for paper machine manufacturers.



Maximum principal stress distribution

### Deep Groove Ball Bearings

Deep groove ball bearings are characterized by high performance and quality. This top-of-the-line design includes special bearings with low friction torque that minimize surface damage such as smearing in high-speed expander rolls, maintenance-free sealed ball bearings with high-performance seals, and silent ball bearings suitable for motors and pumps.



## Bearing Designations

### TL Series Spherical Roller Bearings

#### Bearing Designation

Example : **TL 23152 CA g3 M K E4 C3 S11**

Spherical roller bearings (Bearing type) ,  
Width Series 3 (Bearing Series) ,  
Diameter Series 1 (Bearing Series) ,  
Bearing bore 260 mm (Bore number)

Machined-brass cage (Cage type)

Max. operating temperature: less than 200 °C  
(Special specification)

Radial internal clearance C3 (Internal clearance)

Outer ring with oil groove and oil holes (External features)

Tapered bore (External features)

TL spec. inner ring. (Special spec, material) g5: Inner and outer ring

### Molded-Oil™ Bearings

#### Bearing Designation

Example : **22212 L12 CAM C3**

Spherical roller bearings (Bearing type) ,  
Width Series 2 (Bearing Series) ,  
Diameter Series 3 (Bearing Series) ,  
Bearing bore 90 mm (Bore number)

Radial internal clearance C3  
(Internal clearance)

Machined-brass  
cage (Cage type)

Molded-Oil™ for high-speed, L11 for general use)

### Triple Ring Bearings

#### Bearing Designation

Example : **2SL 180-2 UPA**

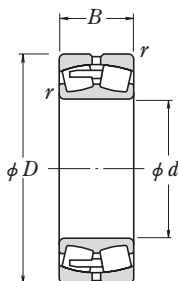
Triple ring bearings  
(Spherical roller bearings)

Bearing bore 180 mm

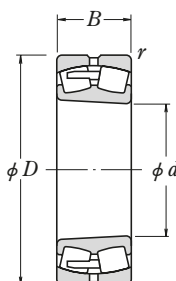
Special accuracy (Tolerance class)

# ■ TL Series Spherical Roller Bearings

Bore Diameter 40 – 160 mm



Cylindrical Bore

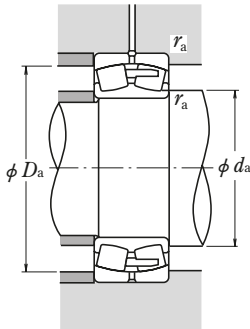


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings				Bearing
$d$	$D$	$B$	$r$ min.	$C_r$ (kN)	$C_{0r}$ (kgf)	$C_r$ (kN)	$C_{0r}$ (kgf)	Cylindrical Bore
<b>40</b>	90	33	1.5	122	129	12 400	13 200	<b>TL22308CAME4</b>
<b>55</b>	120	43	2	209	241	21 300	24 600	<b>TL22311CAME4</b>
<b>60</b>	130	46	2.1	246	288	25 100	29 400	<b>TL22312CAME4</b>
<b>65</b>	140	48	2.1	375	380	38 000	38 500	<b>TL22313EAE4</b>
<b>70</b>	150	51	2.1	425	435	43 500	44 000	<b>TL22314EAE4</b>
<b>75</b>	130	31	2.1	340	415	34 500	42 000	<b>TL22315CAME4</b>
<b>80</b>	170	58	2.1	390	480	39 500	48 500	<b>TL22316CAME4</b>
<b>90</b>	190	64	3	665	705	68 000	72 000	<b>TL22318EAE4</b>
<b>95</b>	200	67	3	525	675	53 500	68 500	<b>TL22319CAME4</b>
<b>100</b>	215	73	3	860	930	88 000	94 500	<b>TL22320EAE4</b>
<b>110</b>	170	45	2	293	465	29 900	47 500	<b>TL23022CDE4</b>
	200	69.8	2.1	515	760	52 500	77 500	<b>TL23222CE4</b>
	240	80	3	1 030	1 120	105 000	115 000	<b>TL22322EAE4</b>
<b>120</b>	260	86	3	1 190	1 320	122 000	134 000	<b>TL22324EAE4</b>
<b>130</b>	280	93	4	995	1 350	101 000	137 000	<b>TL22326CAME4</b>
<b>140</b>	210	53	2	420	715	43 000	73 000	<b>TL23028CDE4</b>
	250	68	3	645	930	65 500	95 000	<b>TL22228CDE4</b>
	250	88	3	835	1 300	85 000	133 000	<b>TL23228CE4</b>
<b>150</b>	225	56	2.1	470	815	48 000	83 000	<b>TL23030CDE4</b>
	225	56	2.1	470	815	48 000	83 000	<b>TL23030CAME4</b>
	250	80	2.1	725	1 180	74 000	121 000	<b>TL23130CAME4</b>
	270	73	3	765	1 120	78 000	114 000	<b>TL22230CDE4</b>
	320	108	4	1 220	1 690	125 000	172 000	<b>TL22330CAME4</b>
<b>160</b>	240	60	2.1	540	955	55 000	97 500	<b>TL23032CDE4</b>
	290	80	3	910	1 320	93 000	135 000	<b>TL22232CDE4</b>
	290	104	3	1 100	1 770	112 000	180 000	<b>TL23232CE4</b>

**Note** (1) Suffix K indicates bearings with tapered bores (taper 1:12).

**Remark** Suffix E4 indicates bearings with an oil groove and holes.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a / F_r \leq e$		$F_a / F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

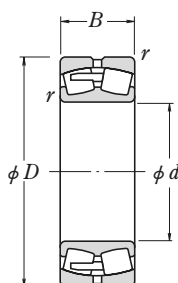
$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

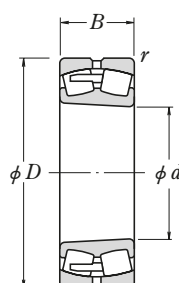
Designations	Abutment and Fillet Dimensions (mm)					Constant <i>e</i>	Axial Load Factors			Mass (kg)
	<i>d<sub>a</sub></i>		<i>D<sub>a</sub></i>	<i>r<sub>a</sub></i>	<i>Y</i> <sub>2</sub>		<i>Y</i> <sub>3</sub>	<i>Y</i> <sub>0</sub>		
	min.	max.	max.	min.					max.	approx.
TL22308CAMKE4 TL22311CAMKE4	49	—	81	77	1.5	0.38	2.6	1.8	1.7	1.0
	65	—	110	103	2	0.36	2.8	1.9	1.8	2.3
TL22312CAMKE4 TL22313EAKE4	72	—	118	111	2	0.36	2.8	1.9	1.9	2.9
	77	84	128	119	2	0.33	3.0	2.0	2.0	3.5
TL22314EAKE4 TL22215CAMKE4	82	91	138	129	2	0.33	3.0	2.0	2.0	4.3
	87	—	148	134	2	0.35	2.9	2.0	1.9	3.6
TL22316CAMKE4	92	—	158	145	2	0.35	2.9	2.0	1.9	6.2
TL22318EAKE4 TL22319CAMKE4	104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.6
	109	—	186	172	2.5	0.35	2.9	1.9	1.9	9.9
TL22320EAKE4	114	130	201	184	2.5	0.33	3.0	2.0	2.0	12.7
TL23022CDKE4 TL23222CKE4 TL22322EAKE4	120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
	122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
	124	145	226	206	2.5	0.30	3.1	2.1	2.0	17.6
TL22324EAKE4	134	157	246	222	2.5	0.32	3.1	2.1	2.0	22.2
TL22326CAMKE4	148	—	262	236	3	0.34	2.9	2.0	1.9	27.8
TL23028CDKE4 TL22228CDKE4 TL23228CKE4	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
	154	163	236	213	2.5	0.25	2.9	1.9	1.9	18.8
TL2303CDKE4 TL23030CAMKE4 TL23130CAMKE4	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
	162	—	213	203	2	0.22	4.6	3.1	3.0	7.9
	162	—	238	218	2	0.3	3.4	2.3	2.2	15.8
TL22230CDKE4 TL22330CAMKE4	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
	168	—	302	270	3	0.35	2.9	1.9	1.9	41.5
TL23032CDKE4 TL22232CDKE4 TL23232CKE4	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
	174	189	276	245	2.5	0.34	2.9	2.0	1.9	30.5

# ■ TL Series Spherical Roller Bearings

Bore Diameter 170 – 260 mm



Cylindrical Bore

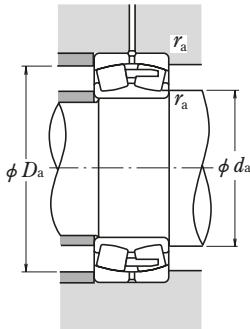


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings				Bearing
$d$	$D$	$B$	$r$ min.	$C_r$ (kN)	$C_{0r}$ (kgf)	$C_r$ (kN)	$C_{0r}$ (kgf)	Cylindrical Bore
<b>170</b>	230	45	2	350	660	35 500	67 500	<b>TL23934BCAME4</b>
	260	67	2.1	640	1 090	65 000	112 000	<b>TL23034CDE4</b>
	280	88	2.1	940	1 570	96 000	160 000	<b>TL23134CAME4</b>
	360	120	4	1 580	2 110	161 000	215 000	<b>TL22334CAME4</b>
<b>180</b>	280	74	2.1	750	1 270	76 000	129 000	<b>TL23036CDE4</b>
	320	112	4	1 300	2 110	133 000	215 000	<b>TL23236CAME4</b>
<b>190</b>	290	75	2.1	775	1 350	79 000	138 000	<b>TL23038CAME4</b>
	320	104	3	1 190	2 020	121 000	206 000	<b>TL23138CAME4</b>
	340	92	4	1 140	1 730	116 000	176 000	<b>TL22238CAME4</b>
	340	120	4	1 440	2 350	147 000	240 000	<b>TL23238CAME4</b>
<b>200</b>	400	132	5	1 890	2 590	193 000	264 000	<b>TL22338CAME4</b>
	310	82	2.1	940	1 700	96 000	174 000	<b>TL23040CAME4</b>
	340	112	3	1 360	2 330	139 000	238 000	<b>TL23140CAME4</b>
	360	98	4	1 300	2 010	133 000	204 000	<b>TL22240CAME4</b>
<b>220</b>	360	128	4	1 660	2 750	169 000	281 000	<b>TL23240CAME4</b>
	340	90	3	1 090	1 980	111 000	202 000	<b>TL23044CAME4</b>
	370	120	4	1 570	2 710	160 000	276 000	<b>TL23144CAME4</b>
	400	108	4	1 570	2 430	160 000	247 000	<b>TL22244CAME4</b>
<b>240</b>	400	144	4	2 520	3 400	257 000	350 000	<b>TL23244CAME4</b>
	460	145	5	2 350	3 400	240 000	345 000	<b>TL22344CAME4</b>
	320	60	2.1	635	1 300	65 000	133 000	<b>TL23948CAME4</b>
	350	92	3	1 160	2 140	118 000	218 000	<b>TL23048CAME4</b>
<b>250</b>	400	128	4	1 790	3 100	182 000	320 000	<b>TL23148CAME4</b>
	500	155	5	2 600	3 800	265 000	385 000	<b>TL22348CAME4</b>
	350	75	2.1	930	1 870	95 000	191 000	<b>TL23952CAME4</b>
	400	104	4	1 430	2 580	145 000	263 000	<b>TL23052CAME4</b>
<b>260</b>	440	144	4	2 160	3 750	221 000	385 000	<b>TL23152CAME4</b>

**Note** (1) Suffix K indicates bearings with tapered bores (taper 1:12).

**Remark** Suffix E4 indicates bearings with an oil groove and holes.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

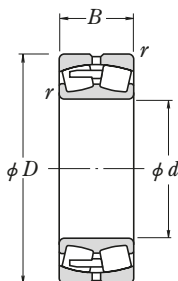
$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

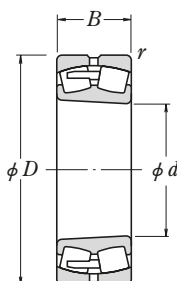
Designations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
	$d_a$		$D_a$	$r_a$			$Y_2$	$Y_3$	$Y_0$	
	min.	max.	max.	min.	max.					approx.
TL23934BCAMKE4 TL23034CDKE4 TL23134CAMKE4 TL22334CAMKE4	180	—	220	213	2	0.17	5.8	3.9	3.8	5.38
	182	191	248	233	2	0.23	4.3	2.9	2.9	13
	182	—	268	245	2	0.29	3.5	2.3	2.3	21
	188	—	342	304	3	0.35	2.9	1.9	1.9	57.9
TL23036CDKE4 TL23236CAMKE4	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
	198	—	302	274	3	0.35	2.9	1.9	1.9	38.5
TL23038CAMKE4 TL23138CAMKE4 TL22238CAMKE4	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
	204	—	306	276	3.5	0.31	3.2	2.2	2.1	34
	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
TL23238CAMKE4 TL22338CAMKE4	208	—	322	288	3	0.35	2.9	1.9	1.9	46.5
	212	—	378	338	4	0.34	2.9	2.0	1.9	77.6
TL23040CAMKE4 TL23140CAMKE4 TL22240CAMKE4 TL23240CAMKE4	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
	214	—	326	293	2.5	0.32	3.2	2.1	2.1	41.5
	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
	218	—	342	307	3	0.35	2.9	1.9	1.9	57
TL23044CAMKE4 TL23144CAMKE4 TL22244CAMKE4	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
	238	—	352	320	3	0.31	3.2	2.2	2.1	52
	238	—	382	348	3	0.27	3.7	2.5	2.4	59
TL23244CAMKE4 TL22344CAMKE4	238	—	382	337	3	0.36	2.8	1.9	1.8	79.5
	242	—	438	391	4	0.33	3.0	2.0	2.0	116
TL23948CAMKE4 TL23048CAMKE4 TL23148CAMKE4 TL22348CAMKE4	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
	258	—	382	347	3	0.31	3.3	2.2	2.2	64.5
	262	—	478	423	4	0.32	3.2	2.1	2.1	147
TL23952CAMKE4 TL23052CAMKE4	272	—	348	333	2	0.19	5.4	3.6	3.5	23
	278	—	382	356	3	0.25	4.1	2.7	2.7	46.6
TL23152CAMKE4	278	—	422	380	3	0.32	3.2	2.1	2.1	88.2

# ■ TL Series Spherical Roller Bearings

Bore Diameter 280 – 500 mm



Cylindrical Bore

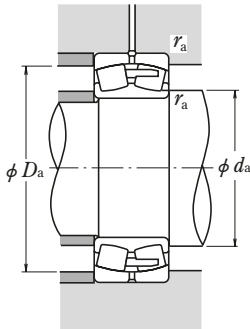


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings				Bearing
$d$	$D$	$B$	$r$ min.	$C_r$ (kN)	$C_{0r}$ (kgf)	$C_r$ (kN)	$C_{0r}$ (kgf)	Cylindrical Bore
<b>280</b>	380	75	2.1	925	1 950	94 500	199 000	<b>TL23956CAME4</b>
	420	106	4	1 540	2 950	157 000	300 000	<b>TL23056CAME4</b>
	460	146	5	2 230	4 000	228 000	410 000	<b>TL23156CAME4</b>
	500	176	5	2 880	4 900	294 000	500 000	<b>TL23256CAME4</b>
<b>300</b>	420	90	3	1 230	2 490	125 000	254 000	<b>TL23960CAME4</b>
	460	118	4	1 920	3 700	196 000	375 000	<b>TL23060CAME4</b>
	500	160	5	2 670	4 800	273 000	490 000	<b>TL23160CAME4</b>
	540	192	5	3 400	5 900	350 000	600 000	<b>TL23260CAME4</b>
<b>320</b>	540	176	5	3 050	5 500	315 000	560 000	<b>TL23164CAME4</b>
<b>340</b>	520	133	5	2 280	4 400	232 000	445 000	<b>TL23068CAME4</b>
	580	190	5	3 600	6 600	370 000	670 000	<b>TL23168CAME4</b>
<b>360</b>	540	134	4	2 390	4 700	244 000	480 000	<b>TL23072CAME4</b>
<b>380</b>	520	106	4	1 870	4 100	190 000	420 000	<b>TL23976CAME4</b>
<b>400</b>	600	148	5	2 970	5 900	305 000	605 000	<b>TL23080CAME4</b>
<b>420</b>	560	106	4	1 870	4 250	191 000	430 000	<b>TL23984CAME4</b>
<b>440</b>	650	157	6	3 150	6 350	320 000	645 000	<b>TL23088CAME4</b>
<b>460</b>	620	118	4	2 220	4 950	227 000	505 000	<b>TL23992CAME4</b>
<b>500</b>	670	128	5	2 460	5 550	250 000	565 000	<b>TL239/500CAME4</b>

**Note** (1) Suffix K indicates bearings with tapered bores (taper 1:12).

**Remark** Suffix E4 indicates bearings with oil groove and holes.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

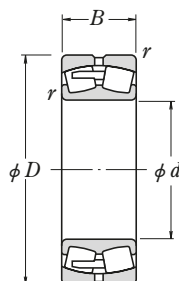
$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Designations	Abutment and Fillet Dimensions (mm)					Constant <i>e</i>	Axial Load Factors			Mass (kg)  approx.
	<i>d</i> <sub>a</sub>		<i>D</i> <sub>a</sub>	<i>r</i> <sub>a</sub>			<i>Y</i> <sub>2</sub>	<i>Y</i> <sub>3</sub>	<i>Y</i> <sub>0</sub>	
	min.	max.	max.	min.	max.					
Tapered Bore <sup>(1)</sup>										
TL23956CAMKE4	292	—	368	351	2	0.18	5.7	3.9	3.8	24.5
TL23056CAMKE4	298	—	402	377	3	0.24	4.2	2.8	2.7	50.5
TL23156CAMKE4	302	—	438	400	4	0.3	3.3	2.2	2.2	94.3
TL23256CAMKE4	302	—	478	425	4	0.35	2.9	1.9	1.9	147
TL23960CAMKE4	314	—	406	386	2.5	0.19	5.2	3.5	3.4	38.2
TL23060CAMKE4	318	—	442	413	3	0.24	4.2	2.8	2.7	70.5
TL23160CAMKE4	322	—	478	433	4	0.31	3.3	2.2	2.2	125
TL23260CAMKE4	322	—	518	458	4	0.35	2.9	1.9	1.9	189
TL23164CAMKE4	342	—	518	466	4	0.31	3.2	2.1	2.1	162
TL23068CAMKE4	362	—	458	465	4	0.24	4.2	2.8	2.8	101
TL23168CAMKE4	362	—	558	499	4	0.31	3.2	2.1	2.1	206
TL23072CAMKE4	382	—	518	485	4	0.24	4.2	2.8	2.8	106
TL23976CAMKE4	398	—	502	482	3	0.18	5.5	3.7	3.6	65.4
TL23080CAMKE4	422	—	578	540	4	0.23	4.4	3.0	2.9	146
TL23984CAMKE4	438	—	542	521	3	0.17	6.0	4.0	3.9	71.6
TL23088CAMKE4	468	—	622	587	5	0.23	4.3	2.9	2.8	173
TL23992CAMKE4	478	—	602	573	3	0.17	5.9	4.0	3.9	100
TL239/500CAMKE4	522	—	648	622	4	0.17	6.0	4.0	3.9	124

# Molded-Oil™ Bearings

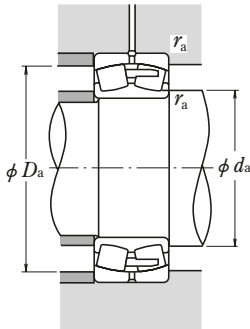
Bore Diameter 35 – 160 mm



Cylindrical Bore

Boundary Dimensions (mm)				Basic Load Ratings				Bearing Designation	Abutment and	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)	Cylindrical Bore	<i>d<sub>a</sub></i> min.	max.
<b>35</b>	80	21	1.5	71	76	7 250	7 750	<b>21307L12CAM</b>	44	—
<b>40</b>	90	23	1.5	82	93	8 350	9 500	<b>21308L11ACAM</b>	49	—
	90	33	1.5	122	129	12 400	13 200	<b>22308L11CAM</b>	49	—
<b>45</b>	85	23	1.1	778	88	7 950	9 000	<b>22209L11CAM</b>	52	—
	100	36	1.5	148	167	15 100	17 100	<b>22309L12CAM</b>	54	—
<b>50</b>	90	23	1.1	82	93	8 350	9 500	<b>22210L11CAM</b>	57	—
<b>55</b>	120	43	2	209	241	21 300	24 600	<b>22311L12CAM</b>	65	—
<b>60</b>	110	28	1.5	127	154	12 900	15 700	<b>22212L12CAM</b>	69	—
<b>65</b>	120	31	1.5	152	190	15 500	19 300	<b>22213L11CAM</b>	74	—
	140	48	2.1	265	315	27 000	32 500	<b>22313L11CAM</b>	77	—
	140	48	2.1	265	315	27 000	32 500	<b>22313L12CAM</b>	77	—
<b>70</b>	125	31	1.5	163	205	16 600	20 900	<b>22214L11CAM</b>	79	—
<b>75</b>	160	55	2.1	340	415	34 500	42 000	<b>22315L12CAM</b>	87	—
<b>80</b>	140	33	2	181	232	18 500	23 700	<b>22216L11CAM</b>	90	—
<b>85</b>	150	36	2	215	276	21 900	28 200	<b>22217L12CAM</b>	95	—
<b>90</b>	160	40	2	256	340	26 200	34 500	<b>22218L12CAM</b>	100	—
<b>95</b>	170	43	2.1	296	395	30 000	40 000	<b>22219L12CAM</b>	107	—
<b>100</b>	165	52	2	345	530	35 500	54 000	<b>23120L11CAM</b>	110	—
	215	73	3	600	785	61 500	80 000	<b>22320L11CAM</b>	114	—
<b>110</b>	200	53	2.1	425	585	43 500	59 500	<b>22222L12CAM</b>	122	—
<b>120</b>	180	46	2	315	525	32 000	53 500	<b>23024L11CAM</b>	130	—
	200	62	2	465	720	47 500	73 500	<b>23124L12CAM</b>	130	—
<b>130</b>	230	64	3	565	815	57 500	83 000	<b>22226L11CAM</b>	144	—
<b>160</b>	220	45	2	360	675	37 000	69 000	<b>23932L11CAM</b>	170	—

**Remark** Bearing designations other than those listed above may be available for production.

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

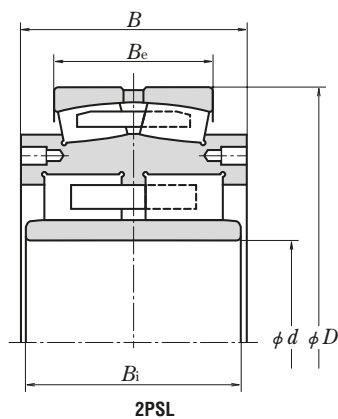
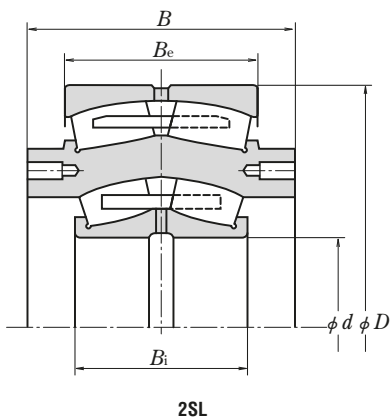
**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
71	67	1.5	0.29	3.5	2.3	2.3	0.52
81	80	1.5	0.25	4.0	2.7	2.6	0.72
81	77	1.5	0.38	2.6	1.8	1.7	1.00
78	75	1	0.28	3.6	2.4	2.4	0.57
91	85	1.5	0.36	2.8	1.9	1.8	1.24
83	80	1	0.25	4.0	2.7	2.6	0.67
110	103	2	0.36	2.8	1.9	1.8	2.30
101	97	1.5	0.25	4.0	2.7	2.6	1.13
111	106	1.5	0.26	3.9	2.6	2.6	1.46
128	117	2	0.35	2.9	1.9	1.9	3.56
128	117	2	0.35	2.9	1.9	1.9	3.56
116	111	1.5	0.25	4.0	2.7	2.7	1.46
148	135	2	0.35	2.9	2.0	1.9	5.26
130	124	2	0.24	4.3	2.9	2.8	2.14
140	134	2	0.24	4.3	2.9	2.8	2.60
150	142	2	0.25	4.1	2.7	2.7	3.44
158	150	2	0.25	4.1	2.7	2.7	3.87
155	144	2	0.30	3.4	2.3	2.2	4.14
201	183	2.5	0.35	2.9	1.9	1.9	12.7
188	176	2	0.24	4.2	2.8	2.7	7.23
170	163	2	0.22	4.5	3.0	2.9	4.15
190	175	2	0.29	3.5	2.4	2.3	7.94
216	203	2.5	0.26	3.9	2.6	2.6	11.0
210	203	2	0.18	5.6	3.8	3.7	4.97

## Triple Ring Bearings



Bearing Designation	Boundary Dimensions (mm)					Mass (kg)
	$d$	$D$	$B_i$	$B_e$	$B$	
<b>2SL180-2 UPA</b>	180	480	140	160	215.9	175
<b>2SL200-2 UPA</b>	200	520	160	180	241.3	230
<b>2SL220-2 UPA</b>	220	600	180	200	279.4	330
<b>2SL240-2 UPA</b>	240	620	200	200	279.4	410
<b>2SL260-2 UPA</b>	260	680	218	218	317.5	490
<b>2SL280-2 UPA</b>	280	720	218	218	317.5	525
<b>2SL300-2 UPA</b>	300	780	243	250	342.9	735
<b>2SL320-2 UPA</b>	320	820	258	258	368.3	840
<b>2SL340-2 UPA</b>	340	870	280	272	393.7	1 050
<b>2SL380-3 UPA</b>	380	980	240	308	431.8	1 370
<b>2PSL180-1 UPA</b>	180	460	153	118	160	127
<b>2PSL240-1 UPA</b>	240	600	205	160	225	285



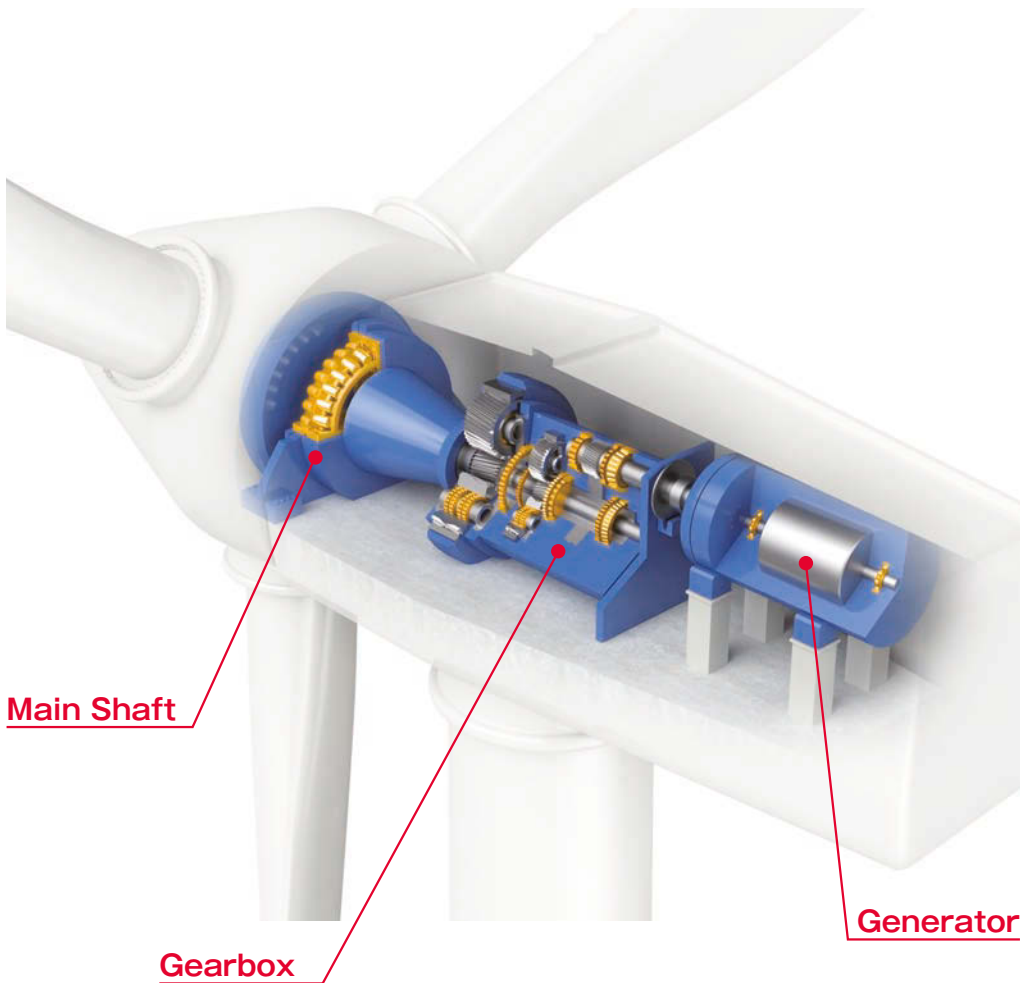
# Bearings for the Wind Power Industry

High-performance, high-quality bearings offer long life for stable, low-maintenance operation.

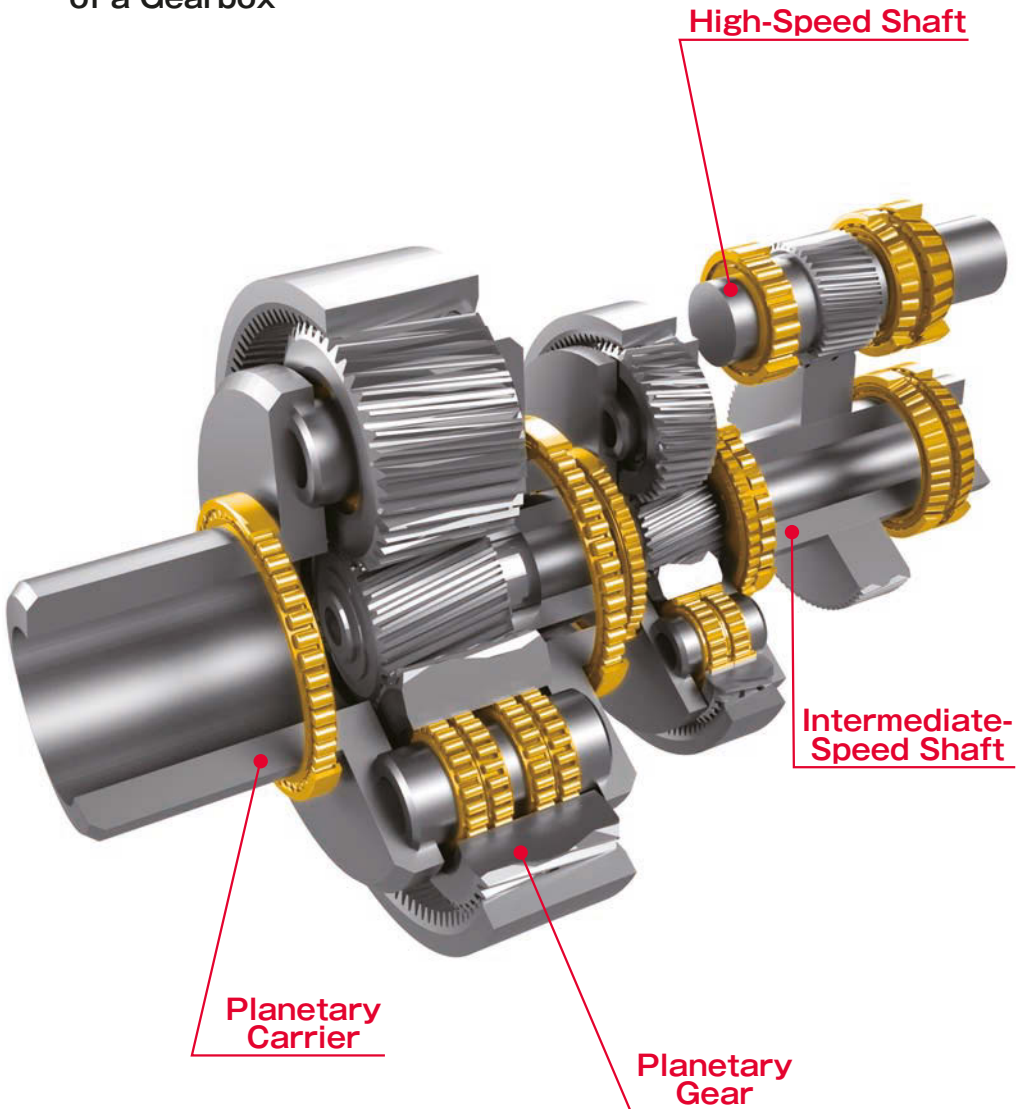


## Example Bearing Designations ..... D 092

## Perspective View of a Nacell



## Perspective View of a Gearbox



## ■ Bearings for the Wind Power Industry

### Bearing Features



### CA Series Spherical Roller Bearings

CA Series double-row self-aligning spherical roller bearings feature a machined-brass cage and high load capacity, superior durability, and high resistance to wear. The CA Series is especially suitable for applications with heavy loads or shocks.

■ Applications: Main shafts



### NCF (Single-Row) and NNCF (Double-Row) Series Full Complement Cylindrical Roller Bearings

Cageless full complement cylindrical roller bearings have the maximum possible number of rollers and can sustain much heavier loads than cylindrical roller bearings of the same size with cages.

■ Applications: Planetary carriers (NCF), Planetary gears (NNCF)



### XM Series High Load Capacity Cylindrical Roller Bearings

By increasing the number of rollers, NSK has reduced the surface pressure exerted on the contact area between the rollers and rings, thereby increasing load capacity and extending the life of the bearing.

■ Applications: Gearboxes



### HR Series High-Load Capacity Tapered Roller Bearings

HR Series tapered roller bearings are capable of taking combined heavy radial loads and axial loads in one direction.

The HR series features tapered rollers guided by larger rollers for superior high-load ratings.

■ Applications: Gearboxes



### Bearings With Black Oxide Coating

These bearings feature a black oxide coating based on the DIN50938 standard to suppress white-structure flaking. Standard bearing steel, carburized steel, or original NSK materials (Super-TF™, AWS-TF™) can be used.

■ Applications: Gearboxes



## QJ Series Four-Point-Contact Ball Bearings

The inner ring is split radially into two pieces. This design allows one bearing to sustain significant axial loads in either direction with high axial load capacity. This type is suitable for carrying pure axial loads or combined loads where axial load is high.

- Applications : Gear Box intermediate-speed shafts, high-speed shafts



## Ceramic-Coated Insulated Bearings

A layer of insulation is formed on the outer ring surface. The boundary dimensions are identical to a standard bearing, enabling easy replacement.

- Applications: Generators



## Super-TF™ Bearings

Super-TF bearings were developed with innovative materials and heat treatment technology for increased durability under harsh conditions.

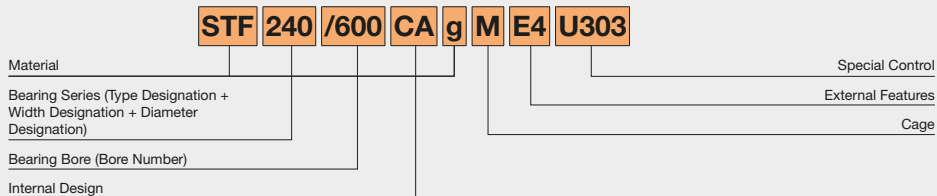
They combine long service life with high resistance to wear and seizure to achieve outstanding cost performance even under contaminated lubrication conditions.



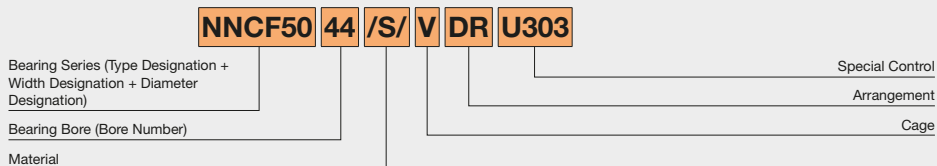
## AWS-TF™ Bearings

AWS-TF bearings were developed with a combination of special heat treatment technology and materials. They provide excellent resistance to flaking, including white-structure flaking.

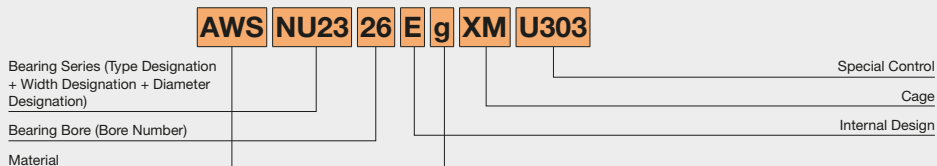
## Example Bearing Designations



240 : Spherical Roller Bearing Width Series 4 Diameter Series 0  
 /600 : Bearing Bore 600 mm  
 CA : High-Capacity Design  
 STF~g : Long-Life Steel  
 M : Machined-Brass Cage  
 E4 : Lubricating Groove in Outside Surface and Holes in Outer Ring  
 U303 : Special Process Control for Wind Turbine Bearings



NNCF50 : NNCF Full Complement Cylindrical Roller Bearing Width Series 5 Diameter Series 0  
 44 : Bearing Bore 220 mm  
 /S/ : Black Oxide Coating  
 V : Without Cage  
 DR : Controlled Size Variation Arrangement  
 U303 : Special Process Control for Wind Turbine Bearings



NU23 : NU-Type Cylindrical Roller Bearing Width Series 2 Diameter Series 3  
 26 : Bearing Bore 130 mm  
 E : High Capacity Design  
 AWS~g : Long-Life Steel, Specialized to Prevent White-Structure Flaking  
 XM : High-Capacity Machined-Brass Cage  
 U303 : Special Process Control for Wind Turbine Bearings

**HR 303 26 J /HR 313 26 J DF +KR U303**

High-Capacity Design

Bearing Series (Type Designation +  
Width Designation + Diameter  
Designation)

Bearing Bore (Bore Number)

Internal Design

Special Control

Spacer

Arrangement

HR/HR : High-Capacity Design

303/313 : Tapered Roller Bearing Width Series 0/1 Diameter Series 3

26/26 : Bearing Bore 130 mm

J/J : Conforms to ISO

DF : Face-to-Face Arrangement

+KR : Bearings With Outer Ring Spacer

U303 : Special Process Control for Wind Turbine Bearings

**QJ3 28 M E U303**

Bearing Series (Type Designation +  
Width Designation + Diameter  
Designation)

Bearing Bore (Bore Number)

Cage

Special Control

External Features

QJ3 : Four-Point-Contact Ball Bearing Diameter Series 3

28 : Bearing Bore 140 mm

M : Machined-Brass Cage

E : Notch in Outer Ring

U303 : Special Process Control for Wind Turbine Bearings

**63 30 HDY2 MR X26 U303**

Bearing Series (Type Designation +  
Width Designation + Diameter  
Designation)

Bearing Bore (Bore Number)

Material

Special Control

Special Specification

Cage

63 : Single-Row Deep Groove Ball Bearing Diameter Series 3

30 : Bearing Bore 150 mm

HDY2 : Ceramic-Insulated Coating on Outer Ring

MR : Ball-Guided Machined-Brass Cage

X26 : Dimensional Stabilizing Treatment

U303 : Special Process Control for Wind Turbine Bearings

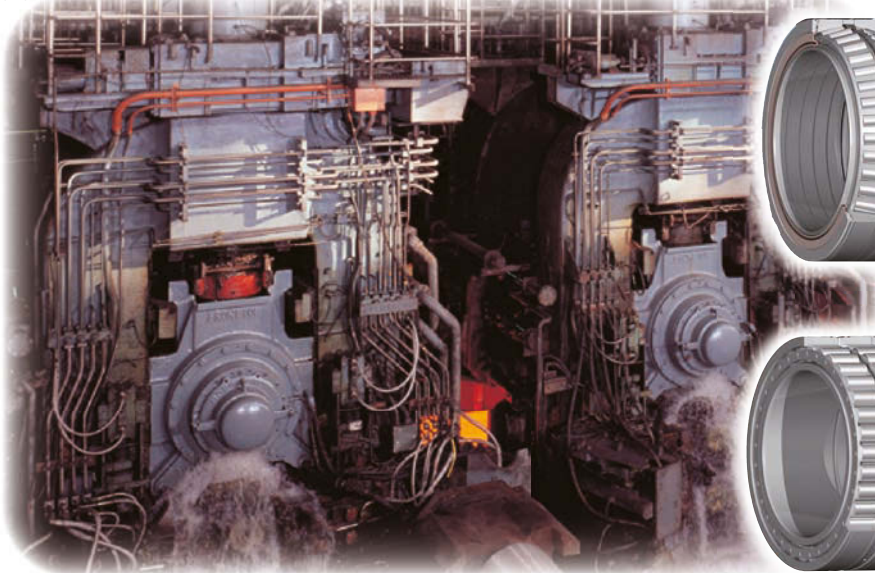
# Bearings for the Steel Industry

High-performance bearings help maximize uptime and reduce maintenance costs.

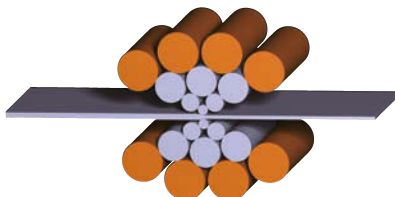
(\*1)



(\*1)



(\*2)



**Bearings for Sintering Equipment ..... D 098**

**AR Series Sealed-Clean Bearings for Pallet Wheels**  
**-2J and 2M Series for Inboard Rollers**

**Bearings for BOFs and Converters ..... D 102**

**Extra-Large Split Bearings for BOFs and Converter Trunnions**

**Bearings for Continuous Casting Machines ..... D 106**

**SWR™ Bearings (Spherical Roller Bearings)**  
**RUB Series Cylindrical Roller Bearings With Aligning Rings**  
**(for Free End)**  
**RNPH/PCR Series Split Cylindrical Roller Bearings**  
**(for Segmented Rolls)**

**Bearings for Rolling Mills (for Roll Necks) ..... D 128**

**KVS Series Extra-Capacity Sealed-Clean™**  
**Four-Row Tapered Roller Bearings**  
**Super-TF™ Bearings**  
**Water-TF™ Bearings**

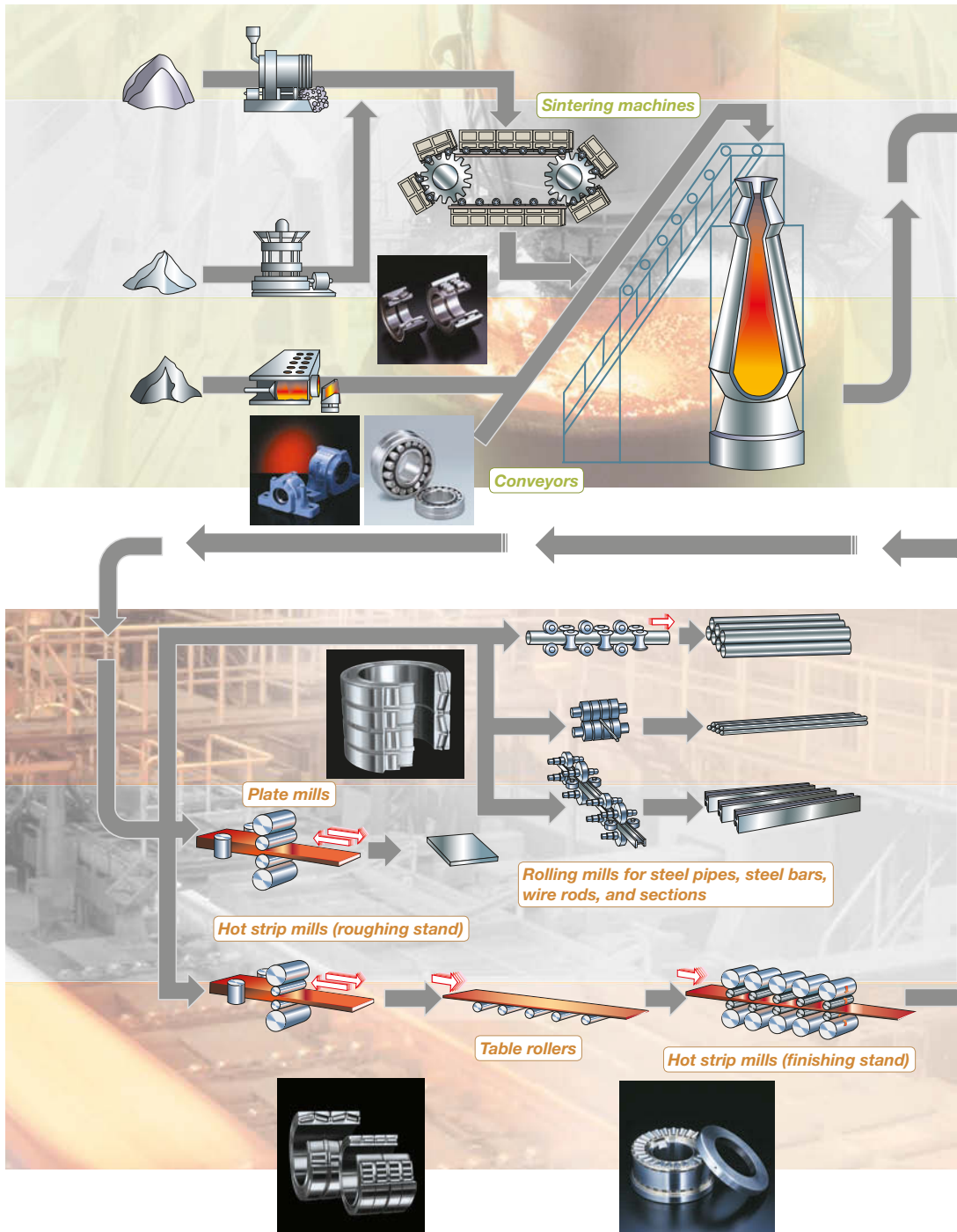
**STF-RV Series Four-Row Cylindrical Roller Bearings**

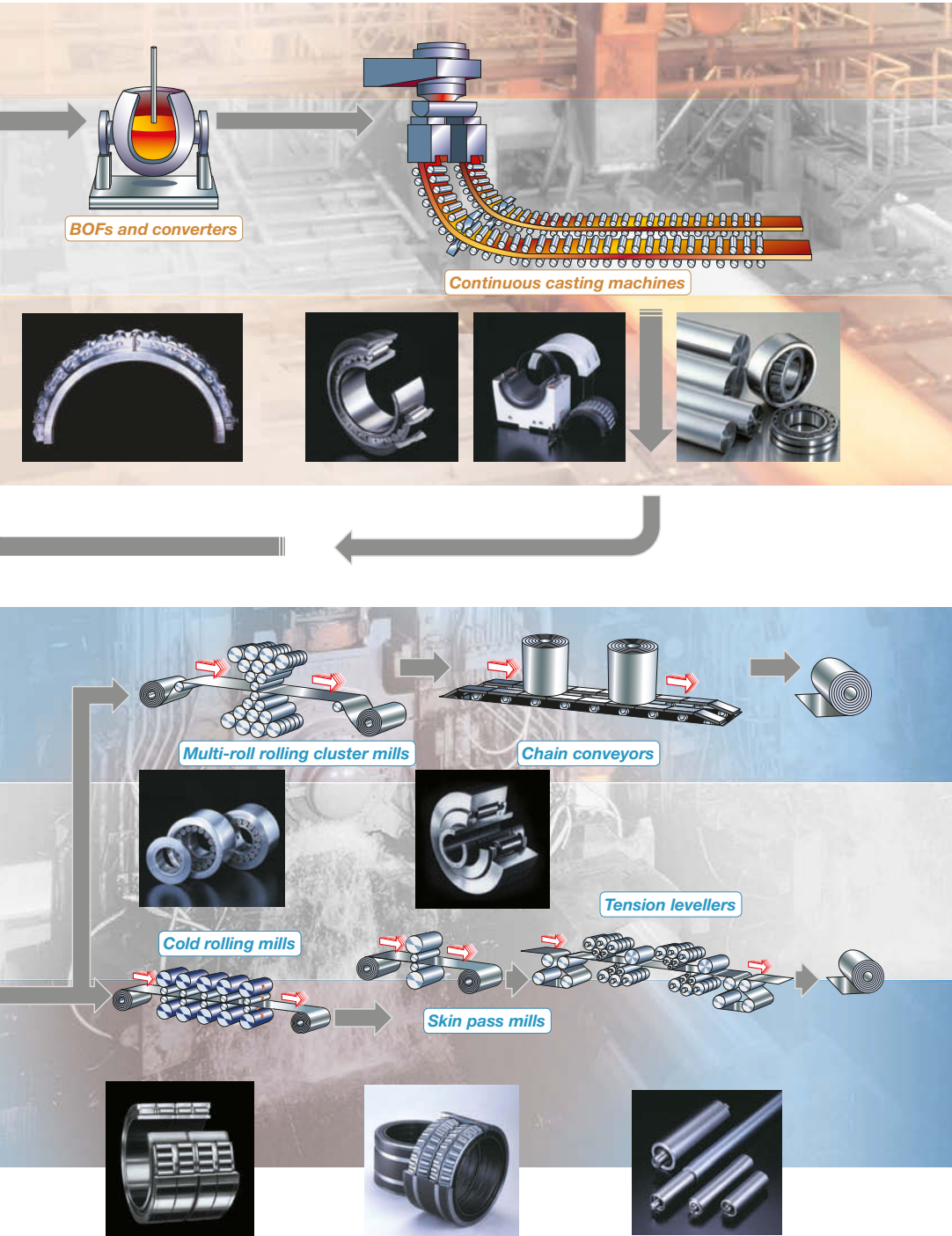
**Backing Bearings for Multi-Roll Rolling Cluster Mills ..... D 166**

**Super-TF™ Backing Bearings**

**Notes** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.  
 (\*2): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

A complete product line for all steel mill processes delivers improved productivity and lower maintenance costs thanks to highly reliable long-life bearings.





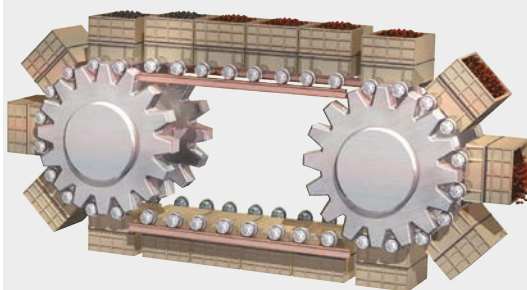
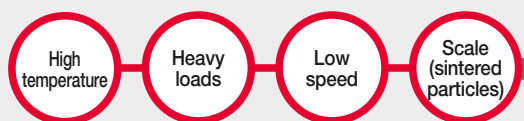
# Bearings for Sintering Equipment

Sealed-Clean Bearings for Pallet Wheels / Sealed-Clean Bearings for Inboard Rollers

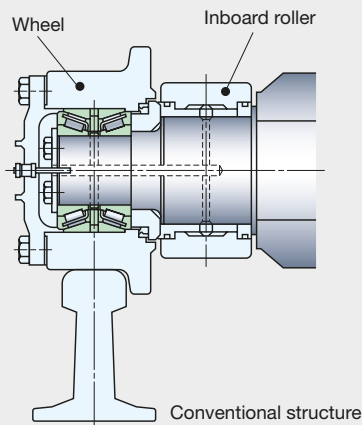
## Benefits

- ① Stable machinery operation through higher reliability and longer operating life
- ② Cleaner areas adjacent to equipment
- ③ Lower maintenance costs

## 1. Operating conditions



Sintering equipment



## 2. Problems

### Typical problems with bearings for sintering equipment

#### Problem 1

Premature failure of bearings for pallet wheels and bearings for inboard rollers (plain bearings)

Poor lubrication

Unbalanced Load  
(Inboard bearings)

- Premature wear and flaking
- Seizure damage
- Fracture of outer rings (Inboard bearings)

#### Problem 2

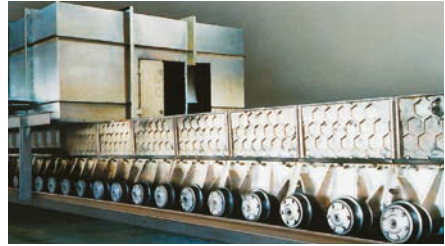
Contamination around equipment, high maintenance costs

Frequent greasing

Leakage of grease into surroundings

High operational cost for grease

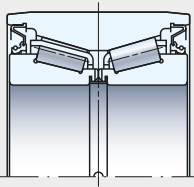
Contamination around equipment, high usage cost



### 3. Countermeasures

#### Features AR-Series Sealed-Clean Bearings for Pallet Wheels

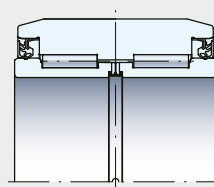
- Optimum crowning of the roller raceway surface enables resistance to unbalanced wheel load
- High sealing performance (featuring a special contact seal)
- Packed with grease featuring excellent heat and pressure resistance
- Easier handling (one-piece design with fastening ring inner ring)



Designations Page D100

#### Features Sealed-Clean Bearings for Inboard Rollers-2J, 2M Series

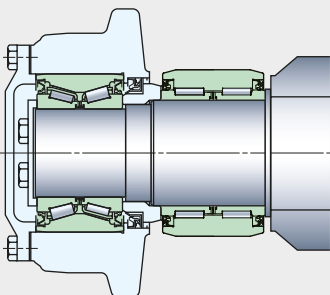
- Higher load capacity (by outer ring thickness design with high strength and full-complement roller type)
- Improvement of axial load capacity
- High sealing performance (featuring a special contact seal)
- Packing of grease with excellent heat and pressure resistance
- Easier handling (one-piece design with fastening ring adopted for the inner ring)



Designations Page D101

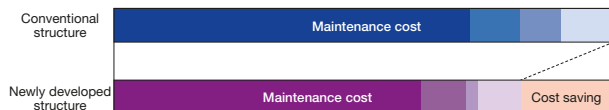
#### Durability Performance of Bearings in Field Test

	Comparison of actual life extension in field tests		
Conventional structure	1		
Newly developed structure	2.5 on average	3 at maximum	



Newly developed structure

#### Estimated Reduction of Maintenance Costs

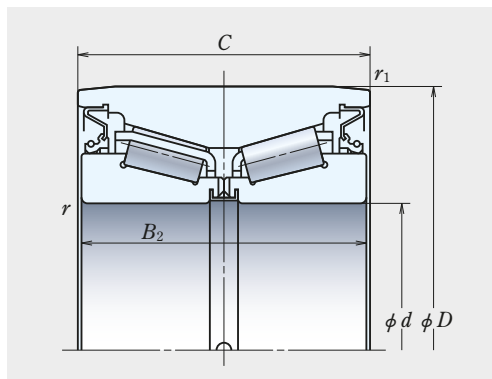


Maintenance costs include replacement costs for bearings, seals, and grease and operational costs associated with bearing replacement and greasing.

If bearing life with the newly developed structure is 2.5 times longer on average, the total reduction in maintenance costs is estimated to be 25 to 35 %.

## ■ Bearings for Sintering Equipment

### AR Series Sealed-Clean Bearings for Pallet Wheels



Bearing Designation	Boundary Dimensions (mm)						Basic Load Ratings (kN)	
	$d$	$D$	$B_2$	$C$	$r(\min)$	$r_1(\min)$	$C_r$	$C_{0r}$
<b>AR80-24</b>	80	150	67	67	2.5	1	269	390
<b>AR90-25</b>	90	160	74	74	2.5	0.5	240	435
<b>AR90-26</b>	90	160	80	80	2.5	0.5	240	435
<b>AR90-27</b>	90	160	78	78	2.5	0.5	240	435
<b>AR90-32A</b>	90	160	100	100	2.5	—	440	850
<b>AR100-29</b>	100	180	98	100	2.5	1	350	675
<b>AR100-30</b>	100	180	100	100	2.5	1	350	675
<b>AR100-38</b>	100	180	100	100	3	0.5	525	835
<b>AR100-39</b>	100	180	98	100	3	0.5	525	835
<b>AR100-40</b>	100	180	98	100	3	0.5	525	835
<b>AR100-44</b>	100	180	91	91	3	0.5	435	665
<b>AR110-28</b>	110	180	86	86	3	0.5	330	660
<b>AR110-29</b>	110	200	92	100	2.5	1	415	805
<b>AR110-39</b>	110	200	100	100	3	1	570	950
<b>AR110-50A</b>	110	200	90	90	3	0.5	500	780

**Remark** Other bearings are available. Please contact NSK for additional information.

## 2J and 2M Series Sealed-Clean Bearings for Inboard Rollers

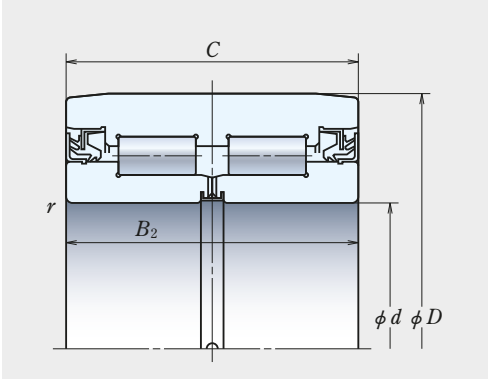


Fig. 1

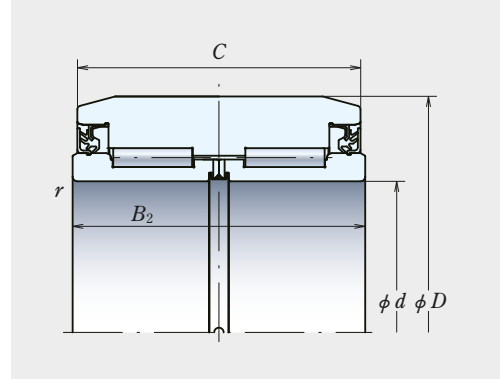


Fig. 2

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Fig.
	$d$	$D$	$B_2$	$C$	$r(\text{min})$	$C_r$	$C_{0r}$	
2J100-2	100	200	120	119	2.1	315	910	1
2J120-9A	120	210	120	120	2.5	610	1 080	1
2J120-14	120	210	132	132	2.1	530	1 320	1
2M120-17	120	210	132	132	2.1	425	1 390	2
2M140-(5)	140	250	116	110	2	395	1 030	2
2M140-( )	140	250	130	130	4	485	1 460	2
2J140-2	140	250	130	130	4	770	1 420	1
2M150-( )	150	320	120	120	5	615	1 350	2
2M158-3	158	250	140	140	5	570	1 850	2
2J160Z-1	160.11	250	130	130	2.5	670	1 540	1
2M160Z-13	160.11	250	150	150	2.5	595	1 980	2
2J160Z-5	160.11	250	155	150	2.1	610	2 050	1

**Remark** Other bearings are available. Please contact NSK for additional information.

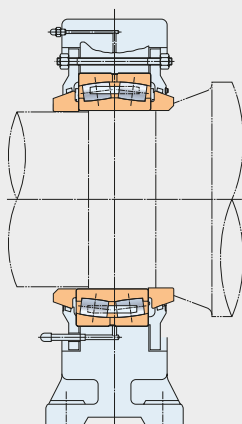
# Bearings for BOFs and Converters

Extra-Large Split Bearings for BOFs and Converter Trunnions

## Benefits

- ❶ Bearings can be replaced without removing the bull gear, thus reducing maintenance costs
- ❷ Further reduced maintenance costs by shortening length of bearing replacement work
- ❸ Reduced production downtime, which affects subsequent processes

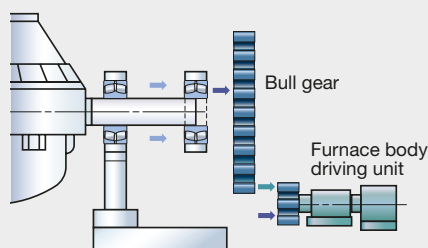
## 1. Operating conditions



## 2. Problems

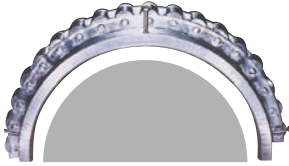
### Typical problems with bearings for BOFs and converters

Inboard bearings cannot be replaced without removing the bull gear



Bearing replacement work is time-consuming and requires expensive maintenance costs

Sudden bearing replacement due to unexpected failure causes large production losses in subsequent processes

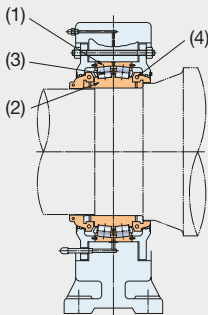


(\*1)

### 3. Countermeasures

#### Features Extra-Large Split Bearings for BOFs and Converter Trunnions

- Split design: (1) outer ring, (2) inner ring, (3) roller and cage assembly, and (4) fastening ring
- Integrated seal sliding surface with a fastening ring



Newly developed structure

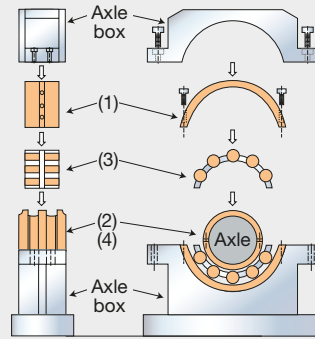
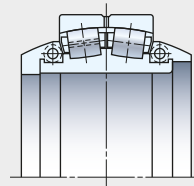
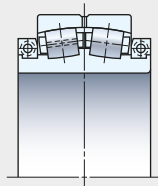


Image of bearing mounting

- Bearing Structure



Designations Pages D104 and D105

#### Reduction of Maintenance Costs

Comparison of time required for bearing replacement work

Bearing type	Comparison of time required for bearing replacement work in field test		
Conventional structure (one-piece type)	1		
Newly developed structure (split type)	0.65	0.35	Reduction

- The bearing replacement period reflects actual result for bearings with bore diameter of 1 200 mm to 1 400 mm.
- The bearing with the newly developed structure reduced the time needed for bearing replacement work by approximately 35 % and significantly reduced maintenance costs.

**Note** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.

## Extra-Large Split Bearings for BOFs and Converter Trunnions

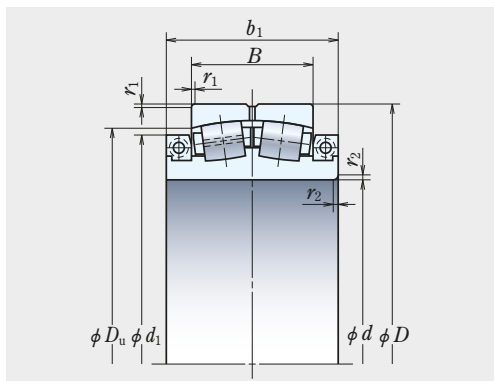


Fig. 1

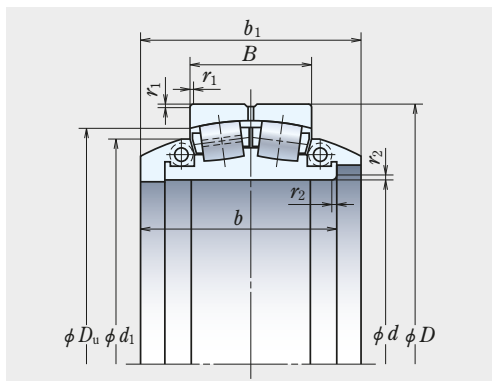


Fig. 2 Clamp Ring With Tangential Seal Surface

Bearing Designation	Boundary Dimensions (mm)								
	$d$	$D$	$B$	$b$	$b_1$	$d_1$	$D_u$	$r_1(\text{min})$	$r_2(\text{min})$
<b>750SLPT1051</b>	750	1 000	250	355	—	905	914.4	6	7.5
<b>SL850-7</b>	850	1 120	272	385	—	1 015	1 025	6	6
<b>900SLPT1251</b>	900	1 250	285	410	—	1 100	1 142	7.5	19
<b>950SLPT1451</b>	950	1 400	300	520	600	1 182	1 265	7.5	28
<b>SL1120-3</b>	1 120	1 580	320	632.5	697.5	1 400	1 445	9.5	30
<b>*1200SLPT1751</b>	1 200	1 700	410	780	780	1 470	1 536	9.5	31
<b>1200SLPT1752</b>	1 200	1 700	410	660	730	1 470	1 536	9.5	19
<b>1320SLPT1851</b>	1 320	1 850	530	815	814	1 600	1 670	12	31
<b>*1400SLPT1951</b>	1 400	1 900	530	880	880	1 680	1 710	12	31
<b>*1400SLPT1953</b>	1 400	1 900	530	810	860	1 680	1 710	12	31

**Remarks** 1. The shapes of bearings marked with an asterisk \* are not exactly the same as shown in Fig. 2.

2. Other bearings are available. Please contact NSK for additional information.

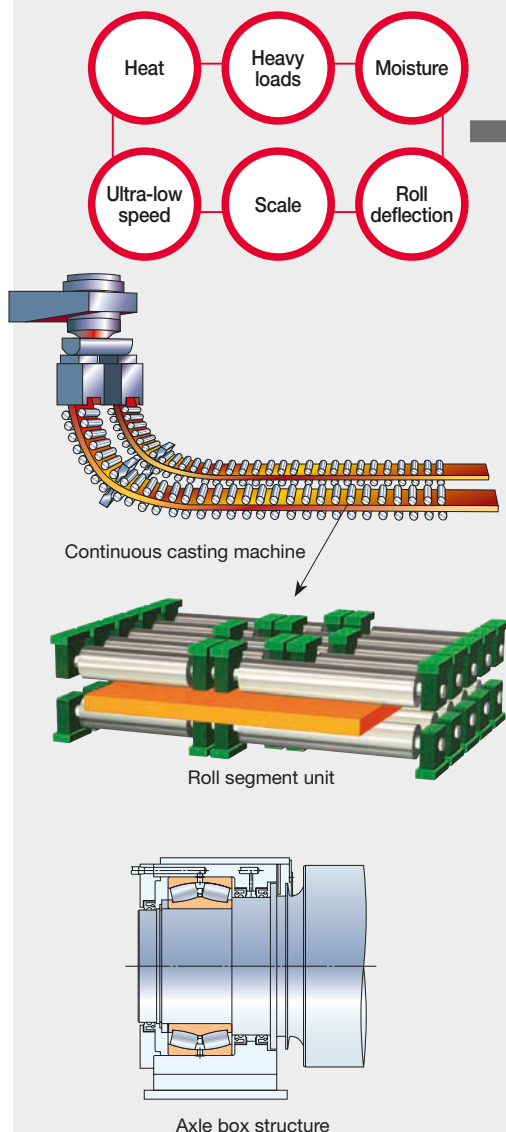
	Basic Load Ratings (kN)		Fig.
	$C_r$	$C_{0r}$	
	6 800	18 300	1
	8 000	21 600	1
	9 850	24 200	1
	12 300	27 900	2
	13 200	32 000	2
	17 300	43 500	2*
	17 300	43 500	2
	22 500	63 500	2
	22 800	65 000	2*
	22 800	65 000	2*

# Bearings for Continuous Casting Machines

## Bearings for Guide Rolls

- Benefits**
- ❶ Improved bearing durability reduces unplanned downtime
  - ❷ Less frequent roll segment replacement reduces maintenance costs

### 1. Operating conditions



### 2. Problems

#### Typical problems with bearings for continuous casting machines

Differential sliding specific to spherical roller bearings

Uneven wear



Flaking



Crack

- Expansion of roll gaps (failure of rolls)
- Decline in product quality
- Unexpected downtime
- High bearing usage cost



(\*1)

### 3. Countermeasures

#### Features SWR™ Bearings (Spherical Roller Bearings)

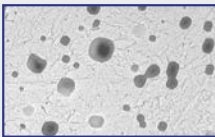
- Improved wear resistance → Three times higher than AISI 52100 bearing steel
- Improved flaking life → Five times higher than AISI 52100 bearing steel
- Improved toughness of material core  
(prevention of cracks) → Five times stronger than AISI 52100 bearing steel

Designations Pages D108 to D115

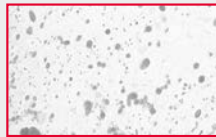
SWR Bearing CAT.No.E1242



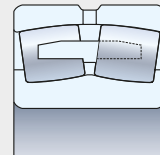
Microstructure (TEM)



SUJ2 1μm



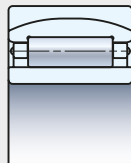
SWR 1μm



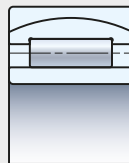
SWR

#### Features RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

- Cylindrical roller bearings with self-aligning capabilities prevent internal wear problems caused by sliding
- Smooth relief of roll expansion
- Available in easy-to-handle cage and higher load capacity full complement types



RUB (with cage)

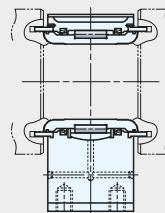


RUB (full complement)

Designations Pages D116 to D123

#### Features RNPH/PCR Series Split Cylindrical Roller Bearings (for Segmented Rolls)

- Cylindrical roller bearings with self-aligning capabilities prevent wear problems caused by sliding
- Full-complement, higher load capacity design
- Multi-functional seal and high-rigidity plunger block unit



RNPH/PCR

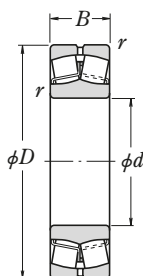
Designations Pages D124 to D127

**Note** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.

## ■ Bearings for Continuous Casting Machines

### SWR™ Bearings (Spherical Roller Bearings)

Bore Diameter 40 – 100 mm



EA

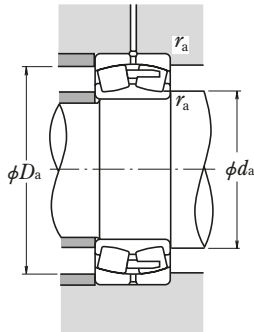


C, CD



CA

Boundary Dimensions (mm)				Basic Load Ratings				Bearing Designation	Abutment	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)		<i>d<sub>a</sub></i> min.	<i>d<sub>a</sub></i> max.
<b>40</b>	80	23	1.1	90.5	99.5	9 200	10 100	<b>22208SWREAE4</b>	47	49
	90	33	1.5	136	153	13 900	15 600	<b>22308SWRCAME4</b>	49	—
<b>50</b>	90	23	1.1	99	119	10 100	12 100	<b>22210SWREAE4</b>	57	60
<b>55</b>	100	25	1.5	119	144	12 100	14 600	<b>22211SWREAE4</b>	64	65
	120	29	2	142	174	14 500	17 800	<b>21311SWREAE4</b>	65	72
<b>60</b>	95	26	1.1	98.5	141	10 000	14 400	<b>23012SWRCE4</b>	67	68
	110	28	1.5	142	174	14 500	17 800	<b>22212SWREAE4</b>	69	72
	110	28	1.5	178	154	18 100	15 700	<b>22212SWRCAME4</b>	69	—
	130	31	2.1	190	244	19 400	24 900	<b>21312SWREAE4</b>	72	87
<b>65</b>	130	46	2.1	246	288	25 100	29 400	<b>22312SWRCAME4</b>	72	—
	120	31	1.5	152	190	15 500	19 300	<b>22213SWRCAME4</b>	74	—
<b>70</b>	140	48	2.1	265	315	27 000	32 500	<b>22313SWRCAME4</b>	77	—
	125	31	1.5	225	232	22 900	23 600	<b>22214SWREAE4</b>	79	84
<b>75</b>	125	31	1.5	163	205	16 600	20 900	<b>22214SWRCAME4</b>	79	—
	130	31	1.5	238	244	24 200	24 900	<b>22215SWREAE4</b>	84	87
<b>80</b>	140	33	2	264	275	27 000	28 000	<b>22216SWREAE4</b>	90	94
	170	39	2.1	355	375	36 000	38 000	<b>21316SWREAE4</b>	92	109
	170	58	2.1	390	480	39 500	48 500	<b>22316SWRCAME4</b>	92	—
<b>85</b>	150	36	2	310	325	320	33 500	<b>22217SWREAE4</b>	95	101
<b>90</b>	160	40	2	360	395	37 000	40 000	<b>22218SWREAE4</b>	100	108
	160	52.4	2	340	490	34 500	50 000	<b>23218SWRCE4</b>	100	105
	190	64	3	665	705	68 000	72 000	<b>22318SWREAE4</b>	104	115
<b>95</b>	170	43	2.1	296	395	30 000	40 000	<b>22219SWRCAME4</b>	107	—
<b>100</b>	150	37	1.5	212	335	21 600	34 500	<b>23020SWRCDE4</b>	109	112
	150	50	1.5	276	470	28 100	48 000	<b>24020SWRCE4</b>	109	110
	165	65	2	345	535	35 500	54 000	<b>24120SWRCAME4</b>	110	113
	180	46	2.1	455	490	46 500	50 000	<b>22220SWREAE4</b>	112	119

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

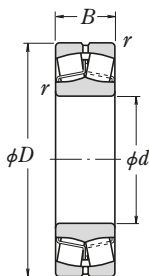
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
73	70	1	0.28	3.6	2.4	2.4	0.5
81	77	1.5	0.38	2.6	1.8	1.7	1.0
83	81	1	0.24	4.3	2.9	2.8	0.61
91	89	1.5	0.23	4.3	2.9	2.8	0.81
110	98	2	0.23	4.4	3.0	2.9	1.58
88	85	1	0.26	3.9	2.6	2.5	0.68
101	98	1.5	0.23	4.4	3.0	2.9	1.1
101	97	1.5	0.25	4.0	2.7	2.6	1.17
118	117	2	0.22	4.5	3.0	3.0	1.98
118	111	2	0.36	2.8	1.9	1.9	2.9
111	106	1.5	0.26	3.9	2.6	2.6	1.57
128	117	2	0.35	2.9	1.9	1.9	3.56
116	111	1.5	0.23	4.3	2.9	2.8	1.58
116	111	1.5	0.25	4.0	2.7	2.7	1.64
121	117	1.5	0.22	4.5	3.0	3.0	1.64
130	126	2	0.22	4.6	3.1	3.0	2.01
158	146	2	0.23	4.4	3.0	2.9	4.32
158	145	2	0.35	2.9	2.0	1.9	6.2
140	135	2	0.22	4.6	3.1	3.0	2.54
150	142	2	0.24	4.3	2.9	2.8	3.3
150	138	2	0.32	3.2	2.1	2.1	4.51
176	163	2.5	0.33	3.1	2.1	2.0	8.56
158	150	2	0.25	4.1	2.7	2.7	4.19
141	136	1.5	0.22	4.6	3.1	3.0	2.31
141	132	1.5	0.30	3.4	2.3	2.2	3.08
155	144	2	0.30	3.4	2.3	2.2	4.38
168	160	2	0.24	4.3	2.9	2.8	4.84

## ■ Bearings for Continuous Casting Machines

### SWR™ Bearings (Spherical Roller Bearings)

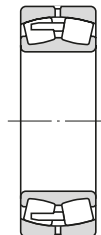
Bore Diameter 110 – 140 mm



EA

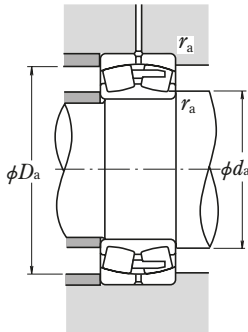


C, CD



CA

Boundary Dimensions (mm)				Basic Load Ratings				Bearing Designation	Abutment	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)	<i>C<sub>r</sub></i> (kN)	<i>C<sub>0r</sub></i> (kgf)		<i>d<sub>a</sub></i> min.	<i>d<sub>a</sub></i> max.
<b>110</b>	170	45	2	293	465	29 900	47 500	<b>23022SWRCDE4</b>	120	124
	170	45	2	293	465	30 900	47 500	<b>23022SWRCAME4</b>	120	—
	170	60	2	380	645	38 500	66 000	<b>24022SWRCE4</b>	120	121
	180	56	2	480	630	49 000	64 000	<b>23122SWRCAME4</b>	120	—
	180	69	2	460	750	47 000	76 500	<b>24122SWRCE4</b>	120	123
	200	53	2.1	605	645	61 500	66 000	<b>22222SWREAE4</b>	122	129
	200	53	2.1	425	585	43 500	59 500	<b>22222SWRCAME4</b>	122	—
	200	69.8	2.1	645	760	65 000	77 500	<b>23222SWRCAME4</b>	122	—
	240	80	3	1030	1120	10 500	115 000	<b>22322SWREAE4</b>	124	145
	180	46	2	315	525	32 000	53 500	<b>23024SWRCDE4</b>	130	134
	180	46	2	395	525	40 000	53 500	<b>23024SWRCAME4</b>	130	—
	180	60	2	395	705	40 500	72 000	<b>24024SWRCE4</b>	130	131
<b>120</b>	180	60	2	480	680	49 000	69 000	<b>24024SWRCAME4</b>	130	131
	200	80	2	575	950	58 500	96 500	<b>24124SWRCE4</b>	130	136
	200	80	2	695	905	70 500	92 000	<b>24124SWRCAME4</b>	130	—
	215	58	2.1	490	690	50 000	70 000	<b>22224SWRCAME4</b>	132	—
	215	76	2.1	790	970	80 500	99 000	<b>23224SWRCAME4</b>	132	—
	260	86	3	845	1 120	80 600	115 000	<b>22324SWRCAME4</b>	134	—
	200	52	2	400	655	40 500	67 000	<b>23026SWRCDE4</b>	140	147
	200	69	2	495	865	50 500	88 000	<b>24026SWRCE4</b>	140	143
	200	69	2	620	865	60 300	88 000	<b>24026SWRCAME4</b>	140	—
	210	80	2	590	1 010	60 000	103 000	<b>24126SWRCE4</b>	140	146
	210	80	2	590	1 010	60 000	103 000	<b>24126SWRCAME4</b>	140	—
	230	64	3	820	940	83 500	96 000	<b>22226SWREAE4</b>	144	152
<b>130</b>	230	64	3	565	815	57 500	83 000	<b>22226SWRCAME4</b>	144	—
	230	80	3	875	1 080	89 500	110 000	<b>23226SWRCAME4</b>	144	—
	210	53	2	420	715	43 000	73 000	<b>23028SWRCDE4</b>	150	157
	210	69	2	525	945	53 500	96 500	<b>24028SWRCE4</b>	150	154
	210	69	2	635	905	64 500	92 500	<b>24028SWRCAME4</b>	150	—
	210	53	2	420	715	43 000	73 000	<b>23028SWRCDE4</b>	150	157
	210	69	2	525	945	53 500	96 500	<b>24028SWRCE4</b>	150	154
	210	69	2	635	905	64 500	92 500	<b>24028SWRCAME4</b>	150	—

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

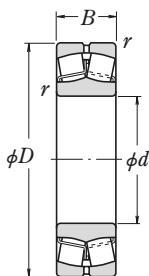
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
160	153	2	0.24	4.2	2.8	2.8	3.76
160	153	2	0.24	4.2	2.8	2.8	3.74
160	148	2	0.32	3.1	2.1	2.1	4.96
170	158	2	0.28	3.5	2.4	2.3	5.67
170	154	2	0.36	2.8	1.9	1.8	6.84
188	178	2	0.25	4.0	2.7	2.6	6.99
188	176	2	0.24	4.2	2.8	2.7	7.26
188	170	2	0.34	3.0	2.0	1.9	9.58
226	206	2.5	0.33	3.1	2.1	2.0	17.6
170	163	2	0.22	4.5	3.0	2.9	4.11
170	163	2	0.22	4.5	3.0	2.9	4.11
170	158	2	0.32	3.2	2.1	2.1	5.33
170	158	2	0.32	3.2	2.1	2.1	5.33
190	171	2	0.37	2.7	1.8	1.8	10
190	171	2	0.37	2.7	1.8	1.8	9.86
203	189	2	0.25	4.1	2.7	2.7	9.05
203	182	2	0.34	2.9	2.0	1.9	12
246	219	2.5	0.35	2.9	2.0	1.9	22.3
190	180	2	0.23	4.3	2.9	2.9	5.98
190	175	2	0.31	3.2	2.2	2.1	7.84
190	175	2	0.31	3.2	2.2	2.1	7.83
200	180	2	0.35	2.9	1.9	1.9	10.7
200	180	2	0.37	2.7	1.8	1.8	10.6
216	204	2.5	0.26	3.8	2.6	2.5	11
216	203	2.5	0.26	3.9	2.6	2.6	11.3
216	196	2.5	0.34	2.9	2.0	1.9	14.3
200	190	2	0.22	4.5	3.0	2.9	6.49
200	186	2	0.29	3.4	2.3	2.2	8.37
200	186	2	0.31	3.2	2.2	2.1	8.32

# Bearing for Continuous Casting Machines

## SWR™ Bearings (Spherical Roller Bearings)

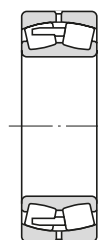
Bore Diameter 140 – 180 mm



EA

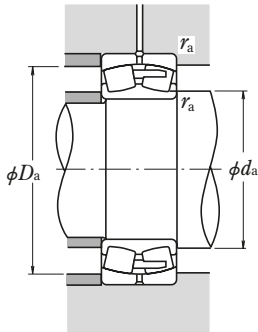


C, CD



CA

Boundary Dimensions (mm)				Basic Load Ratings (kN) (kgf)				Bearing Designation	Abutment	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		<i>d<sub>a</sub></i> min.	max.
140	225	68	2.1	725	945	73 500	96 500	23128SWRCAME4	152	—
	225	85	2.1	670	1 160	68 500	118 000	24128SWRCE4	152	156
	225	85	2.1	835	1 160	85 500	118 000	24128SWRCAME4	152	—
	250	68	3	645	930	65 500	95 000	22228SWRCDE4	154	167
	250	68	3	835	945	85 500	96 500	22228SWRCAME4	154	—
	250	88	3	835	1 300	85 000	133 000	23228SWRCAME4	154	—
	225	56	2.1	470	815	48 000	83 000	23030SWRCDE4	162	168
	225	75	2.1	590	1 090	60 500	111 000	24030SWRCE4	162	165
	225	75	2.1	740	1 090	75 500	111 000	24030SWRCAME4	162	—
150	250	80	2.1	725	1 180	74 000	121 000	23130SWRCE4	162	174
	250	100	2.1	890	1 530	91 000	156 000	24130SWRCE4	162	169
	270	73	3	765	1 120	78 000	114 000	22230SWRCDE4	164	179
	270	96	3	975	1 560	99 500	159 000	23230SWRCE4	164	176
	240	60	2.1	540	955	55 000	97 500	23032SWRCDE4	172	179
	240	80	2.1	680	1 260	69 000	128 000	24032SWRCE4	172	177
	240	80	2.1	845	1 260	86 500	128 000	24032SWRCAE3	172	—
	270	109	2.1	1 040	1 760	106 000	179 000	24132SWRCE4	172	179
	290	80	3	910	1 320	93 000	135 000	22232SWRCDE4	174	190
170	290	80	3	1 140	1 320	116 000	135 000	22232SWRCAME4	174	—
	260	67	2.1	640	1 090	65 000	112 000	23034SWRCDE4	182	191
	260	90	2.1	825	1 520	84 000	155 000	24034SWRCE4	182	188
	280	88	2.1	940	1 570	96 000	160 000	23134SWRCAME4	182	—
	280	109	2.1	1 080	1 860	110 000	190 000	24134SWRCE4	182	190
	310	86	4	990	1 500	101 000	153 000	22234SWRCDE4	188	206
	310	110	4	1 200	1 910	122 000	195 000	23234SWRCE4	188	201
	280	74	2.1	750	1 270	76 000	129 000	23036SWRCDE4	192	202
	280	100	2.1	965	1 750	98 500	178 000	24036SWRCE4	192	200
180	280	100	2.1	1 210	1 750	123 000	178 000	24036SWRCAME4	192	—
	300	96	3	1 320	1 760	134 000	180 000	23136SWRCAME4	194	—
	300	118	3	1 190	2 040	121 000	208 000	24136SWRCE4	194	202
	300	118	3	1 490	2 040	152 000	208 000	24136SWRCAME4	194	—
	320	86	4	1 020	1 540	104 000	157 000	22236SWRCDE4	198	212

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

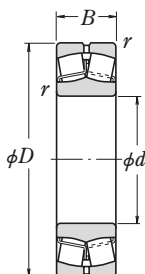
The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
213	198	2	0.28	3.6	2.4	2.3	10.5
213	193	2	0.35	2.9	1.9	1.9	13
213	192	2	0.37	2.7	1.8	1.8	12.9
236	219	2.5	0.25	4.0	2.7	2.6	14.5
236	221	2.5	0.26	3.9	2.6	2.5	14.2
236	213	2.5	0.35	2.9	2.0	1.9	18.8
213	203	2	0.22	4.6	3.1	3.0	7.9
213	198	2	0.30	3.4	2.3	2.2	10.5
213	198	2	0.30	3.4	2.3	2.2	10.4
238	218	2	0.30	3.4	2.3	2.2	15.8
238	212	2	0.38	2.6	1.8	1.7	19.8
256	236	2.5	0.26	3.9	2.6	2.5	18.4
256	230	2.5	0.35	2.9	1.9	1.9	24.2
228	216	2	0.22	4.5	3.0	2.9	9.66
228	212	2	0.30	3.4	2.3	2.2	12.7
228	212	2	0.30	3.4	2.3	2.2	12.3
258	229	2	0.39	2.6	1.7	1.7	25.4
276	255	2.5	0.26	3.8	2.6	2.5	23.1
276	255	2.5	0.26	3.8	2.6	2.5	23.1
248	233	2	0.23	4.3	2.9	2.8	13
248	228	2	0.31	3.2	2.2	2.1	17.3
268	245	2	0.29	3.5	2.3	2.3	21.6
268	239	2	0.37	2.7	1.8	1.8	26.6
292	270	3	0.26	3.8	2.6	2.5	28.8
292	261	3	0.34	2.9	2.0	1.9	36.4
26	249	2	0.24	4.2	2.8	2.8	17.1
268	245	2	0.32	3.1	2.1	2.0	22.7
268	245	2	0.32	3.1	2.1	2.0	22.5
286	260	2.5	0.31	3.3	2.2	2.2	27.4
286	255	2.5	0.37	2.7	1.8	1.8	33.1
286	255	2.5	0.37	2.7	1.8	1.8	33
302	278	3	0.26	3.9	2.6	2.6	30.2

## ■ Bearings for Continuous Casting Machines

### SWR™ Bearings (Spherical Roller Bearings)

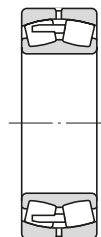
Bore Diameter 190 – 240 mm



EA

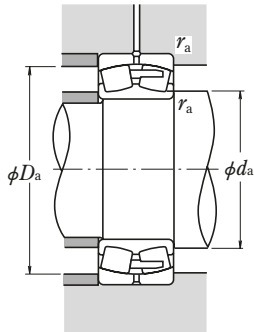


C, CD



CA

Boundary Dimensions (mm)				Basic Load Ratings (kN) (kgf)				Bearing Designation	Abutment	
<i>d</i>	<i>D</i>	<i>B</i>	<i>r</i> min.	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>	<i>C<sub>r</sub></i>	<i>C<sub>0r</sub></i>		<i>d<sub>a</sub></i> min.	max.
<b>190</b>	290	75	2.1	970	1 350	99 000	138 000	<b>23038SWRCAME4</b>	202	—
	290	100	2.1	975	1 840	99 500	188 000	<b>24038SWRCE4</b>	202	210
	290	100	2.1	1 220	1 840	124 000	188 000	<b>24038SWRCAME4</b>	202	—
	320	128	3	1 370	2 330	140 000	238 000	<b>24138SWRCE4</b>	204	211
	320	128	3	1 710	2 330	175 000	238 000	<b>24138SWRCAME4</b>	204	—
	340	92	4	1 140	1 730	116 000	176 000	<b>22238SWRCAME4</b>	208	—
	340	120	4	1 440	2 350	147 000	240 000	<b>23238SWRCE4</b>	208	222
	310	82	2.1	1 180	1 700	120 000	174 000	<b>23040SWRCAME4</b>	212	—
	310	109	2.1	1 140	2 120	116 000	216 000	<b>24040SWRCE4</b>	212	223
	310	109	2.1	1 420	2 120	145 000	216 000	<b>24040SWRCAME4</b>	212	—
<b>200</b>	340	140	3	1 570	2 670	160 000	272 000	<b>24140SWRCE4</b>	214	226
	340	140	3	1 960	2 660	199 000	271 000	<b>24140SWRCAME4</b>	214	—
	360	98	4	1 300	2 010	133 000	204 000	<b>22240SWRCAME4</b>	218	—
	340	90	3	1 360	1 980	139 000	202 000	<b>23044SWRCAME4</b>	234	—
	340	118	3	1 640	2 490	168 000	265 000	<b>24044SWRCE4</b>	234	244
	340	118	3	1 310	2 490	134 000	254 000	<b>24044SWRCAME4</b>	234	—
<b>220</b>	370	150	4	1 800	3 200	183 000	325 000	<b>24144SWRCE4</b>	238	248
	370	150	4	1 800	3 200	183 000	325 000	<b>24144SWRCAME4</b>	238	—
	400	108	4	1 570	2 430	160 000	247 000	<b>22244SWRCAME4</b>	238	—
	400	144	4	2 010	3 400	206 000	350 000	<b>23244SWRCE4</b>	238	260
	360	118	3	1 730	2 730	176 000	278 000	<b>24048SWRCAME4</b>	254	—
<b>240</b>	400	160	4	2 660	3 800	272 000	385 000	<b>24148SWRCAME4</b>	258	—

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

The values of  $e$ ,  $Y_2$ ,  $Y_3$ , and  $Y_0$  are given in the table below.

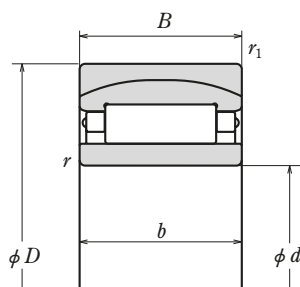
and Fillet Dimensions (mm)			Constant $e$	Axial Load Factors			Mass (kg) approx.
$D_a$ max.	$D_a$ min.	$r_a$ max.		$Y_2$	$Y_3$	$Y_0$	
278	261	2	0.24	4.2	2.8	2.8	17.6
278	253	2	0.31	3.2	3.2	2.1	24
278	253	2	0.32	3.1	2.1	2.0	23.8
306	269	2.5	0.4	2.5	1.7	1.6	41.5
306	269	2.5	0.38	2.6	1.8	1.7	40.9
322	296	3	0.26	3.8	2.6	2.5	35.5
322	288	3	0.35	2.9	1.9	1.9	47.6
298	279	2	0.25	4.0	2.7	2.6	22.6
298	271	2	0.32	3.1	2.1	2.0	30.4
298	271	2	0.33	3.0	2.0	2.0	30.2
326	290	2.5	0.39	2.6	1.8	1.7	51.3
326	290	2.5	0.39	2.5	1.7	1.7	50.8
342	315	3	0.26	3.8	2.6	2.5	42.6
326	302	2.5	0.24	4.1	2.8	2.7	29.7
326	296	2.5	0.31	3.2	2.1	2.1	40.5
326	296	2.5	0.32	3.2	2.1	2.1	39
352	313	3	0.39	2.6	1.7	1.7	66.7
352	313	3	0.39	2.6	1.7	1.7	64.3
382	348	3	0.27	3.7	2.5	2.4	59
382	337	3	0.35	2.9	1.9	1.9	80.4
346	317	2.5	0.30	3.3	2.2	2.2	42.2
382	341	3	0.38	2.7	1.8	1.8	79.6

# ■ Bearings for Continuous Casting Machines

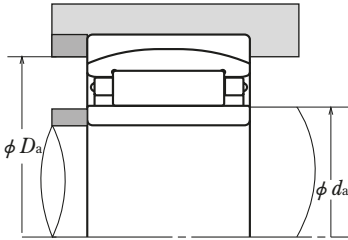
## RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 90 – 240 mm

With Cage



Boundary Dimensions (mm)						Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>b</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>90</b>	160	56	50	1.1	2	220	335
	170	68	52.4	2	2	270	375
	190	64	64	3	3	340	490
<b>100</b>	165	52	52	2	1.1	221	385
	165	58	52	2	1.1	221	385
	180	46	46	2.1	2.1	251	375
	215	73	73	3	1.5	435	595
<b>110</b>	170	75	45	1.1	1.1	191	325
<b>120</b>	180	46	46	2.5	2.5	215	415
	180	76	46	2	2	215	415
	200	80	80	2	2	370	680
<b>124.96</b>	255	133	66	2.1	5	430	590
<b>130</b>	200	79	52	2	2	261	440
	230	90	90	3	3	540	930
<b>140</b>	250	68	68	3	3	480	740
<b>150</b>	250	100	100	2.1	2.1	540	1 040
	270	130	96	3	3	690	1 210
<b>180</b>	280	100	100	2.1	2.1	635	1 300
	300	136	96	3	3	630	1 250
	300	158	118	3	3	755	1 460
	320	140	112	4	4	950	1 690
<b>200</b>	310	82	82	2.5	2.5	635	1 210
	310	109	109	2.1	2.1	770	1 540
	340	140	140	3	3	1 080	2 200
<b>220</b>	380	120	120	4	4	1 090	1 950
	400	108	108	4	4	1 040	1 770
<b>240</b>	400	150	128	4	4	1 260	2 500



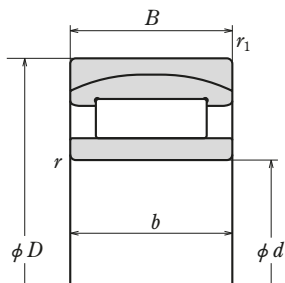
Bearing Designation	Abutment and Fillet Dimensions (mm)		
	$d_a$ min.	$d_a$ max.	$D_a$ min.
<b>90RUB1601P</b>	99	105	143
<b>90RUB1702P</b>	99	106	153
<b>90RUB1908P</b>	103	109	166
<b>100RUB31AP</b>	106.5	113	147
<b>100RUB1602P</b>	106.5	113	147
<b>100RUB22P</b>	111	117	163
<b>100RUB23P</b>	108	125	190
<b>110RUB1701P</b>	116.5	121	155
<b>120RUB30P</b>	132	133	165
<b>120RUB1801P</b>	129	133	166
<b>120RUB41P</b>	129	136	174
<b>125RUB2502P</b>	144.96	154	229
<b>130RUB2001P</b>	139	144	184
<b>130RUB2301P</b>	143	149	200
<b>140RUB22P</b>	153	161	227
<b>150RUB41P</b>	161	169	219
<b>150RUB2702P</b>	163	172	236
<b>180RUB40P</b>	191	200	250
<b>180RUB3002P</b>	193	203	260
<b>180RUB3001P</b>	193	203	260
<b>180RUB3201P</b>	196	207	279
<b>200RUB30P</b>	213	222	286
<b>200RUB40P</b>	211	222	280
<b>200RUB41P</b>	213	229	295
<b>220RUB3801P</b>	236	251	341
<b>220RUB22E1P</b>	236	255	358
<b>240RUB4001P</b>	256	269	362

## ■ Bearings for Continuous Casting Machines

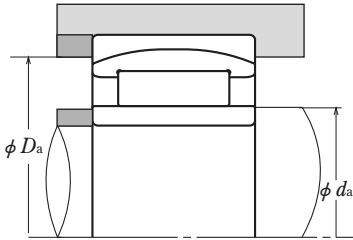
### RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 50 – 110 mm

Full Complement



Boundary Dimensions (mm)						Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>b</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>50</b>	90	23	23	1.5	1.5	69.5	104
	110	40	40	2	2	140	295
<b>55</b>	90	32	32	1.1	1.1	82	195
	100	25	25	1.5	1.5	88	121
<b>65</b>	120	31	31	1.5	1.5	131	200
	140	48	48	2.1	2.1	221	440
<b>70</b>	125	31	31	1.5	1.5	127	213
<b>75</b>	130	31	31	1.5	1.5	151	248
<b>85</b>	150	65	65	2.5	2.5	286	595
<b>90</b>	150	72	60	1.5	1	262	575
	190	64	64	3	1.5	415	780
<b>100</b>	150	50	50	2	2	230	530
	150	66	50	2	2	230	530
	165	52	52	2	2	272	550
	180	46	46	2.1	2.1	277	545
	180	60.3	60.3	2.1	2.1	360	650
<b>103</b>	180	60	60	2	2	330	790
<b>110</b>	170	45	45	2	2	246	565
	170	60	60	2	2	300	735
	180	56	56	2.5	2.5	335	670
	180	69	69	2	2	385	835
	200	53	53	2.5	2.1	380	625



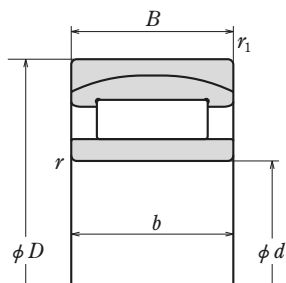
Bearing Designation	Abutment and Fillet Dimensions (mm)		
	$d_a$ min.	$d_a$ max.	$D_a$ min.
<b>50RUB22PV</b> <b>50RUB23PV</b>	57 59	58 70	80 94
<b>55RUB9001PV</b> <b>55RUB22APV</b>	61.5 62	62.5 63	80 90
<b>65RUB22PV</b> <b>65RUB23PV</b>	73 76	75 85	107 121
<b>70RUB22APV</b>	78	85	113
<b>75RUB22APV</b>	83	85	118
<b>85RUB1501P</b>	97	98	130
<b>90RUB1501PV</b> <b>90RUB23APV</b>	95 98	101 116	131 168
<b>100RUB40PV</b> <b>100RUB1501PV</b> <b>100RUB31PV</b>	108 108 109	109 109 113	134 134 147
<b>100RUB22APV</b> <b>100RUB32PV</b>	111 111	123 116	164 160
<b>103RUB1801PV</b>	112	132	163
<b>110RUB30A1PV</b> <b>110RUB40PV</b> <b>110RUB31A1PV</b>	119 119 123	123 123 124	155 151 161
<b>110RUB41A2PV</b> <b>110RUB22APV</b>	119 121	123 130	157 180

# Bearing s for Continuous Casting Machines

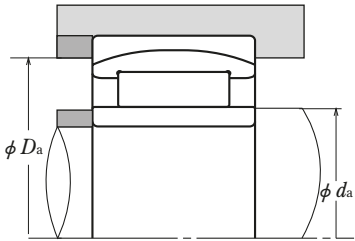
## RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 120 – 160 mm

Full Complement



Boundary Dimensions (mm)						Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>b</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
120	180	46	46	2	2	275	625
	180	60	60	2	2	330	790
	180	80	60	2	2	330	790
	200	80	80	2.5	2.5	470	1 040
	225	58	58	2.5	2.5	460	690
130	200	69	69	2	2	410	955
	210	64	64	2	2	415	865
	210	80	80	2	2	510	1 130
	230	64	64	3	3	495	840
	230	80	80	3	3	585	1 090
140	210	53	53	2	2	365	885
	210	69	69	2	2	420	990
	225	68	68	2.1	2.1	485	1 000
	225	85	85	2.1	2.1	575	1 310
	250	68	68	3	3	510	1 110
150	250	88	88	3	3	670	1 500
	225	56	56	2.5	2.5	390	840
	225	75	75	2.1	2.1	485	1 210
	225	92	75	2.1	2.1	465	1 160
	250	80	80	2.1	2.1	595	1 290
160	250	100	100	2.1	2.1	710	1 620
	270	96	96	3	3	815	1 640
	240	80	80	2.1	2.1	530	1 330
	240	85	80	2.1	2.1	530	1 330
	270	109	109	2.1	2.1	855	1 830



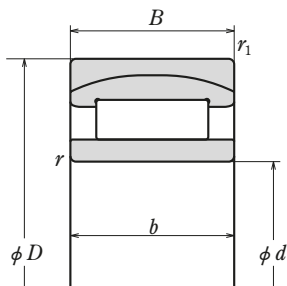
Bearing Designation	Abutment and Fillet Dimensions (mm)		
	$d_a$ min.	$d_a$ max.	$D_a$ min.
<b>120RUB30B2PV</b>	129	132	165
<b>120RUB40A2PV</b>	129	132	163
<b>120RUB1803PV</b>	129	132	163
<b>20RUB41A1PV</b>	133	137	174
<b>120RUB2201APV</b>	133	138	204
<b>130RUB40A1PV</b>	139	143	180
<b>130RUB31APV</b>	139	144	189
<b>130RUB41A2PV</b>	139	144	184
<b>130RUB22APV</b>	143	151	208
<b>130RUB32APV</b>	143	146	204
<b>140RUB30A2PV</b>	149	155	194
<b>140RUB40APV</b>	149	152	190
<b>140RUB31APV</b>	151	156	203
<b>140RUB41A1PV</b>	151	156	200
<b>140RUB22APV</b>	153	172	227
<b>140RUB32PV</b>	153	170	221
<b>150RUB30APV</b>	163	166	208
<b>150RUB40A1PV</b>	161	165	203
<b>150RUB2201PV</b>	161	164	203
<b>150RUB31APV</b>	161	170	221
<b>150RUB41APV</b>	161	170	219
<b>150RUB32APV</b>	163	174	236
<b>160RUB40A1PV</b>	171	176	217
<b>160RUB2402PV</b>	171	176	217
<b>160RUB41AE2PV</b>	171	181	237

## ■ Bearings for Continuous Casting Machines

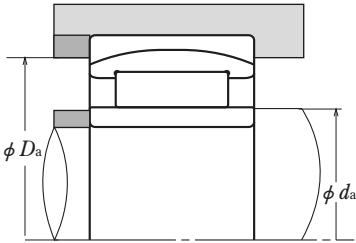
### RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 170 – 240 mm

Full Complement



Boundary Dimensions (mm)						Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>b</i>	<i>r</i> min.	<i>r</i> <sub>1</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>170</b>	260	67	67	2.1	2.1	555	1 130
	260	90	90	2.1	2.1	655	1 580
	310	110	110	4	4	1 060	2 090
<b>180</b>	280	100	100	2.5	2.5	785	1 870
	300	118	118	3	3	940	2 120
	320	112	112	4	4	1 090	2 190
<b>190</b>	290	100	100	2.1	2.1	850	2 100
	320	104	104	3	3	1 050	2 240
	340	120	120	4	4	1 210	2 430
<b>200</b>	310	109	109	2.1	2.1	1 030	2 550
	340	112	112	3	3	1 160	2 470
	340	140	140	3	3	1 340	3 100
<b>220</b>	340	90	90	3	3	905	2 020
	340	118	118	3	3	1 110	2 630
	340	135	118	3	3	1 010	2 670
	370	150	150	4	4	1 510	3 500
<b>240</b>	400	128	128	4	4	1 540	3 400



Bearing Designation	Abutment and Fillet Dimensions (mm)		
	$d_a$ min.	$d_a$ max.	$D_a$ min.
<b>170RUB30APV</b>	181	188	239
<b>170RUB40A1PV</b>	181	188	233
<b>170RUB32APV</b>	186	195	273
<b>180RUB40APV</b>	193	198	250
<b>180RUB41APV</b>	193	202	260
<b>180RUB32APV</b>	196	204	279
<b>190RUB40A1PV</b>	201	210	260
<b>190RUB31APV</b>	203	214	286
<b>190RUB32APV</b>	206	218	297
<b>200RUB40A1PV</b>	211	219	280
<b>200RUB31APV</b>	213	230	305
<b>200RUB41APV</b>	213	230	295
<b>220RUB30PV</b>	233	243	313
<b>220RUB40APV</b>	233	243	308
<b>220RUB3401PV</b>	233	247	308
<b>220RUB41APV</b>	236	248	322
<b>240RUB31APV</b>	256	271	362

# Bearings for Continuous Casting Machines

## RNPH Series Split Cylindrical Roller Bearings (for Segmented Rolls)

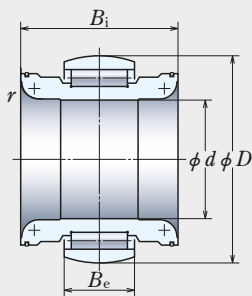


Fig. 1

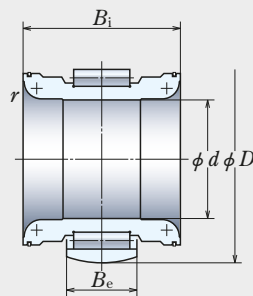


Fig. 2

Bearing Designation	Boundary Dimensions (mm)			
	$d$	$D$	$B_i$	$B_e$
<b>100RNPH1801</b>	100	185	169	74
<b>110RNPH1801</b>	110	180	137	49
<b>110RNPH1803</b>	110	185	154	76
<b>110RNPH2001</b>	110	200	179	80
<b>115RNPH2001</b>	115	205	202	98
<b>120RNPH1901</b>	120	195	157	66
<b>120RNPH2001</b>	120	205	179	80
<b>130RNP2001</b>	130	205	139	60
<b>130RNP2101</b>	130	215	174	75
<b>130RNPH2105</b>	130	215	143	60
<b>130RNPH2107</b>	130	215	174	75
<b>130RNPH2201</b>	130	225	189	90
<b>130RNPH2202</b>	130	220	186	79
<b>135RNPH2101</b>	135	215	183	84
<b>135RNPH2102</b>	135	210	183	84
<b>140RNPH2102</b>	140	215	162	60
<b>140RNPH2103</b>	140	215	189	74
<b>140RNPH2302</b>	140	235	194	84
<b>140RNP2401</b>	140	245	184	85
<b>145RNPH2201</b>	145	225	179	76
<b>145RNPH2303</b>	145	232	196	84
<b>145RNPH2401</b>	145	240	208	89
<b>150RNPH2303</b>	150	230	199	78
<b>150RNPH2401</b>	150	245	159	80
<b>150RNPH2403</b>	150	240	195	84
<b>150RNPH2503</b>	150	250	169	70
<b>150RNPH2505</b>	150	250	208	89
<b>150RNPH2601</b>	150	265	187	98
<b>150RNPH2702</b>	150	275	199	100
<b>155RNPH2401</b>	155	245	199	88
<b>160RNPH2502</b>	160	255	199	90
<b>160RNPH2504</b>	160	255	189	86
<b>160RNPH2601</b>	160	265	200	82
<b>160RNPH2703</b>	160	275	214	100
<b>170RNPH2601</b>	170	265	214	100
<b>180RNPH2901</b>	180	290	214	85

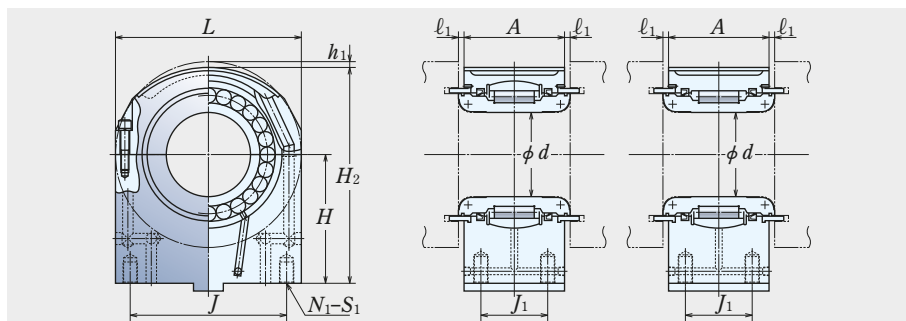
**Remark** Other bearings are available. Please contact NSK for additional information.



$r$	Basic Load Ratings (kN)		Roll Diameter (mm)	Fig.
	$C_r$	$C_{0r}$		
15	475	950	225	2
15	272	570	230	2
20	450	1 070	230	2
20	535	1 090	250	2
15	625	1 460	240	2
20	410	950	250	2
20	560	1 220	255	2
20	455	1 030	270	1
20	540	1 190	280	1
20	460	975	250	2
20	550	1 230	250	2
20	670	1 460	280	2
20	555	1 370	280	2
20	570	1 350	250	2
20	515	1 350	250	2
20	415	950	270	2
2.5	490	1 170	265	2
20	665	1 530	285	2
20	710	1 510	310	1
20	560	1 340	280	2
20	630	1 440	280	2
20	765	1 780	295	2
2.5	555	1 340	280	2
20	680	1 550	280	2
18	690	1 630	290	2
20	640	1 500	300	2
20	780	1 840	295	2
20	900	1 950	320	2
20	945	1 970	330	2
20	740	1 720	300	2
20	735	1 730	310	2
20	745	1 780	305	2
20	745	1 700	320	2
25	945	2 190	325	2
20	880	2 050	330	2
20	880	2 050	335	2

# Bearings for Continuous Casting Machines

## PCR Series Plummer Units for Split Cylindrical Roller Bearings



Bearing Designation	Shaft Diameter (mm)		<i>L</i>	<i>A</i>	<i>H</i>
	<i>d</i>				
<b>100PCR2201</b>	100		235	152	132
<b>110PCR2301</b>	110		230	120	160
<b>110PCR2303</b>	110		230	135	180
<b>110PCR2502</b>	110		250	156	150
<b>115PCR2401</b>	115		245	183	190
<b>120PCR2501</b>	120		250	142	165
<b>120PCR2502</b>	120		255	162	230
<b>130PCR2701</b>	130		265	118	190
<b>130PCR2801</b>	130		280	156	160
<b>130PCR2705</b>	130		270	132	197
<b>130PCR2604</b>	130		265	175	145
<b>130PCR2802</b>	130		280	172	180
<b>130PCR2603</b>	130		265	171	175
<b>135PCR2701</b>	135		270	160	160
<b>135PCR2502</b>	135		250	160	160
<b>140PCR2701</b>	140		270	145	180
<b>140PCR2601</b>	140		265	174	175
<b>140PCR2804</b>	140		285	179	175
<b>140PCR3101</b>	140		310	166	175
<b>145PCR2801</b>	145		280	162	250
<b>145PCR2804</b>	145		280	183	260
<b>145PCR2901</b>	145		295	195	270
<b>150PCR2801</b>	150		280	184	175
<b>150PCR280</b>	150		330	144	310
<b>150PCR3004</b>	150		305	180	205.5
<b>150PCR3003</b>	150		300	150	180
<b>150PCR2901</b>	150		295	193	310
<b>150PCR3203</b>	150		320	168	220
<b>150PCR3301</b>	150		330	182	220
<b>155PCR3001</b>	155		300	182	260
<b>160PCR3101</b>	160		310	178	185
<b>160PCR3002</b>	160		305	174	217
<b>160PCR3302</b>	160		330	185	225
<b>160PCR3401</b>	160		340	199	200
<b>170PCR3301</b>	170		320	194	290.5
<b>180PCR3301</b>	180		335	150	217.5

**Remark** Other bearings are available. Please contact NSK for additional information.



Boundary Dimensions (mm)

$h_1$	$H_2$	$\ell_1$	$J$	$J_1$	$N_1$	$S_1$
10	234.5	9	165	100	4	M20
10	265	9.5	140	—	2	M30
10	285	10	170	—	2	M30
11.5	263.5	12	—	—	1	M36
10	300	10	150	—	2	M24
11.5	278.5	9	190	90	4	M24
10	347.5	9	205	100	4	M24
11.5	313.5	11	195	65	4	M30
10	290	9.5	200	100	4	M24
9	313	6	220	93	4	3/4-10UNC
10	260	7.5	210	120	4	M16
11.5	308.5	9	220	110	4	M30
12.5	295	8	230	90	4	M20
10	275	12	180	130	4	M20
10	275	12	150	130	4	M20
10	305	9.5	170	—	2	M30
7.5	300	8	230	130	4	M20
12.5	305	8	250	97.5	4	M20
10	320	9.5	220	110	4	M24
10	380	9	220	100	4	M30
10	390	7	220	123	4	M30
10	407.5	7	230	130	4	M30
10	305	8	230	140	4	M20
10	440	8	350	260	4	φ33
14.5	336	8	230	120	4	M24
10	320	10	195	90	4	M30
10	447.5	8	215	126	4	M30
15	365	10	240	90	4	M36
11.5	373.5	9	260	110	4	M36
10	400	9	240	110	4	M30
16.5	323.5	11	150	—	2	M30
12.5	357	8	255	135	4	3/4-10UNC
20	365	8	250	130	4	M24
15.5	347	8	290	130	4	M20
10	445.5	10.5	260	340	4	φ26
10	375	10	240	82	4	M30

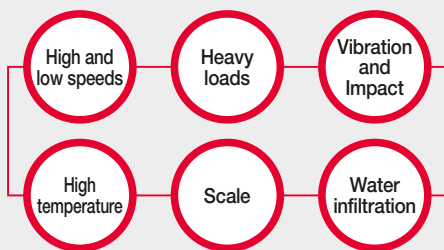
# Bearings for Rolling Mills

## Four-Row Tapered Roller Bearings for Roll Necks

### Benefits

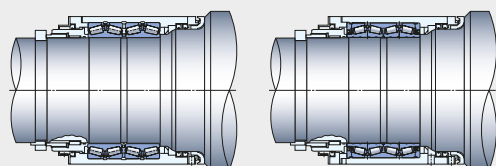
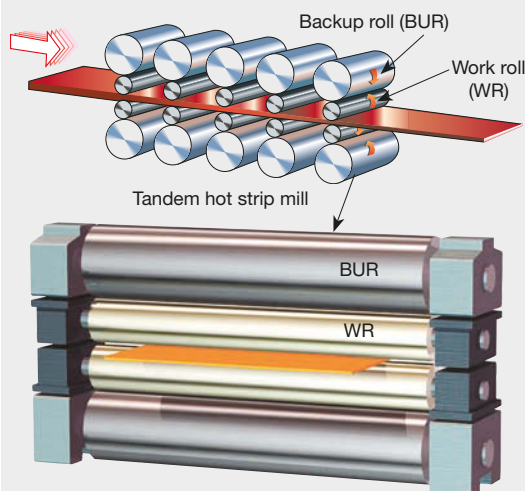
- ❶ Higher reliability and longer operating life prevent unexpected accidents
- ❷ Bearing seal requires less cleaning of work environment and reduces grease consumption
- ❸ Lower maintenance costs

### 1. Operating conditions



Major target mills:

- Hot strip mills
- Cold rolling mills
- Skin pass mills
- Temper rolling mills

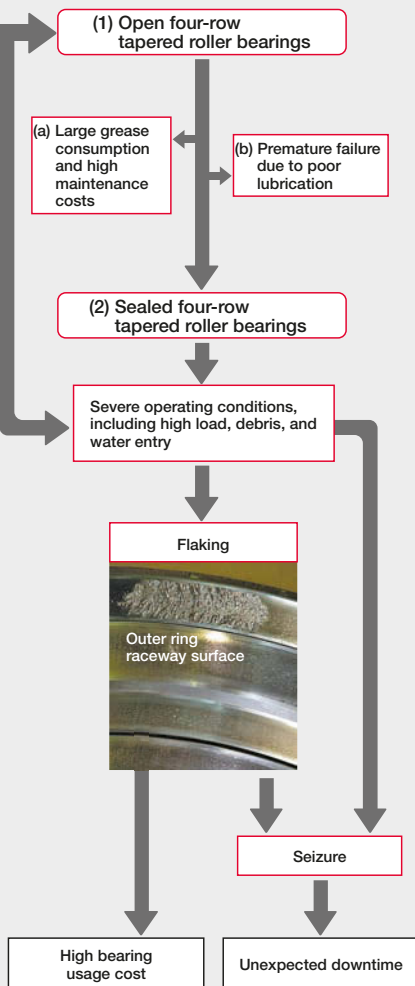


(1) Open four-row tapered roller bearing

(2) Sealed four-row tapered roller bearing

### 2. Problems

#### Typical problems for work roll bearings





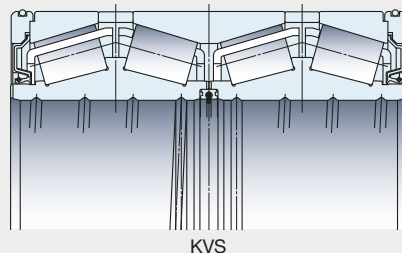
(\*1)

### 3. Countermeasures

#### ■ Design countermeasures

##### Features KVS Series Extra-Capacity Sealed-Clean™ Four-Row Tapered Roller Bearings

- Load capacity increased by 15%~35% compared to conventional sealed bearings
- Adoption of Super-TF™ steel as standard
- A new type of intermediate seal controls negative pressure during operation to prevent infiltration of water
- Improved sealing through usage of heat- and wear-resistant sealing materials
- Easier handling of seals



KVS

#### ■ Material Countermeasures 1

##### Features Super-TF™ Bearings

- Adoption of Super-TF™ material
- Control of retained austenite reduces stress concentrations resulting from dents caused by infiltration of debris

	Comparison of Actual Life Extension in Field Test		
Conventional Sealed Bearing	1		
KVS Bearing	2		

Super-TF™ steel is standard for the KVS Series but can also be used with the KVE Series.

#### ■ Material Countermeasures 2

##### Features Water-TF™ Bearings-WTF Series

- Adoption of super-clean steel with an optimum alloy balance controls development and progress of cracks caused by water infiltration at early stages of flaking
- Control of retained austenite reduces stress concentrations resulting from dents caused by infiltration of debris

	Comparison of Actual Life Extension in Field Test		
Conventional Steel	1		
Material for Water TF Bearing	3		

Water-TF™ steel is used as a special-purpose specification for the KVS Series, though it can also be used with the KVE Series.

**Note** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.

## ■ Bearings for Rolling Mills

### Super-TF/Water-TF Series Sealed Four-Row Tapered Roller Bearings (Figures of Typical Four-Row Tapered Roller Bearings)

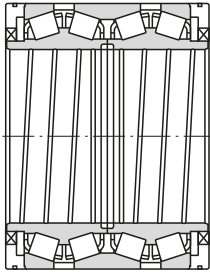


Fig. 1 Basic Design of Two-Seal Type (KVE)

	Variations
1-1	Oil holes in outer ring spacers
1-2	Without an intermediate bore seal (for dry rolling)
1-3	Without an intermediate bore seal, with holes in outer ring spacers
1-4	With inner ring spacer, with an intermediate bore seal
1-5	For vertical rolls (special outer ring spacers)

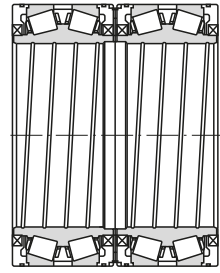
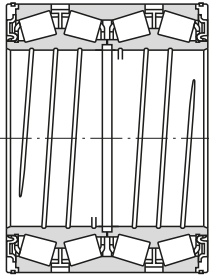


Fig. 2 Basic Design of Four-Seal Type (KVE)

	Variations
2-1	Oil holes in outer ring spacers
2-2	Clearance between inner ring faces

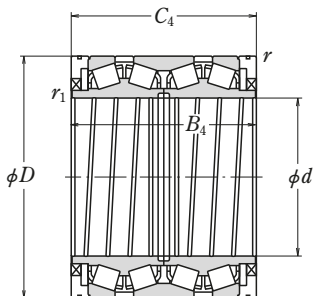
**Fig. 3 Basic Design of Two-Seal Type (KVS)**

	Variations
3-1	Oil holes in outer ring spacers

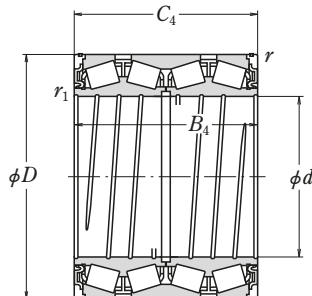
## ■ Bearings for Rolling Mills

### Super-TF/Water-TF Series Sealed Four-Row Tapered Roller Bearings

Bore Diameter 101.600 – 250 mm



KVE



KVS

Boundary Dimensions (mm/inch)						Basic Load Ratings			
$d$	$D$	$B_4$	$C_4$	$r_1$ min.	$r$ min.	$C_r$ (kN)	$C_{0r}$	$C_r$ (kgf)	$C_{0r}$
<b>101.600</b> <b>4.000</b>	200.025 7.8750	320.000 12.5984	320.000 12.5984	1.0	3.0	1 450	2 420	148 000	247 000
<b>150</b>	210	240	240	1	2.5	990	2 270	101 000	231 000
<b>170</b>	240	175	175	2.5	2.5	1 020	2 000	103 000	204 000
<b>187.325</b> <b>7.3750</b>	269.875 10.6250	230.000 9.0551	230.000 9.0551	2.0	3.3	1 460	3 200	149 000	325 000
<b>215.900</b> <b>8.5000</b>	288.925 11.3750	177.800 7.0000	177.800 7.0000	0.8	3.3	1 070	2 350	109 000	239 000
<b>216.103</b> <b>8.5080</b>	330.2 13.0000	263.525 10.3750	269.875 10.6250	1.5	3.3	2 290	4 550	233 000	465 000
<b>220</b>	295	315	315	1	2.5	1 410	3 450	144 000	350 000
	295	335	335	1	2.5	1 410	3 450	144 000	350 000
	300	270	270	2.5	2.5	1 650	4 000	168 000	410 000
	320	290	290	1.5	2.5	1 970	4 500	201 000	460 000
	330	260	260	4	3	2 330	4 800	237 000	490 000
<b>225</b>	320	230	230	1	2	1 510	3 300	154 000	335 000
<b>228.600</b> <b>9.0000</b>	400.050 15.7500	296.875 11.6880	296.875 11.6880	3.3	3.3	2 410	4 250	246 000	435 000
<b>234.950</b> <b>9.2500</b>	327.025 12.8750	196.850 7.7500	196.850 7.7500	1.5	3.3	1 550	3 200	158 000	325 000
<b>240</b>	320	250	250	3	3	1 510	3 700	154 000	375 000
	338	248	248	2	3	1 820	4 000	185 000	405 000
	338	290	290	2	3	2 120	5 000	216 000	510 000
<b>244.475</b> <b>9.6250</b>	327.025 12.8750	193.680 7.6250	193.680 7.6250	1.5	3	1 370	3 300	148 000	325 000
<b>245</b>	345	310	310	2	3	2 700	6 650	275 000	680 000
<b>250</b>	365	270	270	2.5	3	2 210	4 650	225 000	475 000
	365	270	270	2.5	3	2 210	4 650	225 000	475 000

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

Where  $Y_0 \div Y_3$

The values of  $e$ ,  $Y_2$ , and  $Y_3$  are given in the table below.

Bearing Designations		Figure <sup>(1)</sup>	Constant	Axial Load Factors		Mass (kg)
Super-TF Series	Water-TF Series					
				<i>e</i>	<i>Y</i> <sub>2</sub>	<i>Y</i> <sub>3</sub>
*STF101KVE2051Eg		1-2	0.36	2.8	1.9	47.8
STF150KVE2101Eg		1-1	0.32	3.2	2.1	26.1
STF170KVS2401Eg		3	0.32	3.2	2.1	23
*STF187KVE2651Eg		1-1	0.29	3.4	2.3	43.6
*STF215KVS2851Eg	*WTF215KVS2851Eg	3	0.49	2.1	1.4	38
*STF216KVS3351Eg	*WTF216KVS3351Eg	3	0.46	2.2	1.5	77
STF220KVE2902Eg	WTF220KVE2902Eg	2-1	0.40	2.5	1.7	61.2
STF220KVE2901Eg	WTF220KVE2901Eg	2-1	0.40	2.5	1.7	65
STF220KVE3001Eg	WTF220KVE3001Eg	1-2	0.41	2.5	1.7	56.5
STF220KVE3201Eg	WTF220KVE3201Eg	1	0.33	3.0	2.0	78.7
STF220KVS3301Eg	WTF220KVS3301Eg	3	0.40	2.5	1.7	76
STF225KVE3201Eg	WTF225KVE3201Eg	1	0.41	2.4	1.6	59.9
*STF228KVE4052Eg	*WTF228KVE4052Eg	1	0.46	2.2	1.5	161
*STF234KVS3251Eg	*WTF234KVS3251Eg	3	0.46	2.2	1.5	49
STF240KVE3202Eg	WTF240KVE3202Eg	1	0.33	3.0	2.0	56.3
STF240KVE3301Eg	WTF240KVE3301Eg	1	0.43	2.3	1.6	70.6
STF240KVE3302Eg	WTF240KVE3302Eg	1	0.42	2.4	1.6	82.6
*STF244KVS3251Eg	*WTF244KVS3251Eg	3	0.40	2.5	1.7	43
STF245KVS3402Eg	WTF245KVS3402Eg	3	0.40	2.5	1.7	85
STF250KVE3601AEg	WTF250KVE3601AEg	1	0.33	3.0	2.0	96
STF250KVE3601Eg	WTF250KVE3601Eg	1-1	0.33	3.0	2.0	96

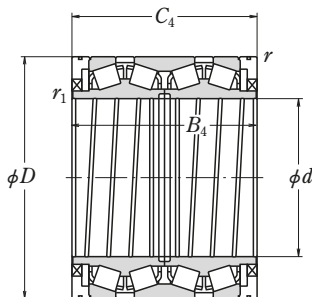
**Remark** Inch Series bearings are marked with an asterisk (\*).

**Note** <sup>(1)</sup> Refer to Pages D130 and D131.

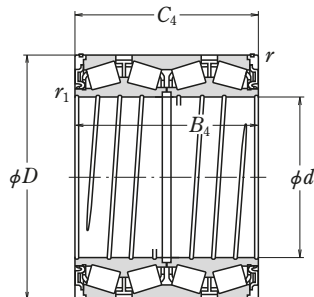
## ■ Bearings for Rolling Mills

### Super-TF/ Water-TF Series Sealed Four-Row Tapered Roller Bearings

Bore Diameter 254.000 – 304.902 mm



KVE



KVS

Boundary Dimensions (mm/inch)						Basic Load Ratings			
<i>d</i>	<i>D</i>	<i>B</i> <sub>4</sub>	<i>C</i> <sub>4</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> min.	<i>C</i> <sub>r</sub> (kN)	<i>C</i> <sub>0r</sub> (kgf)	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>254.000</b> <b>10.0000</b>	358.775 14.1250	269.875 10.6250	269.875 10.6250	1.5	3.3	2 420	5 500	247 000	560 000
<b>260</b>	365 365	340 340	340 340	2.7 2.5	4 4	2 960 2 960	7 350 7 350	300 000 300 000	750 000 750 000
<b>260.350</b> <b>10.2500</b>	422.275 16.6250	314.325 12.3750	317.500 12.5000	6.4	3.3	3 600	7 050	370 000	720 000
<b>266.700</b> <b>10.5000</b>	355.600 14.0000	230.188 9.0625	228.600 9.0000	1.5	3.3	1 960	4 600	200 000	470 000
<b>276.225</b> <b>10.8750</b>	393.700 15.5000	269.875 10.6251	269.875 10.6251	1.5	3.3	2 720	6 100	277 000	620 000
<b>279.400</b> <b>11.0000</b>	393.700 15.5000	269.875 10.6250	269.875 10.6250	1.5	6.4	2 720	6 100	277 000	620 000
	393.700 15.5000	270.630 10.6547	269.875 10.6250	1.5	6.4	2 290	5 150	233 000	525 000
<b>279.4</b>	393.7 410	320 420	320 420	1.5 1	6.4 6.4	3 100 3 300	7 350 7 400	315 000 335 000	745 000 755 000
<b>280</b>	380 395 395 410 412	290 340 340 268 340	290 340 340 268 340	1.5 1.5 1.5 1.5 3	3 2.5 2.5 6.4 3	2 230 2 950 2 950 2 330 3 300	5 350 7 050 7 050 4 600 7 400	227 000 300 000 300 000 237 000 335 000	545 000 720 000 720 000 470 000 755 000
<b>290</b>	400	346	346	3	4	3 250	8 400	330 000	855 000
<b>304.648</b> <b>11.9940</b>	438.048 17.2460	280.990 11.6260	279.400 11.0000	3.3	3.3	3 100	6 750	315 000	690 000
	438.048 17.2460	281.740 11.0921	279.400 11.0000	3.3	3.3	2 630	5 600	268 000	570 000
<b>304.8</b> <b>12.0000</b>	419.100 16.5000	269.875 10.6250	269.875 10.6250	1.5	6.4	2 850	6 550	291 000	665 000
<b>304.902</b> <b>12.0040</b>	412.648 16.2460	266.700 10.5000	266.700 10.5000	1.5	3.3	2 760	6 500	281 000	665 000

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

Where  $Y_0 \doteq Y_3$

The values of  $e$ ,  $Y_2$ , and  $Y_3$  are given in the table below.

Bearing Designations		Figure <sup>(1)</sup>	Constant $e$	Axial Load Factors		Mass (kg)
Super-TF Series	Water-TF Series			$Y_2$	$Y_3$	approx.
*STF254KVS3552Eg	*WTF254KVS3552Eg	3	0.40	2.5	1.7	86
STF260KVS3601Eg	WTF260KVS3601Eg	3	0.40	2.5	1.7	110
STF260KVS3651Eg	WTF260KVS3651Eg	3	0.40	2.5	1.7	110
*STF260KVS4251Eg	*WTF260KVS4251Eg	3	0.33	3.0	2.0	170
*STF266KVS3551Eg	*WTF266KVS3551Eg	3	0.35	2.9	1.9	62
*STF276KVS3952Eg	*WTF276KVS3952Eg	3	0.45	2.2	1.5	105
*STF279KVS3952Eg	*WTF279KVS3952Eg	3	0.45	2.2	1.5	102
*STF279KVE3951Eg	*WTF279KVE3951Eg	1	0.41	2.5	1.7	105
STF279KVS3954Eg	WTF279KVS3954Eg	3	0.40	2.5	1.7	120
STF279KVE4101Eg	WTF279KVE4101Eg	2	0.42	2.4	1.6	190
STF280KVE3801Eg	WTF280KVE3801Eg	1-4	0.37	2.7	1.8	96.2
STF280KVE3901Eg	WTF280KVE3901Eg	1	0.40	2.5	1.7	133
STF280KVE3902Eg	WTF280KVE3902Eg	1	0.40	2.5	1.7	133
STF280KVE4101Eg	WTF280KVE4101Eg	1-4	0.33	3.0	2.0	121
STF280KVE4102Eg	WTF280KVE4102Eg	1-1	0.42	2.4	1.6	156
STF290KVS4001Eg	WTF290KVS4001Eg	3	0.40	2.5	1.7	112
*STF304KVS4351Eg	*WTF304KVS4351Eg	3	0.45	2.2	1.5	132
*STF304KVE4351Eg	*WTF304KVE4351Eg	1-2	0.47	2.1	1.4	140
*STF304KVS4151Eg	*WTF304KVS4151Eg	3	0.33	3.0	2.0	111
*STF304KVS4152Eg	*WTF304KVS4152Eg	3	0.33	3.0	2.0	100

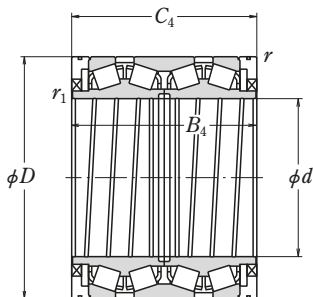
**Remark** Inch Series bearings are marked with an asterisk (\*).

**Note** <sup>(1)</sup> Refer to Pages D130 and D131.

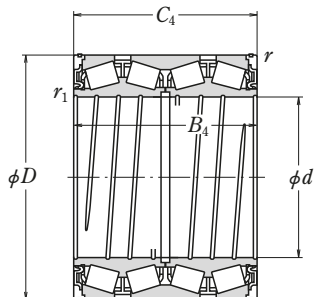
## ■ Bearings for Rolling Mills

### Super-TF/Water-TF Series Sealed Four-Row Tapered Roller Bearings

Bore Diameter 310 – 482.600 mm



KVE



KVS

Boundary Dimensions (mm/inch)						Basic Load Ratings			
$d$	$D$	$B_4$	$C_4$	$r_1$ min.	$r$ min.	$C_r$ (kN)	$C_{0r}$	$C_r$ (kgf)	$C_{0r}$
<b>310</b>	430	310	310	3	3	3 350	8 200	345 000	835 000
	430	350	350	2.7	3	3 700	9 550	375 000	970 000
<b>317.500</b> <b>12.5000</b>	422.275	269.875	269.875	1.5	3.3	2 740	6 750	279 000	690 000
	16.6250	10.6250	10.6250						
<b>343.052</b> <b>13.5060</b>	447.675	367.000	367.000	2.5	3.0	3 450	8 100	350 000	825 000
	17.6250	14.4488	14.4488						
<b>343.052</b> <b>13.5060</b>	457.098	254.000	254.000	1.5	3.3	2 430	6 700	289 000	685 000
	17.9960	10.0000	10.0000						
<b>355.600</b> <b>14.0000</b>	457.098	299.000	299.000	1.5	3.3	2 830	6 950	289 000	705 000
	17.9960	11.7717	11.7717						
<b>395</b> <b>406.400</b> <b>16.0000</b>	457.200	252.412	252.412	1.5	3.3	2 650	6 750	270 000	685 000
	18.0000	9.9375	9.9375						
<b>395</b> <b>406.400</b> <b>16.0000</b>	545	360	360	2.5	5	3 600	9 050	365 000	920 000
	546.100	288.925	288.925	1.5	6.4	3 950	9 450	400 000	965 000
<b>420</b>	546.100	346.000	346.000	0.5	6.4	2 560	5 800	261 000	590 000
	21.5000	13.6221	13.6221						
<b>440</b>	590	395	375	2.5	5	3 550	8 200	365 000	835 000
	590	510	510	4	4	5 450	14 300	555 000	1 460 000
<b>450</b>	620	454	454	4	6	6 500	15 700	665 000	1 600 000
	595	368	368	4	5	5 550	15 000	565 000	1 520 000
<b>457.200</b> <b>18.0000</b>	596.900	276.225	279.400	1.5	3.3	4 000	9 850	405 000	1 010 000
	23.5000	10.8750	11.0000						
<b>460</b>	590	470	470	2.5	5	4 900	14 100	500 000	1 440 000
	615	435	435	3	5	4 650	12 800	470 000	1 310 000
<b>480</b>	678	574	574	3	5	8 400	21 500	860 000	2 190 000
	615.950	330.200	330.200	4.3	6.4	4 900	13 500	500 000	1 370 000
	19.0000	24.2500	13.0000						

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

Where  $Y_0 \div Y_3$

The values of  $e$ ,  $Y_2$ , and  $Y_3$  are given in the table below.

Bearing Designations		Figure <sup>(1)</sup>	Constant $e$	Axial Load Factors		Mass (kg)
Super-TF Series	Water-TF Series			$Y_2$	$Y_3$	approx.
STF310KVS4301Eg	WTF310KVS4301Eg	3	0.46	2.2	1.5	140
STF310KVS4302Eg	WTF310KVS4302Eg	3	0.46	2.2	1.5	155
*STF317KVS4251Eg	*WTF317KVS4251Eg	3	0.34	3.0	2.0	100
*STF317KVE4451Eg	*WTF317KVE4451Eg	1	0.46	2.2	1.5	184
*STF343KVS4551Eg	*WTF343KVS4551Eg	3	0.45	2.2	1.5	110
*STF343KVE4561Eg	*WTF343KVE4561Eg	1	0.46	2.2	1.5	137
*STF355KVS4551Eg	*WTF355KVS4551Eg	3	0.32	3.2	2.1	98
STF395KVE5401Eg	WTF395KVE5401Eg	1-1	0.47	2.1	1.4	255
*STF406KVS5451Eg	*WTF406KVS5451Eg	3	0.48	2.1	1.4	184
*STF406KVE5454Eg	*WTF406KVE5454Eg	2-1	0.47	2.1	1.4	231
STF420KVE5901Eg	WTF420KVE5901Eg	1-1	0.80	1.3	0.8	332
STF440KVE5901Eg	WTF440KVE5901Eg	2-1	0.38	2.7	1.8	396
STF440KVE6201Eg	WTF440KVE6201Eg	1-1	0.33	3.0	2.0	435
STF450KVS5901Eg	WTF450KVS5901Eg	3	0.33	3.0	2.0	272
*STF457KVS5951Eg	*WTF457KVS5951Eg	3	0.47	2.2	1.4	206
STF460KVE5901Eg	WTF460KVE5901Eg	1-1	0.28	3.6	2.4	322
STF480KVE6101AEg	WTF480KVE6101AEg	2-2	0.32	3.2	2.1	323
STF480KVE6702Eg	WTF480KVE6702Eg	2-1	0.34	3.0	2.0	662
*STF482KVS6151Eg	*WTF482KVS6151Eg	3	0.33	3.1	2.1	235

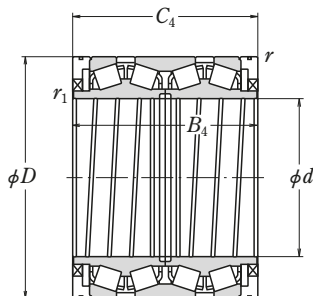
**Remark** Inch Series bearings are marked with an asterisk (\*).

**Note** <sup>(1)</sup> Refer to Pages D130 and D131.

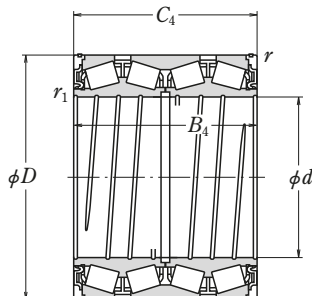
## ■ Bearings for Rolling Mills

### Super-TF/Water-TF Series Sealed Four-Row Tapered Roller Bearings

Bore Diameter 482.600 – 825.5 mm



KVE



KVS

Boundary Dimensions (mm/inch)						Basic Load Ratings			
$d$	$D$	$B_4$	$C_4$	$r_1$ min.	$r$ min.	$C_r$ (kN)	$C_{0r}$ (kN)	$C_r$ (kgf)	$C_{0r}$ (kgf)
	615.950 24.2500	330.200 13.0000	330.200 13.0000	4.3	6.4	3 650	9 650	370 000	985 000
	615.950 24.2500	419.100 16.5000	402.050 15.8287	2.3	6.4	4 700	13 600	480 000	1 380 000
	647.700 25.5000	417.512 16.4375	417.512 16.4375	3.3	6.4	5 500	13 800	560 000	1 410 000
<b>488.950</b> <b>19.2500</b>	622.300 24.5000	365.125 14.3750	365.125 14.3750	3.8	6.4	3 450	8 950	350 000	915 000
<b>490</b>	625	435	435	3	5	4 550	12 500	465 000	1 280 000
<b>509.948</b> <b>20.0767</b>	654.924 25.7844	377.000 14.8425	379.000 14.9213	1.5	6.4	4 800	13 000	490 000	1 330 000
<b>520</b>	735	535	535	5	6	8 800	22 700	900 000	2 310 000
<b>558.800</b> <b>22.0000</b>	736.600 29.0000	540.000 21.2598	540.000 21.2598	3.3	6.4	8 950	25 300	910 000	2 580 000
<b>595.312</b> <b>23.4375</b>	844.550 33.2500	615.950 24.2500	615.950 24.2500	1.5	6.4	12 600	33 000	1 290 000	3 350 000
	844.550 33.2500	615.950 24.2500	615.950 24.2500	3.3	6.4	10 900	27 200	1 110 000	2 780 000
<b>609.600</b> <b>24.0000</b>	787.400 31.0000	361.950 14.2500	361.950 14.2500	1.5	6.4	5 450	14 400	555 000	1 470 000
<b>711.200</b> <b>28.0000</b>	914.400 36.0000	387.350 15.2500	317.500 12.5000	3.3	6.4	6 400	19 300	655 000	1 970 000
	914.400 36.0000	410.000 16.1417	410.000 16.1417	3.3	6.4	7 000	20 100	715 000	2 050 000
	914.400 36.0000	425.450 16.7500	387.350 15.2500	8.0	6.4	6 400	19 300	655 000	1 970 000
<b>785</b>	1 015	700	700	4	6	13 500	41 000	1 380 000	4 150 000
<b>825.5</b>	1 160	565	565	5	6	13 900	33 500	1 420 000	3 400 000

**Dynamic Equivalent Load**

$$P = XF_r + YF_a$$

$F_a/F_r \leq e$		$F_a/F_r > e$	
$X$	$Y$	$X$	$Y$
1	$Y_3$	0.67	$Y_2$

**Static Equivalent Load**

$$P_0 = F_r + Y_0 F_a$$

Where  $Y_0 \doteq Y_3$

The values of  $e$ ,  $Y_2$ , and  $Y_3$  are given in the table below.

Bearing Designations		Figure <sup>(1)</sup>	Constant $e$	Axial Load Factors		Mass (kg) approx.
Super-TF Series	Water-TF Series			$Y_2$	$Y_3$	
*STF482KVE6152Eg	*WTF482KVE6152Eg	1	0.37	2.7	1.8	243
*STF482KVE6155Eg	*WTF482KVE6155Eg	1	0.38	2.7	1.8	302
*STF482KVE6453Eg	*WTF482KVE6453Eg	1-5	0.37	2.7	1.8	392
*STF488KVE6251Eg	*WTF488KVE6251Eg	2	0.29	3.5	2.3	272
STF490KVE6201AEg	WTF490KVE6201AEg	2-2	0.32	3.2	2.1	329
*STF509KVE6554Eg	*WTF509KVE6554Eg	1	0.41	2.4	1.6	321
STF520KVE7301Eg	WTF520KVE7301Eg	1-1	0.33	3.0	2.0	726
*STF558KVE7351Eg	*WTF558KVE7351Eg	1-3	0.35	2.9	1.9	625
*STF595KVE8451Eg	*WTF595KVE8451Eg	1	0.33	3.0	2.0	1 110
*STF595KVE8452Eg	*WTF595KVE8452Eg	4	0.35	2.9	1.9	1 110
*STF609KVE7851Eg	*WTF609KVE7851Eg	1	0.42	2.4	1.6	452
*STF711KVE9152AEg	*WTF711KVE9152AEg	1	0.38	2.6	1.8	585
*STF711KVE9153Eg	*WTF711KVE9153Eg	1-1	0.44	2.3	1.5	681
*STF711KVE9155Eg	*WTF711KVE9155Eg	1	0.38	2.6	1.8	675
STF785KVE1001Eg	WTF785KVE1001Eg	2-1	0.40	2.5	1.7	1 460
STF825KVE1101Eg	WTF825KVE1101Eg	1	0.40	2.5	1.7	1 890

**Remark** Inch Series bearings are marked with an asterisk (\*).

**Note** <sup>(1)</sup> Refer to Pages D130 and D131.

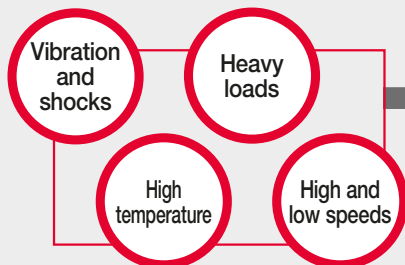
# Bearings for Rolling Mills

## Four-Row Cylindrical Roller Bearings for Roll Necks

### Benefits

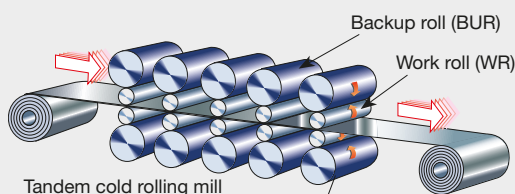
- ❶ Higher reliability and longer operating life prevent unexpected downtime
- ❷ Lower maintenance costs
- ❸ Smoother rolling improves plate making precision

### 1. Operating conditions

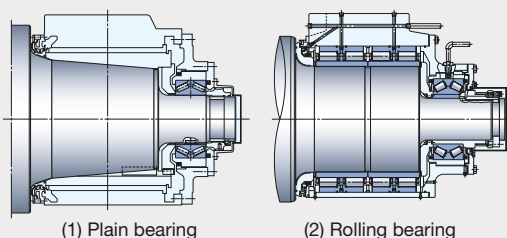
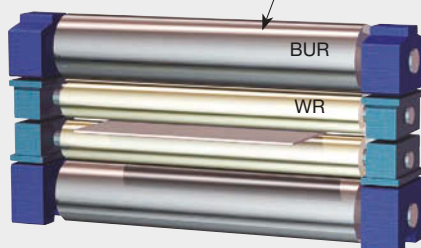


Major target mills:

- Plate mills
- Hot strip mills
- Cold rolling mills
- Skin pass mills
- Temper rolling mills
- Bar mills
- Rod mills
- Section mills

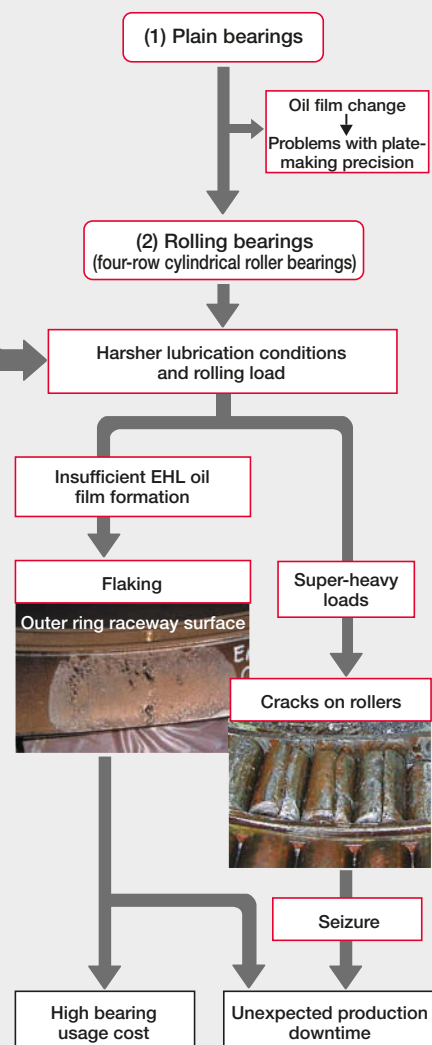


Tandem cold rolling mill



### 2. Problems

#### Typical problems for backup roll bearings



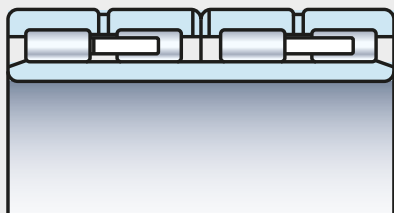


(\*1)

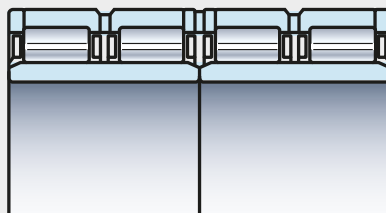
### 3. Countermeasures

#### Features Super-TF™ RV Series Four-Row Cylindrical Roller Bearings

- Adoption of long-life Super-TF steel results in longer durability, even under boundary lubrication with insufficient EHL oil film formation
- Higher load capacity
- Higher rotational accuracy



RV (Brass cage)



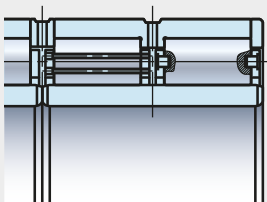
RV (Pin cage)

	Comparison of Actual Life Extension in Field Test		
Conventional Steel	1		
Super-TF Steel	2		

#### Features Super-TF™ RV Series Stud-Type Four-Row Cylindrical Roller Bearings

Target: bearings for backup rolls of plate mills

- Solid-type rollers and a stud-type cage were developed to protect against roller breakage.
- Higher load capacity
- Adoption of long-life Super-TF steel
- Higher rotational accuracy



**Designations** Pages D144 to D165

**Instruction Manual** CAT.No.E9001 (Roll Neck Bearing Manual)

**Super-TF Material** Pages A258 to A261

**Note** (\*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.

## Four-Row Cylindrical Roller Bearings

### Figures of Typical Four-Row Cylindrical Roller Bearings

Cylindrical Bores

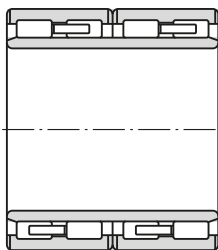


Figure 1

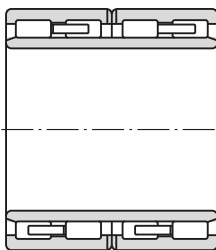


Figure 2

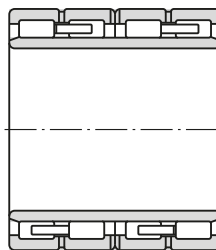


Figure 3

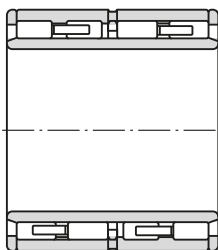


Figure 4

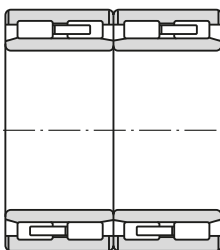


Figure 5

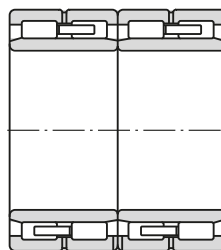


Figure 6

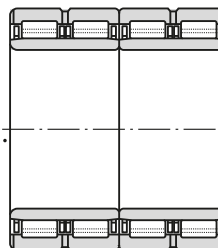


Figure 7

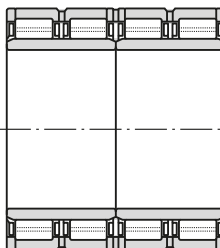


Figure 8

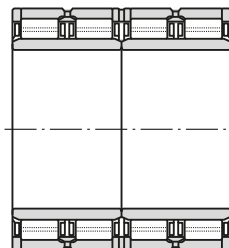


Figure 9

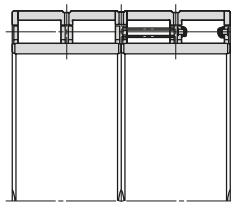
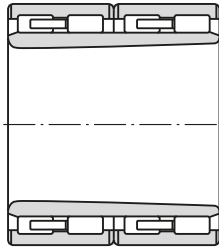
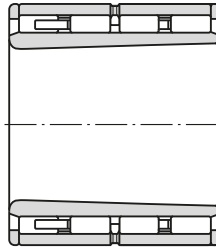
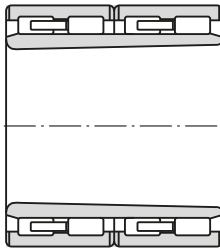
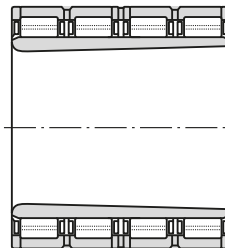


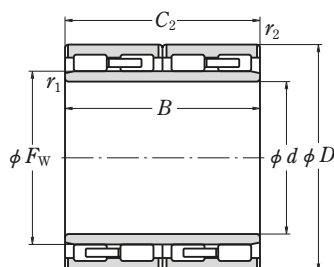
Figure 8SP

**Tapered Bores****Figure 10****Figure 11****Figure 12****Figure 13**

# Bearings for Rolling Mills

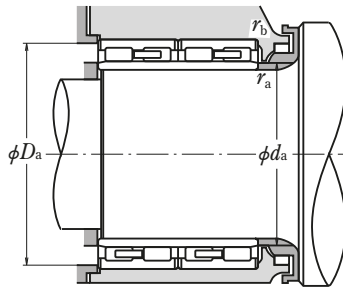
## Four-Row Cylindrical Roller Bearings

Bore Diameter 100 – 160 mm



Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>100</b>	140	104	104	111	1.5	1.1	400	820
<b>110</b>	160	120	120	124	1.1	1.1	560	1 080
	170	120	120	127	2	2	615	1 100
<b>120</b>	165	87	87	134.5	1.1	1.1	365	725
	180	105	105	136	2	2	530	880
	215	174	174	147	2.1	2.1	1 060	1 600
<b>127</b>	174.625	150.812	150.812	139.5	1.5	2	735	1 580
	203.2	127	127	147.5	2	1.5	705	1 110
<b>130</b>	200	125	125	149	2	2	700	1 190
	200	104	104	149	2	2	570	950
<b>140</b>	210	116	116	160	2	2	640	1 130
<b>145</b>	210	155	155	166	1.5	1.5	925	1 920
	225	156	156	169	2	2	975	1 820
<b>150</b>	220	150	150	168	2	2	900	1 700
	225	150	150	168.5	1.5	2.1	970	1 810
	225	136	136	168.776	2.1	2.1	820	1 460
	230	130	130	174	2.1	2.1	845	1 520
	230	156	156	174	2	2	965	1 810
<b>159.99</b>	220	180	180	176	2	2	1 050	2 410
<b>160</b>	230	130	130	178	2	2	780	1 340
	230	168	168	179	2	2	900	2 050
	230	168	168	180	2	2	1 040	2 200
	230	180	180	178	2	2	1 080	2 280
	240	120	120	183	2.1	2.1	745	1 320
	240	170	170	183	2	2	1 080	2 050
	240	145	145	180.016	2.1	2.1	920	1 600

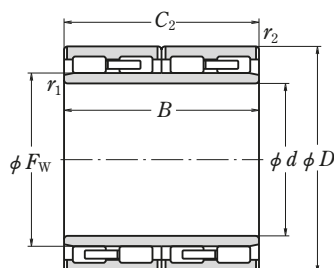
Note <sup>(1)</sup> Refer to Pages D142 and D143.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>HTF100RV1401g</b>	3	110	130	1.5	1	4.8
<b>HTF110RV1601g</b>	3	119	150	1	1	7.9
<b>HTF110RV1701g</b>	1	122	157	2	2	9.9
<b>HTF120RV1601g</b>	1	130	155	1	1	5.4
<b>HTF120RV1801g</b>	1	132	167	2	2	8.9
<b>HTF120RV2101g</b>	1	134	199	2	2	26.6
<b>HTF127RV1722g</b>	1	138	163	1.5	1.5	10.5
<b>HTF127RV2001g</b>	1	139	190	2	2	15.4
<b>STF130RV2001g</b>	1	142	187	2	2	14
<b>STF130RV2003g</b>	1	142	187	2	2	11.7
<b>STF140RV2101g</b>	1	152	196	2	2	13.9
<b>STF145RV2101g</b>	1	157	197	1.5	1.5	17.8
<b>STF145RV2201g</b>	1	158	211	2	2	23
<b>STF150RV2201g</b>	1	163	206	2	2	20
<b>STF150RV2203g</b>	1	162	209	1.5	2	20.8
<b>STF150RV2204g</b>	1	165	209	2	2	18.6
<b>STF150RV2301g</b>	1	165	214	2	2	19.6
<b>STF150RV2302g</b>	1	163	216	2	2	23.6
<b>STF159RV2201g</b>	2	173	206	2	2	20.6
<b>STF160RV2301g</b>	1	173	216	2	2	16.4
<b>STF160RV2307g</b>	1	173	216	2	2	23.0
<b>STF160RV2302g</b>	1	173	216	2	2	22.7
<b>STF160RV2303g</b>	2	173	216	2	2	24.2
<b>STF160RV2401g</b>	1	175	224	2	2	18.8
<b>STF160RV2402g</b>	1	173	226	2	2	26.6
<b>STF160RV2403g</b>	1	175	224	2	2	22.3

## Four-Row Cylindrical Roller Bearings

Bore Diameter 165.1 – 200 mm

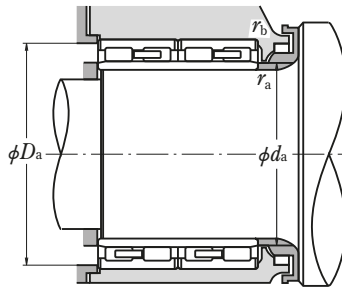


Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>165.1</b>	225.45	168.3	168.3	180.975	1.5	2.5	1 010	2 220
<b>170</b>	230	120	120	187	2	2	755	1 610
	240	160	160	190	2	2	1 000	2 130
	250	168	168	192	2.1	2.1	1 210	2 320
	250	170	170	192	2.1	2.1	1 210	2 320
	255	180	180	193	2.1	2.1	1 310	2 500
<b>180</b>	260	150	150	195	2.1	2.1	1 030	1 840
	250	156	156	200	2	2	1 020	2 230
	260	168	168	202	2.1	2.1	1 150	2 300
	265	180	180	204	2.1	2.1	1 340	2 690
	265	180	180	203	2.1	2.1	1 230	2 420
<b>190</b>	280	180	180	205.085	2.1	2.1	1 410	2 490
	260	168	168	212	2	2	1 140	2 600
	270	200	200	212	2.1	2.1	1 470	3 100
	270	170	170	213	2.1	2.1	1 290	2 610
	270	170	170	212	2	2	1 290	2 610
<b>200</b>	280	200	200	214	2.1	2.1	1 480	2 920
	250	200	200	215	1	1	900	2 500
	270	170	170	222	2.1	2.1	1 120	2 590
	270	200	200	222.25	2.1	2.1	1 330	3 250
	280	200	200	224	2.1	2.1	1 410	3 200
<b>Steel Industry</b>	280	200	200	222	2.1	2.1	1 410	3 200
	280	190	190	223	2.1	2.1	1 350	3 050
	280	170	170	223	2.1	2.1	1 150	2 460
	280	200	200	222	2.1	2.1	1 500	3 200
	290	192	192	226	2.1	2.1	1 420	3 000
<b>INDUSTRY SOLUTIONS</b>	310	230	230	229	2.1	2.1	1 840	3 500
	320	216	216	231	3	3	2 120	3 900

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

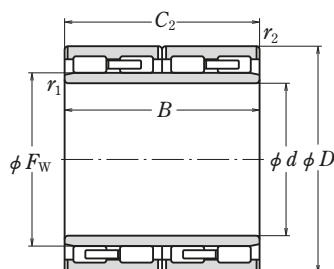
"SP" indicates a special design.

Please consult with NSK for detailed specifications.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF165RV2221g</b>	5	177	209	1.5	2	19.4
<b>STF170RV2301g</b>	1	183	216	2	2	14
<b>STF170RV2402g</b>	1	183	226	2	2	22.8
<b>STF170RV2501g</b>	1	185	234	2	2	27.4
<b>STF170RV2502g</b>	1	185	234	2	2	27.7
<b>STF170RV2503g</b>	1	185	239	2	2	31.5
<b>STF170RV2602g</b>	1	185	244	2	2	28.2
<b>STF180RV2501g</b>	1	193	236	2	2	23.4
<b>STF180RV2601g</b>	1	195	244	2	2	29.2
<b>STF180RV2602g</b>	1	195	248	2	2	33.7
<b>STF180RV2603g</b>	1	195	248	2	2	33.4
<b>STF180RV2802g</b>	3	195	263	2	2	40.9
<b>STF190RV2601g</b>	1	203	245	2	2	26.6
<b>STF190RV2701g</b>	1	206	253	2	2	36
<b>STF190RV2702g</b>	1	206	253	2	2	30.4
<b>STF190RV2703g</b>	1	203	255	2	2	30.6
<b>STF190RV2801g</b>	1	206	263	2	2	41.3
<b>STF200RV2521g</b>	SP	210	240	1	1	22.3
<b>STF200RV2702g</b>	1	216	253	2	2	27.9
<b>STF200RV2703g</b>	SP	216	253	2	2	34.4
<b>STF200RV2801g</b>	1	216	263	2	2	38.3
<b>STF200RV2802g</b>	1	216	263	2	2	38.6
<b>STF200RV2803g</b>	1	216	263	2	2	36.4
<b>STF200RV2804g</b>	1	216	263	2	2	32.3
<b>STF200RV2808g</b>	1	216	263	2	2	37.8
<b>STF200RV2901g</b>	1	216	273	2	2	42.3
<b>STF200RV3102g</b>	1	216	293	2	2	63.7
<b>STF200RV3231g</b>	4	218	300	4	4	69.9

## Four-Row Cylindrical Roller Bearings Bore Diameter 210 – 260 mm

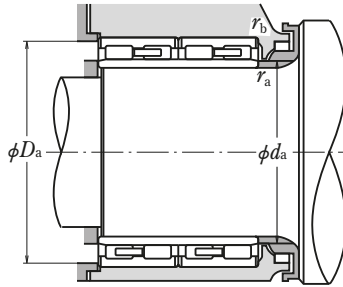


Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>210</b>	290	192	192	236	2.1	2.1	1 400	3 350
	300	210	210	234	2	2	1 750	3 600
<b>219.954</b>	310	183	183	244.5	1.5	1	1 480	3 150
<b>220</b>	310	192	192	247	2.1	2.1	1 540	3 450
	310	225	225	245	2.1	2.1	1 740	3 900
	310	192	192	246	2.1	2.1	1 540	3 450
	310	192	192	246	2.1	2.1	1 660	3 550
	310	225	225	244	2.1	2.1	1 900	4 100
	320	210	210	248	2.1	2.1	1 790	3 650
	320	210	210	249	2.1	2.1	1 850	3 600
	320	210	210	246	2.1	2.1	1 900	3 750
<b>222.25</b>	320.675	241.3	241.3	251	2.1	2.1	1 990	4 350
<b>230</b>	330	206	206	260	2.1	2.1	1 760	3 900
	330	206	206	258	2.1	2.1	1 870	3 950
	340	260	260	261	3	3	2 390	5 100
	365	250	250	266	3	3	2 310	4 300
<b>240</b>	330	220	220	270	3	3	1 770	4 400
	330	220	220	264	3	3	1 840	4 100
	340	220	220	268	3	3	1 890	3 900
	360	220	220	272	3	3	2 250	4 350
<b>250</b>	340	230	230	276	4	4	2 030	4 750
	350	220	220	278	3	3	1 930	4 200
<b>259.948</b>	368	218	218	290	2.1	1.1	2 010	4 350
<b>260</b>	355	260	260	286	2.1	2.1	2 090	5 000
	370	220	220	292	3	3	2 050	4 450
	370	220	220	290	3	3	2 220	4 450
	370	260	260	290	3	3	2 720	5 950
	380	280	280	294	3	3	2 820	6 250
	400	290	290	296	4	4	3 250	6 350

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"SP" indicates a special design.

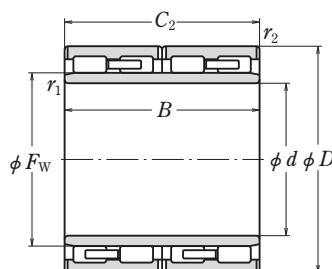
Please consult with NSK for detailed specifications.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
STF210RV2901g	1	226	273	2	2	39
STF210RV3001g	1	224	285	2	2	47.4
STF219RV3131g	4	233	298	1.5	1	45.3
STF220RV3101g	1	236	293	2	2	46.1
STF220RV3102g	1	236	293	2	2	52.9
STF220RV3103g	1	236	293	2	2	46.2
STF220RV3106g	1	236	293	2	2	46.0
STF220RV3107g	1	236	293	2	2	53.0
STF220RV3201g	1	236	302	2	2	56
STF220RV3202g	1	236	302	2	2	54.9
STF220RV3203g	SP	236	302	2	2	57
STF222RV3201g	2	238	303	2	2	65
STF230RV3301g	1	246	312	2	2	58.2
STF230RV3302g	1	246	312	2	2	57.3
STF230RV3401g	1	248	320	2.5	2.5	81
STF230RV3601g	5	248	344	2.5	2.5	98.3
STF240RV3301g	1	259	310	2.5	2.5	57.7
STF240RV3304g	3	259	310	2.5	2.5	55.1
STF240RV3403g	1	259	320	2.5	2.5	61.7
STF240RV3601g	2	259	340	2.5	2.5	77.8
STF250RV3401g	1	272	317	3	3	60.3
STF250RV3501g	1	269	330	2.5	2.5	64.8
STF259RV3631g	4	277	354	2	1	76.7
STF260RV3521g	5	277	337	2	2	74.5
STF260RV3701g	1	279	349	2.5	2.5	76
STF260RV3704g	1	279	349	2.5	2.5	73.5
STF260RV3721g	1	279	349	2.5	2.5	89.3
STF260RV3801g	1	279	359	2.5	2.5	107
STF260RV4001g	1	282	376	3	3	133

## Four-Row Cylindrical Roller Bearings

Bore Diameter 270 – 330 mm

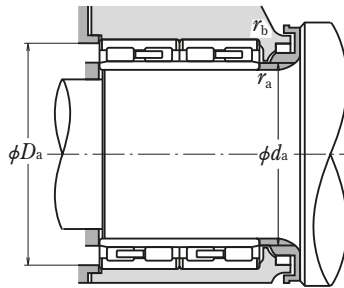


Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>270</b>	380	230	230	298	2.1	2.1	2 330	5 050
<b>280</b>	390	220	220	312	3	3	2 120	4 800
	390	240	240	312	3	3	2 360	5 500
	390	275	275	308	3	1.1	2 860	6 450
	390	220	220	312	3	3	2 280	5 100
	390	275	275	308	Spec.	1.1	2 860	6 450
	390	275	275	308	Spec.	3	2 860	6 450
	400	285	285	316	3	3	3 000	6 950
	400	234	234	320	3	3	2 270	5 600
<b>290</b>	410	240	240	320	3	3	2 570	5 450
	410	240	240	321	3	3	2 600	5 250
	420	300	300	327	3	3	3 300	7 500
	420	300	300	332	Spec.	1.5	3 550	8 350
<b>300</b>	420	300	300	332	2	2	3 200	7 200
	420	300	300	332	3	3	2 720	6 900
	420	240	240	332	3	3	2 670	5 750
	420	300	300	332	3	3	3 200	7 200
<b>310</b>	420	300	300	332	Spec.	1.5	3 550	8 350
	420	300	300	332	2	2	3 200	7 200
	420	300	300	338	3	3	3 300	8 050
	430	240	240	344.5	3	3	2 610	5 950
<b>320</b>	440	240	240	351	4	4	2 490	5 350
	450	240	240	358	3	3	2 760	6 150
	450	240	240	355	3	3	2 710	5 750
	460	340	340	360	3	3	3 850	8 700
<b>330</b>	460	240	240	364	3	3	2 820	6 100
	480	350	350	364	4	1.5	4 850	10 500
	430	230	230	358	3	3	2 340	5 850
	440	200	200	360	3	3	2 160	4 750
	460	340	340	365	4	4	3 550	8 650
	460	340	340	365	4	2.5	4 150	9 750

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"SP" indicates a special design.

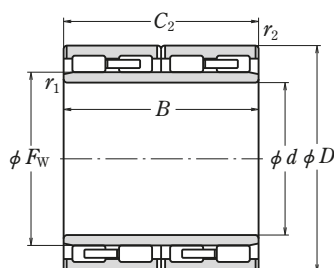
Please consult with NSK for detailed specifications.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF270RV3801g</b>	1	287	361	2	2	83
<b>STF280RV3901g</b>	1	299	369	2.5	2.5	80.9
<b>STF280RV3902g</b>	1	299	369	2.5	2.5	88.5
<b>STF280RV3903g</b>	1	299	375	2.5	1	100
<b>STF280RV3907Ag</b>	1	299	369	2.5	2.5	81.6
<b>STF280RV3911Ag</b>	SP	298	375	2	1	99.5
<b>STF280RV3921Ag</b>	6	298	369	2	2.5	99.2
<b>STF280RV4021g</b>	5	299	379	2.5	2.5	117
<b>STF290RV3901g</b>	1	310	369	2.5	2.5	79.7
<b>STF290RV4101g</b>	1	310	389	2.5	2.5	99
<b>STF290RV4102g</b>	1	310	389	2.5	2.5	97.1
<b>STF290RV4201g</b>	1	310	398	2.5	2.5	138
<b>STF300RV4021g</b>	5	316	383	2	2	103
<b>STF300RV4201g</b>	1	320	398	2.5	2.5	101
<b>STF300RV4204Ag</b>	3	320	398	2.5	2.5	127
<b>STF300RV4216g</b>	SP	319	403	2	1.5	132
<b>STF300RV4221g</b>	5	316	402	2	2	128
<b>STF310RV4201g</b>	1	330	398	2.5	2.5	119
<b>STF310RV4301g</b>	1	330	408	2.5	2.5	107
<b>STF320RV4401g</b>	1	343	415	3	3	104
<b>STF320RV4501g</b>	1	340	428	2.5	2.5	120
<b>STF320RV4502g</b>	1	340	428	2.5	2.5	117
<b>STF320RV4601g</b>	3	340	438	2.5	2.5	184
<b>STF320RV4621g</b>	5	340	438	2.5	2.5	131
<b>STF320RV4811g</b>	8	343	462	3	1.5	232
<b>STF330RV4301g</b>	1	350	408	2.5	2.5	86.3
<b>STF330RV4401g</b>	3	350	418	2.5	2.5	83.8
<b>STF330RV4601g</b>	1	353	435	3	3	174
<b>STF330RV4611g</b>	SP	353	439	3	2	172

## Four-Row Cylindrical Roller Bearings

Bore Diameter 340 – 400 mm



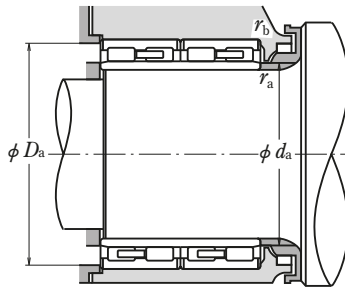
Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>340</b>	450	250	250	371	3	3	2 720	6 750
	450	250	250	368	3	3	2 720	6 750
	480	350	350	378	4	4	4 050	9 400
	480	350	350	378	Spec.	1.5	4 600	11 100
	490	300	300	379	5	5	3 750	8 200
<b>345</b>	480	350	350	376	3	3	4 400	10 300
<b>350</b>	500	380	380	389	5	5	4 850	11 100
<b>360</b>	480	290	290	394	3	3	3 250	8 300
	500	250	250	394	3	3	3 450	7 250
	510	370	370	400	4	4	4 500	10 100
<b>370</b>	480	250	250	401	3	3	2 830	7 350
	520	380	380	409	4	2	6 000	14 400
	520	380	380	409	Spec.	1.5	5 600	13 300
	540	400	400	415	4	4	5 250	12 000
<b>380</b>	500	290	290	414	3	3	3 350	8 800
	520	290	290	418	4	4	3 750	8 850
	520	280	280	417	4	4	3 650	8 450
	540	340	340	424	5	5	4 700	10 900
	540	400	400	424	5	5	5 050	12 000
	540	400	400	422	5	2	6 000	14 400
	540	400	400	424	5	2	5 750	13 800
<b>390</b>	510	290	290	424	3	3	3 400	9 000
	550	400	400	434	5	5	5 150	12 400
<b>400</b>	520	250	250	432	4	4	3 000	7 700
	550	300	300	441	4	4	4 150	9 750
	560	400	400	446	5	5	5 650	13 600
	560	410	410	445	5	2	6 550	16 500
	560	400	400	446	5	5	4 750	11 300
	560	410	410	445	5	2	6 550	16 500

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

"SP" indicates a special design.

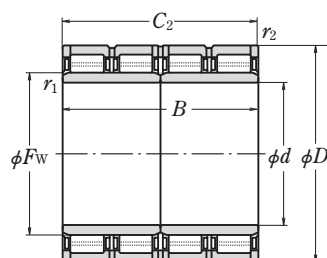
Please consult with NSK for detailed specifications.



Bearing Designation	Fig- ure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF340RV4501g</b>	1	361	428	2.5	2.5	108
<b>STF340RV4502g</b>	3	361	428	2.5	2.5	108
<b>STF340RV4801g</b>	1	364	454	3	3	198
<b>STF340RV4812Eg</b>	1	355	462	2.9	1.5	208
<b>STF340RV4901g</b>	1	368	460	4	4	186
<b>STF345RV4821g</b>	6	366	457	2.5	2.5	190
<b>STF350RV5021g</b>	6	378	470	4	4	237
<b>STF360RV4801g</b>	1	381	457	2.5	2.5	146
<b>STF360RV5022g</b>	5	381	477	2.5	2.5	146
<b>STF360RV5101g</b>	1	384	484	3	3	234
<b>STF370RV4801g</b>	1	391	457	2.5	2.5	116
<b>STF370RV5211g</b>	SP	394	500	3	2	263
<b>STF370RV5212g</b>	SP	393	501	3	1.5	252
<b>STF370RV5401g</b>	1	394	513	3	3	311
<b>STF380RV5001g</b>	1	401	477	2.5	2.5	153
<b>STF380RV5201g</b>	1	404	493	3	3	181
<b>STF380RV5202g</b>	1	404	493	3	3	174
<b>STF380RV5431g</b>	4	408	509	4	4	259
<b>STF380RV5401g</b>	3	408	509	4	4	280
<b>STF380RV5411g</b>	8	408	520	4	2	305
<b>STF380RV5412g</b>	SP	408	520	4	2	294
<b>STF390RV5101g</b>	1	412	487	2.5	2.5	156
<b>STF390RV5521g</b>	6	419	519	4	4	303
<b>STF400RV5202g</b>	3	425	493	3	3	136
<b>STF400RV5501g</b>	1	425	523	3	3	212
<b>STF400RV5612g</b>	8	429	529	4	4	308
<b>STF400RV5613g</b>	8M	429	539	4	2	315
<b>STF400RV5621g</b>	6	429	529	4	4	304
<b>STF400RV5611g</b>	8	429	539	4	2	315

## Bearings for Rolling Mills

### Four-Row Cylindrical Roller Bearings Bore Diameter 406.4 – 500 mm



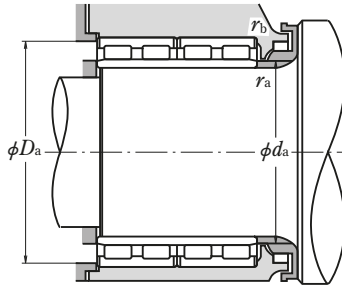
Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>406.4</b>	609.6	304.8	304.8	460	5	5	4 650	9 150
<b>410</b>	600	440	440	460	5	5	7 350	16 600
<b>420</b>	560	280	280	457	4	4	3 800	9 250
	560	400	400	458	4	4	4 950	13 000
	600	440	440	470	5	2	7 100	17 200
	600	440	440	465	5	5	7 300	17 200
<b>430</b>	591	420	420	476	4	4	6 350	16 100
	591	420	420	476	4	4	5 200	13 400
<b>440</b>	620	450	450	487	5	5	7 350	17 800
	620	450	450	487	Spec.	3	8 100	19 700
	620	450	450	490	4	4	7 450	19 000
<b>450</b>	630	450	450	500	4	4	6 950	17 500
<b>460</b>	620	400	400	506	4	4	5 500	14 700
	620	400	400	502	4	4	6 400	16 600
	620	460	460	502	4	4	7 100	19 100
	650	470	470	509	6	3	8 400	20 900
	650	470	470	509	4	3	8 600	21 200
	670	500	500	522	6	6	8 900	22 700
<b>470</b>	660	470	470	519	4	4	8 450	20 800
<b>480</b>	680	420	420	528	Spec.	3	8 350	19 000
	680	500	500	532	4	3	9 400	23 500
	680	500	500	534	5	5	9 000	23 100
	680	500	500	534	5	5	9 000	23 100
	700	400	400	538	6	6	7 650	17 400
<b>500</b>	670	450	450	540	Spec.	4	7 750	20 000
	670	450	450	540	5	5	8 300	22 300
	680	420	405	550	5	5	6 700	17 600

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

"SP" indicates a special design.

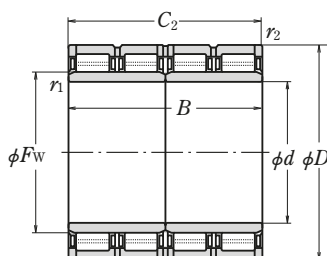
Please consult with NSK for detailed specifications.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF406RV6001g</b>	1	435	577	4	4	307
<b>STF410RV6011g</b>	8	439	568	4	4	438
<b>STF420RV5601g</b>	1	445	533	3	3	190
<b>STF420RV5602g</b>	6	445	533	3	3	270
<b>STF420RV6011g</b>	8	449	579	4	4	419
<b>STF420RV6012g</b>	8	449	568	4	4	402
<b>STF430RV5911g</b>	8	455	563	3	3	347
<b>STF430RV5921g</b>	5	455	563	3	3	347
<b>STF440RV6213g</b>	8	470	588	4	4	430
<b>STF440RV6215g</b>	8	466	594	3	2.5	433
<b>STF440RV6221g</b>	5	466	591	3	3	430
<b>STF450RV6321g</b>	5	476	601	3	3	440
<b>STF460RV6201g</b>	1	486	591	3	3	347
<b>STF460RV6211g</b>	8	486	591	3	3	358
<b>STF460RV6212g</b>	8M	486	591	3	3	412
<b>STF460RV6511g</b>	8	496	624	5	2.5	514
<b>STF460RV6513g</b>	8	486	624	3	2.5	501
<b>STF460RV6721g</b>	7	496	631	5	5	596
<b>STF470RV6611g</b>	8	496	631	3	3	505
<b>STF480RV6814g</b>	8	508	653	3.5	2.5	490
<b>STF480RV6815g</b>	8	506	653	3	2.5	586
<b>STF480RV6801g</b>	7	510	646	4	4	610
<b>STF480RV6811g</b>	8	510	646	4	4	610
<b>STF480RV7031g</b>	9	517	660	5	5	538
<b>STF500RV6713g</b>	8	529	640	3.5	3	446
<b>STF500RV6712Eg</b>	SP	531	637	4	4	464
<b>STF500RV6812g</b>	8	531	646	4	4	451

## Four-Row Cylindrical Roller Bearings

Bore Diameter 500 – 610 mm



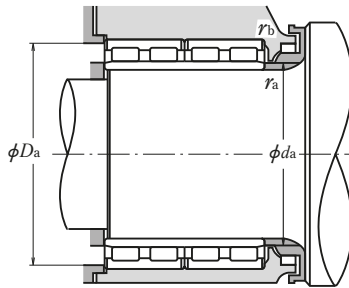
Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>500</b>	690	510	510	550	5	5	8 850	23 900
	690	510	510	552	5	5	9 000	24 600
	700	515	515	554	5	5	9 100	23 800
	710	480	480	558	5	5	8 500	21 200
	720	530	530	560	6	6	9 950	25 300
	720	530	530	568	6	6	10 100	25 900
<b>510</b>	670	320	320	554	5	5	4 950	12 700
	680	500	500	560	5	5	8 950	25 700
<b>520</b>	735	535	535	574.5	5	5	10 400	26 300
	735	535	535	574.5	5	5	10 800	27 500
<b>530</b>	780	570	570	601	6	6	11 800	29 200
	780	570	570	595	6	6	11 800	29 200
<b>536.176</b>	762.03	558.8	558.8	600	5	5	10 800	28 800
	762.03	558.8	558.8	598	Spec.	4	11 600	30 000
<b>550</b>	740	510	510	602	5	5	9 150	25 700
	740	510	510	600	Spec.	2	10 100	27 600
<b>560</b>	800	600	600	620	6	6	12 400	31 500
	820	600	600	625	Spec.	6	14 100	34 000
<b>570</b>	815	594	594	628	6	6	13 200	32 000
	815	594	594	628	6	6	13 700	33 500
<b>571.1</b>	812.97	594	594	636	6	5	13 200	34 500
<b>600</b>	820	575	575	660	Spec.	3	12 900	35 500
	850	600	600	664	5	5	14 600	37 500
	870	640	640	682	7.5	4	15 700	40 000
	870	640	640	672	7.5	4	15 700	40 000
	870	640	640	669	5	5	15 700	40 000
<b>610</b>	850	570	570	670	6	5	12 600	33 000
	870	660	660	680	6	6	15 400	41 500

**Notes** <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

"SP" indicates a special design.

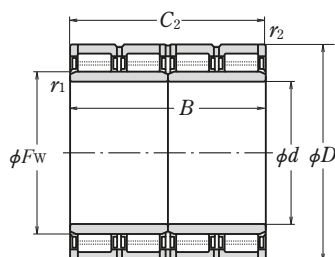
Please consult with NSK for detailed specifications.



Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF500RV6913g</b>	8M	531	656	4	4	480
<b>STF500RV6921g</b>	7	531	656	4	4	580
<b>STF500RV7021g</b>	7	531	666	4	4	622
<b>STF500RV7111g</b>	8	531	676	4	4	632
<b>STF500RV7211g</b>	8	537	680	5	5	782
<b>STF500RV7214g</b>	8M	537	680	5	5	722
<b>STF510RV6701g</b>	1	541	637	4	4	298
<b>STF510RV6811g</b>	8	541	646	4	4	514
<b>STF520RV7331g</b>	9	551	700	4	4	750
<b>STF520RV7311g</b>	8M	551	700	4	4	733
<b>STF530RV7811g</b>	8M	568	738	5	5	960
<b>STF530RV7813g</b>	8	568	738	5	5	960
<b>STF536RV7631g</b>	9	568	727	4	4	849
<b>STF536RV7612Eg</b>	SP	568	731	5.8	3	849
<b>STF550RV7411Ag</b>	8M	582	705	4	4	648
<b>STF550RV7413g</b>	8	580	716	3.5	2	632
<b>STF560RV8011g</b>	8	598	758	5	5	1 020
<b>STF560RV8211g</b>	8	595	778	4.5	5	1 100
<b>STF570RV8113g</b>	8	608	773	5	5	1 010
<b>STF570RV8111g</b>	8	608	773	5	5	960
<b>STF571RV8111g</b>	8	610	777	5	4	947
<b>STF600RV8212Eg</b>	SP	629	790	5.5	2.5	931
<b>STF600RV8511g</b>	8M	633	813	4	4	1 110
<b>STF600RV8711g</b>	8M	645	836	6	3	1 320
<b>STF600RV8713g</b>	8	645	836	6	3	1 320
<b>STF600RV8714g</b>	8M	633	833	4	4	1 310
<b>STF610RV8511g</b>	8	649	813	5	4	1 040
<b>STF610RV8711g</b>	8	649	827	5	5	1 330

## Four-Row Cylindrical Roller Bearings

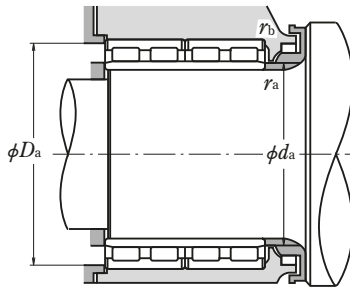
Bore Diameter 628 – 750 mm



Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>628</b>	922	600	600	702	6	5	15 600	37 000
<b>634.5</b>	901.87	674	674	705	7.5	4	16 200	43 500
	901.87	674	674	705	5	4	17 000	44 500
<b>640</b>	870	610	610	697	6	3	14 200	40 000
	880	600	600	700	6	6	14 200	38 000
<b>650</b>	900	650	650	710	Spec.	5	16 000	42 000
	920	670	670	723	7.5	7.5	16 200	44 000
	920	690	690	723	7.5	7.5	16 600	45 000
<b>660</b>	930	660	660	728	6	6	17 000	44 000
<b>680</b>	980	640	640	760	Spec.	4	17 500	43 500
<b>690</b>	960	670	670	760	7.5	7.5	17 400	47 000
	980	715	715	767.5	7.5	7.5	17 900	48 000
	980	750	750	766	7.5	7.5	19 200	53 000
	980	750	750	766	7.5	7.5	19 200	53 000
	980	750	750	766	7.5	7.5	19 200	53 000
<b>700</b>	930	620	620	763	6	6	12 900	38 000
	930	620	620	763	6	6	14 800	43 000
	980	700	700	774	6	6	18 000	48 500
	980	700	700	774	6	6	17 800	49 000
<b>710</b>	1000	715	715	787.5	7.5	7.5	18 700	50 500
<b>725</b>	1000	700	700	796	6	6	18 200	51 000
	1000	700	700	790	Spec.	4	19 000	51 500
	1000	700	700	796	6	6	17 700	49 500
<b>730</b>	960	620	620	790	6	3	15 000	44 500
	1030	750	750	809	6	6	20 700	56 500
<b>750</b>	1000	670	670	813	6	6	16 800	49 500
	1000	670	670	813	Spec.	3	17 500	50 000

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

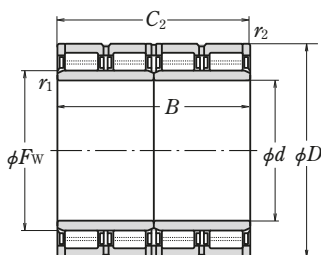


Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF628RV9211g</b>	8	668	883	5	4	1 390
<b>STF634RV9031g</b>	9	680	868	6	3	1 440
<b>STF634RV9011g</b>	8M	668	868	4	3	1 410
<b>STF640RV8711g</b>	8M	680	839	5	2.5	1 100
<b>STF640RV8812g</b>	8	680	836	5	5	1 110
<b>STF650RV9011g</b>	8	688	862	4.5	4	1 280
<b>STF650RV9212g</b>	8	696	870	6	6	1 470
<b>STF650RV9211g</b>	8	696	870	6	6	1 520
<b>STF660RV9311g</b>	8	700	885	5	5	1 440
<b>STF680RV9811g</b>	8	727	944	6	3	1 630
<b>STF690RV9611g</b>	8	737	909	6	6	1 520
<b>STF690RV9831g</b>	9	737	929	6	6	1 790
<b>STF690RV9832g</b>	9M	737	929	6	6	1 880
<b>STF690RV9812g</b>	8	737	929	6	6	1 880
<b>STF690RV9813g</b>	8M	737	929	6	6	1 860
<b>STF700RV9311g</b>	8	741	885	5	5	1 200
<b>STF700RV9313g</b>	8	741	885	5	5	1 180
<b>STF700RV9813g</b>	8	741	934	5	5	1 680
<b>STF700RV9821g</b>	7	741	934	5	5	1 720
<b>STF710RV1011g</b>	8	757	948	6	6	1 840
<b>STF725RV1011g</b>	8	767	954	5	5	1 670
<b>STF725RV1012g</b>	8	763	964	4.5	3	1 700
<b>STF725RV1021g</b>	7	767	954	5	5	1 670
<b>STF730RV9611g</b>	8	772	928	5	2.5	1 250
<b>STF730RV1011g</b>	8	772	983	5	5	2 050
<b>STF750RV1011g</b>	8	792	954	5	5	1 520
<b>STF750RV1013g</b>	8	798	967	6	2.5	1 490

## ■ Bearings for Rolling Mills

### Four-Row Cylindrical Roller Bearings

Bore Diameter 755 – 850 mm



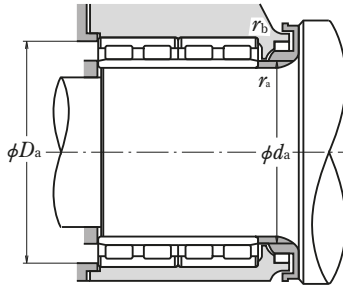
Boundary Dimensions (mm)							Basic Load Ratings (kN)	
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i> <sub>2</sub>	<i>F</i> <sub>w</sub>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub> min.	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub>
<b>755</b>	1 070	750	750	837	7.5	7.5	21 700	58 500
<b>760</b>	1 030	750	750	834	7.5	7.5	18 200	53 500
	1 030	750	750	828	7.5	7.5	20 800	60 000
	1 080	805	790	845	6	6	22 200	61 000
<b>761.425</b>	1 079.602	787.4	787.4	846	Spec.	7.5	23 900	65 500
	1 079.602	787.4	787.4	845	7.5	7.5	22 200	61 000
<b>770</b>	1 075	770	770	847	7.5	7.5	23 100	63 500
<b>780</b>	1 070	780	780	853	6	6	22 800	64 500
<b>800</b>	1 080	700	700	878	6	3	19 100	56 000
	1 080	700	700	878	6	3	19 600	58 000
	1 080	750	750	880	6	6	19 200	56 500
	1 080	750	750	880	6	6	18 700	56 500
<b>820</b>	1 100	745	720	892	6	3	19 700	58 500
	1 100	745	720	892	6	6	20 100	59 000
	1 130	650	650	891	Spec.	6	20 300	53 000
	1 130	800	800	903	7.5	7.5	22 900	66 500
	1 130	825	800	903	7.5	7.5	22 900	66 500
	1 160	840	840	911	7.5	7.5	25 600	72 000
<b>840</b>	1 160	840	840	920	2	7.5	24 900	71 000
<b>850</b>	1 150	840	840	928	7.5	4	23 300	68 500
	1 150	840	840	928	7.5	8	25 600	77 500
	1 180	650	650	945	7.5	7.5	19 600	53 000
	1 180	850	850	940	7.5	7.5	24 600	72 000
	1 180	875	850	940	7.5	7.5	24 600	72 000

Notes <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

"SP" indicates a special design.

Please consult with NSK for detailed specifications.

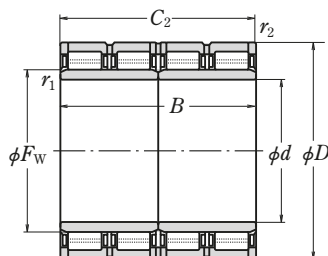


Bearing Designation	Figure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF755RV1011g</b>	8	803	1 017	6	6	2 230
<b>STF760RV1031g</b>	9	808	978	6	6	1 880
<b>STF760RV1012g</b>	8M	808	978	6	6	1 850
<b>STF760RV1032Ag</b>	9M	802	1 032	5	5	2 430
<b>STF761RV1012g</b>	8	807	1 026	5.5	6	2 390
<b>STF761RV1032g</b>	9	810	1 026	6	6	2 390
<b>STF770RV1011g</b>	8M	819	1 022	6	6	2 220
<b>STF780RV1013g</b>	8	823	1 023	5	5	2 140
<b>STF800RV1013g</b>	8	843	1 045	5	2.5	1 920
<b>STF800RV1011g</b>	8	843	1 045	5	2.5	1 910
<b>STF800RV1012g</b>	8	843	1 032	5	5	2 050
<b>STF800RV1032g</b>	9	843	1 032	5	5	2 050
<b>STF820RV1132g</b>	SP	863	1 065	5	2.5	2 000
<b>STF820RV1119g</b>	8M	863	1 052	5	5	1 990
<b>STF820RV1112g</b>	8	867	1 081	5.5	5	2 000
<b>STF820RV1117g</b>	8M	870	1 076	6	6	2 510
<b>STF820RV1134g</b>	SP	870	1 076	6	6	2 530
<b>STF820RV1111Ag</b>	8	870	1 105	6	6	2 900
<b>STF840RV1111g</b>	8M	866	1 105	2	6	2 790
<b>STF850RV1114g</b>	8	900	1 111	6	3	2 610
<b>STF850RV1115g</b>	8	900	1 093	6	6.5	2 600
<b>STF850RV1133g</b>	9	900	1 125	6	6	2 260
<b>STF850RV1111g</b>	8M	900	1 125	6	6	2 850
<b>STF850RV1112Ag</b>	8M	900	1 125	6	6	2 880

## ■ Bearings for Rolling Mills

### Four-Row Cylindrical Roller Bearings

Bore Diameter 860 – 1348.95 mm



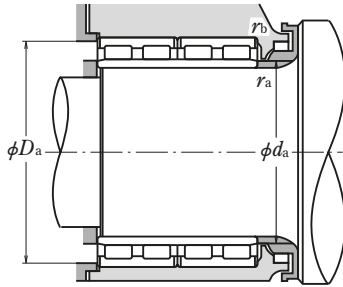
Boundary Dimensions (mm)							Basic Load Ratings (kN)	
$d$	$D$	$B$	$C_2$	$F_w$	$r_1$ min.	$r_2$ min.	$C_r$	$C_{0r}$
<b>860</b>	1 130	670	670	934	6	6	18 400	56 500
	1 160	735	710	940	7.5	4	20 400	60 000
<b>865</b>	1 180	750	750	945.3	Spec.	7.5	23 800	67 000
<b>870</b>	1 145	705	685	940	9.5	6	20 500	61 000
<b>880</b>	1 230	850	850	970	7.5	7.5	29 100	81 000
<b>900</b>	1 220	810	800	981	7.5	6	25 900	74 500
	1 220	840	840	989	7.5	4	26 800	80 000
	1 230	895	870	985	7.7	7.5	25 800	76 000
	1 280	930	930	1 000	7.5	7.5	32 000	89 500
	1 280	930	930	1 000	7.5	7.5	33 000	93 000
<b>920</b>	1 280	865	865	1 015	7.5	7.5	28 000	80 000
<b>950</b>	1 330	950	950	1 053	Spec.	9	33 500	97 000
	1 360	1 000	1 000	1 075	9.5	5	37 500	108 000
<b>1 120</b>	1 580	1 150	1 150	1 255	9.5	9.5	43 500	134 500
<b>1 270</b>	1 602	850	850	1 350	7.5	7.5	32 000	103 000
<b>1 300</b>	1 655	890	880	1 391	7.5	7.5	34 000	110 500
<b>1 348.95</b>	1 745	1 010	1 000	1 466	11.4	7.5	42 500	134 000

**Notes** <sup>(1)</sup> Refer to Pages D142 and D143.

"M" indicates a bearing designed for oil mist lubrication.

"SP" indicates a special design.

Please consult with NSK for detailed specifications.

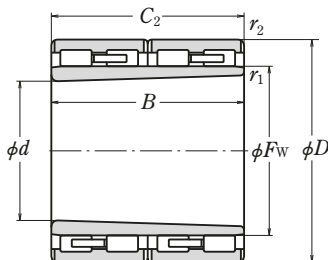


Bearing Designation	Fig- ure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)				Mass (kg) approx.
		$d_a$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF860RV1132g</b>	9	904	1 081	5	5	1 780
<b>STF860RV1133g</b>	9	910	1 121	6	3	2 200
<b>STF865RV1111g</b>	8	915	1 125	6	6	2 480
<b>STF870RV1111g</b>	8	929	1 096	8	5	1 970
<b>STF880RV1211g</b>	8	931	1 174	6	6	3 240
<b>STF900RV1216g</b>	8	951	1 170	6	5	2 790
<b>STF900RV1212g</b>	8	951	1 179	6	3	2 950
<b>STF900RV1211g</b>	8M	951	1 174	6	6	3 200
<b>STF900RV1213g</b>	8	951	1 223	6	6	3 990
<b>STF900RV1217g</b>	8	951	1 223	6	6	4 010
<b>STF920RV1211Ag</b>	8M	972	1 223	6	6	3 510
<b>STF950RV1314g</b>	8	1 008	1 266	7.5	7.5	4 240
<b>STF950RV1311g</b>	8	1 010	1 313	8	4	4 910
<b>STF1120RV1511g</b>	8	1 184	1 509	8	8	7 400
<b>STF1270RV1612g</b>	SP	1 329	1 538	6	6	4 130
<b>STF1300RV1612g</b>	SP	1 359	1 590	6	6	4 710
<b>STF1348RV1711g</b>	SP	1 423	1 678	9.5	6	6 240

## ■ Bearings for Rolling Mills

### Four-Row Cylindrical Roller Bearings

Bore Diameter 110.417 – 633.333 mm

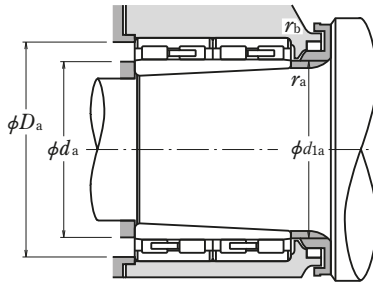


Boundary Dimensions (mm)							Basic Load Ratings (kN)	
$d$	$D$	$B$	$C_2$	$F_w$	$r_1$ min.	$r_2$ min.	$C_r$	$C_{0r}$
<b>110.417</b>	180	115	115	136	1	1	490	840
<b>151.5</b>	230	168	168	180	1	1	1 040	2 170
<b>179.75</b>	260	175	168	212	1.1	2	1 140	2 600
<b>180</b>	260	175	168	212	1.1	2	1 140	2 600
<b>181.5</b>	260	168	168	209	1	2	1 140	2 600
<b>235.367</b>	360	268	268	278	1.5	1.5	2 770	6 000
<b>266.25</b>	400	285	285	312	2	2	3 200	7 500
<b>356.667</b>	550	400	400	434	5	5	5 450	13 300
	550	400	400	431.9	3	2.5	5 450	13 300
<b>412.335</b>	650	488	488	494.5	3	4	8 900	21 100
<b>485</b>	740	540	540	580	5	5	10 100	26 800
<b>633.333</b>	960	680	680	745.8	7.5	7.5	18 100	47 000

**Notes** <sup>(1)</sup> Refer to Pages D142 and D143.

"SP" indicates a special design.

Please consult with NSK for detailed specifications.



Bearing Designation	Fig- ure <sup>(1)</sup>	Abutment and Fillet Dimensions (mm)					Mass (kg) approx.
		$d_a$	$d_{1a}$	$D_a$	$r_a$ max.	$r_b$ max.	
<b>STF120RVK1801g</b>	10	118	128	171	1	1	10
<b>STF165RVK2331g</b>	11	160	174	220	1	1	23.5
<b>STF193RVK2602g</b>	10	190	205	245	1	2	25.1
<b>STF194RVK2602g</b>	10	191	206	245	1	2	25
<b>STF195RVK2602g</b>	10	191	205	245	1	2	24.2
<b>STF257RVK3631g</b>	11	249	272	344	1.5	1.5	92.9
<b>STF290RVK4031g</b>	11	281	305	383	2	2	118
<b>STF390RVK5531g</b>	12	385	419	519	4	4	328
<b>STF390RVK5532g</b>	12	378	412	527	2.5	2	328
<b>STF453RVK6521g</b>	SP	434	476	621	2.5	3	603
<b>STF530RVK7431g</b>	13	516	561	705	4	4	823
<b>STF690RVK9632g</b>	13	679	737	909	6	6	1 720

# Backing Bearings for Multi-Roll Rolling Cluster Mills

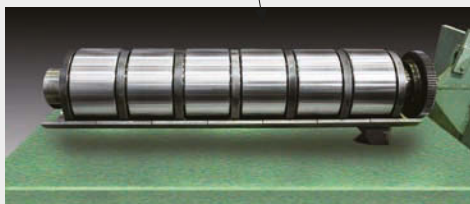
## Benefits

- ❶ Higher reliability and longer operating life prevent unexpected downtime
- ❷ Lower maintenance costs
- ❸ Smoother rolling of backing bearing roll improves plate-making precision.

## 1. Operating conditions



E.g. Sendzimir Mill



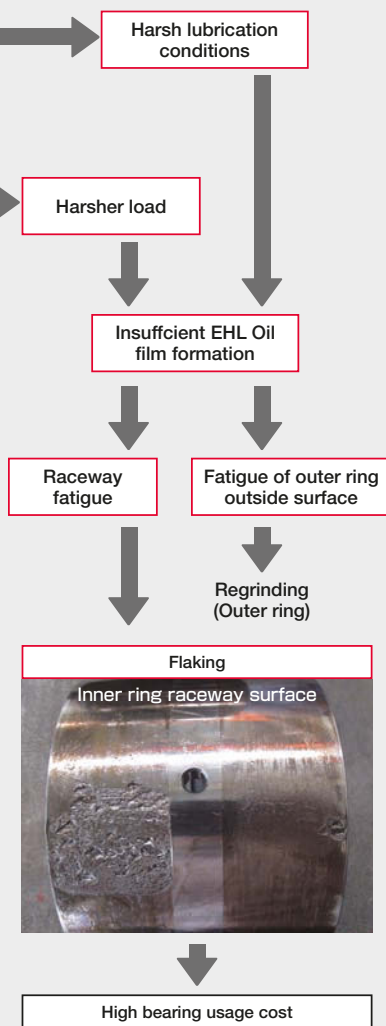
Backing bearings of a roll assemble unit



Backing bearings

## 2. Problems

### Typical problems with backing bearings



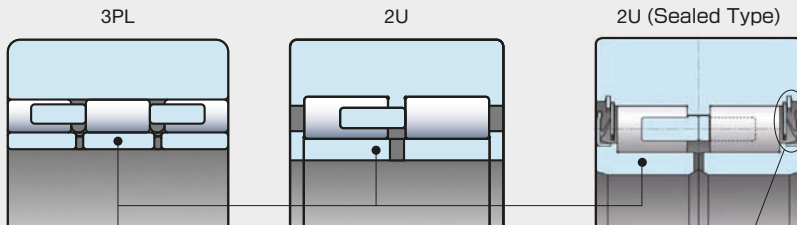


(\*1)

### 3. Countermeasures

#### Features Super-TF™ Backing Bearings

- Improved performance and durability under harsh load conditions and poor oil-film formation
- Outer ring: optimized hardness for regrinding and ring thickness for strength
- Inner ring: adoption of Super TF steel results in longer life even under poor lubrication
- Sealed Type (2U): Strong sealing maintains optimized internal pressure under oil mist or oil-air lubrication.



Adoption of Super-TF Material



Distribution of carbides and carbonitrides in a Super-TF bearing.  
(x 4000 magnification).



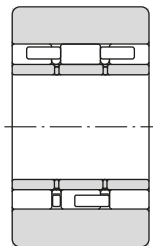
Designations Pages D170 to D173

Super-TF Material Pages A258 to A261

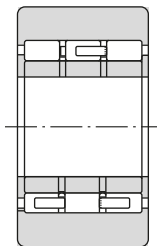
**Note** (\*1): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

## ■ Backing Bearings for Multi-Roll Rolling Mills

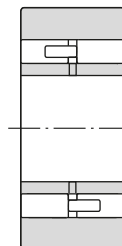
Typical Backing Bearings for Multi-Roll Rolling Mills



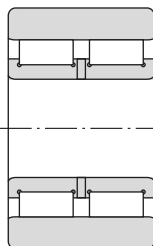
**3PL**  
**Figure 1**



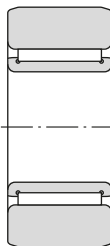
**3U**  
**Figure 2**



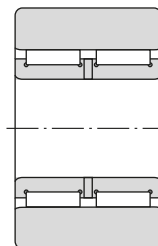
**2PL**  
**Figure 3**



**2L**  
**Figure 4**



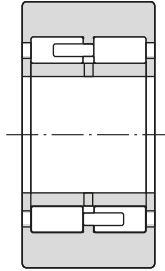
**S**  
**Figure 5**



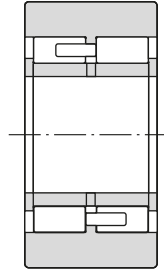
**2S**  
**Figure 6**



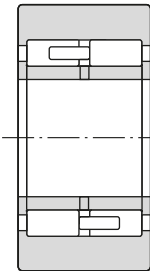
**2U**  
**Figure 7**



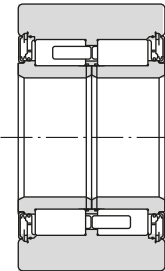
**2U**  
**Figure 8**



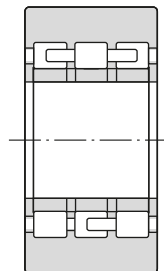
**2U**  
**Figure 9**



**2U**  
**Figure 10**

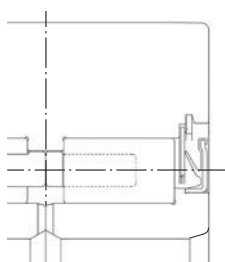


**2U (Sealed Types)**  
**Figure 11**

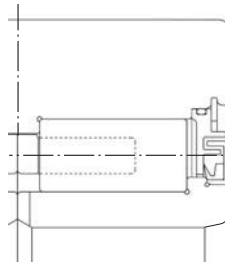


**3U**  
**Figure 12**

**Sealed 2U bearing structure examples**



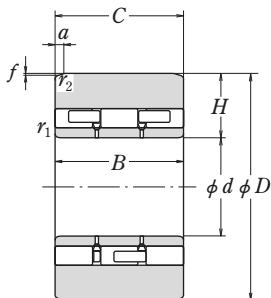
**2U180-7**



**2U130-36, 2U130-16B**

# ■ Backing Bearings for Multi-Roll Rolling Cluster Mills

Bore Diameter 31.75 – 120 mm



Boundary Dimensions (mm)						Basic Load Ratings (kN)		Permissible Radial Load Pu (kN) approx.	Bearing Designation
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub> <sup>(1)</sup>		
<b>31.75</b>	76.2	46.23	45.85	1	0.8	94.5	174	91.8	<b>2S31Z-5</b>
<b>50</b>	120	80	80	1.5	1.5	257	385	147	<b>2U50-4</b>
	120	85	85	1	1.5	305	435	113	<b>*2U50-4g3</b>
<b>55</b>	120	26	26	1.6	1.6	74.5	142	90.2	<b>2U50-6</b>
	120	52.2	52	1.6	1.6	159	375	185	<b>*2U50-6g3</b>
	120	52.2	52	1	1	186	298	115	<b>S55-2</b>
<b>60</b>	160	95	95	1.1	1.5	400	590	290	<b>*S55-2g5</b>
<b>62</b>	155	90	90	1.5	1	355	530	247	<b>S55-1</b>
	155	110	110	1.5	1	405	620	297	<b>S55-1g5</b>
<b>70</b>	160	90	90	1.1	1	410	745	303	
<b>90</b>	220	95	95	1.1	2	590	880	347	
	220.02	96	94	1.5	1.5	520	730	333	<b>2U90-18</b>
	220	120	119	1	3	685	1 020	411	<b>*STF2U90-18g4</b>
	220	122	119	1	3	685	1 020	410	<b>2U90-13</b>
	220	120	120	1	2	675	1 260	494	<b>2U90-11</b>
	220	130	130	1	2	680	1 090	499	<b>2U90-17</b>
	230	100	100	2.5	2	645	990	322	<b>3U90-1</b>
<b>100</b>	225	80	80	2	1.5	535	925	366	<b>3U90-4</b>
	225	120	119	2	3	550	1 000	586	<b>2U90-9</b>
	225	120	120	2	2	715	1 350	542	
<b>100</b>	260	130	130	2	2	950	1 580	617	<b>2PL100-3</b>
<b>110</b>	280	165	165	2.5	2	1 120	1 880	818	<b>2U100-14</b>
<b>115</b>	260	140	140	1.1	2	940	1 660	613	<b>*2U100-14g3</b>
<b>120</b>	280	165	165	2.5	2	1 190	2 060	802	<b>3PL100-1A</b>
	300	160	160	2	2	1 180	1 960	847	
	350	165	165	2.5	2	1 370	2 220	1 140	<b>2U100-15</b>
									<b>3U110-4</b>
									<b>3U115-3</b>
									<b>2U120-15</b>
									<b>3U120-4</b>
									<b>2U120-14</b>

Notes <sup>(1)</sup> These basic load ratings are not the limiting load. *C*<sub>0r</sub> is for reference.

<sup>(2)</sup> Refer to Pages D168 and D169.

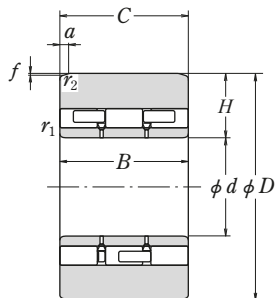
"SP" indicates a special design.

Figure <sup>(3)</sup>	Outer Ring Edge Bevel		Radial Thickness When Delivered		Mass (kg)
	<i>a</i>	<i>f</i>	<i>H</i>		approx.
6	—	—	22.2	0 to +0.010	1.3
9	6.5	0.042	34.976	±0.010	5.2
9	6.5	0.042	34.984	±0.010	5.3
5	—	—	32.5	-0.025 to -0.010	1.7
5	7	0.041	32.485	-0.010 to +0.005	3.4
4	5	0.036	32.5	0 to +0.010	3.2
9	6.5	0.042	49.984	±0.010	11.5
10	6	0.036	46.484	±0.010	9.9
2	6	0.036	46.484	±0.010	12.1
1	6	0.035	45	-0.048 to -0.018	10.7
8	6	0.105	64.982	±0.010	20.8
8	8	0.047	65	-0.010 to 0	20.5
8	21	0.086	65	-0.015 to 0	26.0
8SP	21	0.086	65	-0.015 to 0	27.0
2	6	0.105	64.98	0 to +0.010	27.2
2SP	6	0.105	64.982	±0.010	28.7
10SP	12	0.07	69.98	±0.010	24.4
3	7.6	0.045	62.47	0 to +0.010	18.4
8	12	0.07	62.5	±0.010	27.2
1	8	0.093	62.47	0 to +0.010	27.5
10SP	12	0.07	79.97	±0.010	41.5
2	12	0.072	84.965	±0.010	60.2
2	12	0.209	72.47	±0.010	42.1
9	12	0.072	79.965	±0.010	58.0
2SP	12	0.07	89.966	±0.010	66.7
9	12	0.072	114.965	±0.010	98.5

**Remarks** Ensure that outer ring strength (permissible radial load: Pu) is sufficient when using the outer ring as a roll. Bearings marked with an asterisk (\*) have a special material design. "STF" bearing designations indicate bearings with Super-TF™ material. Please consult with NSK for selection and usage of bearings.

# ■ Backing Bearings for Multi-Roll Rolling Cluster Mills

Bore Diameter 130 – 180 mm



Boundary Dimensions (mm)						Basic Load Ratings (kN)		Permissible Radial Load Pu (kN) approx.	Bearing Designation
<i>d</i>	<i>D</i>	<i>B</i>	<i>C</i>	<i>r</i> <sub>1</sub> min.	<i>r</i> <sub>2</sub>	<i>C</i> <sub>r</sub>	<i>C</i> <sub>0r</sub> <sup>(1)</sup>		
130	300	132	129	2	4	1 040	1 580	590	2U130-32 *2U130-32g2 *STF2U130-32g3
	300.02	150	149	2	4	1 100	1 850	732	2U130-34
	300	160	159.5	2	1.1	1 470	2 670	799	3PL130-2C *3PL130-2Cg2
	300	172.64	172.64	2	4	1 580	2 930	862	3PL130-1C 3PL130-1F
	300	172.64	172.64	2	4	1 580	2 930	862	*3PL130-1Fg2 *STF3PL130-1Fg3
	300.02	172.64	172.64	2	3	1 580	2 930	862	3PL130-1Y
	300	172.64	172.64	2	4	1 580	2 930	862	3PL130-7B
	300	172.644	172.644	2	4	1 370	2 440	854	2U130-26
	300	172.644	172.644	3	4	1 240	2 150	808	2U130-36 *2U130-36g2
	300	172.64	170	2	2	1 240	2 150	800	2U130-16B
	300	172.64	171.6	2	4	1 320	2 300	866	3U130-2
	350	175	175	2.5	2	1 450	2 410	1 230	2U130-29B
179.984	406.4	224	220.66	3	3.3	1 950	3 550	1 460	2U179Z-3
	406.43	224.25	220	3	4	2 250	4 250	1 570	2U179Z-14
									*STF2U179Z-14gA5
180	406.42	171.04	171.04	2.1	4	2 060	3 800	1 220	3PL180-3B
	406.42	171.04	171.04	2.1	4	2 060	3 800	1 220	3PL180-3E
	406.42	171.04	171.04	0.6	1	1 900	3 300	1 150	2U180-3 *STF2U180-3g3
	406.42	171.04	170	2	3	1 650	2 850	1 220	2U180-5
	406.42	171.04	170	2	3	1 650	2 850	1 220	2U180-5A
	406.42	171.04	171.04	3	4	1 560	2 660	1 150	2U180-7 *STF2U180-7g3
	406.42	176	170	2	3	1 650	2 850	1 220	2U180-8
	406.4	217	217	2.1	1.5	2 550	5 000	1 560	3PL180-1B *3PL180-1Bg2
	406.4	224	220	2.1	1.5	2 050	3 750	1 580	3U180-2 *3U180-2g2
	406.4	224	220	2.1	1.5	2 050	3 750	1 580	3U180-3
	406.42	224	224	2.1	1.5	2 610	5 150	1 610	3PL180-2A *3PL180-2Ag2
	406.42	224	224	0.6	1	2 360	4 400	1 510	2U180-4 *STF2U180-4g3

Notes <sup>(1)</sup> These basic load ratings are not the limiting load. *C*<sub>0r</sub> is for reference.

<sup>(2)</sup> Refer to Pages D168 and D169.

"SP" indicates a special design.

Fig- ure <sup>(2)</sup>	Outer Ring Edge Bevel (mm)		Radial Thickness When Delivered (mm)		Mass (kg)
	<i>a</i>	<i>f</i>	<i>H</i>		approx.
8SP	28.2	0.082	85	-0.015 to 0	52.3
9SP 1	25	0.145	85.01	-0.015 to 0	60.9
	9	0.209	84.95	0 to +0.010	66.6
1 1SP	10	0.131	84.95	0 to +0.010	71.8
	10	0.131	84.95	0 to +0.010	72
1	25.4	0.148	84.965	-0.010 to 0	72.1
1	25	0.087	84.95	0 to +0.010	72
9	12.7	0.2	84.955	±0.010	69.1
11	25	0.15	84.955	±0.010	68.8
11	30	0.05	84.95	0 to +0.030	71.2
12	10	0.131	84.95	0 to +0.010	69.4
9	12	0.10	109.965	±0.010	102
11	15.9	0.093	113.205	-0.015 to 0	168
11	60	0.175	113.181	±0.015	161
1	25	0.145	113.155	-0.010 to 0	129
1	25	0.145	113.155	±0.005	129
9	25	0.145	113.16	-0.010 to 0	125
8	25	0.145	113.2	-0.015 to 0	124
8	36.5	0.212	113.2	-0.015 to 0	124
8	25	0.25	113.155	±0.010	123
8	25	0.145	113.2	-0.015 to 0	128
1	10	0.058	113.16	-0.012 to 0	164
12	10	0.058	113.16	-0.012 to 0	162
12	10	0.058	113.205	-0.015 to 0	162
1	10	0.058	113.155	-0.012 to 0	169
9	25	0.145	113.16	-0.010 to 0	164

**Remarks** Ensure that outer ring strength (permissible radial load: Pu) is sufficient when using the outer ring as a roll.  
 Bearings marked with an asterisk (\*) have a special material design.  
 "STF" bearing designations indicate bearings with Super-TF™ material.  
 Please consult with NSK for selection and usage of bearings.



## APPENDICES

<b>Appendix Table 1</b>	<b>SI (International Units) System Conversion Table .....</b>	<b>E 002</b>
<b>Appendix Table 2</b>	<b>N–kgf Force Conversion Table.....</b>	<b>E 004</b>
<b>Appendix Table 3</b>	<b>kg–lb Mass Conversion Table.....</b>	<b>E 005</b>
<b>Appendix Table 4</b>	<b>°C–°F Temperature Conversion Table.....</b>	<b>E 006</b>
<b>Appendix Table 5</b>	<b>Viscosity Conversion Table .....</b>	<b>E 007</b>
<b>Appendix Table 6</b>	<b>inch–mm Conversion Table .....</b>	<b>E 008</b>
<b>Appendix Table 7</b>	<b>Hardness Conversion Table .....</b>	<b>E 010</b>
<b>Appendix Table 8</b>	<b>Physical and Mechanical Properties of Materials .....</b>	<b>E 011</b>
<b>Appendix Table 9</b>	<b>Tolerances for Shaft Diameters .....</b>	<b>E 012</b>
<b>Appendix Table 10</b>	<b>Tolerances for Housing Bore Diameters ...</b>	<b>E 014</b>
<b>Appendix Table 11</b>	<b>Values of IT Standard Tolerance Grades..</b>	<b>E 016</b>
<b>Appendix Table 12</b>	<b>Speed Factor <math>f_n</math> .....</b>	<b>E 018</b>
<b>Appendix Table 13</b>	<b>Fatigue Life Factor <math>f_h</math> and Fatigue Life <math>L-L_h</math> .....</b>	<b>E 019</b>
<b>Appendix Table 14</b>	<b>Index of Inch Series Tapered Roller Bearings .....</b>	<b>E 020</b>

**Appendix Table 1 SI (International Units) System Conversion Table**

Comparison of SI, CGS, and Engineering Units										
Units Unit System	Length	Mass	Time	Temp.	Acceleration	Force	Stress	Pressure	Energy	Power
SI	m	kg	s	K, °C	m/s <sup>2</sup>	N	Pa	Pa	J	W
CGS System	cm	g	s	°C	Gal	dyn	dyn/cm <sup>2</sup>	dyn/cm <sup>2</sup>	erg	erg/s
Engineering Unit System	m	kgf · s <sup>2</sup> /m	s	°C	m/s <sup>2</sup>	kgf	kgf/m <sup>2</sup>	kgf/m <sup>2</sup>	kgf · m	kgf · m/s

Parameter	SI Units		Units Other Than SI		Conversion Factors From SI Units
	Names of Units	Symbols	Name of Units	Symbols	
Angle	Radian	rad	Degree Minute Second	° ' "	180/π 10 800/π 648 000/π
Length	Meter	m	Micron Angstrom	μ Å	10 <sup>6</sup> 10 <sup>10</sup>
Area	Square meter	m <sup>2</sup>	Are Hectare	a ha	10 <sup>-2</sup> 10 <sup>-4</sup>
Volume	Cubic meter	m <sup>3</sup>	Liter Deciliter	l, L dl, dL	10 <sup>3</sup> 10 <sup>4</sup>
Time	Second	s	Minute Hour Day	min h d	1/60 1/3 600 1/86 400
Frequency	Hertz	Hz	Cycle	s <sup>-1</sup>	1
Speed of Rotation	Revolution per second	s <sup>-1</sup>	Revolution per minute	rpm	60
Speed	Meter per second	m/s	Kilometer per hour Knot	km/h kn	3 600/1 000 3 600/1 852
Acceleration	Meter per second per second	m/s <sup>2</sup>	Gal g	Gal G	10 <sup>2</sup> 1/9.806 65
Mass	Kilogram	kg	Ton	t	10 <sup>-3</sup>
Force	Newton	N	Kilogram-force Ton-force Dyne	kgf tf dyn	1/9.806 65 1/ (9.806 65×10 <sup>3</sup> ) 10 <sup>5</sup>
Torque or Moment	Newton · meter	N · m	Kilogram-force meter	kgf · m	1/9.806 65
Stress	Pascal	Pa (N/m <sup>2</sup> )	Kilogram-force per square centimeter Kilogram-force per square millimeter	kgf/cm <sup>2</sup> kgf/mm <sup>2</sup>	1/ (9.806 65×10 <sup>4</sup> ) 1/ (9.806 65×10 <sup>6</sup> )

Prefixes Used in SI

Multiples	Prefix	Symbols	Multiples	Prefix	Symbols
10 <sup>18</sup>	Exa	E	10 <sup>-1</sup>	Deci	d
10 <sup>15</sup>	Peta	P	10 <sup>-2</sup>	Centi	c
10 <sup>12</sup>	Tera	T	10 <sup>-3</sup>	Milli	m
10 <sup>9</sup>	Giga	G	10 <sup>-6</sup>	Micro	μ
10 <sup>6</sup>	Mega	M	10 <sup>-9</sup>	Nano	n
10 <sup>3</sup>	Kilo	k	10 <sup>-12</sup>	Pico	p
10 <sup>2</sup>	Hecto	h	10 <sup>-15</sup>	Femto	f
10	Deca	da	10 <sup>-18</sup>	Ato	a

Conversion Factors From SI Units (Continued)

Parameter	SI Units		Units Other Than SI		Conversion Factors From SI Units
	Names of Units	Symbols	Names of Units	Units	
Pressure	Pascal (Newton per square meter)	Pa (N/m <sup>2</sup> )	Kilogram-force per square meter Water Column Mercury Column Torr Bar Atmosphere	kgf/m <sup>2</sup> mH <sub>2</sub> O mmHg Torr bar atm	1/9.806 65 1/(9.806 65×10 <sup>3</sup> ) 760/(1.013 25×10 <sup>5</sup> ) 760/(1.013 25×10 <sup>5</sup> ) 10 <sup>-5</sup> 1/(1.013 25×10 <sup>5</sup> )
Energy	Joule (Newton · meter)	J (N · m)	Erg Calorie (International) Kilogram-force meter Kilowatt hour French horsepower hour	erg cal <sub>IT</sub> kgf · m kW · h PS · h	10 <sup>7</sup> 1/4.186 8 1/9.806 65 1/(3.6×10 <sup>6</sup> ) ≈ 3.776 72×10 <sup>-7</sup>
Work	Watt (Joule per second)	W (J/s)	Kilogram-force meter per second Kilocalorie per hour French horsepower	kgf · m/s kcal/h PS	1/9.806 65 1/1.163 ≈ 1/735.498 8
Viscosity, Viscosity Index	Pascal second	Pa · s	Poise	P	10
Kinematic Viscosity, Kinematic Viscosity Index	Square meter per second	m <sup>2</sup> /s	Stokes Centistokes	St cSt	10 <sup>4</sup> 10 <sup>6</sup>
Temperature	Kelvin, Degree celsius	K, °C	Degree	°C	(See note <sup>(1)</sup> )
Electric Current, Magnetomotive Force	Ampere	A	Ampere	A	1
Voltage, Electromotive Force	Volt	V	(Watts per ampere)	(W/A)	1
Magnetic Field Strength	Ampere per meter	A/m	Oersted	Oe	4π/10 <sup>3</sup>
Magnetic Flux Density	Tesla	T	Gauss Gamma	Gs γ	10 <sup>4</sup> 10 <sup>9</sup>
Electrical Resistance	Ohm	Ω	(Volts per ampere)	(V/A)	1

**Note** <sup>(1)</sup> The conversion from  $^{\circ}\text{K}$  into  $^{\circ}\text{C}$  is  $\theta = T - 273.15$  but  $\Delta T = \Delta\theta$  for temperature differences. Note that,  $\Delta T$  and  $\Delta\theta$  represent temperature differences measured using the Kelvin and Celsius scales respectively.

**Remarks** Names or symbols in parentheses ( ) are equivalent to those directly above them or on their left.

Example conversion 1 N = 1 / 9.806 65 kgf

**Appendix Table 2 N-kgf Force Conversion Table**

**[Using this table]** To convert between units, find the figure in the shaded column that corresponds to the number in the unit you wish to convert. Then, look to the appropriate column on the right or left in the same row for the converted value. For example, from this table 10 N = 1.0197 kgf, while 10 kgf = 98.066 N.

1 N=0.1019716 kgf  
1 kgf=9.80665 N

N		kgf	N		kgf	N		kgf
9.8066	<b>1</b>	0.1020	333.43	<b>34</b>	3.4670	657.05	<b>67</b>	6.8321
19.613	<b>2</b>	0.2039	343.23	<b>35</b>	3.5690	666.85	<b>68</b>	6.9341
29.420	<b>3</b>	0.3059	353.04	<b>36</b>	3.6710	676.66	<b>69</b>	7.0360
39.227	<b>4</b>	0.4079	362.85	<b>37</b>	3.7729	686.47	<b>70</b>	7.1380
49.033	<b>5</b>	0.5099	372.65	<b>38</b>	3.8749	696.27	<b>71</b>	7.2400
58.840	<b>6</b>	0.6118	382.46	<b>39</b>	3.9769	706.08	<b>72</b>	7.3420
68.647	<b>7</b>	0.7138	392.27	<b>40</b>	4.0789	715.89	<b>73</b>	7.4439
78.453	<b>8</b>	0.8158	402.07	<b>41</b>	4.1808	725.69	<b>74</b>	7.5459
88.260	<b>9</b>	0.9177	411.88	<b>42</b>	4.2828	735.50	<b>75</b>	7.6479
98.066	<b>10</b>	1.0197	421.69	<b>43</b>	4.3848	745.31	<b>76</b>	7.7498
107.87	<b>11</b>	1.1217	431.49	<b>44</b>	4.4868	755.11	<b>77</b>	7.8518
117.68	<b>12</b>	1.2237	441.30	<b>45</b>	4.5887	764.92	<b>78</b>	7.9538
127.49	<b>13</b>	1.3256	451.11	<b>46</b>	4.6907	774.73	<b>79</b>	8.0558
137.29	<b>14</b>	1.4276	460.91	<b>47</b>	4.7927	784.53	<b>80</b>	8.1577
147.10	<b>15</b>	1.5296	470.72	<b>48</b>	4.8946	794.34	<b>81</b>	8.2597
156.91	<b>16</b>	1.6315	480.53	<b>49</b>	4.9966	804.15	<b>82</b>	8.3617
166.71	<b>17</b>	1.7335	490.33	<b>50</b>	5.0986	813.95	<b>83</b>	8.4636
176.52	<b>18</b>	1.8355	500.14	<b>51</b>	5.2006	823.76	<b>84</b>	8.5656
186.33	<b>19</b>	1.9375	509.95	<b>52</b>	5.3025	833.57	<b>85</b>	8.6676
196.13	<b>20</b>	2.0394	519.75	<b>53</b>	5.4045	843.37	<b>86</b>	8.7696
205.94	<b>21</b>	2.1414	529.56	<b>54</b>	5.5065	853.18	<b>87</b>	8.8715
215.75	<b>22</b>	2.2434	539.37	<b>55</b>	5.6084	862.99	<b>88</b>	8.9735
225.55	<b>23</b>	2.3453	549.17	<b>56</b>	5.7104	872.79	<b>89</b>	9.0755
235.36	<b>24</b>	2.4473	558.98	<b>57</b>	5.8124	882.60	<b>90</b>	9.1774
245.17	<b>25</b>	2.5493	568.79	<b>58</b>	5.9144	892.41	<b>91</b>	9.2794
254.97	<b>26</b>	2.6513	578.59	<b>59</b>	6.0163	902.21	<b>92</b>	9.3814
264.78	<b>27</b>	2.7532	588.40	<b>60</b>	6.1183	912.02	<b>93</b>	9.4834
274.59	<b>28</b>	2.8552	598.21	<b>61</b>	6.2203	921.83	<b>94</b>	9.5853
284.39	<b>29</b>	2.9572	608.01	<b>62</b>	6.3222	931.63	<b>95</b>	9.6873
294.20	<b>30</b>	3.0591	617.82	<b>63</b>	6.4242	941.44	<b>96</b>	9.7893
304.01	<b>31</b>	3.1611	627.63	<b>64</b>	6.5262	951.25	<b>97</b>	9.8912
313.81	<b>32</b>	3.2631	637.43	<b>65</b>	6.6282	961.05	<b>98</b>	9.9932
323.62	<b>33</b>	3.3651	647.24	<b>66</b>	6.7301	970.86	<b>99</b>	10.095

**Appendix Table 3 kg-lb Mass Conversion Table**

**[Using this table]** To convert between units, find the figure in the shaded column that corresponds to the number in the unit you wish to convert. Then, look to the appropriate column on the right or left in the same row for the converted value. For example, from this table 10 kg = 22.046 lb, while 10 lb = 4.536 kg.

1 kg=2.2046226 lb

1 lb=0.45359237 kg

kg		lb	kg		lb	kg		lb
0.454	<b>1</b>	2.205	15.422	<b>34</b>	74.957	30.391	<b>67</b>	147.71
0.907	<b>2</b>	4.409	15.876	<b>35</b>	77.162	30.844	<b>68</b>	149.91
1.361	<b>3</b>	6.614	16.329	<b>36</b>	79.366	31.298	<b>69</b>	152.12
1.814	<b>4</b>	8.818	16.783	<b>37</b>	81.571	31.751	<b>70</b>	154.32
2.268	<b>5</b>	11.023	17.237	<b>38</b>	83.776	32.205	<b>71</b>	156.53
2.722	<b>6</b>	13.228	17.690	<b>39</b>	85.980	32.659	<b>72</b>	158.73
3.175	<b>7</b>	15.432	18.144	<b>40</b>	88.185	33.112	<b>73</b>	160.94
3.629	<b>8</b>	17.637	18.597	<b>41</b>	90.390	33.566	<b>74</b>	163.14
4.082	<b>9</b>	19.842	19.051	<b>42</b>	92.594	34.019	<b>75</b>	165.35
4.536	<b>10</b>	22.046	19.504	<b>43</b>	94.799	34.473	<b>76</b>	167.55
4.990	<b>11</b>	24.251	19.958	<b>44</b>	97.003	34.927	<b>77</b>	169.76
5.443	<b>12</b>	26.455	20.412	<b>45</b>	99.208	35.380	<b>78</b>	171.96
5.897	<b>13</b>	28.660	20.865	<b>46</b>	101.41	35.834	<b>79</b>	174.17
6.350	<b>14</b>	30.865	21.319	<b>47</b>	103.62	36.287	<b>80</b>	176.37
6.804	<b>15</b>	33.069	21.772	<b>48</b>	105.82	36.741	<b>81</b>	178.57
7.257	<b>16</b>	35.274	22.226	<b>49</b>	108.03	37.195	<b>82</b>	180.78
7.711	<b>17</b>	37.479	22.680	<b>50</b>	110.23	37.648	<b>83</b>	182.98
8.165	<b>18</b>	39.683	23.133	<b>51</b>	112.44	38.102	<b>84</b>	185.19
8.618	<b>19</b>	41.888	23.587	<b>52</b>	114.64	38.555	<b>85</b>	187.39
9.072	<b>20</b>	44.092	24.040	<b>53</b>	116.84	39.009	<b>86</b>	189.60
9.525	<b>21</b>	46.297	24.494	<b>54</b>	119.05	39.463	<b>87</b>	191.80
9.979	<b>22</b>	48.502	24.948	<b>55</b>	121.25	39.916	<b>88</b>	194.01
10.433	<b>23</b>	50.706	25.401	<b>56</b>	123.46	40.370	<b>89</b>	196.21
10.886	<b>24</b>	52.911	25.855	<b>57</b>	125.66	40.823	<b>90</b>	198.42
11.340	<b>25</b>	55.116	26.308	<b>58</b>	127.87	41.277	<b>91</b>	200.62
11.793	<b>26</b>	57.320	26.762	<b>59</b>	130.07	41.730	<b>92</b>	202.83
12.247	<b>27</b>	59.525	27.216	<b>60</b>	132.28	42.184	<b>93</b>	205.03
12.701	<b>28</b>	61.729	27.669	<b>61</b>	134.48	42.638	<b>94</b>	207.23
13.154	<b>29</b>	63.934	28.123	<b>62</b>	136.69	43.091	<b>95</b>	209.44
13.608	<b>30</b>	66.139	28.576	<b>63</b>	138.89	43.545	<b>96</b>	211.64
14.061	<b>31</b>	68.343	29.030	<b>64</b>	141.10	43.998	<b>97</b>	213.85
14.515	<b>32</b>	70.548	29.484	<b>65</b>	143.30	44.452	<b>98</b>	216.05
14.969	<b>33</b>	72.753	29.937	<b>66</b>	145.51	44.906	<b>99</b>	218.26

**Appendix Table 4 °C-°F Temperature Conversion Table**

**[Using this table]** To convert between units, find the figure in the shaded column that corresponds to the number in the unit you wish to convert. Then, look to the appropriate column on the right or left in the same row for the converted value. For example, from this table 38 °C= 100.4 °F, while 38 °F= 3.3 °C.

$$C = \frac{5}{9}(F - 32)$$

$$F = 32 + \frac{9}{5}C$$

°C		°F	°C		°F	°C		°F	°C		°F
-73.3	<b>-100</b>	-148.0	0.0	<b>32</b>	89.6	21.7	<b>71</b>	159.8	43.3	<b>110</b>	230
-62.2	<b>- 80</b>	-112.0	0.6	<b>33</b>	91.4	22.2	<b>72</b>	161.6	46.1	<b>115</b>	239
-51.1	<b>- 60</b>	- 76.0	1.1	<b>34</b>	93.2	22.8	<b>73</b>	163.4	48.9	<b>120</b>	248
-40.0	<b>- 40</b>	- 40.0	1.7	<b>35</b>	95.0	23.3	<b>74</b>	165.2	51.7	<b>125</b>	257
-34.4	<b>- 30</b>	- 22.0	2.2	<b>36</b>	96.8	23.9	<b>75</b>	167.0	54.4	<b>130</b>	266
-28.9	<b>- 20</b>	- 4.0	2.8	<b>37</b>	98.6	24.4	<b>76</b>	168.8	57.2	<b>135</b>	275
-23.3	<b>- 10</b>	14.0	3.3	<b>38</b>	100.4	25.0	<b>77</b>	170.6	60.0	<b>140</b>	284
-17.8	<b>0</b>	32.0	3.9	<b>39</b>	102.2	25.6	<b>78</b>	172.4	65.6	<b>150</b>	302
-17.2	<b>1</b>	33.8	4.4	<b>40</b>	104.0	26.1	<b>79</b>	174.2	71.1	<b>160</b>	320
-16.7	<b>2</b>	35.6	5.0	<b>41</b>	105.8	26.7	<b>80</b>	176.0	76.7	<b>170</b>	338
-16.1	<b>3</b>	37.4	5.6	<b>42</b>	107.6	27.2	<b>81</b>	177.8	82.2	<b>180</b>	356
-15.6	<b>4</b>	39.2	6.1	<b>43</b>	109.4	27.8	<b>82</b>	179.6	87.8	<b>190</b>	374
-15.0	<b>5</b>	41.0	6.7	<b>44</b>	111.2	28.3	<b>83</b>	181.4	93.3	<b>200</b>	392
-14.4	<b>6</b>	42.8	7.2	<b>45</b>	113.0	28.9	<b>84</b>	183.2	98.9	<b>210</b>	410
-13.9	<b>7</b>	44.6	7.8	<b>46</b>	114.8	29.4	<b>85</b>	185.0	104.4	<b>220</b>	428
-13.3	<b>8</b>	46.4	8.3	<b>47</b>	116.6	30.0	<b>86</b>	186.8	110.0	<b>230</b>	446
-12.8	<b>9</b>	48.2	8.9	<b>48</b>	118.4	30.6	<b>87</b>	188.6	115.6	<b>240</b>	464
-12.2	<b>10</b>	50.0	9.4	<b>49</b>	120.2	31.1	<b>88</b>	190.4	121.1	<b>250</b>	482
-11.7	<b>11</b>	51.8	10.0	<b>50</b>	122.0	31.7	<b>89</b>	192.2	148.9	<b>300</b>	572
-11.1	<b>12</b>	53.6	10.6	<b>51</b>	123.8	32.2	<b>90</b>	194.0	176.7	<b>350</b>	662
-10.6	<b>13</b>	55.4	11.1	<b>52</b>	125.6	32.8	<b>91</b>	195.8	204	<b>400</b>	752
-10.0	<b>14</b>	57.2	11.7	<b>53</b>	127.4	33.3	<b>92</b>	197.6	232	<b>450</b>	842
- 9.4	<b>15</b>	59.0	12.2	<b>54</b>	129.2	33.9	<b>93</b>	199.4	260	<b>500</b>	932
- 8.9	<b>16</b>	60.8	12.8	<b>55</b>	131.0	34.4	<b>94</b>	201.2	288	<b>550</b>	1022
- 8.3	<b>17</b>	62.6	13.3	<b>56</b>	132.8	35.0	<b>95</b>	203.0	316	<b>600</b>	1112
- 7.8	<b>18</b>	64.4	13.9	<b>57</b>	134.6	35.6	<b>96</b>	204.8	343	<b>650</b>	1202
- 7.2	<b>19</b>	66.2	14.4	<b>58</b>	136.4	36.1	<b>97</b>	206.6	371	<b>700</b>	1292
- 6.7	<b>20</b>	68.0	15.0	<b>59</b>	138.2	36.7	<b>98</b>	208.4	399	<b>750</b>	1382
- 6.1	<b>21</b>	69.8	15.6	<b>60</b>	140.0	37.2	<b>99</b>	210.2	427	<b>800</b>	1472
- 5.6	<b>22</b>	71.6	16.1	<b>61</b>	141.8	37.8	<b>100</b>	212.0	454	<b>850</b>	1562
- 5.0	<b>23</b>	73.4	16.7	<b>62</b>	143.6	38.3	<b>101</b>	213.8	482	<b>900</b>	1652
- 4.4	<b>24</b>	75.2	17.2	<b>63</b>	145.4	38.9	<b>102</b>	215.6	510	<b>950</b>	1742
- 3.9	<b>25</b>	77.0	17.8	<b>64</b>	147.2	39.4	<b>103</b>	217.4	538	<b>1000</b>	1832
- 3.3	<b>26</b>	78.8	18.3	<b>65</b>	149.0	40.0	<b>104</b>	219.2	593	<b>1100</b>	2012
- 2.8	<b>27</b>	80.6	18.9	<b>66</b>	150.8	40.6	<b>105</b>	221.0	649	<b>1200</b>	2192
- 2.2	<b>28</b>	82.4	19.4	<b>67</b>	152.6	41.1	<b>106</b>	222.8	704	<b>1300</b>	2372
- 1.7	<b>29</b>	84.2	20.0	<b>68</b>	154.4	41.7	<b>107</b>	224.6	760	<b>1400</b>	2552
- 1.1	<b>30</b>	86.0	20.6	<b>69</b>	156.2	42.2	<b>108</b>	226.4	816	<b>1500</b>	2732
- 0.6	<b>31</b>	87.8	21.1	<b>70</b>	158.0	42.8	<b>109</b>	228.2	871	<b>1600</b>	2912

Appendix Table 5 Viscosity Conversion Table

Kinematic Viscosity mm <sup>2</sup> /s	Saybolt Universal SUS (sec)		No.1 Type Redwood R (sec)		Engler E (degree)
	100°F	210°F	50°C	100°C	
<b>2</b>	32.6	32.8	30.8	31.2	1.14
<b>3</b>	36.0	36.3	33.3	33.7	1.22
<b>4</b>	39.1	39.4	35.9	36.5	1.31
<b>5</b>	42.3	42.6	38.5	39.1	1.40
<b>6</b>	45.5	45.8	41.1	41.7	1.48
<b>7</b>	48.7	49.0	43.7	44.3	1.56
<b>8</b>	52.0	52.4	46.3	47.0	1.65
<b>9</b>	55.4	55.8	49.1	50.0	1.75
<b>10</b>	58.8	59.2	52.1	52.9	1.84
<b>11</b>	62.3	62.7	55.1	56.0	1.93
<b>12</b>	65.9	66.4	58.2	59.1	2.02
<b>13</b>	69.6	70.1	61.4	62.3	2.12
<b>14</b>	73.4	73.9	64.7	65.6	2.22
<b>15</b>	77.2	77.7	68.0	69.1	2.32
<b>16</b>	81.1	81.7	71.5	72.6	2.43
<b>17</b>	85.1	85.7	75.0	76.1	2.54
<b>18</b>	89.2	89.8	78.6	79.7	2.64
<b>19</b>	93.3	94.0	82.1	83.6	2.76
<b>20</b>	97.5	98.2	85.8	87.4	2.87
<b>21</b>	102	102	89.5	91.3	2.98
<b>22</b>	106	107	93.3	95.1	3.10
<b>23</b>	110	111	97.1	98.9	3.22
<b>24</b>	115	115	101	103	3.34
<b>25</b>	119	120	105	107	3.46
<b>26</b>	123	124	109	111	3.58
<b>27</b>	128	129	112	115	3.70
<b>28</b>	132	133	116	119	3.82
<b>29</b>	137	138	120	123	3.95
<b>30</b>	141	142	124	127	4.07
<b>31</b>	145	146	128	131	4.20
<b>32</b>	150	150	132	135	4.32
<b>33</b>	154	155	136	139	4.45
<b>34</b>	159	160	140	143	4.57

Kinematic Viscosity mm <sup>2</sup> /s	Saybolt Universal SUS (sec)		No.1 Type Redwood R (sec)		Engler E (degree)
	100°F	210°F	50°C	100°C	
<b>35</b>	163	164	144	147	4.70
<b>36</b>	168	170	148	151	4.83
<b>37</b>	172	173	153	155	4.96
<b>38</b>	177	178	156	159	5.08
<b>39</b>	181	183	160	164	5.21
<b>40</b>	186	187	164	168	5.34
<b>41</b>	190	192	168	172	5.47
<b>42</b>	195	196	172	176	5.59
<b>43</b>	199	201	176	180	5.72
<b>44</b>	204	205	180	185	5.85
<b>45</b>	208	210	184	189	5.98
<b>46</b>	213	215	188	193	6.11
<b>47</b>	218	219	193	197	6.24
<b>48</b>	222	224	197	202	6.37
<b>49</b>	227	228	201	206	6.50
<b>50</b>	231	233	205	210	6.63
<b>55</b>	254	256	225	231	7.24
<b>60</b>	277	279	245	252	7.90
<b>65</b>	300	302	266	273	8.55
<b>70</b>	323	326	286	294	9.21
<b>75</b>	346	349	306	315	9.89
<b>80</b>	371	373	326	336	10.5
<b>85</b>	394	397	347	357	11.2
<b>90</b>	417	420	367	378	11.8
<b>95</b>	440	443	387	399	12.5
<b>100</b>	464	467	408	420	13.2
<b>120</b>	556	560	490	504	15.8
<b>140</b>	649	653	571	588	18.4
<b>160</b>	742	747	653	672	21.1
<b>180</b>	834	840	734	757	23.7
<b>200</b>	927	933	816	841	26.3
<b>250</b>	1 159	1 167	1 020	1 051	32.9
<b>300</b>	1 391	1 400	1 224	1 241	39.5

Remark 1mm<sup>2</sup>/s=1cSt

**Appendix Table 6 inch - mm Conversion Table**

1"=25.4 mm

inch	0	1	2	3	4	5	6	7	8	9	10
Fraction Decimal	mm										
<b>0 0.000000</b>	<b>0.000</b>	<b>25.400</b>	<b>50.800</b>	<b>76.200</b>	<b>101.600</b>	<b>127.000</b>	<b>152.400</b>	<b>177.800</b>	<b>203.200</b>	<b>228.600</b>	<b>254.000</b>
1/64 0.015625	0.397	25.797	51.197	76.597	101.997	127.397	152.797	178.197	203.597	228.997	254.397
1/32 0.031250	0.794	26.194	51.594	76.994	102.394	127.794	153.194	178.594	203.994	229.394	254.794
3/64 0.046875	1.191	26.591	51.991	77.391	102.791	128.191	153.591	178.991	204.391	229.791	255.191
<b>1/16 0.062500</b>	<b>1.588</b>	<b>26.988</b>	<b>52.388</b>	<b>77.788</b>	<b>103.188</b>	<b>128.588</b>	<b>153.988</b>	<b>179.388</b>	<b>204.788</b>	<b>230.188</b>	<b>255.588</b>
5/64 0.078125	1.984	27.384	52.784	78.184	103.584	128.984	154.384	179.784	205.184	230.584	255.984
3/32 0.093750	2.381	27.781	53.181	78.581	103.981	129.381	154.781	180.181	205.581	230.981	256.381
7/64 0.109375	2.778	28.178	53.578	78.978	104.378	129.778	155.178	180.578	205.978	231.378	256.778
<b>1/8 0.125000</b>	<b>3.175</b>	<b>28.575</b>	<b>53.975</b>	<b>79.375</b>	<b>104.775</b>	<b>130.175</b>	<b>155.575</b>	<b>180.975</b>	<b>206.375</b>	<b>231.775</b>	<b>257.175</b>
9/64 0.140625	3.572	28.972	54.372	79.772	105.172	130.572	155.972	181.372	206.772	232.172	257.572
5/32 0.156250	3.969	29.369	54.769	80.169	105.569	130.969	156.369	181.769	207.169	232.569	257.969
11/64 0.171875	4.366	29.766	55.166	80.566	105.966	131.366	156.766	182.166	207.566	232.966	258.366
<b>3/16 0.187500</b>	<b>4.762</b>	<b>30.162</b>	<b>55.562</b>	<b>80.962</b>	<b>106.362</b>	<b>131.762</b>	<b>157.162</b>	<b>182.562</b>	<b>207.962</b>	<b>233.362</b>	<b>258.762</b>
13/64 0.203125	5.159	30.559	55.959	81.359	106.759	132.159	157.559	182.959	208.359	233.759	259.159
7/32 0.218750	5.556	30.956	56.356	81.756	107.156	132.556	157.956	183.356	208.756	234.156	259.556
15/64 0.234375	5.953	31.353	56.753	82.153	107.553	132.953	158.353	183.753	209.153	234.553	259.953
<b>1/4 0.250000</b>	<b>6.350</b>	<b>31.750</b>	<b>57.150</b>	<b>82.550</b>	<b>107.950</b>	<b>133.350</b>	<b>158.750</b>	<b>184.150</b>	<b>209.550</b>	<b>234.950</b>	<b>260.350</b>
17/64 0.265625	6.747	32.147	57.547	82.947	108.347	133.747	159.147	184.547	209.947	235.347	260.747
9/32 0.281250	7.144	32.544	57.944	83.344	108.744	134.144	159.544	184.944	210.344	235.744	261.144
19/64 0.296875	7.541	32.941	58.341	83.741	109.141	134.541	159.941	185.341	210.741	236.141	261.541
<b>5/16 0.312500</b>	<b>7.938</b>	<b>33.338</b>	<b>58.738</b>	<b>84.138</b>	<b>109.538</b>	<b>134.938</b>	<b>160.338</b>	<b>185.738</b>	<b>211.138</b>	<b>236.538</b>	<b>261.938</b>
21/64 0.328125	8.334	33.734	59.134	84.534	109.934	135.334	160.734	186.134	211.534	236.934	262.334
11/32 0.343750	8.731	34.131	59.531	84.931	110.331	135.731	161.131	186.531	211.931	237.331	262.731
23/64 0.359375	9.128	34.528	59.928	85.328	110.728	136.128	161.528	186.928	212.328	237.728	263.128
<b>3/8 0.375000</b>	<b>9.525</b>	<b>34.925</b>	<b>60.325</b>	<b>85.725</b>	<b>111.125</b>	<b>136.525</b>	<b>161.925</b>	<b>187.325</b>	<b>212.725</b>	<b>238.125</b>	<b>263.525</b>
25/64 0.390625	9.922	35.322	60.722	86.122	111.522	136.922	162.322	187.722	213.122	238.522	263.922
13/32 0.406250	10.319	35.719	61.119	86.519	111.919	137.319	162.719	188.119	213.519	238.919	264.319
27/64 0.421875	10.716	36.116	61.516	86.916	112.316	137.716	163.116	188.516	213.916	239.316	264.716
<b>7/16 0.437500</b>	<b>11.112</b>	<b>36.512</b>	<b>61.912</b>	<b>87.312</b>	<b>112.712</b>	<b>138.112</b>	<b>163.512</b>	<b>188.912</b>	<b>214.312</b>	<b>239.712</b>	<b>265.112</b>
29/64 0.453125	11.509	36.909	62.309	87.709	113.109	138.509	163.909	189.309	214.709	240.109	265.509
15/32 0.468750	11.906	37.306	62.706	88.106	113.506	138.906	164.306	189.706	215.106	240.506	265.906
31/64 0.484375	12.303	37.703	63.103	88.503	113.903	139.303	164.703	190.103	215.503	240.903	266.303
<b>1/2 0.500000</b>	<b>12.700</b>	<b>38.100</b>	<b>63.500</b>	<b>88.900</b>	<b>114.300</b>	<b>139.700</b>	<b>165.100</b>	<b>190.500</b>	<b>215.900</b>	<b>241.300</b>	<b>266.700</b>
33/64 0.515625	13.097	38.497	63.897	89.297	114.697	140.097	165.497	190.897	216.297	241.697	267.097
17/32 0.531250	13.494	38.894	64.294	89.694	115.094	140.494	165.894	191.294	216.694	242.094	267.494
35/64 0.546875	13.891	39.291	64.691	90.091	115.491	140.891	166.291	191.691	217.091	242.491	267.891
<b>9/16 0.562500</b>	<b>14.288</b>	<b>39.688</b>	<b>65.088</b>	<b>90.488</b>	<b>115.888</b>	<b>141.288</b>	<b>166.688</b>	<b>192.088</b>	<b>217.488</b>	<b>242.888</b>	<b>268.288</b>
37/64 0.578125	14.684	40.084	65.484	90.884	116.284	141.684	167.084	192.484	217.884	243.284	268.684
19/32 0.593750	15.081	40.481	65.881	91.281	116.681	142.081	167.481	192.881	218.281	243.681	269.081
39/64 0.609375	15.478	40.878	66.278	91.678	117.078	142.478	167.878	193.278	218.678	244.078	269.478
<b>5/8 0.625000</b>	<b>15.875</b>	<b>41.275</b>	<b>66.675</b>	<b>92.075</b>	<b>117.475</b>	<b>142.875</b>	<b>168.275</b>	<b>193.675</b>	<b>219.075</b>	<b>244.475</b>	<b>269.875</b>
41/64 0.640625	16.272	41.672	67.072	92.472	117.872	143.272	168.672	194.072	219.472	244.872	270.272
21/32 0.656250	16.669	42.069	67.469	92.869	118.269	143.669	169.069	194.469	219.869	245.269	270.669
43/64 0.671875	17.066	42.466	67.866	93.266	118.666	144.066	169.466	194.866	220.266	245.666	271.066
<b>11/16 0.687500</b>	<b>17.462</b>	<b>42.862</b>	<b>68.262</b>	<b>93.662</b>	<b>119.062</b>	<b>144.462</b>	<b>169.862</b>	<b>195.262</b>	<b>220.662</b>	<b>246.062</b>	<b>271.462</b>
45/64 0.703125	17.859	43.259	68.659	94.059	119.459	144.859	170.259	195.659	221.059	246.459	271.859
23/32 0.718750	18.256	43.656	69.056	94.456	119.856	145.256	170.656	196.056	221.456	246.856	272.256
47/64 0.734375	18.653	44.053	69.453	94.853	120.253	145.653	171.053	196.453	221.853	247.253	272.653
<b>3/4 0.750000</b>	<b>19.050</b>	<b>44.450</b>	<b>69.850</b>	<b>95.250</b>	<b>120.650</b>	<b>146.050</b>	<b>171.450</b>	<b>196.850</b>	<b>222.250</b>	<b>247.650</b>	<b>273.050</b>
49/64 0.765625	19.447	44.847	70.247	95.647	121.047	146.447	171.847	197.247	222.647	248.047	273.447
25/32 0.781250	19.844	45.244	70.644	96.044	121.444	146.844	172.244	197.644	223.044	248.444	273.844
51/64 0.796875	20.241	45.641	71.041	96.441	121.841	147.241	172.641	198.041	223.441	248.841	274.241
<b>13/16 0.812500</b>	<b>20.638</b>	<b>46.038</b>	<b>71.438</b>	<b>96.838</b>	<b>122.238</b>	<b>147.638</b>	<b>173.038</b>	<b>198.438</b>	<b>223.838</b>	<b>249.238</b>	<b>274.638</b>
53/64 0.828125	21.034	46.434	71.834	97.234	122.634	148.034	173.434	198.834	224.234	249.634	275.034
27/32 0.843750	21.431	46.831	72.231	97.631	123.031	148.431	173.831	199.231	224.631	250.031	275.431
55/64 0.859375	21.828	47.228	72.628	98.028	123.428	148.828	174.228	199.628	225.028	250.428	275.828
<b>7/8 0.875000</b>	<b>22.225</b>	<b>47.625</b>	<b>73.025</b>	<b>98.425</b>	<b>123.825</b>	<b>149.225</b>	<b>174.625</b>	<b>200.025</b>	<b>225.425</b>	<b>250.825</b>	<b>276.225</b>
57/64 0.890625	22.622	48.022	73.422	98.822	124.222	149.622	175.022	200.422	225.822	251.222	276.622
29/32 0.906250	23.019	48.419	73.819	99.219	124.619	150.019	175.419	200.819	226.219	251.619	277.019
59/64 0.921875	23.416	48.816	74.216	99.616	125.016	150.416	175.816	201.216	226.616	252.016	277.416
<b>15/16 0.937500</b>	<b>23.812</b>	<b>49.212</b>	<b>74.612</b>	<b>100.012</b>	<b>125.412</b>	<b>150.812</b>	<b>176.212</b>	<b>201.612</b>	<b>227.012</b>	<b>252.412</b>	<b>277.812</b>
61/64 0.953125	24.209	49.609	75.009	100.409	125.809	151.209	176.609	202.009	227.409	252.809	278.209
31/32 0.968750	24.606	50.006	75.406	100.806	126.206	151.606	177.006	202.406	227.806	253.206	278.606
63/64 0.984375	25.003	50.403	75.803	101.203	126.603	152.003	177.403	202.803	228.203	253.603	279.003

1"=25.4 mm

inch	11	12	13	14	15	16	17	18	19	20
Fraction Decimal	mm									
<b>0 0.0000</b>	<b>279.400</b>	<b>304.800</b>	<b>330.200</b>	<b>355.600</b>	<b>381.000</b>	<b>406.400</b>	<b>431.800</b>	<b>457.200</b>	<b>482.600</b>	<b>508.000</b>
1/16 0.0625	280.988	306.388	331.788	357.188	382.588	407.988	433.388	458.788	484.188	509.588
1/8 0.1250	282.575	307.975	333.375	358.775	384.175	409.575	434.975	460.375	485.775	511.175
3/16 0.1875	284.162	309.562	334.962	360.362	385.762	411.162	436.562	461.962	487.362	512.762
<b>1/4 0.2500</b>	<b>285.750</b>	<b>311.150</b>	<b>336.550</b>	<b>361.950</b>	<b>387.350</b>	<b>412.750</b>	<b>438.150</b>	<b>463.550</b>	<b>488.950</b>	<b>514.350</b>
5/16 0.3125	287.338	312.738	338.138	363.538	388.938	414.338	439.738	465.138	490.538	515.938
3/8 0.3750	288.925	314.325	339.725	365.125	390.525	415.925	441.325	466.725	492.125	517.525
7/16 0.4375	290.512	315.912	341.312	366.712	392.112	417.512	442.912	468.312	493.712	519.112
<b>1/2 0.5000</b>	<b>292.100</b>	<b>317.500</b>	<b>342.900</b>	<b>368.300</b>	<b>393.700</b>	<b>419.100</b>	<b>444.500</b>	<b>469.900</b>	<b>495.300</b>	<b>520.700</b>
9/16 0.5625	293.688	319.088	344.488	369.888	395.288	420.688	446.088	471.488	496.888	522.288
5/8 0.6250	295.275	320.675	346.075	371.475	396.875	422.275	447.675	473.075	498.475	523.875
11/16 0.6875	296.862	322.262	347.662	373.062	398.462	423.862	449.262	474.662	500.062	525.462
<b>3/4 0.7500</b>	<b>298.450</b>	<b>323.850</b>	<b>349.250</b>	<b>374.650</b>	<b>400.050</b>	<b>425.450</b>	<b>450.850</b>	<b>476.250</b>	<b>501.650</b>	<b>527.050</b>
13/16 0.8125	300.038	325.438	350.838	376.238	401.638	427.038	452.438	477.838	503.238	528.638
7/8 0.8750	301.625	327.025	352.425	377.825	403.225	428.625	454.025	479.425	504.825	530.225
15/16 0.9375	303.212	328.612	354.012	379.412	404.812	430.212	455.612	481.012	506.412	531.812

1"=25.4 mm

inch	21	22	23	24	25	26	27	28	29	30
Fraction Decimal	mm									
<b>0 0.0000</b>	<b>533.400</b>	<b>558.800</b>	<b>584.200</b>	<b>609.600</b>	<b>635.000</b>	<b>660.400</b>	<b>685.800</b>	<b>711.200</b>	<b>736.600</b>	<b>762.000</b>
1/16 0.0625	534.988	560.388	585.788	611.188	636.588	661.988	687.388	712.788	738.188	763.588
1/8 0.1250	536.575	561.975	587.375	612.775	638.175	663.575	688.975	714.375	739.775	765.175
3/16 0.1875	538.162	563.562	588.962	614.362	639.762	665.162	690.562	715.962	741.362	766.762
<b>1/4 0.2500</b>	<b>539.750</b>	<b>565.150</b>	<b>590.550</b>	<b>615.950</b>	<b>641.350</b>	<b>666.750</b>	<b>692.150</b>	<b>717.550</b>	<b>742.950</b>	<b>768.350</b>
5/16 0.3125	541.338	566.738	592.138	617.538	642.938	668.338	693.738	719.138	744.538	769.938
3/8 0.3750	542.925	568.325	593.725	619.125	644.525	669.925	695.325	720.725	746.125	771.525
7/16 0.4375	544.512	569.912	595.312	620.712	646.112	671.512	696.912	722.312	747.712	773.112
<b>1/2 0.5000</b>	<b>546.100</b>	<b>571.500</b>	<b>596.900</b>	<b>622.300</b>	<b>647.700</b>	<b>673.100</b>	<b>698.500</b>	<b>723.900</b>	<b>749.300</b>	<b>774.700</b>
9/16 0.5625	547.688	573.088	598.488	623.888	649.288	674.688	700.088	725.488	750.888	776.288
5/8 0.6250	549.275	574.675	600.075	625.475	650.875	676.275	701.675	727.075	752.475	777.875
11/16 0.6875	550.862	576.262	601.662	627.062	652.462	677.862	703.262	728.662	754.062	779.462
<b>3/4 0.7500</b>	<b>552.450</b>	<b>577.850</b>	<b>603.250</b>	<b>628.650</b>	<b>654.050</b>	<b>679.450</b>	<b>704.850</b>	<b>730.250</b>	<b>755.650</b>	<b>781.050</b>
13/16 0.8125	554.038	579.438	604.838	630.238	655.638	681.038	706.438	731.838	757.238	782.638
7/8 0.8750	555.625	581.025	606.425	631.825	657.225	682.625	708.025	733.425	758.825	784.225
15/16 0.9375	557.212	582.612	608.012	633.412	658.812	684.212	709.612	735.012	760.412	785.812

1"=25.4 mm

inch	31	32	33	34	35	36	37	38	39	40
Fraction Decimal	mm									
<b>0 0.0000</b>	<b>787.400</b>	<b>812.800</b>	<b>838.200</b>	<b>863.600</b>	<b>889.000</b>	<b>914.400</b>	<b>939.800</b>	<b>965.200</b>	<b>990.600</b>	<b>1016.000</b>
1/16 0.0625	788.988	814.388	839.788	865.188	890.588	915.988	941.388	966.788	992.188	1017.588
1/8 0.1250	790.575	815.975	841.375	866.775	892.175	917.575	942.975	968.375	993.775	1019.175
3/16 0.1875	792.162	817.562	842.962	868.362	893.762	919.162	944.562	969.962	995.362	1020.762
<b>1/4 0.2500</b>	<b>793.750</b>	<b>819.150</b>	<b>844.550</b>	<b>869.950</b>	<b>895.350</b>	<b>920.750</b>	<b>946.150</b>	<b>971.550</b>	<b>996.950</b>	<b>1022.350</b>
5/16 0.3125	795.338	820.738	846.138	871.538	896.938	922.338	947.738	973.138	998.538	1023.938
3/8 0.3750	796.925	822.325	847.725	873.125	898.525	923.925	949.325	974.725	1000.125	1025.525
7/16 0.4375	798.512	823.912	849.312	874.712	900.112	925.512	950.912	976.312	1001.712	1027.112
<b>1/2 0.5000</b>	<b>800.100</b>	<b>825.500</b>	<b>850.900</b>	<b>876.300</b>	<b>901.700</b>	<b>927.100</b>	<b>952.500</b>	<b>977.900</b>	<b>1003.300</b>	<b>1028.700</b>
9/16 0.5625	801.688	827.088	852.488	877.888	903.288	928.688	954.088	979.488	1004.888	1030.288
5/8 0.6250	803.275	828.675	854.075	879.475	904.875	930.275	955.675	981.075	1006.475	1031.875
11/16 0.6875	804.862	830.262	855.662	881.062	906.462	931.862	957.262	982.662	1008.062	1033.462
<b>3/4 0.7500</b>	<b>806.450</b>	<b>831.850</b>	<b>857.250</b>	<b>882.650</b>	<b>908.050</b>	<b>933.450</b>	<b>958.850</b>	<b>984.250</b>	<b>1009.650</b>	<b>1035.050</b>
13/16 0.8125	808.038	833.438	858.838	884.238	909.638	935.038	960.438	985.838	1011.238	1036.638
7/8 0.8750	809.625	835.025	860.425	885.825	911.225	936.625	962.025	987.425	1012.825	1038.225
15/16 0.9375	811.212	836.612	862.012	887.412	912.812	938.212	963.621	989.012	1014.412	1039.812

**Appendix Table 7 Hardness Conversion Table (Reference)**

Rockwell C Scale Hardness  (1 471N) {150kgf}	Vickers Hardness	Brinell Hardness		Rockwell Hardness		Shore Hardness
		Standard Ball	Tungsten Carbide Ball	A Scale	B Scale	
				Load <sup>588.4N</sup> {60kgf} Brale Indenter	Load <sup>980.7N</sup> {100kgf} 1.588 mm <sub>Ball</sub> (1/16in)	
<b>68</b>	940	—	—	85.6	—	97
<b>67</b>	900	—	—	85.0	—	95
<b>66</b>	865	—	—	84.5	—	92
<b>65</b>	832	—	739	83.9	—	91
<b>64</b>	800	—	722	83.4	—	88
<b>63</b>	772	—	705	82.8	—	87
<b>62</b>	746	—	688	82.3	—	85
<b>61</b>	720	—	670	81.8	—	83
<b>60</b>	697	—	654	81.2	—	81
<b>59</b>	674	—	634	80.7	—	80
<b>58</b>	653	—	615	80.1	—	78
<b>57</b>	633	—	595	79.6	—	76
<b>56</b>	613	—	577	79.0	—	75
<b>55</b>	595	—	560	78.5	—	74
<b>54</b>	577	—	543	78.0	—	72
<b>53</b>	560	—	525	77.4	—	71
<b>52</b>	544	500	512	76.8	—	69
<b>51</b>	528	487	496	76.3	—	68
<b>50</b>	513	475	481	75.9	—	67
<b>49</b>	498	464	469	75.2	—	66
<b>48</b>	484	451	455	74.7	—	64
<b>47</b>	471	442	443	74.1	—	63
<b>46</b>	458	432	432	73.6	—	62
<b>45</b>	446	421	421	73.1	—	60
<b>44</b>	434	409	409	72.5	—	58
<b>43</b>	423	400	400	72.0	—	57
<b>42</b>	412	390	390	71.5	—	56
<b>41</b>	402	381	381	70.9	—	55
<b>40</b>	392	371	371	70.4	—	54
<b>39</b>	382	362	362	69.9	—	52
<b>38</b>	372	353	353	69.4	—	51
<b>37</b>	363	344	344	68.9	—	50
<b>36</b>	354	336	336	68.4	(109.0)	49
<b>35</b>	345	327	327	67.9	(108.5)	48
<b>34</b>	336	319	319	67.4	(108.0)	47
<b>33</b>	327	311	311	66.8	(107.5)	46
<b>32</b>	318	301	301	66.3	(107.0)	44
<b>31</b>	310	294	294	65.8	(106.0)	43
<b>30</b>	302	286	286	65.3	(105.5)	42
<b>29</b>	294	279	279	64.7	(104.5)	41
<b>28</b>	286	271	271	64.3	(104.0)	41
<b>27</b>	279	264	264	63.8	(103.0)	40
<b>26</b>	272	258	258	63.3	(102.5)	38
<b>25</b>	266	253	253	62.8	(101.5)	38
<b>24</b>	260	247	247	62.4	(101.0)	37
<b>23</b>	254	243	243	62.0	100.0	36
<b>22</b>	248	237	237	61.5	99.0	35
<b>21</b>	243	231	231	61.0	98.5	35
<b>20</b>	238	226	226	60.5	97.8	34
<b>(18)</b>	230	219	219	—	96.7	33
<b>(16)</b>	222	212	212	—	95.5	32
<b>(14)</b>	213	203	203	—	93.9	31
<b>(12)</b>	204	194	194	—	92.3	29
<b>(10)</b>	196	187	187	—	90.7	28
<b>(8)</b>	188	179	179	—	89.5	27
<b>(6)</b>	180	171	171	—	87.1	26
<b>(4)</b>	173	165	165	—	85.5	25
<b>(2)</b>	166	158	158	—	83.5	24
<b>(0)</b>	160	152	152	—	81.7	24

Appendix Table 8 Physical and Mechanical Properties of Materials

Materials	Specific Gravity	Coefficient of Linear Expansion (0° to 100°C) (K <sup>-1</sup> )	Hardness (Brinell)	Young's modulus (MPa) {kgf/mm <sup>2</sup> }	Tensile Strength (MPa) {kgf/mm <sup>2</sup> }	Yield Point (MPa) {kgf/mm <sup>2</sup> }	Elongation (%)
Bearing Steel (hardened)	7.83	12.5×10 <sup>-6</sup>	650 to 740	208 000 {21 200}	1 570 to 1 960 {160 to 200}	—	—
Martensitic Stainless Steel SUS 440C	7.68	10.1×10 <sup>-6</sup>	580	200 000 {20 400}	1 960 {200}	1 860 {190}	—
Mild Steel (C=0.12 to 0.20%)	7.86	11.6×10 <sup>-6</sup>	100 to 130	206 000 {21 000}	373 to 471 {38 to 48}	216 to 294 {22 to 30}	24 to 36
Hard Steel (C=0.3 to 0.5%)	7.84	11.3×10 <sup>-6</sup>	160 to 200	206 000 {21 000}	539 to 686 {55 to 70}	333 to 451 {34 to 46}	14 to 26
Austenitic Stainless Steel SUS 304	8.03	16.3×10 <sup>-6</sup>	150	193 000 {19 700}	588 {60}	245 {25}	60
Gray Iron FC200	7.3	10.4×10 <sup>-6</sup>	223	98 100 {10 000}	More than 200 {20}	—	—
Spheroidal graphite Iron FCD400	7.0	11.7×10 <sup>-6</sup>	Less than 201	169 000 {17 200}	More than 400 {41}	—	More than 12
Aluminum	2.69	23.7×10 <sup>-6</sup>	15 to 26	70 600 {7 200}	78 {8}	34 {3.5}	35
Zinc	7.14	31×10 <sup>-6</sup>	30 to 60	92 200 {9 400}	147 {15}	—	30 to 40
Copper	8.93	16.2×10 <sup>-6</sup>	50	123 000 {12 500}	196 {20}	69 {7}	15 to 20
(Annealed) Brass (Machined)	8.5	19.1×10 <sup>-6</sup>	45  85 to 130	103 000 {10 500}	294 to 343 {30 to 35}  363 to 539 {37 to 55}	—	65 to 75  15 to 50

**Remark** The hardness of hardened bearing steel and martensitic stainless steel is usually expressed using the Rockwell C Scale, but for comparison, here it is converted into Brinell hardness.

**Appendix Table 9 Tolerances**

Diameter Classification (mm)		Single Plane Mean 6.0. Deviation ( $\Delta_{dmp}$ )	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6
over	incl.														
3	6	0 - 8	- 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	0 - 8	- 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	0 - 8	- 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	0 - 10	- 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	0 - 12	- 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	0 - 15	- 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	0 - 20	- 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	0 - 25	- 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	0 - 30	- 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	0 - 35	- 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	0 - 40	- 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	0 - 45	- 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	0 - 50	- 260 - 304	- 145 - 189	- 76 - 120	—	- 22 - 66	—	0 - 44	0 - 70	0 - 110	0 - 175	0 - 280	—	± 22
630	800	0 - 75	- 290 - 340	- 160 - 210	- 80 - 130	—	- 24 - 74	—	0 - 50	0 - 80	0 - 125	0 - 200	0 - 320	—	± 25
800	1 000	0 - 100	- 320 - 376	- 170 - 226	- 86 - 142	—	- 26 - 82	—	0 - 56	0 - 90	0 - 140	0 - 230	0 - 360	—	± 28
1 000	1 250	0 - 125	- 350 - 416	- 195 - 261	- 98 - 164	—	- 28 - 94	—	0 - 66	0 - 105	0 - 165	0 - 260	0 - 420	—	± 33
1 250	1 600	0 - 160	- 390 - 468	- 220 - 298	- 110 - 188	—	- 30 - 108	—	0 - 78	0 - 125	0 - 195	0 - 310	0 - 500	—	± 39
1 600	2 000	0 - 200	- 430 - 522	- 240 - 332	- 120 - 212	—	- 32 - 124	—	0 - 92	0 - 150	0 - 230	0 - 370	0 - 600	—	± 46

## for Shaft Diameters

Units :  $\mu\text{m}$ 

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	$\pm 16$	$\pm 26$	+ 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	$\pm 18$	+ 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	$\pm 20$	+ 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

Appendix Table 10

Diameter Classification (mm)		Single Plane Mean O.D. Deviation (Normal) $\Delta D_{mp}$	E6	F6		F7	G6		G7	H6		H7	H8		J6	J7	JS6	JS7
over	incl.																	
10	18	0 - 8	+ 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	0 - 9	+ 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	0 - 11	+ 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	0 - 13	+ 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	0 - 15	+ 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	0 - 18 0 - 25	+ 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	0 - 30	+ 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	0 - 35	+ 142 + 110	+ 88 + 56	+ 108 + 56	+ 49 + 17	+ 69 + 17	+ 32 0	+ 52 0	+ 81 0	+ 25 - 7	+ 36 - 16	± 16	± 26				
315	400	0 - 40	+ 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	0 - 45	+ 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	0 - 50	+ 189 + 145	+ 120 + 76	+ 146 + 76	+ 66 + 22	+ 92 + 22	+ 44 0	+ 70 0	+ 110 0	—	—	± 22	± 35				
630	800	0 - 75	+ 210 + 160	+ 130 + 80	+ 160 + 80	+ 74 + 24	+ 104 + 24	+ 50 0	+ 80 0	+ 125 0	—	—	± 25	± 40				
800	1 000	0 - 100	+ 226 + 170	+ 142 + 86	+ 176 + 86	+ 82 + 26	+ 116 + 26	+ 56 0	+ 90 0	+ 140 0	—	—	± 28	± 45				
1 000	1 250	0 - 125	+ 261 + 195	+ 164 + 98	+ 203 + 98	+ 94 + 28	+ 133 + 28	+ 66 0	+ 105 0	+ 165 0	—	—	± 33	± 52.5				
1 250	1 600	0 - 160	+ 298 + 220	+ 188 + 110	+ 235 + 110	+ 108 + 30	+ 155 + 30	+ 78 0	+ 125 0	+ 195 0	—	—	± 39	± 62.5				
1 600	2 000	0 - 200	+ 332 + 240	+ 212 + 120	+ 270 + 120	+ 124 + 32	+ 182 + 32	+ 92 0	+ 150 0	+ 230 0	—	—	± 46	± 75				
2 000	2 500	0 - 250	+ 370 + 260	+ 240 + 130	+ 305 + 130	+ 144 + 34	+ 209 + 34	+ 110 0	+ 175 0	+ 280 0	—	—	± 55	± 87.5				

## Tolerances for Housing Bore Diameters

Units :  $\mu\text{m}$ 

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

**Appendix Table 11 Values of**

Basic Size (mm)		Standard										
		IT1	IT2	IT3	IT4	IT5	IT6	IT7	IT8	IT9	IT10	IT11
over	incl.	Tolerances (μm)										
—	3	0.8	1.2	2	3	4	6	10	14	25	40	60
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90
10	18	1.2	2	3	5	8	11	18	27	43	70	110
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160
50	80	2	3	5	8	13	19	30	46	74	120	190
80	120	2.5	4	6	10	15	22	35	54	87	140	220
120	180	3.5	5	8	12	18	25	40	63	100	160	250
180	250	4.5	7	10	14	20	29	46	72	115	185	290
250	315	6	8	12	16	23	32	52	81	130	210	320
315	400	7	9	13	18	25	36	57	89	140	230	360
400	500	8	10	15	20	27	40	63	97	155	250	400
500	630	9	11	16	22	32	44	70	110	175	280	440
630	800	10	13	18	25	36	50	80	125	200	320	500
800	1 000	11	15	21	28	40	56	90	140	230	360	560
1 000	1 250	13	18	24	33	47	66	105	165	260	420	660
1 250	1 600	15	21	29	39	55	78	125	195	310	500	780
1 600	2 000	18	25	35	46	65	92	150	230	370	600	920
2 000	2 500	22	30	41	55	78	110	175	280	440	700	1 100
2 500	3 150	26	36	50	68	96	135	210	330	540	860	1 350

- Remarks**
- Standard tolerance grades IT14 to IT18 must not be used for basic sizes less than or equal to 1 mm.
  - Values for standard tolerance grades IT1 to IT5 for basic sizes over 500 mm are included for experimental use.

## IT Standard Tolerance Grades

Grades							Basic Size (mm)	
IT12	IT13	IT14	IT15	IT16	IT17	IT18		
Tolerances (mm)							over	incl.
0.10	0.14	0.25	0.40	0.60	1.00	1.40	—	3
0.12	0.18	0.30	0.48	0.75	1.20	1.80	3	6
0.15	0.22	0.36	0.58	0.90	1.50	2.20	6	10
0.18	0.27	0.43	0.70	1.10	1.80	2.70	10	18
0.21	0.33	0.52	0.84	1.30	2.10	3.30	18	30
0.25	0.39	0.62	1.00	1.60	2.50	3.90	30	50
0.30	0.46	0.74	1.20	1.90	3.00	4.60	50	80
0.35	0.54	0.87	1.40	2.20	3.50	5.40	80	120
0.40	0.63	1.00	1.60	2.50	4.00	6.30	120	180
0.46	0.72	1.15	1.85	2.90	4.60	7.20	180	250
0.52	0.81	1.30	2.10	3.20	5.20	8.10	250	315
0.57	0.89	1.40	2.30	3.60	5.70	8.90	315	400
0.63	0.97	1.55	2.50	4.00	6.30	9.70	400	500
0.70	1.10	1.75	2.80	4.40	7.00	11.00	500	630
0.80	1.25	2.00	3.20	5.00	8.00	12.50	630	800
0.90	1.40	2.30	3.60	5.60	9.00	14.00	800	1 000
1.05	1.65	2.60	4.20	6.60	10.50	16.50	1 000	1 250
1.25	1.95	3.10	5.00	7.80	12.50	19.50	1 250	1 600
1.50	2.30	3.70	6.00	9.20	15.00	23.00	1 600	2 000
1.75	2.80	4.40	7.00	11.00	17.50	28.00	2 000	2 500
2.10	3.30	5.40	8.60	13.50	21.00	33.00	2 500	3 150

**Appendix Table 12 Speed Factor  $f_n$**

Ball Bearings  $f_n = (0.03 n)^{-1/3}$   
 Roller Bearings  $f_n = (0.03 n)^{-3/10}$

Speed $n$ (min <sup>-1</sup> )	Speed Factor $f_n$	
	Ball Bearings	Roller Bearings
10	1.49	1.44
11	1.45	1.39
12	1.41	1.36
13	1.37	1.33
14	1.34	1.30
15	1.30	1.27
16	1.28	1.25
17	1.25	1.22
18	1.23	1.20
19	1.21	1.18
20	1.19	1.17
21	1.17	1.15
22	1.15	1.13
23	1.13	1.12
24	1.12	1.10
25	1.10	1.09
26	1.09	1.08
27	1.07	1.07
28	1.06	1.05
29	1.05	1.04
30	1.04	1.03
31	1.02	1.02
32	1.01	1.01
<b>33.3</b>	<b>1.00</b>	<b>1.00</b>
34	0.993	0.994
36	0.975	0.977
38	0.957	0.961
40	0.941	0.947
42	0.926	0.933
44	0.912	0.920
46	0.898	0.908
48	0.886	0.896
50	0.874	0.885
55	0.846	0.861
60	0.822	0.838
65	0.800	0.818
70	0.781	0.800
75	0.763	0.784
80	0.747	0.769
85	0.732	0.755
90	0.718	0.742
95	0.705	0.730
100	0.693	0.719
110	0.672	0.699
120	0.652	0.681
130	0.635	0.665
140	0.620	0.650
150	0.606	0.637
160	0.593	0.625
170	0.581	0.613

Speed $n$ (min <sup>-1</sup> )	Speed Factor $f_n$	
	Ball Bearings	Roller Bearings
180	0.570	0.603
190	0.560	0.593
200	0.550	0.584
220	0.533	0.568
240	0.518	0.553
260	0.504	0.540
280	0.492	0.528
300	0.481	0.517
320	0.471	0.507
340	0.461	0.498
360	0.452	0.490
380	0.444	0.482
400	0.437	0.475
420	0.430	0.468
440	0.423	0.461
460	0.417	0.455
480	0.411	0.449
500	0.405	0.444
550	0.393	0.431
600	0.382	0.420
650	0.372	0.410
700	0.362	0.401
750	0.354	0.393
800	0.347	0.385
850	0.340	0.378
900	0.333	0.372
950	0.327	0.366
1 000	0.322	0.360
1 050	0.317	0.355
1 100	0.312	0.350
1 150	0.307	0.346
1 200	0.303	0.341
1 250	0.299	0.337
1 300	0.295	0.333
1 400	0.288	0.326
1 500	0.281	0.319
1 600	0.275	0.313
1 700	0.270	0.307
1 800	0.265	0.302
1 900	0.260	0.297
2 000	0.255	0.293
2 100	0.251	0.289
2 200	0.247	0.285
2 300	0.244	0.281
2 400	0.240	0.277
2 500	0.237	0.274
2 600	0.234	0.271
2 700	0.231	0.268
2 800	0.228	0.265
2 900	0.226	0.262

Speed $n$ (min <sup>-1</sup> )	Speed Factor $f_n$	
	Ball Bearings	Roller Bearings
3 000	0.223	0.259
3 200	0.218	0.254
3 400	0.214	0.250
3 600	0.210	0.245
3 800	0.206	0.242
4 000	0.203	0.238
4 200	0.199	0.234
4 400	0.196	0.231
4 600	0.194	0.228
4 800	0.191	0.225
5 000	0.188	0.222
5 200	0.186	0.220
5 400	0.183	0.217
5 600	0.181	0.215
5 800	0.179	0.213
6 000	0.177	0.211
6 200	0.175	0.209
6 400	0.173	0.207
6 600	0.172	0.205
6 800	0.170	0.203
7 000	0.168	0.201
7 200	0.167	0.199
7 400	0.165	0.198
7 600	0.164	0.196
7 800	0.162	0.195
8 000	0.161	0.193
8 500	0.158	0.190
9 000	0.155	0.186
9 500	0.152	0.183
10 000	0.149	0.181
11 000	0.145	0.176
12 000	0.141	0.171
13 000	0.137	0.167
14 000	0.134	0.163
15 000	0.130	0.160
16 000	0.128	0.157
17 000	0.125	0.154
18 000	0.123	0.151
19 000	0.121	0.149
20 000	0.119	0.147
22 000	0.115	0.143
24 000	0.112	0.139
26 000	0.109	0.136
28 000	0.106	0.133
30 000	0.104	0.130
32 000	0.101	0.127
34 000	0.099	0.125
36 000	0.097	0.123
38 000	0.096	0.121
40 000	0.094	0.119

Appendix Table 13 Fatigue Life Factor  $f_h$  and Fatigue Life  $L$ - $L_h$ Ball Bearings  $L=(C/P)^3$   $L_h=500 f_h^3$ Roller Bearings  $L=(C/P)^{10/3}$   $L_h=500 f_h^{10/3}$ 

$C/P$ or $f_h$	Ball Bearing Life		Roller Bearing Life	
	$L$ ( $10^6$ rev)	$L_h$ (h)	$L$ ( $10^6$ rev)	$L_h$ (h)
0.70	0.34	172	0.30	152
0.75	0.42	211	0.38	192
0.80	0.51	256	0.48	238
0.85	0.61	307	0.58	291
0.90	0.73	365	0.70	352
0.95	0.86	429	0.84	421
<b>1.00</b>	<b>1.00</b>	<b>500</b>	<b>1.00</b>	<b>500</b>
1.05	1.16	579	1.18	588
1.10	1.33	665	1.37	687
1.15	1.52	760	1.59	797
1.20	1.73	864	1.84	918
1.25	1.95	977	2.10	1 050
1.30	2.20	1 100	2.40	1 200
1.35	2.46	1 230	2.72	1 360
1.40	2.74	1 370	3.07	1 530
1.45	3.05	1 520	3.45	1 730
1.50	3.38	1 690	3.86	1 930
1.55	3.72	1 860	4.31	2 150
1.60	4.10	2 050	4.79	2 400
1.65	4.49	2 250	5.31	2 650
1.70	4.91	2 460	5.86	2 930
1.75	5.36	2 680	6.46	3 230
1.80	5.83	2 920	7.09	3 550
1.85	6.33	3 170	7.77	3 890
1.90	6.86	3 430	8.50	4 250
1.95	7.41	3 710	9.26	4 630
2.00	8.00	4 000	10.1	5 040
2.05	8.62	4 310	10.9	5 470
2.10	9.26	4 630	11.9	5 930
2.15	9.94	4 970	12.8	6 410
2.20	10.6	5 320	13.8	6 920
2.25	11.4	5 700	14.9	7 460
2.30	12.2	6 080	16.1	8 030
2.35	13.0	6 490	17.3	8 630
2.40	13.8	6 910	18.5	9 250
2.45	14.7	7 350	19.8	9 910
2.50	15.6	7 810	21.2	10 600
2.55	16.6	8 290	22.7	11 300
2.60	17.6	8 790	24.2	12 100
2.65	18.6	9 300	25.8	12 900
2.70	19.7	9 840	27.4	13 700
2.75	20.8	10 400	29.1	14 600
2.80	22.0	11 000	30.9	15 500
2.85	23.1	11 600	32.8	16 400
2.90	24.4	12 200	34.8	17 400
2.95	25.7	12 800	36.8	18 400
3.00	27.0	13 500	38.9	19 500
3.05	28.4	14 200	41.1	20 600
3.10	29.8	14 900	43.4	21 700
3.15	31.3	15 600	45.8	22 900
3.20	32.8	16 400	48.3	24 100
3.25	34.3	17 200	50.8	25 400
3.30	35.9	18 000	53.5	26 800
3.35	37.6	18 800	56.3	28 100
3.40	39.3	19 700	59.1	29 600

$C/P$ or $f_h$	Ball Bearing Life		Roller Bearing Life	
	$L$ ( $10^6$ rev)	$L_h$ (h)	$L$ ( $10^6$ rev)	$L_h$ (h)
3.45	41.1	20 500	62.0	31 000
3.50	42.9	21 400	65.1	32 500
3.55	44.7	22 400	68.2	34 100
3.60	46.7	23 300	71.5	35 800
3.65	48.6	24 300	74.9	37 400
3.70	50.7	25 300	78.3	39 200
3.75	52.7	26 400	81.9	41 000
3.80	54.9	27 400	85.6	42 800
3.85	57.1	28 500	89.4	44 700
3.90	59.3	29 700	93.4	46 700
3.95	61.6	30 800	97.4	48 700
4.00	64.0	32 000	102	50 800
4.05	66.4	33 200	106	52 900
4.10	68.9	34 500	110	55 200
4.15	71.5	35 700	115	57 400
4.20	74.1	37 000	120	59 800
4.25	76.8	38 400	124	62 200
4.30	79.5	39 800	129	64 600
4.35	82.3	41 200	134	67 200
4.40	85.2	42 600	140	69 800
4.45	88.1	44 100	145	72 500
4.50	91.1	45 600	150	75 200
4.55	94.2	47 100	156	78 000
4.60	97.3	48 700	162	80 900
4.65	101	50 300	168	83 900
4.70	104	51 900	174	87 000
4.75	107	53 600	180	90 100
4.80	111	55 300	187	93 300
4.85	114	57 000	193	96 600
4.90	118	58 800	200	99 900
4.95	121	60 600	207	103 000
5.00	125	62 500	214	107 000
5.10	133	66 300	228	114 000
5.20	141	70 300	244	122 000
5.30	149	74 400	260	130 000
5.40	157	78 700	276	138 000
5.50	166	83 200	294	147 000
5.60	176	87 800	312	156 000
5.70	185	92 600	331	165 000
5.80	195	97 600	351	175 000
5.90	205	103 000	371	186 000
6.00	216	108 000	392	196 000
6.50	275	137 000	513	256 000
7.00	343	172 000	656	328 000
7.50	422	211 000	826	413 000
8.00	512	256 000	1 020	512 000
8.50	614	307 000	1 250	627 000
9.00	729	365 000	1 520	758 000
9.50	857	429 000	1 820	908 000
10.0	1 000	—	2 150	—
11.0	1 330	—	2 960	—
12.0	1 730	—	3 960	—
13.0	2 200	—	5 170	—
14.0	2 740	—	6 610	—
15.0	3 380	—	8 320	—

**Appendix Table 14 Index of Inch Series Tapered Roller Bearings**

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>332</b>	<i>D</i> 80.000	C214, C218, C220
<b>336</b>	<i>d</i> 41.275	C220
<b>342</b>	<i>d</i> 41.275	C220
<b>342 S</b>	<i>d</i> 42.875	C220
<b>344</b>	<i>d</i> 40.000	C218
<b>344 A</b>	<i>d</i> 40.000	C218
<b>346</b>	<i>d</i> 31.750	C214
<b>354 A</b>	<i>D</i> 85.000	C222
<b>359 S</b>	<i>d</i> 46.038	C222
<b>362 A</b>	<i>D</i> 88.900	C222, C224
<b>366</b>	<i>d</i> 50.000	C224
<b>368</b>	<i>d</i> 50.800	C224
<b>368 A</b>	<i>d</i> 50.800	C224
<b>369 A</b>	<i>d</i> 47.625	C222
<b>372</b>	<i>D</i> 100.000	C224
<b>374</b>	<i>D</i> 93.264	C222
<b>376</b>	<i>d</i> 45.000	C222
<b>377</b>	<i>d</i> 52.388	C224
<b>382</b>	<i>D</i> 98.425	C226
<b>382 A</b>	<i>D</i> 96.838	C226
<b>382 S</b>	<i>D</i> 96.838	C226
<b>385</b>	<i>d</i> 55.000	C226
<b>387</b>	<i>d</i> 57.150	C226
<b>387 A</b>	<i>d</i> 57.150	C226
<b>388 A</b>	<i>d</i> 57.531	C226
<b>390 A</b>	<i>d</i> 63.500	C228
<b>394 A</b>	<i>D</i> 110.000	C228, C230
<b>395</b>	<i>d</i> 63.500	C228
<b>395 A</b>	<i>d</i> 66.675	C230
<b>395 S</b>	<i>d</i> 66.675	C230
<b>397</b>	<i>d</i> 60.000	C228
<b>399 A</b>	<i>d</i> 68.262	C230
<b>414</b>	<i>D</i> 88.501	C218
<b>418</b>	<i>d</i> 38.100	C218
<b>432</b>	<i>D</i> 95.250	C220
<b>432 A</b>	<i>D</i> 95.250	C222
<b>436</b>	<i>d</i> 46.038	C222
<b>438</b>	<i>d</i> 44.450	C220
<b>453 A</b>	<i>D</i> 107.950	C222
<b>453 X</b>	<i>D</i> 104.775	C226
<b>460</b>	<i>d</i> 44.450	C222
<b>462</b>	<i>d</i> 57.150	C226
<b>469</b>	<i>d</i> 57.150	C226
<b>472</b>	<i>D</i> 120.000	C230, C232
<b>472 A</b>	<i>D</i> 120.000	C230
<b>478</b>	<i>d</i> 65.000	C230
<b>480</b>	<i>d</i> 68.262	C230
<b>484</b>	<i>d</i> 70.000	C232
<b>492 A</b>	<i>D</i> 133.350	C234, C236
<b>493</b>	<i>D</i> 136.525	C232, C234, C236
<b>495</b>	<i>d</i> 82.550	C234
<b>495 A</b>	<i>d</i> 76.200	C232
<b>495 AX</b>	<i>d</i> 76.200	C232
<b>496</b>	<i>d</i> 80.962	C234

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>497</b>	<i>d</i> 85.725	C236
<b>498</b>	<i>d</i> 84.138	C236
<b>522</b>	<i>D</i> 101.600	C222, C224
<b>528</b>	<i>d</i> 47.625	C222
<b>529</b>	<i>d</i> 50.800	C224
<b>529 X</b>	<i>d</i> 50.800	C224
<b>532 X</b>	<i>D</i> 107.950	C226
<b>539</b>	<i>d</i> 53.975	C226
<b>552 A</b>	<i>D</i> 123.825	C226, C228, C230
<b>553 X</b>	<i>D</i> 122.238	C228, C230
<b>555 S</b>	<i>d</i> 57.150	C226
<b>557 S</b>	<i>d</i> 53.975	C226
<b>558</b>	<i>d</i> 60.325	C228
<b>559</b>	<i>d</i> 63.500	C228
<b>560</b>	<i>d</i> 66.675	C230
<b>560 S</b>	<i>d</i> 68.262	C230
<b>563</b>	<i>D</i> 127.000	C228, C230, C232
<b>563 X</b>	<i>D</i> 127.000	C230
<b>565</b>	<i>d</i> 63.500	C228
<b>566</b>	<i>d</i> 69.850	C230
<b>567</b>	<i>d</i> 73.025	C232
<b>567 A</b>	<i>d</i> 71.438	C232
<b>567 S</b>	<i>d</i> 71.438	C232
<b>568</b>	<i>d</i> 73.817	C232
<b>569</b>	<i>d</i> 64.963	C228
<b>570</b>	<i>d</i> 68.262	C230
<b>572</b>	<i>D</i> 139.992	C232, C234
<b>572 X</b>	<i>D</i> 139.700	C234
<b>575</b>	<i>d</i> 76.200	C232
<b>580</b>	<i>d</i> 82.550	C234
<b>581</b>	<i>d</i> 80.962	C234
<b>582</b>	<i>d</i> 82.550	C234
<b>590 A</b>	<i>d</i> 76.200	C232
<b>592</b>	<i>D</i> 152.400	C238
<b>592 A</b>	<i>D</i> 152.400	C232, C236, C238
<b>593</b>	<i>d</i> 88.900	C236
<b>594</b>	<i>d</i> 95.250	C238
<b>596</b>	<i>d</i> 85.725	C236
<b>597</b>	<i>d</i> 93.662	C238
<b>598</b>	<i>d</i> 92.075	C238
<b>598 A</b>	<i>d</i> 92.075	C238
<b>614 X</b>	<i>D</i> 115.000	C226
<b>622 X</b>	<i>d</i> 55.000	C226
<b>632</b>	<i>D</i> 136.525	C228, C232
<b>633</b>	<i>D</i> 130.175	C228, C230, C232
<b>637</b>	<i>d</i> 60.325	C228
<b>639</b>	<i>d</i> 63.500	C228
<b>643</b>	<i>d</i> 69.850	C230
<b>644</b>	<i>d</i> 71.438	C232
<b>645</b>	<i>d</i> 71.438	C232
<b>652</b>	<i>D</i> 152.400	C232, C234
<b>653</b>	<i>D</i> 146.050	C230, C232, C234, C236
<b>653 X</b>	<i>D</i> 150.000	C232
<b>655</b>	<i>d</i> 69.850	C230

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>657</b>	<i>d</i> 73.025	C232
<b>658</b>	<i>d</i> 74.612	C232
<b>659</b>	<i>d</i> 76.200	C232
<b>661</b>	<i>d</i> 79.375	C234
<b>663</b>	<i>d</i> 82.550	C234
<b>664</b>	<i>d</i> 84.138	C236
<b>665</b>	<i>d</i> 85.725	C236
<b>665 A</b>	<i>d</i> 85.725	C236
<b>672</b>	<i>D</i> 168.275	C236, C238, C240
<b>677</b>	<i>d</i> 85.725	C236
<b>681</b>	<i>d</i> 92.075	C238
<b>683</b>	<i>d</i> 95.250	C238
<b>685</b>	<i>d</i> 98.425	C238
<b>687</b>	<i>d</i> 101.600	C240
<b>742</b>	<i>D</i> 150.089	C230, C234, C236
<b>743</b>	<i>D</i> 150.000	C234
<b>745 A</b>	<i>d</i> 69.850	C230
<b>749</b>	<i>d</i> 85.026	C236
<b>749 A</b>	<i>d</i> 82.550	C234
<b>749 S</b>	<i>d</i> 85.026	C236
<b>750</b>	<i>d</i> 79.375	C234
<b>752</b>	<i>D</i> 161.925	C234, C236
<b>753</b>	<i>D</i> 168.275	C234, C236
<b>757</b>	<i>d</i> 82.550	C234
<b>758</b>	<i>d</i> 85.725	C236
<b>759</b>	<i>d</i> 88.900	C236
<b>760</b>	<i>d</i> 90.488	C236
<b>766</b>	<i>d</i> 88.900	C236
<b>772</b>	<i>D</i> 180.975	C238, C240
<b>776</b>	<i>d</i> 95.250	C238
<b>779</b>	<i>d</i> 98.425	C238
<b>780</b>	<i>d</i> 101.600	C240
<b>782</b>	<i>d</i> 104.775	C240
<b>787</b>	<i>d</i> 104.775	C240
<b>792</b>	<i>D</i> 206.375	C242
<b>795</b>	<i>d</i> 120.650	C242
<b>797</b>	<i>d</i> 130.000	C242
<b>799</b>	<i>d</i> 128.588	C242
<b>799 A</b>	<i>d</i> 130.175	C242
<b>832</b>	<i>D</i> 168.275	C234, C236
<b>837</b>	<i>d</i> 76.200	C234
<b>842</b>	<i>d</i> 82.550	C234
<b>843</b>	<i>d</i> 76.200	C234
<b>850</b>	<i>d</i> 88.900	C236
<b>854</b>	<i>D</i> 190.500	C236, C238, C240
<b>855</b>	<i>d</i> 88.900	C236
<b>857</b>	<i>d</i> 92.075	C238
<b>861</b>	<i>d</i> 101.600	C240
<b>864</b>	<i>d</i> 95.250	C238
<b>866</b>	<i>d</i> 98.425	C238
<b>932</b>	<i>D</i> 212.725	C240
<b>938</b>	<i>d</i> 114.300	C240
<b>1220</b>	<i>D</i> 57.150	C210
<b>1280</b>	<i>d</i> 22.225	C210

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>1328</b>	<i>D</i> 52.388	C210
<b>1329</b>	<i>D</i> 53.975	C210
<b>1380</b>	<i>d</i> 22.225	C210
<b>1620</b>	<i>D</i> 66.675	C216
<b>1680</b>	<i>d</i> 33.338	C216
<b>1729</b>	<i>D</i> 56.896	C210, C212
<b>1755</b>	<i>d</i> 22.225	C210
<b>1779</b>	<i>d</i> 23.812	C212
<b>1922</b>	<i>D</i> 57.150	C212
<b>1988</b>	<i>d</i> 28.575	C212
<b>1997 X</b>	<i>d</i> 26.988	C212
<b>A2047</b>	<i>d</i> 12.000	C210
<b>A2126</b>	<i>D</i> 31.991	C210
<b>2523</b>	<i>D</i> 69.850	C214, C216
<b>2558</b>	<i>d</i> 30.162	C214
<b>2559</b>	<i>d</i> 30.162	C214
<b>2580</b>	<i>d</i> 31.750	C214
<b>2582</b>	<i>d</i> 31.750	C214
<b>2585</b>	<i>d</i> 33.338	C216
<b>2631</b>	<i>D</i> 66.421	C214
<b>2690</b>	<i>d</i> 29.367	C214
<b>2720</b>	<i>D</i> 76.200	C218
<b>2729</b>	<i>D</i> 76.200	C218
<b>2735 X</b>	<i>D</i> 73.025	C218
<b>2788</b>	<i>d</i> 38.100	C218
<b>2789</b>	<i>d</i> 39.688	C218
<b>2820</b>	<i>D</i> 73.025	C216
<b>2877</b>	<i>d</i> 34.925	C216
<b>2924</b>	<i>D</i> 85.000	C222
<b>2984</b>	<i>d</i> 46.038	C222
<b>3120</b>	<i>D</i> 72.626	C214, C216
<b>3188</b>	<i>d</i> 31.750	C214
<b>3197</b>	<i>d</i> 33.338	C216
<b>3320</b>	<i>D</i> 80.167	C218
<b>3386</b>	<i>d</i> 39.688	C218
<b>3420</b>	<i>D</i> 79.375	C216, C218
<b>3478</b>	<i>d</i> 34.925	C216
<b>3479</b>	<i>d</i> 36.512	C218
<b>3490</b>	<i>d</i> 38.100	C218
<b>3525</b>	<i>D</i> 87.312	C220
<b>3576</b>	<i>d</i> 41.275	C220
<b>3578</b>	<i>d</i> 44.450	C220
<b>3720</b>	<i>D</i> 93.264	C220
<b>3730</b>	<i>D</i> 93.264	C224
<b>3775</b>	<i>d</i> 50.800	C224
<b>3780</b>	<i>d</i> 50.800	C224
<b>3782</b>	<i>d</i> 44.450	C220
<b>3820</b>	<i>D</i> 85.725	C220
<b>3877</b>	<i>d</i> 41.275	C220
<b>3920</b>	<i>D</i> 112.712	C228, C230
<b>3926</b>	<i>D</i> 112.712	C226, C228
<b>3981</b>	<i>d</i> 58.738	C226
<b>3982</b>	<i>d</i> 63.500	C228
<b>3984</b>	<i>d</i> 66.675	C230

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>3994</b>	<i>d</i> 66.675	C230
<b>A4050</b>	<i>d</i> 12.700	C210
<b>A4059</b>	<i>d</i> 15.000	C210
<b>A4138</b>	<i>D</i> 34.988	C210
<b>4335</b>	<i>D</i> 90.488	C220
<b>4388</b>	<i>d</i> 41.275	C220
<b>4535</b>	<i>D</i> 104.775	C226
<b>4595</b>	<i>d</i> 53.975	C226
<b>A5069</b>	<i>d</i> 17.455	C210
<b>A5144</b>	<i>D</i> 36.525	C210
<b>5335</b>	<i>D</i> 103.188	C222
<b>5356</b>	<i>d</i> 44.450	C222
<b>5535</b>	<i>D</i> 122.238	C226, C228
<b>5566</b>	<i>d</i> 55.562	C226
<b>5582</b>	<i>d</i> 60.325	C228
<b>5584</b>	<i>d</i> 63.500	C228
<b>5735</b>	<i>D</i> 135.733	C232, C234
<b>5760</b>	<i>d</i> 76.200	C232
<b>5795</b>	<i>d</i> 77.788	C234
<b>A6062</b>	<i>d</i> 15.875	C210
<b>A6067</b>	<i>d</i> 16.993	C210
<b>A6075</b>	<i>d</i> 19.050	C210
<b>A6157</b>	<i>D</i> 39.992	C210
<b>6220</b>	<i>D</i> 127.000	C224, C226
<b>6279</b>	<i>d</i> 50.800	C224
<b>6280</b>	<i>d</i> 53.975	C226
<b>6320</b>	<i>D</i> 135.755	C228, C230
<b>6376</b>	<i>d</i> 60.325	C228
<b>6379</b>	<i>d</i> 65.088	C230
<b>6420</b>	<i>D</i> 149.225	C226, C230, C232
<b>6454</b>	<i>d</i> 69.850	C230
<b>6455</b>	<i>d</i> 57.150	C226
<b>6460</b>	<i>d</i> 73.025	C232
<b>6461</b>	<i>d</i> 76.200	C232
<b>6535</b>	<i>D</i> 161.925	C232, C234, C236
<b>6536</b>	<i>D</i> 161.925	C232
<b>6559</b>	<i>d</i> 82.550	C234
<b>6575</b>	<i>d</i> 76.200	C232
<b>6576</b>	<i>d</i> 76.200	C232
<b>6580</b>	<i>d</i> 88.900	C236
<b>9121</b>	<i>D</i> 152.400	C228, C230
<b>9180</b>	<i>d</i> 61.912	C228
<b>9185</b>	<i>d</i> 68.262	C230
<b>9220</b>	<i>D</i> 161.925	C232
<b>9285</b>	<i>d</i> 76.200	C232
<b>9320</b>	<i>D</i> 177.800	C234
<b>9321</b>	<i>D</i> 171.450	C234, C236
<b>9378</b>	<i>d</i> 76.200	C234
<b>9380</b>	<i>d</i> 76.200	C234
<b>9385</b>	<i>d</i> 84.138	C236
<b>02420</b>	<i>D</i> 68.262	C212, C214
<b>02473</b>	<i>d</i> 25.400	C212
<b>02474</b>	<i>d</i> 28.575	C212
<b>02475</b>	<i>d</i> 31.750	C214

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>02820</b>	<i>D</i> 73.025	C212, C216
<b>02872</b>	<i>d</i> 28.575	C212
<b>02878</b>	<i>d</i> 34.925	C216
<b>03062</b>	<i>d</i> 15.875	C210
<b>03162</b>	<i>D</i> 41.275	C210
<b>05062</b>	<i>d</i> 15.875	C210
<b>05068</b>	<i>d</i> 17.462	C210
<b>05075</b>	<i>d</i> 19.050	C210
<b>05079</b>	<i>d</i> 19.990	C210
<b>05175</b>	<i>D</i> 44.450	C210
<b>05185</b>	<i>D</i> 47.000	C210
<b>07079</b>	<i>d</i> 20.000	C210
<b>07087</b>	<i>d</i> 22.225	C210
<b>07097</b>	<i>d</i> 25.000	C212
<b>07098</b>	<i>d</i> 24.981	C212
<b>07100</b>	<i>d</i> 25.400	C212
<b>07100SA</b>	<i>d</i> 25.400	C212
<b>07196</b>	<i>D</i> 50.005	C210, C212
<b>07204</b>	<i>D</i> 51.994	C210, C212
<b>07205</b>	<i>D</i> 52.001	C212
<b>08118</b>	<i>d</i> 30.162	C214
<b>08125</b>	<i>d</i> 31.750	C214
<b>08231</b>	<i>D</i> 58.738	C214
<b>09062</b>	<i>d</i> 15.875	C210
<b>09067</b>	<i>d</i> 19.050	C210
<b>09074</b>	<i>d</i> 19.050	C210
<b>09078</b>	<i>d</i> 19.050	C210
<b>09081</b>	<i>d</i> 20.625	C210
<b>09194</b>	<i>D</i> 49.225	C210
<b>09195</b>	<i>D</i> 49.225	C210
<b>09196</b>	<i>D</i> 49.225	C210
<b>11162</b>	<i>d</i> 41.275	C220
<b>11300</b>	<i>D</i> 76.200	C220
<b>11520</b>	<i>D</i> 42.862	C210
<b>11590</b>	<i>d</i> 15.875	C210
<b>LM11710</b>	<i>D</i> 39.878	C210
<b>LM11749</b>	<i>d</i> 17.462	C210
<b>LM11910</b>	<i>D</i> 45.237	C210
<b>LM11949</b>	<i>d</i> 19.050	C210
<b>12168</b>	<i>d</i> 42.862	C220
<b>12303</b>	<i>D</i> 76.992	C220
<b>12520</b>	<i>D</i> 49.225	C210
<b>12580</b>	<i>d</i> 20.638	C210
<b>M12610</b>	<i>D</i> 50.005	C210
<b>M12648</b>	<i>d</i> 22.225	C210
<b>M12649</b>	<i>d</i> 21.430	C210
<b>LM12710</b>	<i>D</i> 45.237	C210
<b>LM12711</b>	<i>D</i> 45.975	C210
<b>LM12749</b>	<i>d</i> 22.000	C210
<b>13175</b>	<i>d</i> 44.450	C220
<b>13181</b>	<i>d</i> 46.038	C222
<b>13318</b>	<i>D</i> 80.962	C220, C222
<b>13620</b>	<i>D</i> 69.012	C218
<b>13621</b>	<i>D</i> 69.012	C218

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>13685</b>	<i>d</i> 38.100	C218
<b>13687</b>	<i>d</i> 38.100	C218
<b>13830</b>	<i>D</i> 63.500	C218
<b>13889</b>	<i>d</i> 38.100	C218
<b>14123 A</b>	<i>d</i> 31.750	C214
<b>14125 A</b>	<i>d</i> 31.750	C214
<b>14130</b>	<i>d</i> 33.338	C216
<b>14131</b>	<i>d</i> 33.338	C216
<b>14137 A</b>	<i>d</i> 34.925	C216
<b>14138 A</b>	<i>d</i> 34.925	C216
<b>14139</b>	<i>d</i> 34.976	C216
<b>14274</b>	<i>D</i> 69.012	C214, C216
<b>14276</b>	<i>D</i> 69.012	C214, C216
<b>14283</b>	<i>D</i> 72.085	C216
<b>15100</b>	<i>d</i> 25.400	C212
<b>15101</b>	<i>d</i> 25.400	C212
<b>15106</b>	<i>d</i> 26.988	C212
<b>15112</b>	<i>d</i> 28.575	C212
<b>15113</b>	<i>d</i> 28.575	C212
<b>15116</b>	<i>d</i> 30.112	C214
<b>15117</b>	<i>d</i> 30.000	C214
<b>15118</b>	<i>d</i> 30.213	C214
<b>15119</b>	<i>d</i> 30.213	C214
<b>15120</b>	<i>d</i> 30.213	C214
<b>15123</b>	<i>d</i> 31.750	C214
<b>15125</b>	<i>d</i> 31.750	C214
<b>15126</b>	<i>d</i> 31.750	C214
<b>15245</b>	<i>D</i> 62.000	C212, C214
<b>15250</b>	<i>D</i> 63.500	C214
<b>15250 X</b>	<i>D</i> 63.500	C212
<b>15520</b>	<i>D</i> 57.150	C212
<b>15523</b>	<i>D</i> 60.325	C212
<b>15578</b>	<i>d</i> 25.400	C212
<b>15580</b>	<i>d</i> 26.988	C212
<b>16150</b>	<i>d</i> 38.100	C218
<b>16284</b>	<i>D</i> 72.238	C218
<b>16929</b>	<i>D</i> 74.988	C220
<b>16986</b>	<i>d</i> 43.000	C220
<b>17098</b>	<i>d</i> 24.981	C212
<b>17118</b>	<i>d</i> 30.000	C214
<b>17244</b>	<i>D</i> 62.000	C212, C214
<b>17520</b>	<i>D</i> 42.862	C210
<b>17580</b>	<i>d</i> 15.875	C210
<b>17831</b>	<i>D</i> 79.985	C222
<b>17887</b>	<i>d</i> 45.230	C222
<b>18200</b>	<i>d</i> 50.800	C224
<b>18337</b>	<i>D</i> 85.725	C224
<b>18520</b>	<i>D</i> 73.025	C218
<b>18590</b>	<i>d</i> 41.275	C218
<b>18620</b>	<i>D</i> 79.375	C222
<b>18690</b>	<i>d</i> 46.038	C222
<b>18720</b>	<i>D</i> 85.000	C224
<b>18790</b>	<i>d</i> 50.800	C224
<b>19138</b>	<i>d</i> 34.976	C216

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>19150</b>	<i>d</i> 38.100	C218
<b>19268</b>	<i>D</i> 68.262	C216, C218
<b>21075</b>	<i>d</i> 19.050	C210
<b>21212</b>	<i>D</i> 53.975	C210
<b>L21511</b>	<i>D</i> 34.988	C210
<b>L21549</b>	<i>d</i> 15.875	C210
<b>22168</b>	<i>d</i> 42.862	C220
<b>22325</b>	<i>D</i> 82.550	C220
<b>23100</b>	<i>d</i> 25.400	C212
<b>23256</b>	<i>D</i> 65.088	C212
<b>23621</b>	<i>D</i> 73.025	C216
<b>23691</b>	<i>d</i> 35.000	C216
<b>24720</b>	<i>D</i> 76.200	C220
<b>24721</b>	<i>D</i> 76.200	C220
<b>24780</b>	<i>d</i> 41.275	C220
<b>25520</b>	<i>D</i> 82.931	C220, C222
<b>25521</b>	<i>D</i> 83.058	C220
<b>25523</b>	<i>D</i> 82.931	C220, C222
<b>25577</b>	<i>d</i> 42.875	C220
<b>25578</b>	<i>d</i> 42.862	C220
<b>25580</b>	<i>d</i> 44.450	C220
<b>25584</b>	<i>d</i> 44.983	C222
<b>25590</b>	<i>d</i> 45.618	C222
<b>25820</b>	<i>D</i> 73.025	C216
<b>25821</b>	<i>D</i> 73.025	C216, C218
<b>25877</b>	<i>d</i> 34.925	C216
<b>25878</b>	<i>d</i> 34.925	C216
<b>25880</b>	<i>d</i> 36.487	C218
<b>26118</b>	<i>d</i> 30.000	C214
<b>26131</b>	<i>d</i> 33.338	C216
<b>26283</b>	<i>D</i> 72.000	C214, C216
<b>26820</b>	<i>D</i> 80.167	C220
<b>26822</b>	<i>D</i> 79.375	C220
<b>26823</b>	<i>D</i> 76.200	C220
<b>26882</b>	<i>d</i> 41.275	C220
<b>26884</b>	<i>d</i> 42.875	C220
<b>27620</b>	<i>D</i> 125.412	C234
<b>27687</b>	<i>d</i> 82.550	C234
<b>27689</b>	<i>d</i> 83.345	C234
<b>27690</b>	<i>d</i> 83.345	C234
<b>27820</b>	<i>D</i> 80.035	C218
<b>27880</b>	<i>d</i> 38.100	C218
<b>28138</b>	<i>d</i> 34.976	C216
<b>28315</b>	<i>D</i> 80.000	C216
<b>28521</b>	<i>D</i> 92.075	C224
<b>28580</b>	<i>d</i> 50.800	C224
<b>28584</b>	<i>d</i> 52.388	C224
<b>28622</b>	<i>D</i> 97.630	C226
<b>28680</b>	<i>d</i> 55.562	C226
<b>28920</b>	<i>D</i> 101.600	C228
<b>28921</b>	<i>D</i> 100.000	C228
<b>28985</b>	<i>d</i> 60.325	C228
<b>29520</b>	<i>D</i> 107.950	C228
<b>29586</b>	<i>d</i> 63.500	C228

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>29620</b>	<i>D</i> 112.712	C230, C232
<b>29630</b>	<i>D</i> 120.650	C230
<b>29675</b>	<i>d</i> 69.850	C230
<b>29685</b>	<i>d</i> 73.025	C232
<b>LM29710</b>	<i>D</i> 65.088	C218
<b>LM29711</b>	<i>D</i> 65.088	C218
<b>LM29748</b>	<i>d</i> 38.100	C218
<b>LM29749</b>	<i>d</i> 38.100	C218
<b>31520</b>	<i>D</i> 76.200	C216
<b>31594</b>	<i>d</i> 34.925	C216
<b>33262</b>	<i>d</i> 66.675	C230
<b>33275</b>	<i>d</i> 69.850	C230
<b>33281</b>	<i>d</i> 71.438	C232
<b>33287</b>	<i>d</i> 73.025	C232
<b>JHM33410</b>	<i>D</i> 55.000	C212
<b>JHM33449</b>	<i>d</i> 24.000	C212
<b>33462</b>	<i>D</i> 117.475	C230, C232
<b>33821</b>	<i>D</i> 95.250	C224
<b>33889</b>	<i>d</i> 50.800	C224
<b>34300</b>	<i>d</i> 76.200	C232
<b>34306</b>	<i>d</i> 77.788	C234
<b>34478</b>	<i>D</i> 121.442	C232, C234
<b>36620</b>	<i>D</i> 193.675	C242
<b>36690</b>	<i>d</i> 146.050	C242
<b>36920</b>	<i>D</i> 227.012	C244
<b>36990</b>	<i>d</i> 177.800	C244
<b>37425</b>	<i>d</i> 107.950	C240
<b>37625</b>	<i>D</i> 158.750	C240
<b>M38510</b>	<i>D</i> 66.675	C216
<b>M38511</b>	<i>D</i> 65.987	C216
<b>M38547</b>	<i>d</i> 35.000	C216
<b>M38549</b>	<i>d</i> 34.925	C216
<b>39236</b>	<i>d</i> 60.000	C228
<b>39250</b>	<i>d</i> 63.500	C228
<b>39412</b>	<i>D</i> 104.775	C228
<b>39520</b>	<i>D</i> 112.712	C228, C230
<b>39521</b>	<i>D</i> 112.712	C230
<b>39585</b>	<i>d</i> 63.500	C228
<b>39590</b>	<i>d</i> 66.675	C230
<b>41100</b>	<i>d</i> 25.400	C212
<b>41125</b>	<i>d</i> 28.575	C212
<b>41126</b>	<i>d</i> 28.575	C212
<b>41286</b>	<i>D</i> 72.626	C212
<b>42350</b>	<i>d</i> 88.900	C236
<b>42362</b>	<i>d</i> 92.075	C238
<b>42368</b>	<i>d</i> 93.662	C238
<b>42375</b>	<i>d</i> 95.250	C238
<b>42376</b>	<i>d</i> 95.250	C238
<b>42381</b>	<i>d</i> 96.838	C238
<b>42584</b>	<i>D</i> 148.430	C238
<b>42587</b>	<i>D</i> 149.225	C236, C238
<b>42620</b>	<i>D</i> 127.000	C232, C234
<b>42687</b>	<i>d</i> 76.200	C232
<b>42688</b>	<i>d</i> 76.200	C232

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>42690</b>	<i>d</i> 77.788	C234
<b>43118</b>	<i>d</i> 30.162	C214
<b>43131</b>	<i>d</i> 33.338	C216
<b>43300</b>	<i>D</i> 76.200	C214
<b>43312</b>	<i>D</i> 79.375	C216
<b>44143</b>	<i>d</i> 36.512	C218
<b>44150</b>	<i>d</i> 38.100	C218
<b>44157</b>	<i>d</i> 40.000	C218
<b>44162</b>	<i>d</i> 41.275	C220
<b>44348</b>	<i>D</i> 88.501	C218, C220
<b>L44610</b>	<i>D</i> 50.292	C212
<b>L44640</b>	<i>d</i> 23.812	C212
<b>L44643</b>	<i>d</i> 25.400	C212
<b>L44649</b>	<i>d</i> 26.988	C212
<b>45220</b>	<i>D</i> 104.775	C226
<b>45221</b>	<i>D</i> 104.775	C226
<b>45289</b>	<i>d</i> 57.150	C226
<b>L45410</b>	<i>D</i> 50.292	C214
<b>L45449</b>	<i>d</i> 29.000	C214
<b>46143</b>	<i>d</i> 36.512	C218
<b>46162</b>	<i>d</i> 41.275	C220
<b>46176</b>	<i>d</i> 44.450	C220
<b>46368</b>	<i>D</i> 93.662	C218, C220
<b>46720</b>	<i>D</i> 225.425	C242
<b>46780</b>	<i>d</i> 158.750	C242
<b>47420</b>	<i>D</i> 120.000	C230, C232
<b>47487</b>	<i>d</i> 69.850	C230
<b>47490</b>	<i>d</i> 71.438	C232
<b>47620</b>	<i>D</i> 133.350	C232, C234
<b>47680</b>	<i>d</i> 76.200	C232
<b>47685</b>	<i>d</i> 82.550	C234
<b>47686</b>	<i>d</i> 82.550	C234
<b>47687</b>	<i>d</i> 82.550	C234
<b>47820</b>	<i>D</i> 146.050	C238
<b>47890</b>	<i>d</i> 92.075	C238
<b>47896</b>	<i>d</i> 95.250	C238
<b>48120</b>	<i>D</i> 161.925	C240
<b>48190</b>	<i>d</i> 107.950	C240
<b>48220</b>	<i>D</i> 182.562	C242
<b>48282</b>	<i>d</i> 120.650	C242
<b>48286</b>	<i>d</i> 123.825	C242
<b>48290</b>	<i>d</i> 127.000	C242
<b>48320</b>	<i>D</i> 190.500	C242
<b>48385</b>	<i>d</i> 133.350	C242
<b>48393</b>	<i>d</i> 136.525	C242
<b>LM48510</b>	<i>D</i> 65.088	C216
<b>LM48511</b>	<i>D</i> 65.088	C216
<b>LM48548</b>	<i>d</i> 34.925	C216
<b>48620</b>	<i>D</i> 200.025	C242
<b>48685</b>	<i>d</i> 142.875	C242
<b>49175</b>	<i>d</i> 44.450	C220
<b>49176</b>	<i>d</i> 44.450	C220
<b>49368</b>	<i>D</i> 93.662	C220
<b>49520</b>	<i>D</i> 101.600	C224

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>49585</b>	<i>d</i> 50.800	C224
<b>52387</b>	<i>d</i> 98.425	C238
<b>52393</b>	<i>d</i> 100.012	C238
<b>52400</b>	<i>d</i> 101.600	C240
<b>52618</b>	<i>D</i> 157.162	C238, C240
<b>52637</b>	<i>D</i> 161.925	C238, C240
<b>53150</b>	<i>d</i> 38.100	C218
<b>53162</b>	<i>d</i> 41.275	C220
<b>53176</b>	<i>d</i> 44.450	C222
<b>53177</b>	<i>d</i> 44.450	C222
<b>53178</b>	<i>d</i> 44.450	C222
<b>53375</b>	<i>D</i> 95.250	C218, C222
<b>53387</b>	<i>D</i> 98.425	C220, C222
<b>55175</b>	<i>d</i> 44.450	C222
<b>55187</b>	<i>d</i> 47.625	C222
<b>55200</b>	<i>d</i> 50.800	C224
<b>55200C</b>	<i>d</i> 50.800	C224
<b>55206</b>	<i>d</i> 52.388	C224
<b>55437</b>	<i>D</i> 111.125	C222, C224
<b>55443</b>	<i>D</i> 112.712	C222
<b>56418</b>	<i>d</i> 106.362	C240
<b>56425</b>	<i>d</i> 107.950	C240
<b>56650</b>	<i>D</i> 165.100	C240
<b>59200</b>	<i>d</i> 50.800	C224
<b>59429</b>	<i>D</i> 108.966	C224
<b>64433</b>	<i>d</i> 109.992	C240
<b>64450</b>	<i>d</i> 114.300	C240
<b>64700</b>	<i>D</i> 177.800	C240
<b>65200</b>	<i>d</i> 50.800	C224
<b>65212</b>	<i>d</i> 53.975	C226
<b>65237</b>	<i>d</i> 60.325	C228
<b>65320</b>	<i>D</i> 114.300	C222
<b>65385</b>	<i>d</i> 44.450	C222
<b>65500</b>	<i>D</i> 127.000	C224, C226, C228
<b>66187</b>	<i>d</i> 47.625	C222
<b>66462</b>	<i>D</i> 117.475	C222
<b>66520</b>	<i>D</i> 122.238	C226, C228
<b>66584</b>	<i>d</i> 53.975	C226
<b>66585</b>	<i>d</i> 60.000	C228
<b>66587</b>	<i>d</i> 57.150	C226
<b>LM67010</b>	<i>D</i> 59.131	C212, C214
<b>LM67043</b>	<i>d</i> 28.575	C212
<b>LM67048</b>	<i>d</i> 31.750	C214
<b>67320</b>	<i>D</i> 203.200	C242
<b>67322</b>	<i>D</i> 196.850	C242
<b>67388</b>	<i>d</i> 127.000	C242
<b>67389</b>	<i>d</i> 130.175	C242
<b>67390</b>	<i>d</i> 133.350	C242
<b>67720</b>	<i>D</i> 247.650	C242, C244
<b>67780</b>	<i>d</i> 165.100	C242
<b>67787</b>	<i>d</i> 174.625	C244
<b>67790</b>	<i>d</i> 177.800	C244
<b>67820</b>	<i>D</i> 266.700	C244
<b>67885</b>	<i>d</i> 190.500	C244

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>67920</b>	<i>D</i> 282.575	C244
<b>67983</b>	<i>d</i> 203.200	C244
<b>67985</b>	<i>d</i> 206.375	C244
<b>L68110</b>	<i>D</i> 59.131	C216
<b>L68111</b>	<i>D</i> 59.975	C216
<b>L68149</b>	<i>d</i> 35.000	C216
<b>68450</b>	<i>d</i> 114.300	C240
<b>68462</b>	<i>d</i> 117.475	C240
<b>68709</b>	<i>D</i> 180.000	C240
<b>68712</b>	<i>D</i> 180.975	C240
<b>JL69310</b>	<i>D</i> 63.000	C218
<b>JL69349</b>	<i>d</i> 38.000	C218
<b>71412</b>	<i>d</i> 104.775	C240
<b>71425</b>	<i>d</i> 107.950	C240
<b>71437</b>	<i>d</i> 111.125	C240
<b>71450</b>	<i>d</i> 114.300	C240
<b>71453</b>	<i>d</i> 115.087	C240
<b>71750</b>	<i>D</i> 190.500	C240
<b>72187</b>	<i>d</i> 47.625	C222
<b>72200</b>	<i>d</i> 50.800	C224
<b>72200C</b>	<i>d</i> 50.800	C224
<b>72212</b>	<i>d</i> 53.975	C226
<b>72212C</b>	<i>d</i> 53.975	C226
<b>72218</b>	<i>d</i> 55.562	C226
<b>72218C</b>	<i>d</i> 55.562	C226
<b>72225C</b>	<i>d</i> 57.150	C226
<b>72487</b>	<i>D</i> 123.825	C222, C224, C226
<b>LM72810</b>	<i>D</i> 47.000	C212
<b>LM72849</b>	<i>d</i> 22.606	C212
<b>74500</b>	<i>d</i> 127.000	C242
<b>74525</b>	<i>d</i> 133.350	C242
<b>74537</b>	<i>d</i> 136.525	C242
<b>74550</b>	<i>d</i> 139.700	C242
<b>74850</b>	<i>D</i> 215.900	C242
<b>74856</b>	<i>D</i> 217.488	C242
<b>77375</b>	<i>d</i> 95.250	C238
<b>77675</b>	<i>D</i> 171.450	C238
<b>78225</b>	<i>d</i> 57.150	C226
<b>78250</b>	<i>d</i> 63.500	C228
<b>LM78310</b>	<i>D</i> 62.000	C216
<b>LM78310A</b>	<i>D</i> 62.000	C216
<b>LM78349</b>	<i>d</i> 35.000	C216
<b>78537</b>	<i>D</i> 136.525	C228
<b>78551</b>	<i>D</i> 140.030	C226, C228
<b>78571</b>	<i>D</i> 144.983	C226
<b>HM81610</b>	<i>D</i> 47.000	C210
<b>HM81649</b>	<i>d</i> 16.000	C210
<b>M84210</b>	<i>D</i> 59.530	C212
<b>M84249</b>	<i>d</i> 25.400	C212
<b>M84510</b>	<i>d</i> 57.150	C212
<b>M84548</b>	<i>d</i> 25.400	C212
<b>M86610</b>	<i>D</i> 64.292	C212, C214
<b>M86643</b>	<i>d</i> 25.400	C212
<b>M86647</b>	<i>d</i> 28.575	C212

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>M86648A</b> <b>M86649</b> <b>M88010</b>	<i>d</i> 30.955 <i>d</i> 30.162 <i>D</i> 68.262	C214 C214 C214, C216
<b>M88043</b> <b>M88046</b> <b>M88048</b>	<i>d</i> 30.162 <i>d</i> 31.750 <i>d</i> 33.338	C214 C214 C216
<b>HM88510</b> <b>HM88542</b> <b>HM88547</b>	<i>D</i> 73.025 <i>d</i> 31.750 <i>d</i> 33.338	C214, C216 C214 C216
<b>HM88610</b> <b>HM88630</b> <b>HM88638</b>	<i>D</i> 72.233 <i>d</i> 25.400 <i>d</i> 32.000	C212, C214, C216, C218 C212 C214
<b>HM88648</b> <b>HM88649</b> <b>HM89410</b>	<i>d</i> 35.717 <i>d</i> 34.925 <i>D</i> 76.200	C218 C216 C216, C218
<b>HM89411</b> <b>HM89443</b> <b>HM89444</b>	<i>D</i> 76.200 <i>d</i> 33.338 <i>d</i> 33.338	C216 C216 C216
<b>HM89446</b> <b>HM89446A</b> <b>HM89449</b>	<i>d</i> 34.925 <i>d</i> 34.925 <i>d</i> 36.512	C216 C216 C218
<b>99100</b> <b>99550</b> <b>99575</b>	<i>D</i> 254.000 <i>d</i> 139.700 <i>d</i> 146.050	C242 C242 C242
<b>99587</b> <b>99600</b> <b>LM102910</b>	<i>d</i> 149.225 <i>d</i> 152.400 <i>D</i> 73.431	C242 C242 C222
<b>LM102949</b> <b>JLM104910</b> <b>LM104911</b>	<i>d</i> 45.242 <i>D</i> 82.000 <i>D</i> 82.550	C222 C224 C224
<b>LM104911A</b> <b>LM104912</b> <b>LM104947A</b>	<i>D</i> 82.550 <i>D</i> 82.931 <i>d</i> 50.000	C224 C224 C224
<b>JLM104948</b> <b>LM104949</b> <b>M201011</b>	<i>d</i> 50.000 <i>d</i> 50.800 <i>D</i> 73.025	C224 C224 C218
<b>M201047</b> <b>JM205110</b> <b>JM205149</b>	<i>d</i> 39.688 <i>D</i> 90.000 <i>d</i> 50.000	C218 C224 C224
<b>JM207010</b> <b>JM207049</b> <b>JH211710</b>	<i>D</i> 95.000 <i>d</i> 55.000 <i>D</i> 120.000	C226 C226 C230
<b>JH211749</b> <b>HM212010</b> <b>HM212011</b>	<i>d</i> 65.000 <i>D</i> 122.238 <i>D</i> 122.238	C230 C228, C230 C228, C230
<b>HM212044</b> <b>HM212046</b> <b>HM212047</b>	<i>d</i> 60.325 <i>d</i> 63.500 <i>d</i> 63.500	C228 C228 C228
<b>HM212049</b> <b>JH217210</b> <b>JH217249</b>	<i>d</i> 66.675 <i>D</i> 150.000 <i>d</i> 85.000	C230 C236 C236
<b>HM218210</b> <b>HM218248</b> <b>HH221410</b>	<i>D</i> 147.000 <i>d</i> 90.000 <i>D</i> 190.500	C236 C236 C236, C238, C240

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>HH221432</b> <b>HH221434</b> <b>HH221440</b>	<i>d</i> 87.312 <i>d</i> 88.900 <i>d</i> 95.250	C236 C236 C238
<b>HH221442</b> <b>HH221447</b> <b>HH221449</b>	<i>d</i> 98.425 <i>d</i> 99.982 <i>d</i> 101.600	C238 C238 C240
<b>HH224310</b> <b>HH224335</b> <b>HH224340</b>	<i>D</i> 212.725 <i>d</i> 101.600 <i>d</i> 107.950	C240 C240 C240
<b>HH224346</b> <b>M224710</b> <b>M224748</b>	<i>d</i> 114.300 <i>D</i> 174.625 <i>d</i> 120.000	C240 C242 C242
<b>LL225710</b> <b>LL225749</b> <b>HM231110</b>	<i>D</i> 165.895 <i>d</i> 127.000 <i>D</i> 236.538	C242 C242 C242
<b>HM231140</b> <b>M236810</b> <b>M236849</b>	<i>d</i> 146.050 <i>D</i> 260.350 <i>d</i> 177.800	C242 C244 C244
<b>LM300811</b> <b>LM300849</b> <b>L305610</b>	<i>D</i> 68.000 <i>d</i> 41.000 <i>D</i> 80.962	C218 C218 C224
<b>L305649</b> <b>JH307710</b> <b>JH307749</b>	<i>d</i> 50.800 <i>D</i> 110.000 <i>d</i> 55.000	C224 C226 C226
<b>JHM318410</b> <b>JHM318448</b> <b>L327210</b>	<i>D</i> 155.000 <i>d</i> 90.000 <i>D</i> 177.008	C236 C236 C242
<b>L327249</b> <b>LM328410</b> <b>LM328448</b>	<i>d</i> 133.350 <i>D</i> 187.325 <i>d</i> 139.700	C242 C242 C242
<b>H414210</b> <b>H414245</b> <b>H414249</b>	<i>D</i> 136.525 <i>d</i> 68.262 <i>d</i> 71.438	C230, C232 C230 C232
<b>JH415610</b> <b>JH415647</b> <b>LM501310</b>	<i>D</i> 145.000 <i>d</i> 75.000 <i>D</i> 73.431	C232 C232 C218
<b>LM501314</b> <b>LM501349</b> <b>LM503310</b>	<i>D</i> 73.431 <i>d</i> 41.275 <i>D</i> 75.000	C218 C218 C222
<b>LM503349</b> <b>HH506310</b> <b>HH506348</b>	<i>d</i> 46.000 <i>D</i> 114.300 <i>d</i> 49.212	C222 C224 C224
<b>JLM506810</b> <b>JLM506849</b> <b>JLM508710</b>	<i>D</i> 90.000 <i>d</i> 55.000 <i>d</i> 95.000	C226 C226 C228
<b>JLM508748</b> <b>JM511910</b> <b>JM511946</b>	<i>d</i> 60.000 <i>D</i> 110.000 <i>d</i> 65.000	C228 C230 C230
<b>JM515610</b> <b>JM515649</b> <b>HM516410</b>	<i>D</i> 130.000 <i>d</i> 80.000 <i>D</i> 133.350	C234 C234 C234
<b>HM516448</b> <b>JHM516810</b> <b>JHM516849</b>	<i>d</i> 82.550 <i>D</i> 140.000 <i>d</i> 85.000	C234 C236 C236

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>HM518410</b>	<i>D</i> 152.400	C236
<b>HM518445</b>	<i>d</i> 88.900	C236
<b>LM522510</b>	<i>D</i> 159.987	C240
<b>LM522546</b>	<i>d</i> 107.950	C240
<b>LM522548</b>	<i>d</i> 109.987	C240
<b>LM522549</b>	<i>d</i> 109.987	C240
<b>JHM522610</b>	<i>D</i> 180.000	C240
<b>JHM522649</b>	<i>d</i> 110.000	C240
<b>JHM534110</b>	<i>D</i> 230.000	C244
<b>JHM534149</b>	<i>d</i> 170.000	C244
<b>LM603011</b>	<i>D</i> 77.788	C222
<b>LM603012</b>	<i>D</i> 77.788	C222
<b>LM603049</b>	<i>d</i> 45.242	C222
<b>L610510</b>	<i>D</i> 94.458	C228
<b>L610549</b>	<i>d</i> 63.500	C228
<b>JM612910</b>	<i>D</i> 115.000	C232
<b>JM612949</b>	<i>d</i> 70.000	C232
<b>LM613410</b>	<i>D</i> 112.712	C230
<b>LM613449</b>	<i>d</i> 69.850	C230
<b>HM617010</b>	<i>D</i> 142.138	C236
<b>HM617049</b>	<i>d</i> 85.725	C236
<b>L623110</b>	<i>D</i> 152.400	C240
<b>L623149</b>	<i>d</i> 114.300	C240
<b>JLM710910</b>	<i>D</i> 105.000	C230
<b>JLM710949</b>	<i>d</i> 65.000	C230
<b>JLM714110</b>	<i>D</i> 115.000	C232
<b>JLM714149</b>	<i>d</i> 75.000	C232
<b>JM714210</b>	<i>D</i> 120.000	C232
<b>JM714249</b>	<i>d</i> 75.000	C232
<b>H715311</b>	<i>D</i> 136.525	C228, C230, C232
<b>H715334</b>	<i>d</i> 61.912	C228
<b>H715340</b>	<i>d</i> 65.088	C230
<b>H715341</b>	<i>d</i> 66.675	C230
<b>H715343</b>	<i>d</i> 68.262	C230
<b>H715345</b>	<i>d</i> 71.438	C232
<b>JM716610</b>	<i>D</i> 130.000	C236
<b>JM716648</b>	<i>d</i> 85.000	C236
<b>JM716649</b>	<i>d</i> 85.000	C236
<b>JM718110</b>	<i>D</i> 145.000	C236
<b>JM718149</b>	<i>d</i> 90.000	C236
<b>JM719113</b>	<i>D</i> 150.000	C238
<b>JM719149</b>	<i>d</i> 95.000	C238
<b>JM720210</b>	<i>D</i> 155.000	C238
<b>JHM720210</b>	<i>D</i> 160.000	C238
<b>JM720249</b>	<i>d</i> 100.000	C238
<b>JHM720249</b>	<i>d</i> 100.000	C238
<b>JL724314</b>	<i>D</i> 170.000	C242
<b>JL724348</b>	<i>d</i> 120.000	C242
<b>JL725316</b>	<i>D</i> 175.000	C242
<b>JL725346</b>	<i>d</i> 125.000	C242
<b>JM734410</b>	<i>D</i> 240.000	C244
<b>JM734449</b>	<i>d</i> 170.000	C244
<b>JM738210</b>	<i>D</i> 260.000	C244
<b>JM738249</b>	<i>d</i> 190.000	C244

Designation INNER RING, OUTER RING	Nominal Dimension (mm) <i>d</i> : I. R. (Bore Dia.) <i>D</i> : O. R. (Outside Dia.)	Pages
<b>HM801310</b>	<i>D</i> 82.550	C218
<b>HM801346</b>	<i>d</i> 38.100	C218
<b>M802011</b>	<i>D</i> 82.550	C220
<b>M802048</b>	<i>d</i> 41.275	C220
<b>HM803110</b>	<i>D</i> 88.900	C220
<b>HM803145</b>	<i>d</i> 41.275	C220
<b>HM803146</b>	<i>d</i> 41.275	C220
<b>HM803149</b>	<i>d</i> 44.450	C220
<b>M804010</b>	<i>D</i> 88.900	C222
<b>M804049</b>	<i>d</i> 47.625	C222
<b>HM804810</b>	<i>D</i> 95.250	C220, C222, C224
<b>HM804840</b>	<i>d</i> 41.275	C220
<b>HM804843</b>	<i>d</i> 44.450	C222
<b>HM804846</b>	<i>d</i> 47.625	C222
<b>HM804848</b>	<i>d</i> 48.412	C224
<b>HM804849</b>	<i>d</i> 48.412	C224
<b>HM807010</b>	<i>D</i> 104.775	C222, C224
<b>HM807011</b>	<i>D</i> 104.775	C224
<b>JHM807012</b>	<i>D</i> 105.000	C224
<b>HM807040</b>	<i>d</i> 44.450	C222
<b>HM807044</b>	<i>d</i> 49.212	C224
<b>JHM807045</b>	<i>d</i> 50.000	C224
<b>HM807046</b>	<i>d</i> 50.800	C224
<b>JLM813010</b>	<i>D</i> 110.000	C232
<b>JLM813049</b>	<i>d</i> 70.000	C232
<b>JLM820012</b>	<i>D</i> 150.000	C238
<b>JLM820048</b>	<i>d</i> 100.000	C238
<b>JM822010</b>	<i>D</i> 165.000	C240
<b>JM822049</b>	<i>d</i> 110.000	C240
<b>JHM840410</b>	<i>D</i> 300.000	C244
<b>JHM840449</b>	<i>d</i> 200.000	C244
<b>HM903210</b>	<i>D</i> 95.250	C222
<b>HM903247</b>	<i>d</i> 44.450	C222
<b>HM903249</b>	<i>d</i> 44.450	C222
<b>HM911210</b>	<i>D</i> 130.175	C226
<b>HM911242</b>	<i>d</i> 53.975	C226
<b>H913810</b>	<i>D</i> 146.050	C228, C230
<b>H913842</b>	<i>d</i> 61.912	C228
<b>H913849</b>	<i>d</i> 69.850	C230

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