MOTION & CONTROL™
NSK

ROLLING BEARINGS for INDUSTRIAL MACHINERY

Part A

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ROLLING BEARINGS for INDUSTRIAL MACHINERY

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 100th 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.

NSK Website ● http://www.nsk.com/

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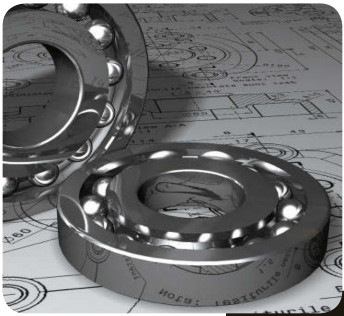
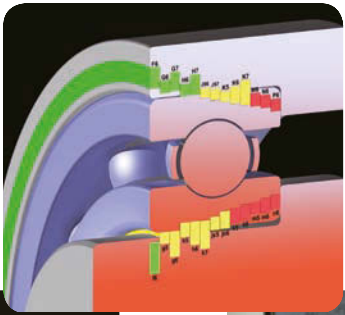
TECHNICAL INFORMATION






een Each Bearing Fatigue Life
NSK

Part A

TECHNICAL INFORMATION

1. TYPES AND FEATURES OF ROLLING BEARINGS

1.TYPES AND FEATURES OF ROLLING BEARINGS

1.1 Design and Classification

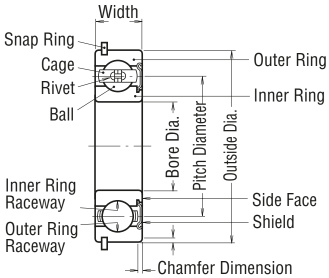
Rolling bearings generally consist of rolling elements, two rings, and a cage. They are classified into radial bearings or thrust bearings depending on the direction of the main load. In addition, depending on the type of rolling elements, they are classified into ball bearings or roller bearings and 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

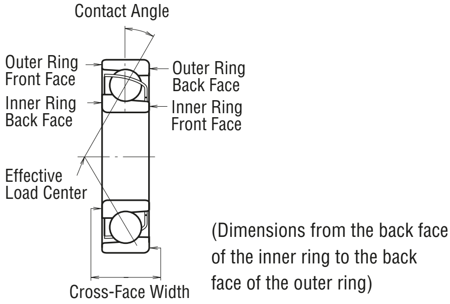
Compared with plain bearings, rolling bearings have the following major advantages:

(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.

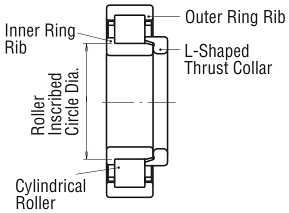
Furthermore, different types of rolling bearings have their own individual advantages. The features of the most common rolling bearings are described on Pages A010 to A013 and in Table 1.1 (Pages A014 and A015).



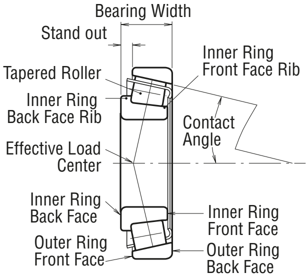
Single-Row Deep Groove Ball Bearing



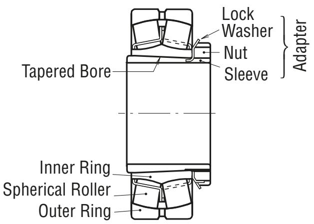
Single-Row Angular Contact Ball Bearing



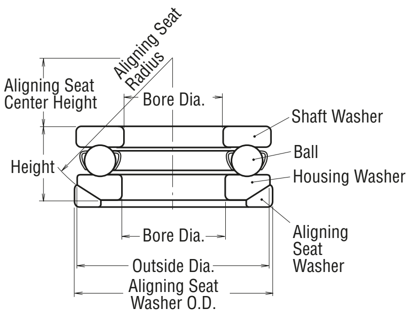
Cylindrical Roller Bearing



Tapered Roller Bearing



Spherical Roller Bearing



Single-Direction Thrust Ball Bearing

Fig. 1.1 Names of Bearing Parts

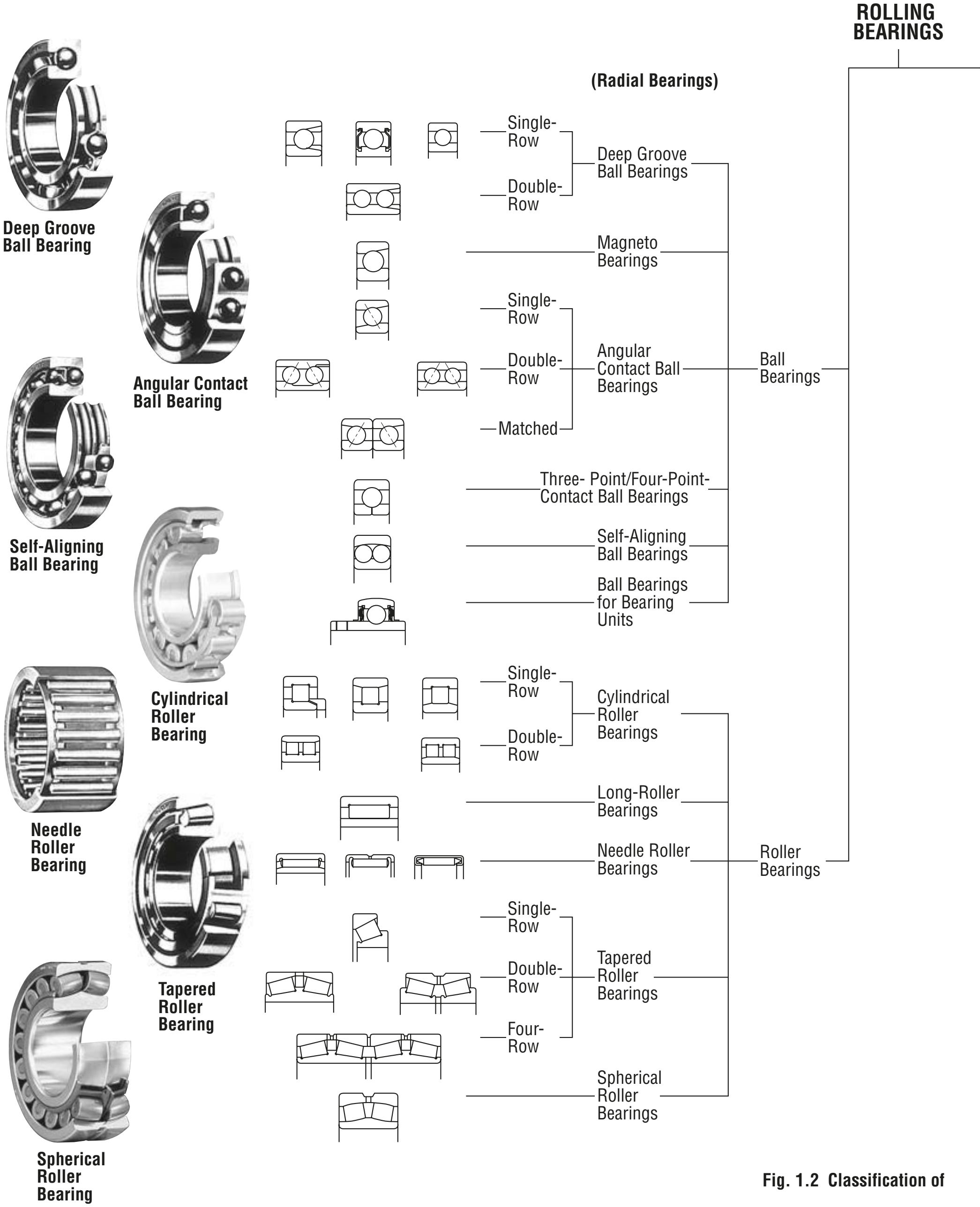
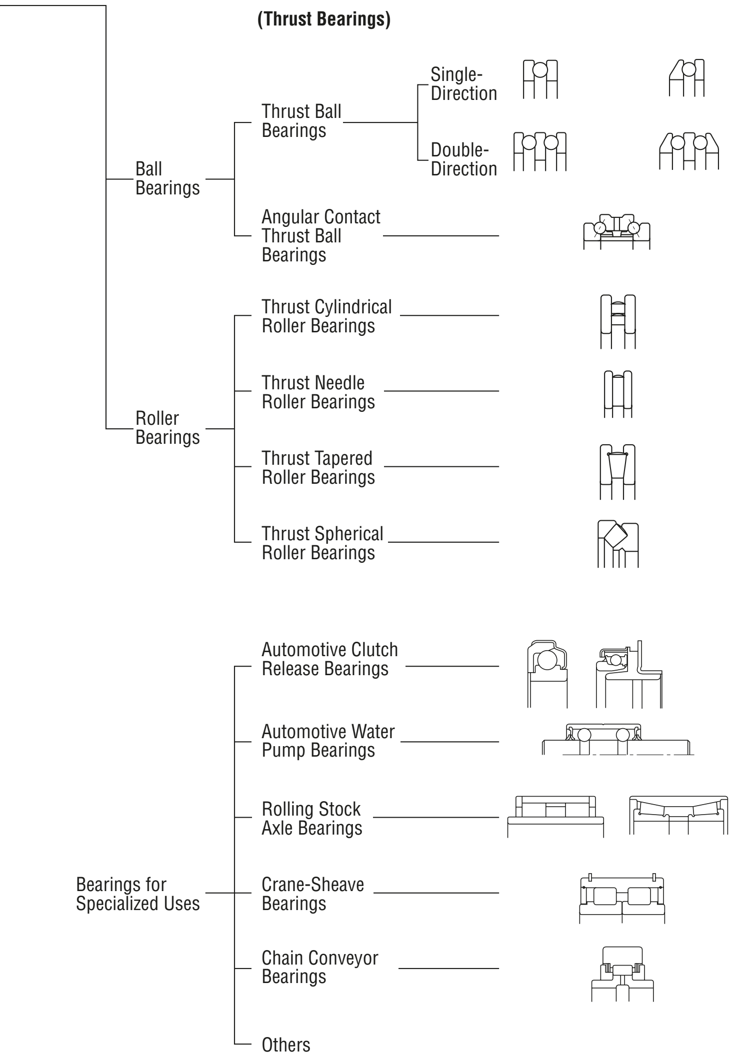


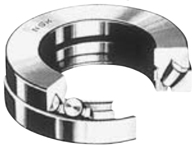
Fig. 1.2 Classification of




Single-Direction Thrust Ball Bearing


Thrust Cylindrical Roller Bearing


Thrust Tapered Roller Bearing

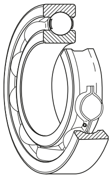

Thrust Spherical Roller Bearing


Sealed Axle Bearing


Cylindrical Roller Bearing for Sheaves

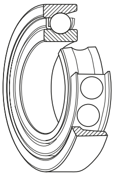
Rolling Bearings

Single-Row Deep Groove Ball Bearings



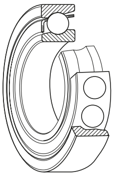
Single-row deep groove ball bearings are the most common type of rolling bearing and are in widespread use. The raceway grooves on both the inner and outer rings have circular arcs of slightly larger radii than those of the balls. They are capable of taking radial loads. In addition, axial loads can 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



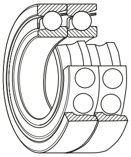
The inner groove of magneto bearings is slightly more shallow than that of deep groove bearings. Since the outer ring has a shoulder on only one side, the outer ring may be removed, which is often advantageous for mounting. In general, two such bearings are used in a paired mounting. Magneto bearings 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.

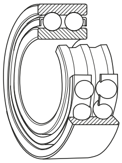
Paired Mounting



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.

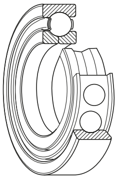
Double-Row Angular Contact Ball Bearings

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.



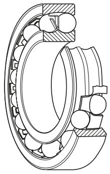
Four-Point-Contact Ball Bearings

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° with each ring. Radial loads are not reccomended. 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.



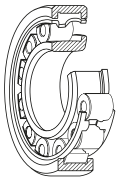
Self-Aligning Ball Bearings

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.

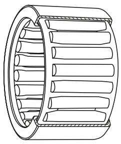


Cylindrical Roller Bearings

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.

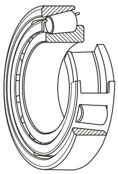


Needle Roller Bearings



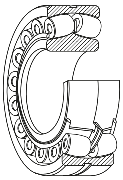
Needle roller bearings contain many slender rollers with a length 3 to 10 times their diameter. As a result, the ratio of the bearing outside diameter to the inscribed circle diameter is small, and they have a rather high radial load capacity.
There are numerous types available, and many have no inner 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



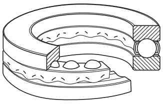
Bearings of this type use conical rollers guided by a back-face rib on the inner ring. These bearings are capable of taking high radial loads and also axial loads in one direction. The HR Series features a greater quantity of larger rollers, allowing for even higher load capacity.
They are generally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

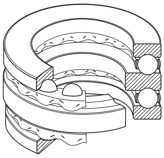


These bearings have barrel-shaped rollers between the inner ring, which has two raceways, and the outer ring, which has one spherical raceway. Since the center of curvature of the outer ring raceway surface coincides with the bearing axis, they are self-aligning in a manner similar to that of self-aligning 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

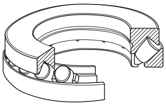


Double-Direction Thrust Ball Bearings



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 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

Features \ 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
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 NNU 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
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☆			☆	☆							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 (α) 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 α: Less than 45°
(A primarily radial load is applied.)

Thrust bearing α: Over 45°
(A primarily axial load is applied.)

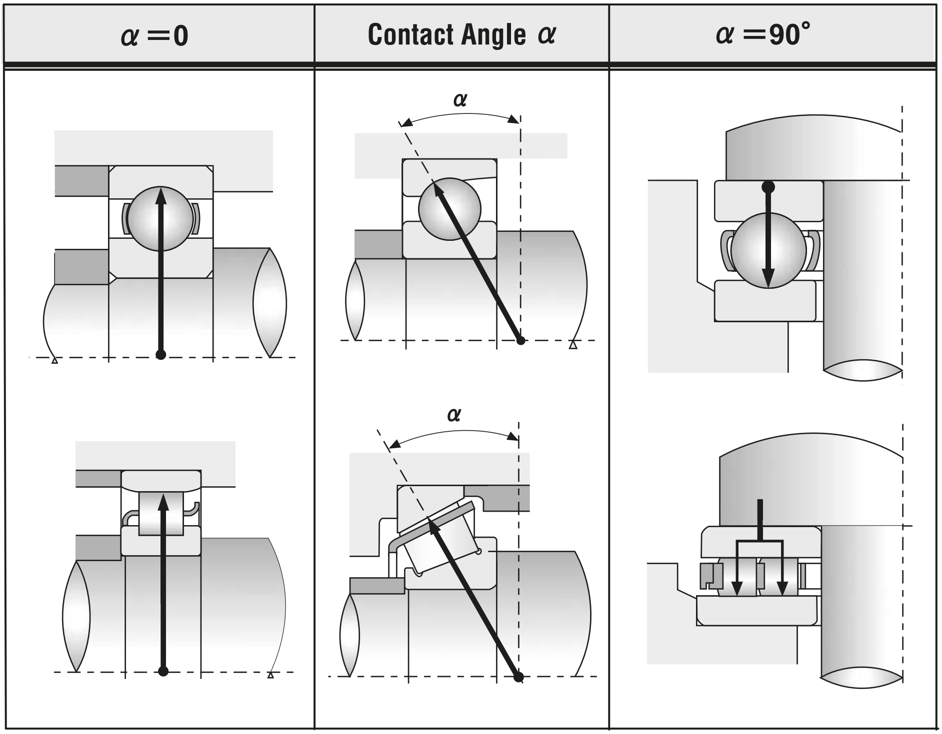


Fig. 1.3 Contact Angle α

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.

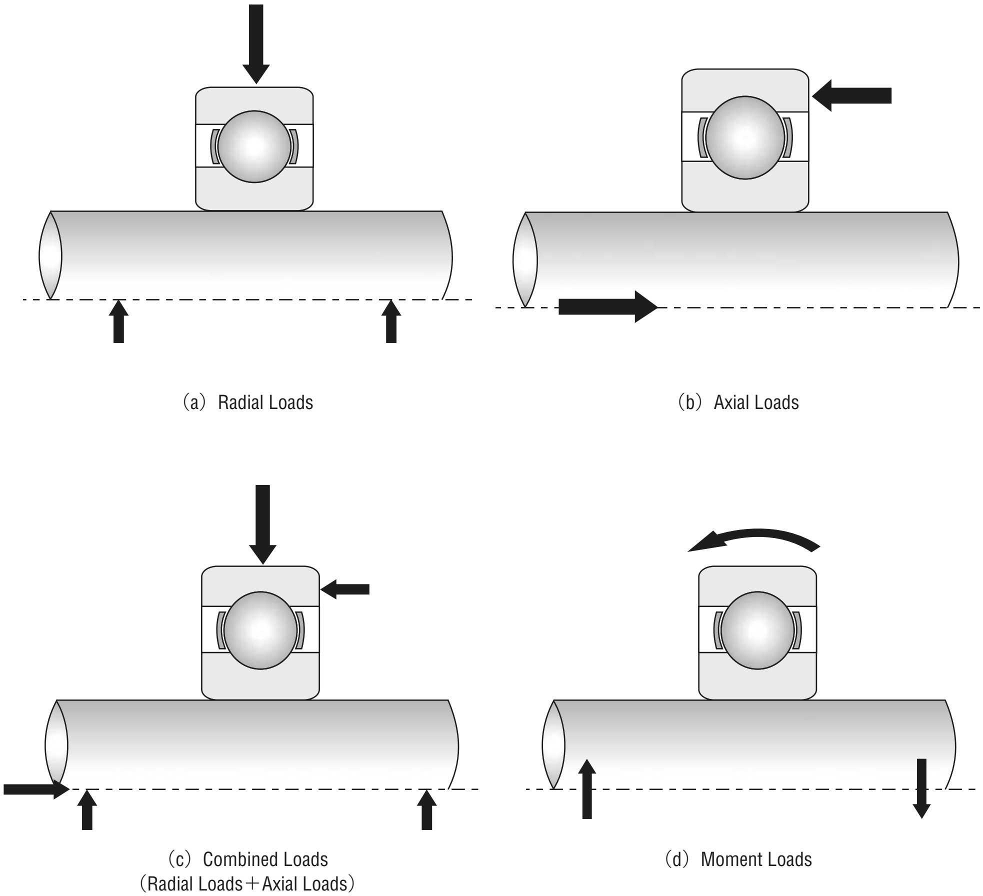


Fig. 1.4 Types of Load


NSK
10
8
HTF
STF

2. SELECTION OF BEARING TYPE

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.

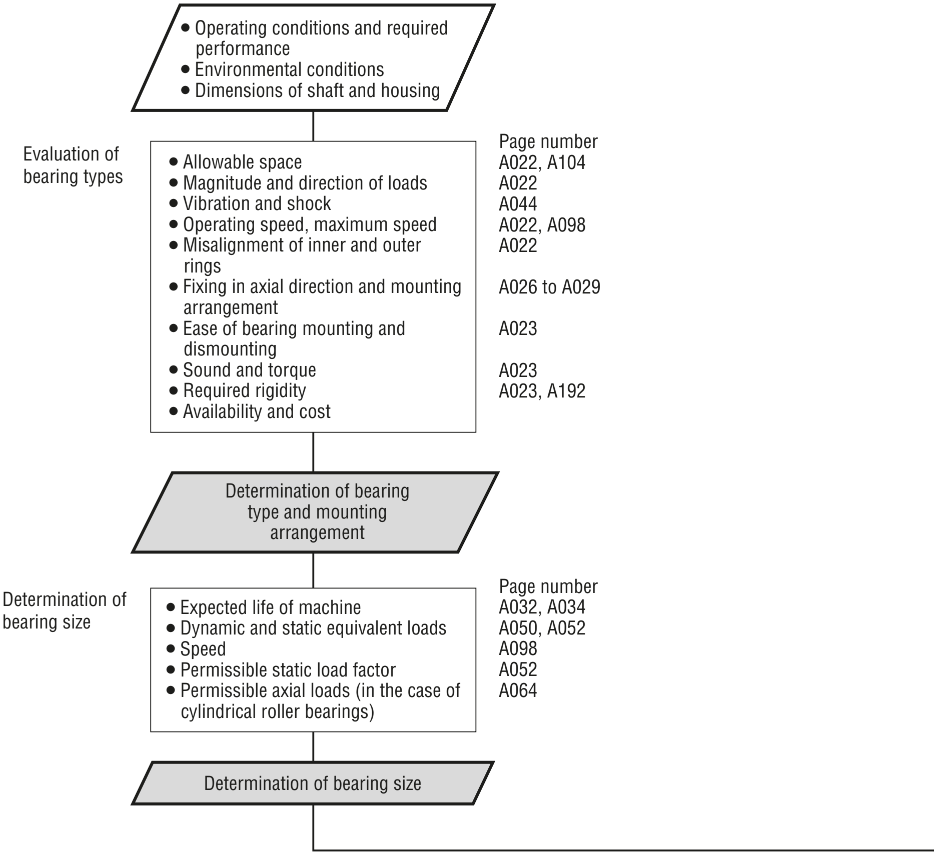
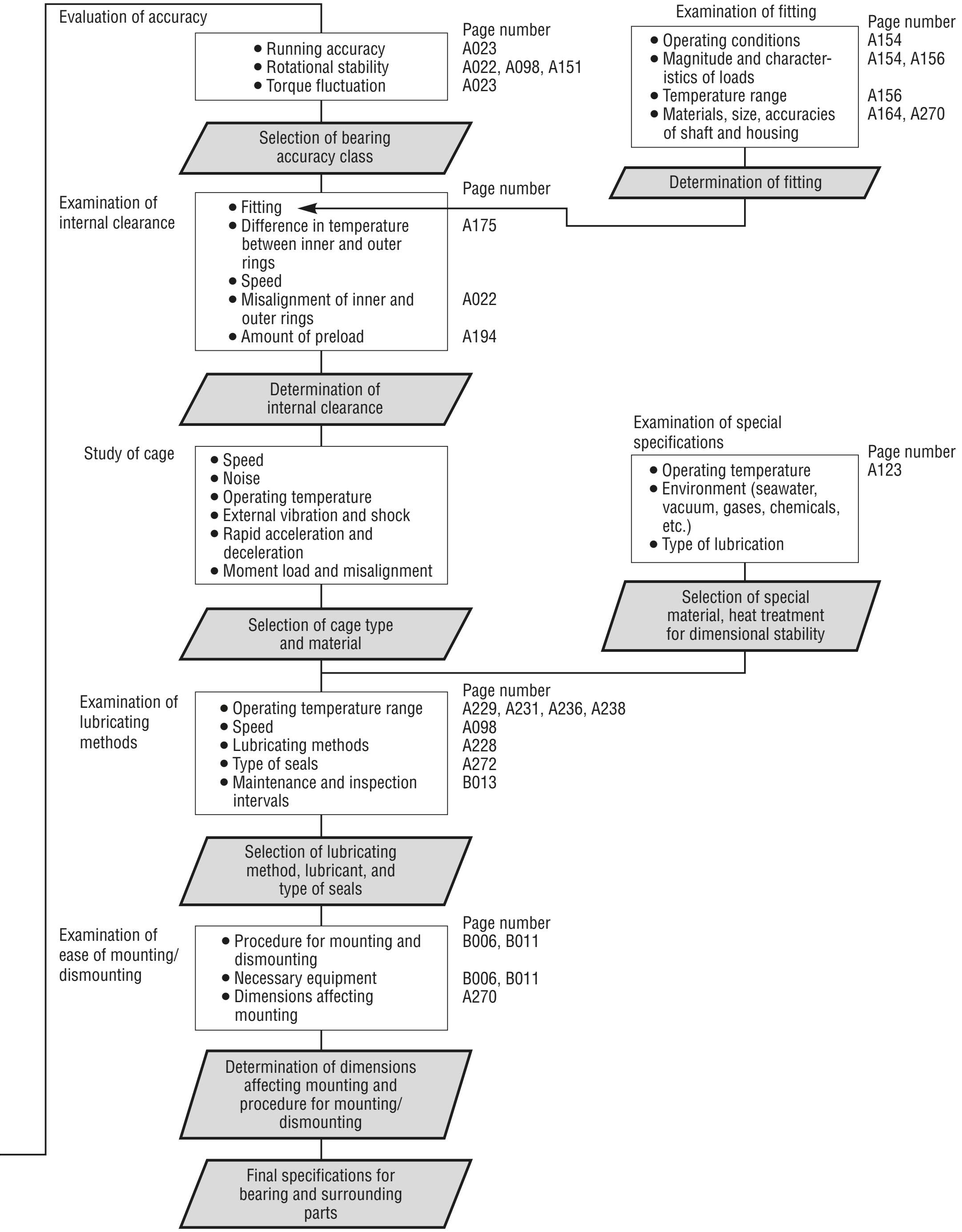


Fig. 2.1 Flowchart for Selection of Rolling Bearings


Evaluation of accuracy
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Final specifications for bearing and surrounding parts

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).

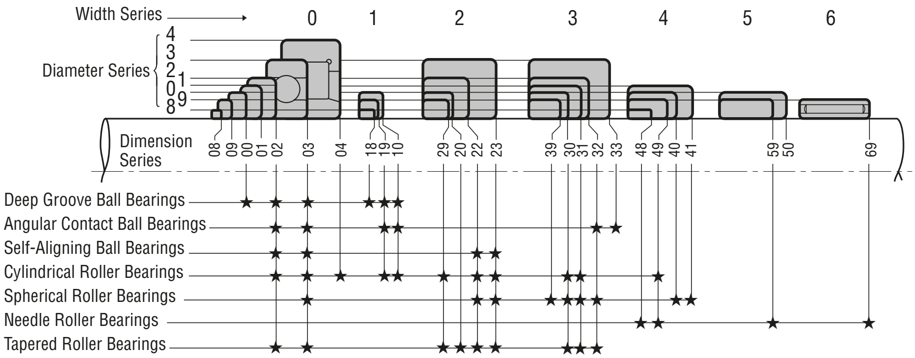
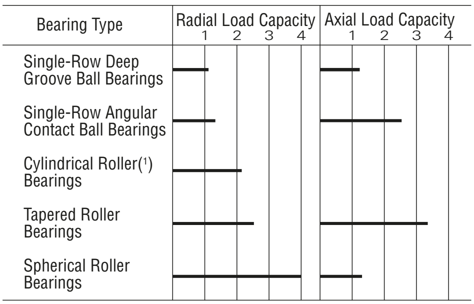


Fig. 2.2 Dimension Series of Radial Bearings



Note(1) Bearings with ribs can take some axial loads.

Fig. 2.3 Relative Load Capacities of Various Bearing Types

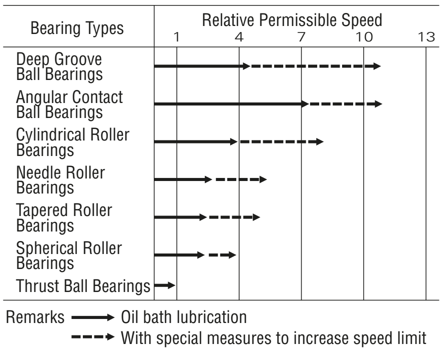


Fig. 2.4 Relative Permissible Speeds of Various Bearing Types

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

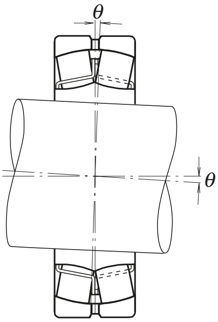


Fig. 2.5 Permissible Misalignment of Spherical Roller Bearings

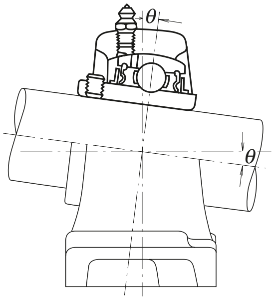


Fig. 2.6 Permissible Misalignment of Ball Bearing Units

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

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

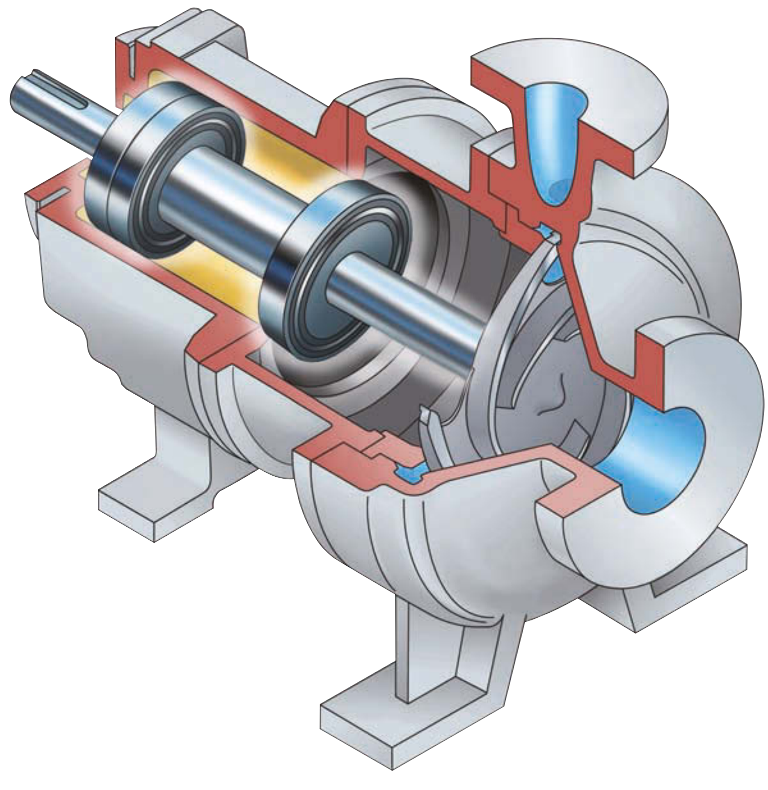
For the main spindles of machine tools that require high running accuracy or high-speed applications like superchargers, high-precision bearings of Accuracy Class 5, 4 or 2 are usually used.

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.



3. SELECTION OF BEARING ARRANGEMENT

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.

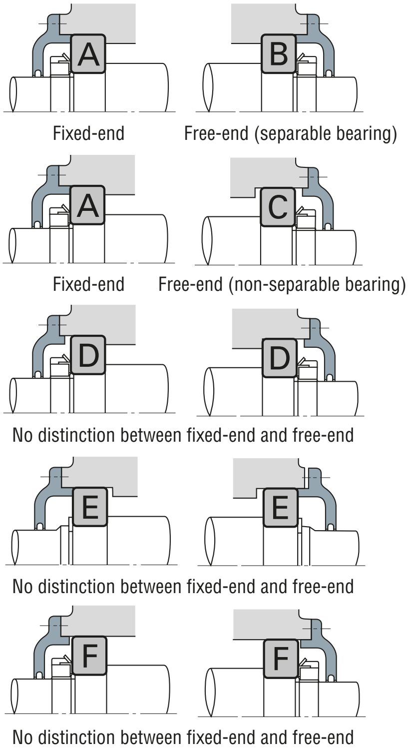
Other bearings must be "free-end" bearings that carry only radial loads to relieve the shaft's thermal elongation and contraction.

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

BEARING C(¹)
- 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 D,E(²)
- Angular Contact Ball Bearing
- Tapered Roller Bearing
- Magneto Bearing
- Cylindrical Roller Bearing (NJ, NF types)

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

Notes: (¹) 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.
(²) 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

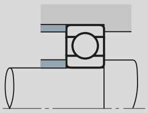
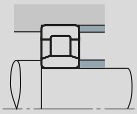
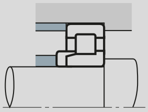
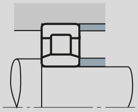
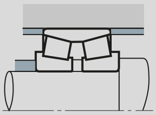
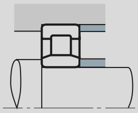
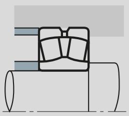
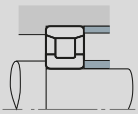
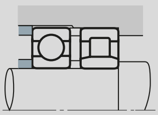
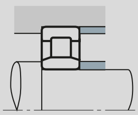
Bearing Arrangements		Remarks	Application Examples
Fixed-end	Free-end		
		◯This is a common arrangement in which abnormal loads are not applied to bearings even if the shaft expands or contracts. ◯If mounting error is small, this is suitable for high speeds.	Medium-sized electric motors, blowers
		◯This arrangement can withstand heavy loads and shock loads and can take some axial load. ◯All cylindrical roller bearings are separable. This is helpful when interference is necessary for both the inner and outer rings.	Traction motors for rolling stock
		◯This arrangement is used when loads are relatively heavy. ◯A back-to-back type is used for maximum rigidity as a fixed-end bearing. ◯Both the shaft and housing must have high accuracy and the mounting error must be small.	Table rollers for steel mills, main spindles of lathes
		◯This arrangement is suitable when interference is necessary for both the inner and outer rings. Heavy axial loads cannot be applied.	Calender rolls of paper making machines, axles of diesel locomotives
		◯This arrangement is suitable for high speeds and heavy radial loads. Moderate axial loads can also be applied. ◯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.	Reduction gears in diesel locomotives

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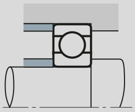
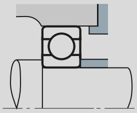
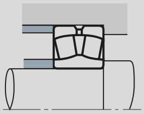
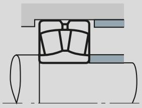
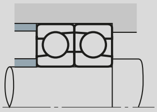
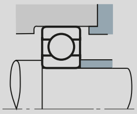
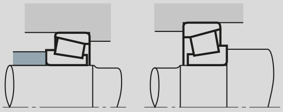
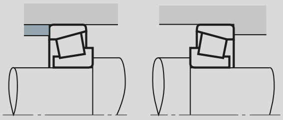
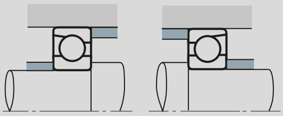
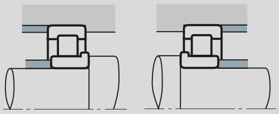
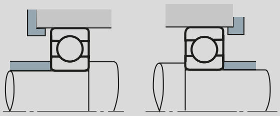
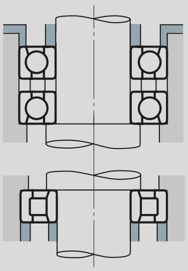
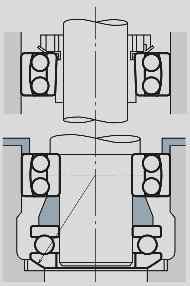
Table 3. 1 Representative Bearing Mounting Arrangements and Application Examples (cont'd)

Bearing Arrangements: Fixed-end	Bearing Arrangements: Free-end	Remarks	Application Examples
		◯This is the most common arrangement. ◯It can sustain not only radial loads, but also moderate axial loads.	Double-suction volute pumps, automotive transmissions
		◯This is the most suitable arrangement when there is mounting error or shaft deflection. ◯It is often used for general and industrial applications in which heavy loads are applied.	Speed reducers, table rollers of steel mills, wheels for overhead travelling cranes
		◯This is suitable when there are rather heavy axial loads in both directions. ◯Double-row angular contact bearings may be used instead of an arrangement of two angular contact ball bearings.	Worm gear reducers
When there is no distinction between fixed-end and free-end		**Remarks**	**Application Examples**
 Back-to-back mounting  Face-to-face mounting		◯This arrangement is widely used since it can withstand heavy loads and shock loads. ◯The back-to-back arrangement is especially good when the distance between bearings is short and moment loads are applied. ◯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. ◯To use this arrangement with a preload, take extra care to ensure the correct amount of preload and clearance adjustment.	Pinion shafts of automotive differential gears, automotive front and rear axles, worm gear reducers
 Back-to-back mounting		◯This arrangement is used at high speeds when radial loads are not so heavy and axial loads are relatively heavy. ◯It provides good rigidity of the shaft by preloading. ◯For moment loads, back-to-back mounting is better than face-to-face mounting.	Grinding wheel shafts

Continued on next page

When there is no distinction between fixed-end and free-end	Remarks	Application Examples
 NJ + NJ mounting	◯This arrangement can withstand heavy loads and shock loads. ◯It can be used if interference is necessary for both the inner and outer rings. ◯Take care to ensure sufficient axial clearance during operation. ◯NF type + NF type mounting is also possible.	Final reduction gears of construction machines
	◯Sometimes a spring is used on the side of the outer ring of one bearing.	Small electric motors, small speed reducers, small pumps
Vertical arrangements	**Remarks**	**Application Examples**
	◯Matched angular contact ball bearings are used on the fixed end. ◯A cylindrical roller bearing is used on the free end.	Vertical electric motors
	◯The spherical center of the self-aligning seat must coincide with that of the self-aligning ball bearing. ◯The upper bearing is on the free end.	Vertical openers (spinning and weaving machines)

4. SELECTION OF BEARING SIZE

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.

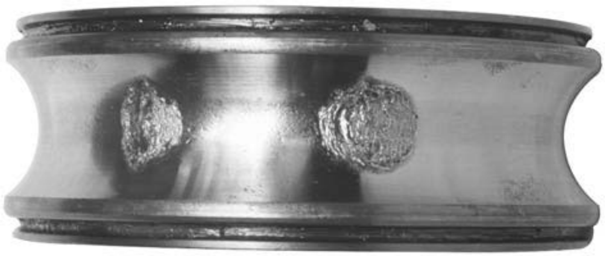


Fig. 4.1 Flaking Example

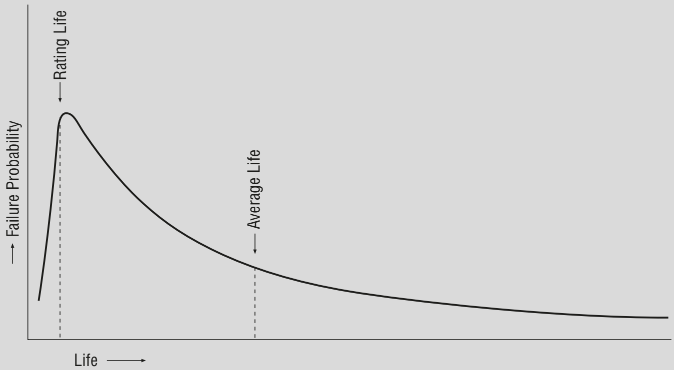


Fig. 4.2 Failure Probability and Bearing Life

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	$L_h=\frac{10^6}{60n}\left(\frac{C}{P}\right)^3=500f_h^3$	$L_h=\frac{10^6}{60n}\left(\frac{C}{P}\right)^{\frac{10}{3}}=500f_h^{\frac{10}{3}}$
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:

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

For roller bearings $L=\left(\frac{C}{P}\right)^{\frac{10}{3}}$ .... (**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 (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:

$$C=\frac{f_h \cdot P}{f_n}$$ .... (**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:

$$C_t=f_t \cdot C$$ .... (**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

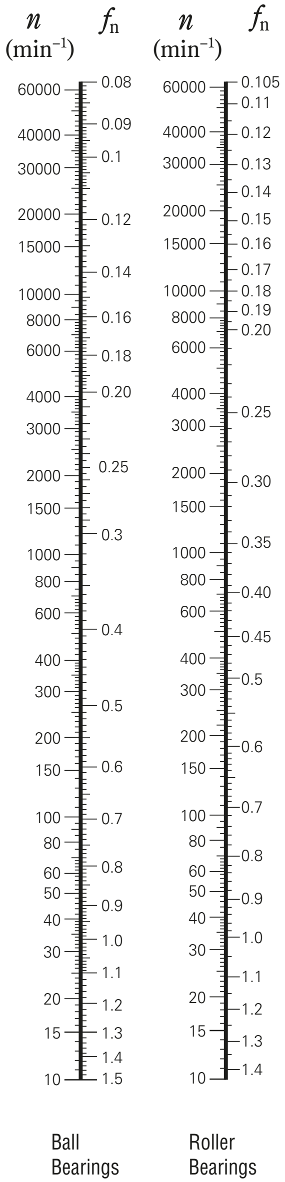


Fig. 4.3 Bearing Speed and Speed Factor

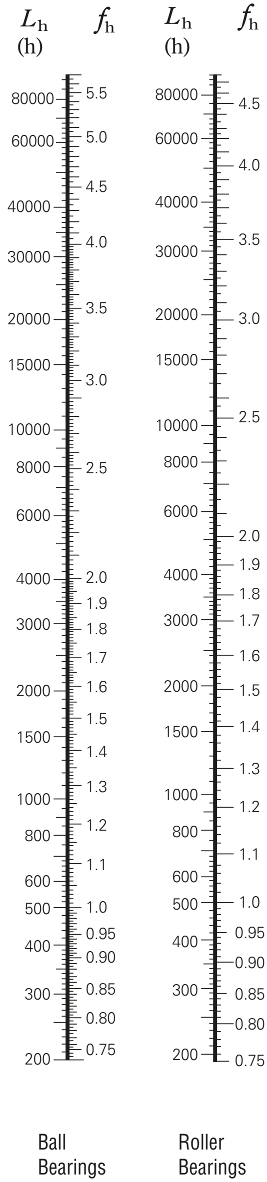


Fig. 4.4 Fatigue Life Factor and Fatigue Life

4.2.5 Correction of Basic Rating Life

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

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

For roller bearings $L_{10} = \left(\frac{C}{P}\right)^{\frac{10}{3}}$ ·················· (**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:

$L_{na} = a_1\, a_2\, a_3\, L_{10}$ ······························ (**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.

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

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_{0r} (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 applicablity of the rating fatigue life equations.

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 ... and the rating fatigue life of the entire group of bearings as L, the equation below is obtained:

$$\frac{1}{L^e}=\frac{1}{L_1^e}+\frac{1}{L_2^e}+\frac{1}{L_3^e}+\cdots \qquad (\mathbf{4.8})$$

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.

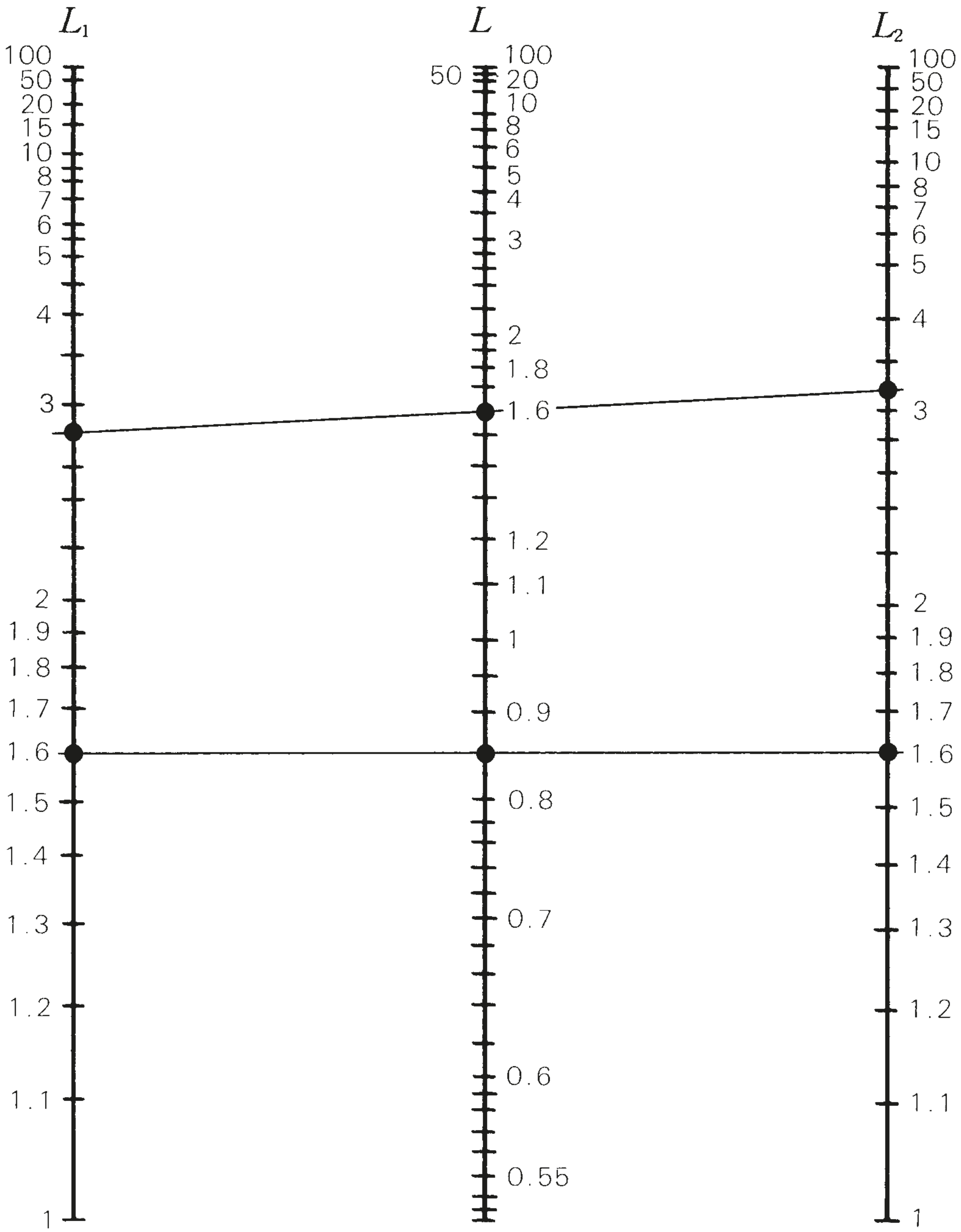


Fig. 4.5 Life Calculation Chart

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.

$$ln\frac{1}{S}\propto\frac{\tau_o^c\cdot N^e\cdot V}{Z_o^h} \qquad (4.9)$$

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.

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

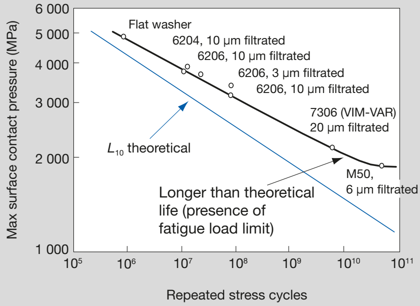


Fig. 4.6 Life Test Results Under Clean Lubrication

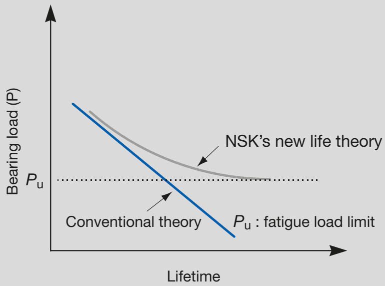


Fig. 4.7 NSK's New Life Theory That Considers Fatigue Limit

(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 μm filtration	10–30 μm filtration	30–100 μm filtration	Greater than 100 μm 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.	—

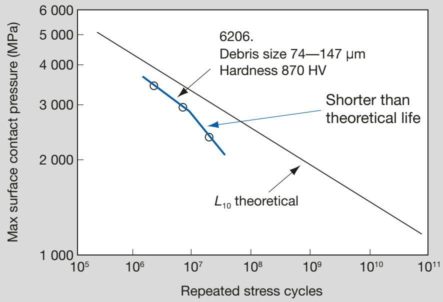


Fig. 4.8 Life Test Results Under Contaminated Lubrication Conditions

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

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

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

(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.

(4) *New life calculation formula* L_{able}

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

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

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

Life Correction Factor a_{NSK}

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

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

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 ν is the operational viscosity and ν_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_{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
τ : Internal stress
τu : Internal stress at fatigue limit
V : Stress volume
Z0 : Depth at which maximum shear stress occurs
ac : Contamination coefficient
aL : Lubrication parameter
(a function of viscosity ratio K)
P : Load applied to bearing
Pu : Fatigue load limit
C : Basic dynamic load rating
e, c, h : Constants

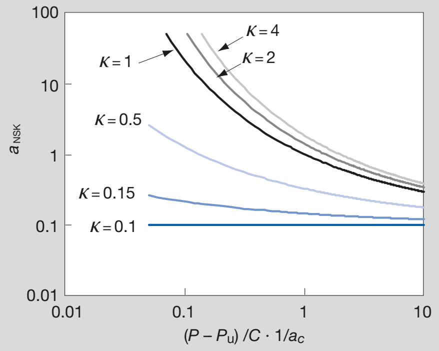


Fig. 4.9 New Life Calculation Diagram for Ball Bearings

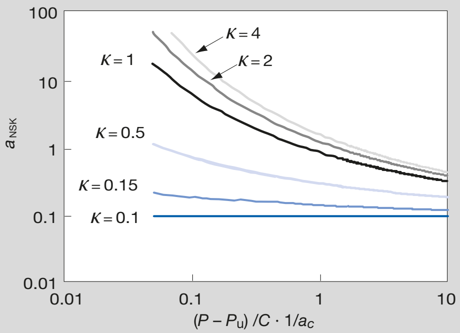


Fig. 4.10 New Life Calculation Diagram for Roller Bearings

Table 4.5 Reliability Factor a_1 Used in New Life Calculauton Formula L_{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:

$$\left.\begin{aligned} F_r &= f_w \cdot F_{rc} \\ F_a &= f_w \cdot F_{ac} \end{aligned}\right\} \cdots\cdots (\mathbf{4.15})$$

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.

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:

$$\left.\begin{aligned} M &= 9\ 550\ 000H / n \ ....(\mathrm{N \cdot mm}) \\ &= \ \ 974\ 000H / n \ ....\{\mathrm{kgf \cdot mm}\} \end{aligned}\right\} \cdots\cdots (\mathbf{4.16})$$

$$P_k = M / r \cdots\cdots (\mathbf{4.17})$$

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^{-1})

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.

$$K_b = f_b \cdot P_k \cdots\cdots (\mathbf{4.18})$$

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

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

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:

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

$$P_k = M / r \cdots\cdots \quad (\mathbf{4.20})$$

$$S_k = P_k \tan\theta \cdots\cdots \quad (\mathbf{4.21})$$

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

where M : Torque applied to gear (N · mm),{kgf · 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 (min^{-1})

r : Pitch circle radius of drive gear (mm)

θ : 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:

$$F_{CI} = \frac{b}{c} K \cdots\cdots \quad (\mathbf{4.23})$$

$$F_{CII} = \frac{a}{c} K \cdots\cdots \quad (\mathbf{4.24})$$

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.

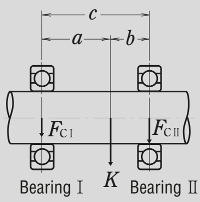


Fig. 4.11 Radial Load Distribution (1)

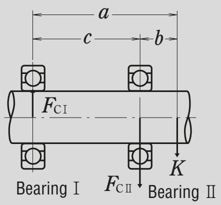


Fig. 4.12 Radial Load Distribution (2)

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
⋮ ⋮ ⋮
Load F_n : Speed n_n ; Operating time t_n

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

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

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:

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

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

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

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)

$$F_m \fallingdotseq 0.65\, F_{max} \quad \cdots\cdots\cdots\cdots \textbf{(4.28)}$$

In the case of Fig. 4.15 (b)

$$F_m \fallingdotseq 0.75\, F_{max} \quad \cdots\cdots\cdots\cdots \textbf{(4.29)}$$

(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 $F_R \geqq F_S$

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

b) Where $F_R < F_S$

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

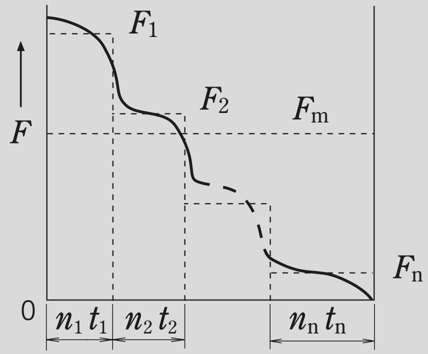


Fig. 4.13 Incremental Load Variation

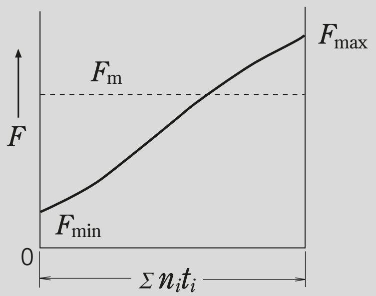


Fig. 4.14 Simple Load Fluctuation

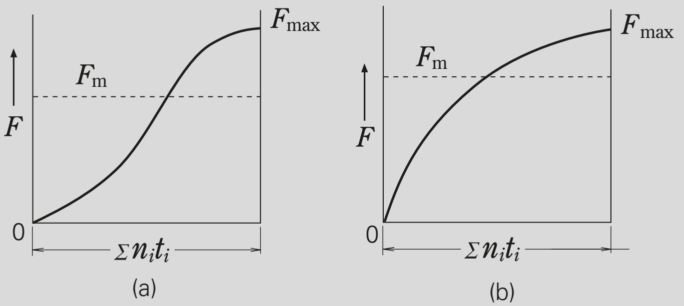


Fig. 4.15 Sinusoidal Load Variation

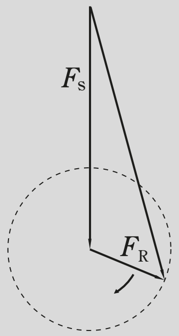


Fig. 4.16 Rotating Load and Stationary Load

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:

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

where F_R : Rotating load (N), {kgf}
F_S : Stationary load (N), {kgf}
θ : 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 $F_R \ll F_S$.

$$F_R \gg F_S,\ F=F_R-F_S\cos\theta \quad \cdots\cdots \quad \textbf{(4.33)}$$
$$F_R \ll F_S,\ F=F_S-F_R\cos\theta \quad \cdots\cdots \quad \textbf{(4.34)}$$

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

$F_R>F_S$,

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

$F_R<F_S$,

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

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).

$$F_m=F_{min}+0.65\,(F_{max}-F_{min})$$
$$F_R \geqq F_S,\ F_m=F_R+0.3F_S \quad \cdots\cdots \quad \textbf{(4.37)}$$
$$F_R \leqq F_S,\ F_m=F_S+0.3F_R \quad \cdots\cdots \quad \textbf{(4.38)}$$

$$F_m=F_{min}+0.75\,(F_{max}-F_{min})$$
$$F_R \geqq F_S,\ F_m=F_R+0.5F_S \quad \cdots\cdots \quad \textbf{(4.39)}$$
$$F_R \leqq F_S,\ F_m=F_S+0.5F_R \quad \cdots\cdots \quad \textbf{(4.40)}$$

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:

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

or

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

Accordingly, F_m can be expressed by the following equation:

$F_R \geqq F_S$,

$$F_m=F_R+\left(0.3+0.2\frac{F_S}{F_R}\right)F_S$$
$$=F_R+0.3F_S+0.2\frac{F_S^2}{F_R} \quad \cdots\cdots \quad \textbf{(4.41)}$$

$F_R \leqq F_S$,

$$F_m=F_S+\left(0.3+0.2\frac{F_R}{F_S}\right)F_R$$
$$=F_S+0.3F_R+0.2\frac{F_R^2}{F_S} \quad \cdots\cdots \quad \textbf{(4.42)}$$

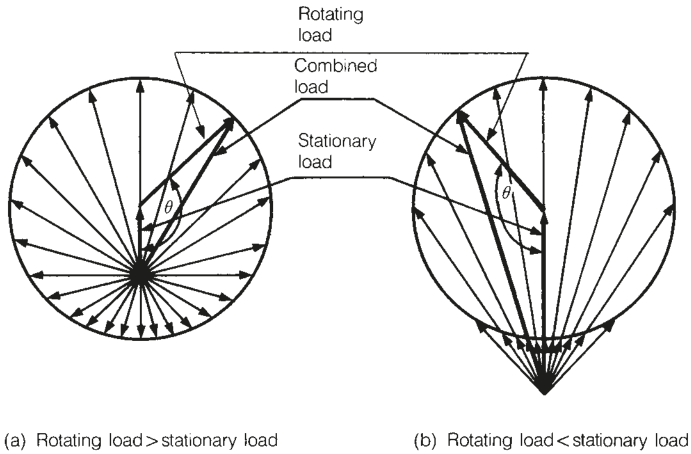


Fig. 4.17 Combined Rotating and Stationary Loads

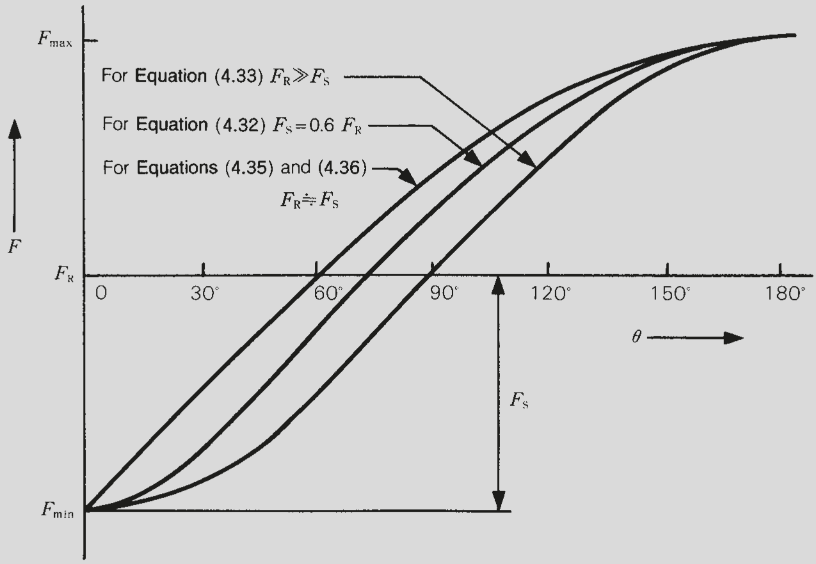


Fig. 4.18 Chart of Combined Loads

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:

$$P = XF_r + YF_a \quad \cdots\cdots (\mathbf{4.43})$$

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 $\alpha = 0°$ 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:

$$P = F_a + 1.2F_r \quad \cdots\cdots (\mathbf{4.44})$$

where $\dfrac{F_r}{F_a} \leqq 0.55$

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:

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

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 $F_{r\,\mathrm{I}}$ and $F_{r\,\mathrm{II}}$ 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:

where $F_{ae} + \frac{0.6}{Y_{\mathrm{II}}} F_{r\,\mathrm{II}} \geqq \frac{0.6}{Y_{\mathrm{I}}} F_{r\,\mathrm{I}}$

$$\left.\begin{aligned} P_{\mathrm{I}} &= XF_{r\,\mathrm{I}} + Y_{\mathrm{I}}\left(F_{ae} + \frac{0.6}{Y_{\mathrm{II}}} F_{r\,\mathrm{II}}\right) \\ P_{\mathrm{II}} &= F_{r\,\mathrm{II}} \end{aligned}\right\} \quad \cdots\cdots \quad \textbf{(4.46)}$$

where $F_{ae} + \frac{0.6}{Y_{\mathrm{II}}} F_{r\,\mathrm{II}} < \frac{0.6}{Y_{\mathrm{I}}} F_{r\,\mathrm{I}}$

$$\left.\begin{aligned} P_{\mathrm{I}} &= F_{r\,\mathrm{I}} \\ P_{\mathrm{II}} &= XF_{r\,\mathrm{II}} + Y_{\mathrm{II}}\left(\frac{0.6}{Y_{\mathrm{I}}} F_{r\,\mathrm{I}} - F_{ae}\right) \end{aligned}\right\} \quad \cdots\cdots \quad \textbf{(4.47)}$$

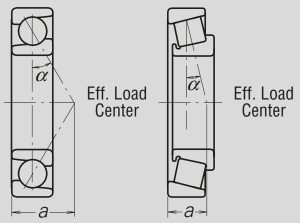


Fig. 4.19 Effective Load Centers

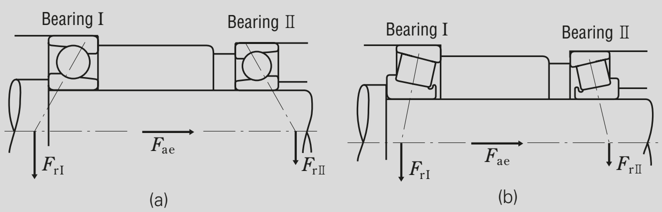


Fig. 4.20 Loads in Opposed Paired Mounting Arrangement

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^2}
For other ball bearings	4 200 MPa {428 kgf/mm^2}
For roller bearings	4 000 MPa {408 kgf/mm^2}

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_o 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_o 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:

$$P_o = X_o F_r + Y_o F_a \quad \cdots\cdots \quad (\mathbf{4.47})$$

$$P_o = F_r \quad \cdots\cdots \quad (\mathbf{4.48})$$

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*

$$P_o = X_o F_r + F_a \qquad \alpha \neq 90° \quad \cdots\cdots \quad (\mathbf{4.49})$$

where P_o : Static equivalent load (N), {kgf}
α : 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

$\alpha = 90°$ 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_o values increased.

$$f_s = \frac{C_o}{P_o} \quad \cdots\cdots \quad (\mathbf{4.50})$$

where C_o : 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 N and speed n =900 min^{-1}.

The basic load rating C_r of **6208** is 29 100 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 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 N

Speed n =1 900 min^{-1}

Basic rating life $L_h \geqq 10\ 000$ h

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

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

Therefore, $C_r \geqq 2.72 \cdot \frac{3\ 000}{0.26} = 31\ 380$ 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 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 N (Page C024)

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

$$e \fallingdotseq 0.26$$

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 N

Axial load F_a = 8 000 N

Speed n = 500 min^{-1}

Basic rating life $L_h \geqq 30\ 000$ h

The value of the fatigue life factor f_h which makes $L_h \geqq 30\ 000$ 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 $F_a / F_r \leqq e$

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

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.

Therefore, $P = XF_r + YF_a = F_r + Y_3 F_a$

$$= 45\,000 + 2.2 \cdot\ 8\,000$$

$$= 62\,600 \text{ N}$$

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

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

Consequently, $C_r \geqq 490\,000$ N

The smallest Series 231 spherical roller bearing satisfying this value of C_r is **23126CE4** (C_r = 505 000 N).

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

$$P = F_r + Y_3 F_a = 45\,000 + 2.4 \cdot\ 8\,000$$

$$= 64\,200 \text{ N}$$

$$L_h = 500 \left(f_n \frac{C_r}{P}\right)^{\frac{10}{3}}$$

$$= 500 \left(0.444 \cdot \frac{505\,000}{64\,200}\right)^{\frac{10}{3}}$$

$$= 500 \cdot\ 3.49^{\frac{10}{3}} \fallingdotseq 32\,000 \text{ h}$$

(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 N and axial load F_{ae}=2 000 N are applied to **HR30305DJ** as shown in Fig. 4.21. The speed is 600 min^{-1}.

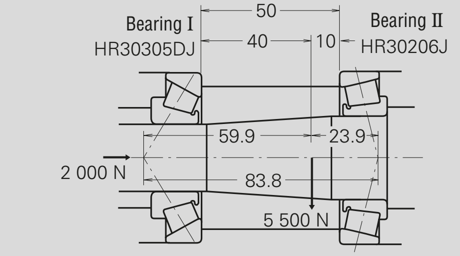


Fig. 4.21 Loads on Tapered Roller Bearings

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 (**HR30305DJ**)	38 000	$Y_I = 0.73$	0.83
Bearing Ⅱ (**HR30206J**)	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:

$$F_{ae} + \frac{0.6}{Y_{\text{II}}} F_{r\text{II}} = 2\,000 + \frac{0.6}{1.6} \cdot 3\,931$$
$$= 3\,474 \text{ N}$$

$$\frac{0.6}{Y_{\text{I}}} F_{r\text{I}} = \frac{0.6}{0.73} \cdot 1\,569 = 1\,290 \text{ N}$$

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

For bearing Ⅰ,

$F_{r\text{I}} = 1\,569$ N

$F_{a\text{I}} = 3\,474$ N

since $F_{a\text{I}} / F_{r\text{I}} = 2.2 > e = 0.83$

the dynamic equivalent load $P_{\text{I}} = XF_{r\text{I}} + Y_{\text{I}} F_{a\text{I}}$

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

$= 3\,164$ N

The fatigue life factor $f_h = f_n \frac{C_r}{P_{\text{I}}}$

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

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

$= 109\,750$ h

For bearing Ⅱ

since $F_{r\text{II}} = 3\,931$ N, $F_{a\text{II}} = 0$

the dynamic equivalent load

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

fatigue life factor

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

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

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

(Example 6)
Select a bearing for a speed reducer under the following conditions:
Operating conditions

Radial load $F_r = 245\,000$ N

Axial load $F_a = 49\,000$ N

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

Size limitation

Shaft diameter: 300 mm

Housing bore: Less than 500 mm

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	**23960 CAME4**	1 540 000	0.19	3.5
	460	118	**23060 CAME4**	2 400 000	0.24	2.8
	460	160	**24060 CAME4**	2 890 000	0.32	2.1
	500	160	**23160 CAME4**	3 350 000	0.31	2.2
	500	200	**24160 CAME4**	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**.

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 α when a load is applied. (see Equations (9.8), (9.9), and (9.10) in Section 9.6.2)

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

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

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

Namely, δ_a refers to the change in Equation (4.52) to determine a contact angle α corresponding to the contact angle known from observation of the raceway. Thus, δ_a and α 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 α 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.

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

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):

$$\frac{f_0}{C_{0r}}F_a = A\,F_a$$
$$= K\,\{\sqrt{(\sin\alpha_0+h)^2+\cos^2\alpha_0}-1\}^{3/2}\cdot\frac{\sin\alpha}{\cos\alpha_0} \quad \cdots\cdots \textbf{(4.54)}$$

where K: Constant determined from material and design of bearing

In other words, h is assumed and contact angle α is determined from Equation (4.52). Then h and α 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 α 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 AF_a = 0.212 × 35.0 = 7.42 and α ≒ 26° according to Fig. 4.22.
The initial contact angle of 15° has changed to 26° under axial load.

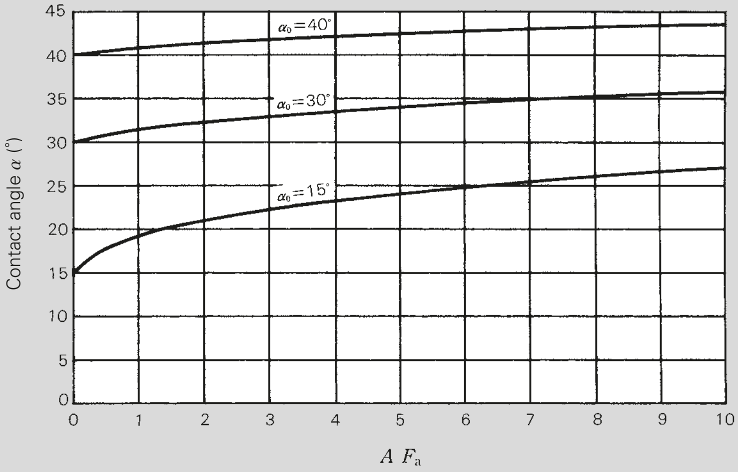


Fig. 4.22 Change in Contact Angle of Angular Contact Ball Bearings Under Axial Load

Table 4.10 Constant A Value of Angular Contact Ball Bearings

Units: 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° 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$\fallingdotseq$7.5, thus $\alpha\fallingdotseq$24° based on Fig. 4.23.

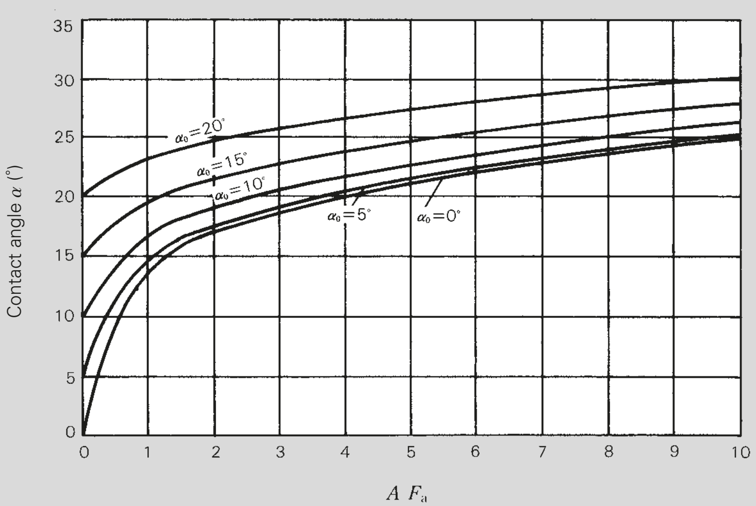


Fig. 4.23 Change in Contact Angle of Deep Groove Ball Bearings Under Axial Load

Table 4.11 Constant A Value of Deep Groove Ball Bearing

Units: 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_{0r} 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 α for F_a is determined from the right terms of Equations (4.51) and Equation (4.52), while Q is calculated as follows:

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

θ of Fig. 4.24 is determined as follows:

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

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

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

$$\gamma \geqq \alpha+\theta$$

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.

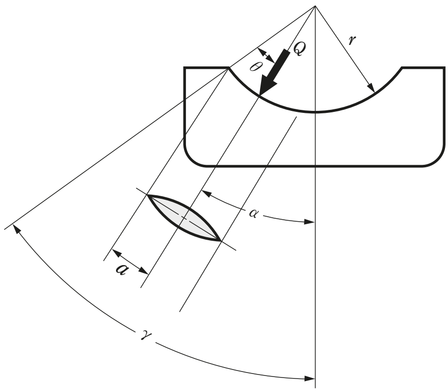


Fig. 4.24 Contact Ellipse

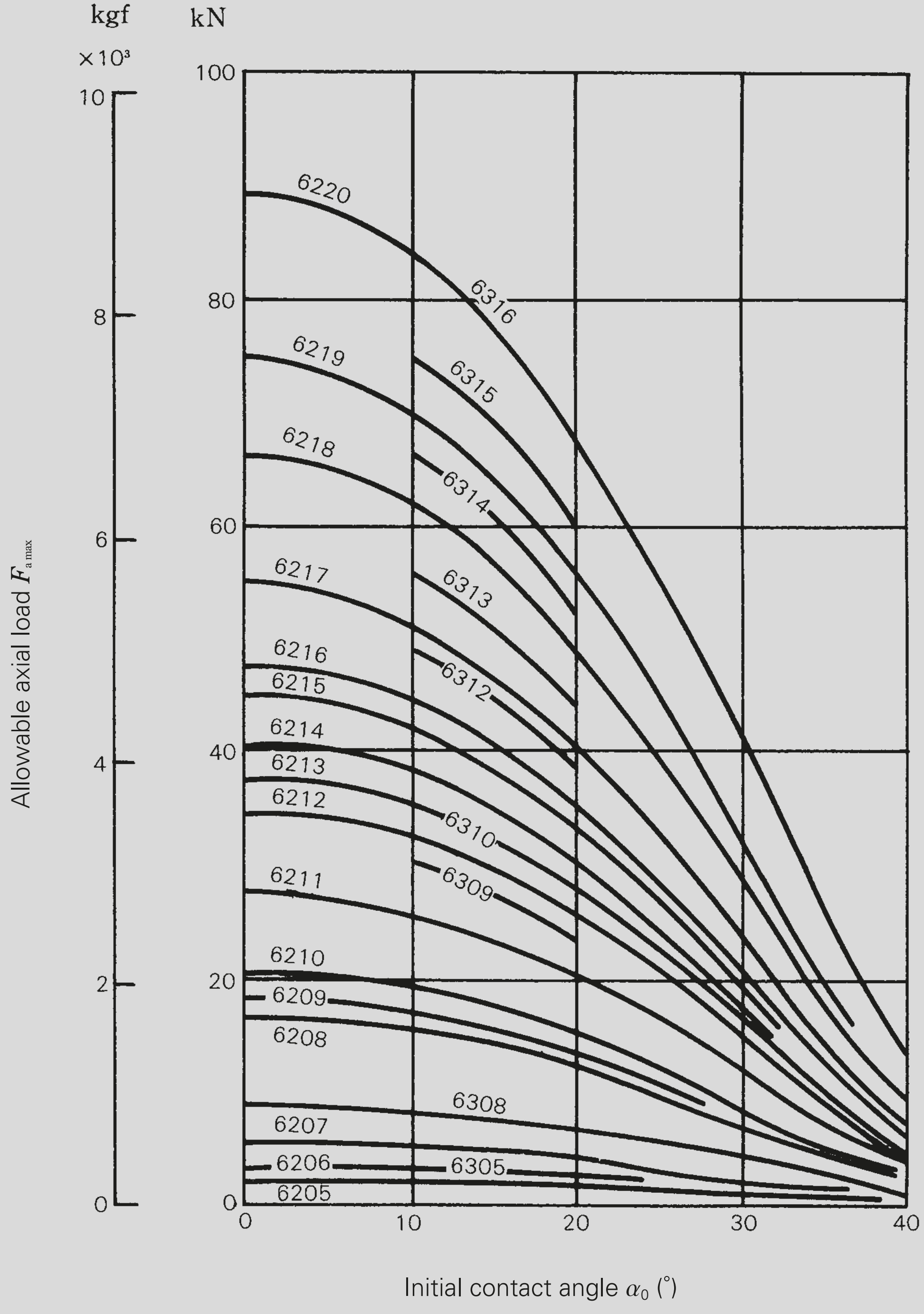


Fig. 4.25 Allowable Axial Load for Deep Groove Ball Bearings

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)

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

$$= f\left\{\frac{900\ (k\cdot d)^2}{n+1\ 500} - 0.023\times(k\cdot d)^{2.5}\right\}\{\mathrm{kgf}\} \quad \cdots\cdots (\mathbf{4.55})$$

Oil lubrication (Empirical equation)

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

$$= f\left\{\frac{490\ (k\cdot d)^2}{n+1\ 000} - 0.000135\times(k\cdot d)^{3.4}\right\}\{\mathrm{kgf}\} \quad \cdots\cdots (\mathbf{4.56})$$

where C_A : Allowable axial load (N), {kgf}
d : Bearing bore diameter (mm)
n : Bearing speed (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.

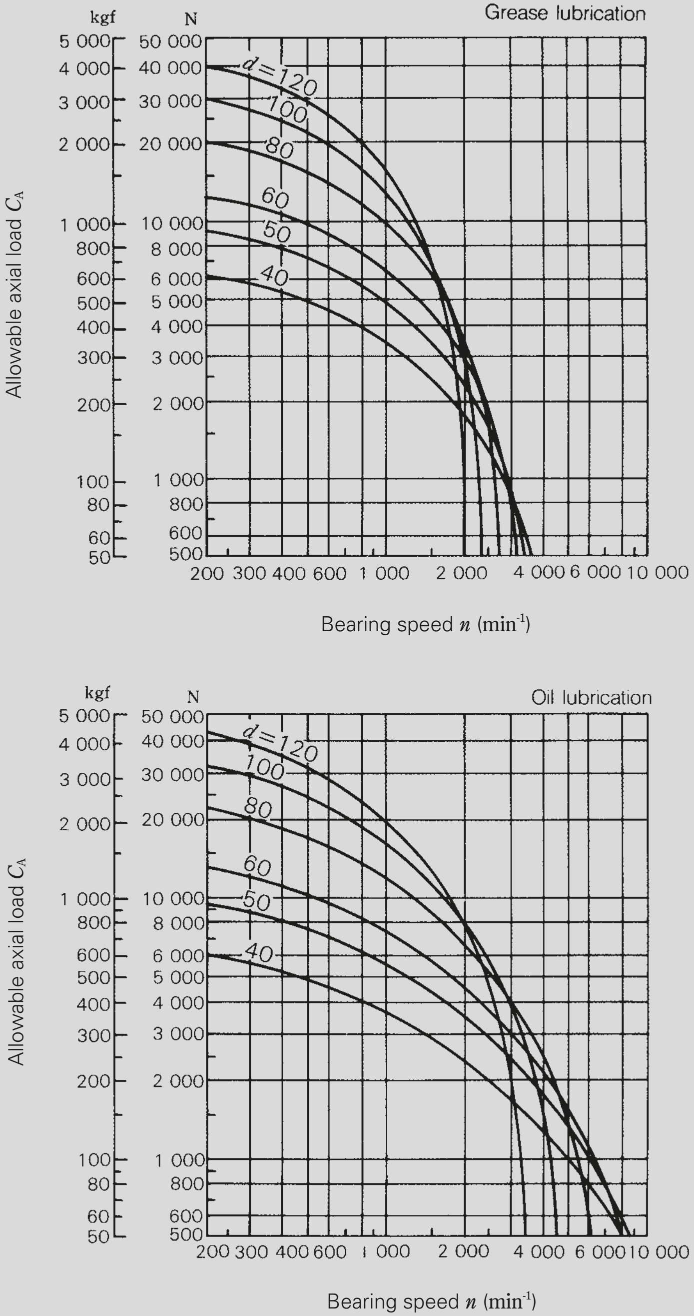
Moreover, if the bearing speed is very slow or exceeds 50 % of the allowable speed in the bearing tables or if the bearing bore diameter exceeds 200 mm, each bearing must be precisely checked for lubrication, cooling method, etc. Please contact NSK in such cases.

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.

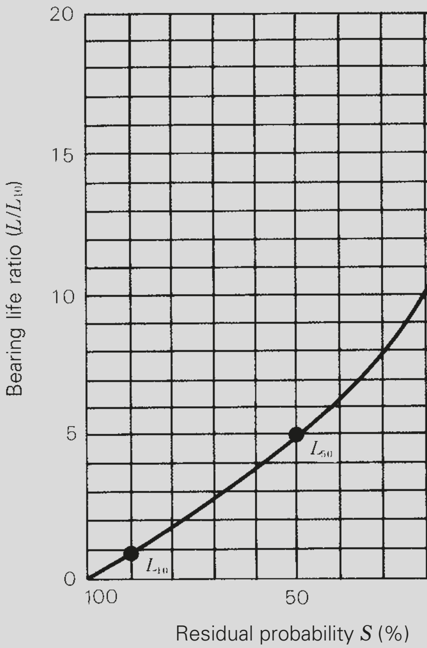


Fig. 4.27 Bearing Life and Residual Probability

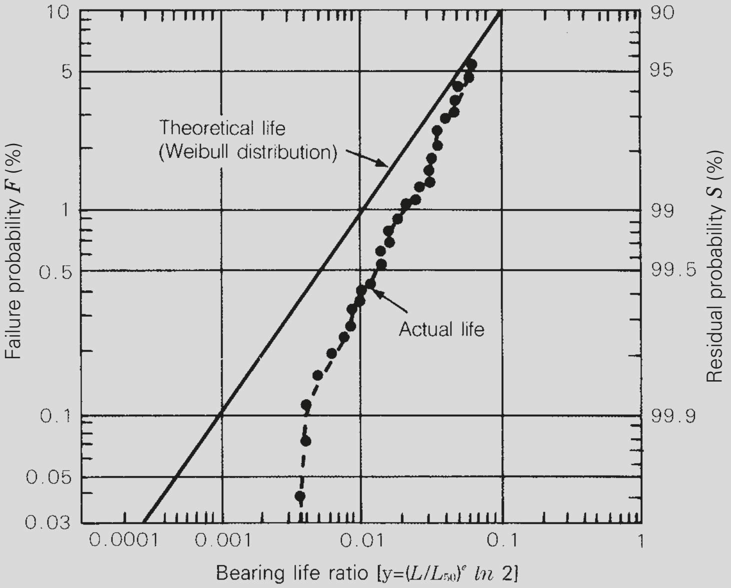


Fig. 4.28 Life Distribution in the Low-Failure Ratio Range

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:

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

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

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 ε = 0.5 (Fig. 4.29).
The load distribution with ε=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 Δ_r and a function $f(\varepsilon)$ of load factor ε:

For deep groove ball bearings:

$$f(\varepsilon) = \frac{\Delta_r \cdot D_w^{1/3}}{0.00044\left(\frac{F_r}{Z}\right)^{2/3}} \quad \cdots\cdots \quad (\mathrm{N})$$

$$f(\varepsilon) = \frac{\Delta_r \cdot D_w^{1/3}}{0.002\left(\frac{F_r}{Z}\right)^{2/3}} \quad \cdots\cdots \quad \{\mathrm{kgf}\} \quad \cdots\cdots \quad (\mathbf{4.58})$$

For cylindrical roller bearings:

$$f(\varepsilon) = \frac{\Delta_r \cdot L_{we}^{0.8}}{0.000077\left(\frac{F_r}{Z \cdot i}\right)^{0.9}} \quad \cdots\cdots \quad (\mathrm{N})$$

$$f(\varepsilon) = \frac{\Delta_r \cdot L_{we}^{0.8}}{0.0006\left(\frac{F_r}{Z \cdot i}\right)^{0.9}} \quad \cdots\cdots \quad \{\mathrm{kgf}\} \quad \cdots\cdots \quad (\mathbf{4.59})$$

where Δ_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_ε : Life with clearance of Δ_r
L : Life with zero clearance, obtained from Equation (4.57)

The relationship between load factor ε and $f(\varepsilon)$ and the life ratio L_ε/L, when radial internal clearance Δ_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.

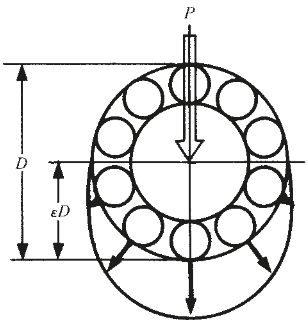


Fig. 4.29 Load Distribution With ε = 0.5

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

ε	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

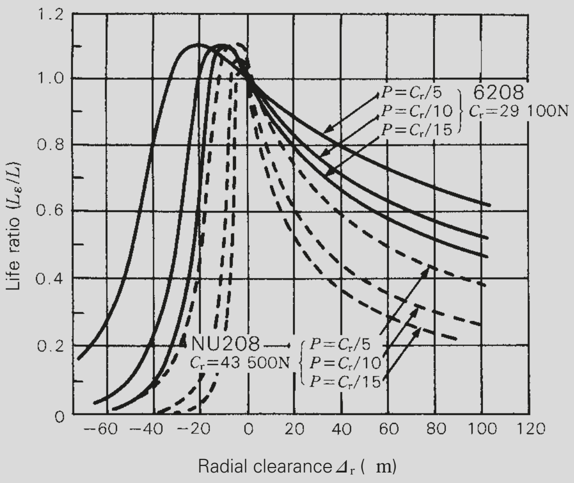


Fig. 4.30 Radial Clearance and Bearing Life Ratio

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_θ. 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.

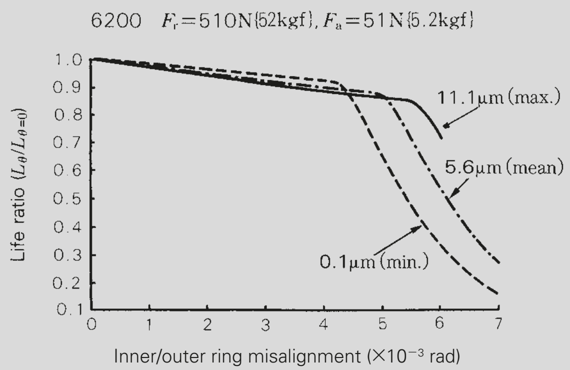


Fig. 4.31 Life Vs. Misalignment

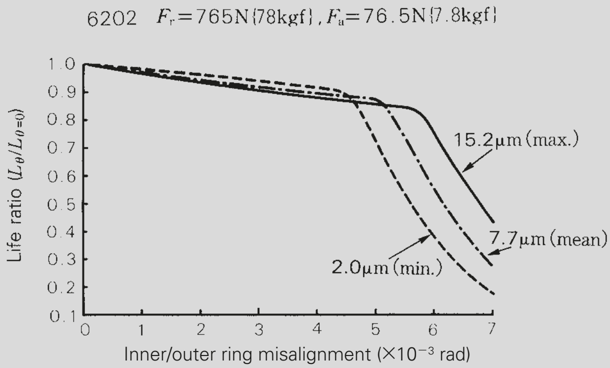


Fig. 4.32 Life Vs. Misalignment

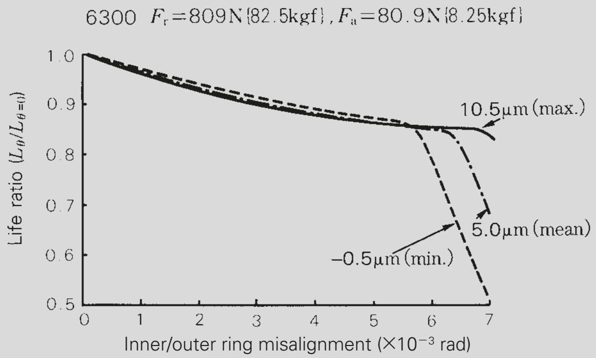


Fig. 4.33 Life Vs. Misalignment

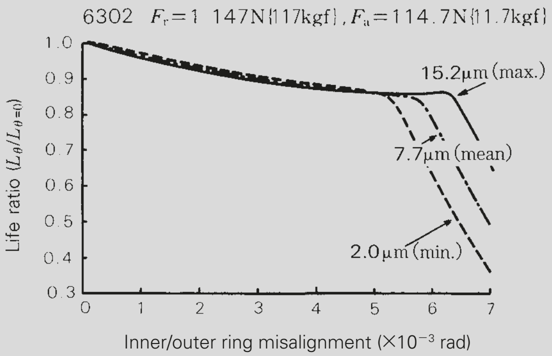


Fig. 4.34 Life Vs. Misalignment

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_θ.

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.

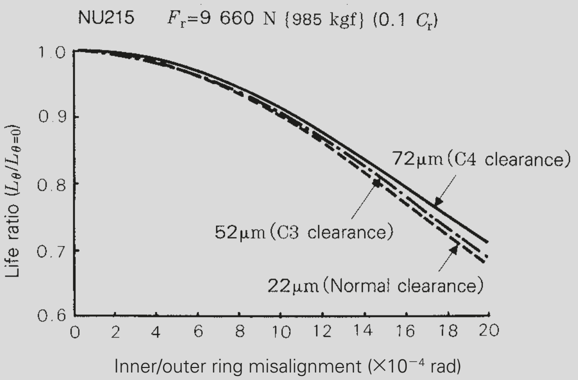


Fig. 4.35 Life Vs. Misalignment

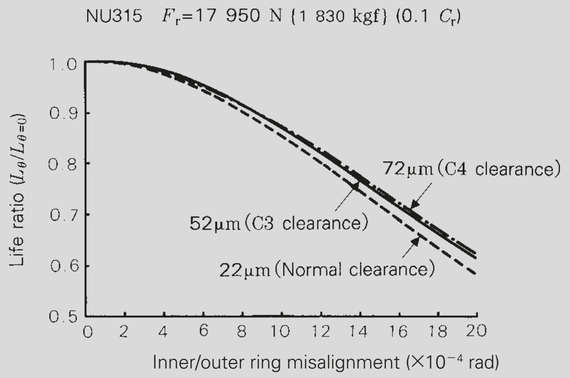


Fig. 4.36 Life Vs. Misalignment

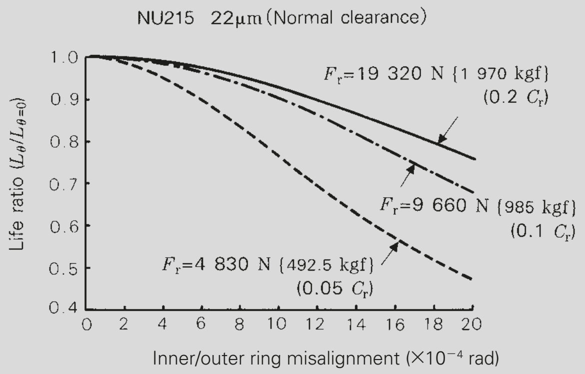


Fig. 4.37 Life Vs. Misalignment

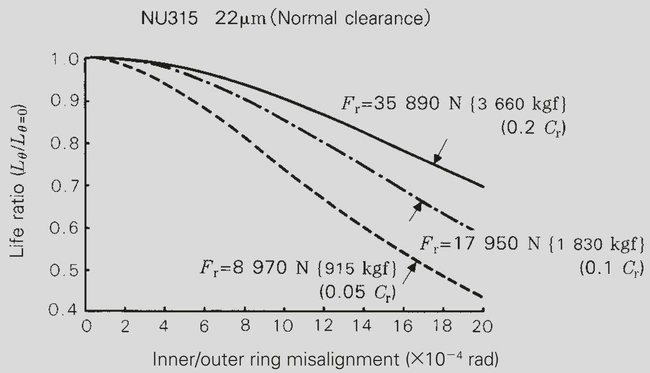


Fig. 4.38 Life Vs. Misalignment

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 Λ, 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 Λ. Namely, when Λ 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 Λ 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 Λ = 0.3–3 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 $\Lambda \fallingdotseq 1$ when compared with life values at around Λ = 3–4 where life changes at a slower rate. Life becomes about 1/10 or less at $\Lambda \leqq 0.5$ 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.

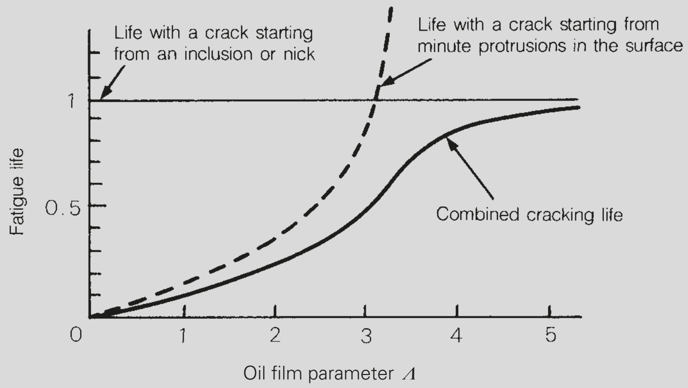


Fig. 4.39 Life According to Oil Film Parameter Λ (Tallian, et al.)

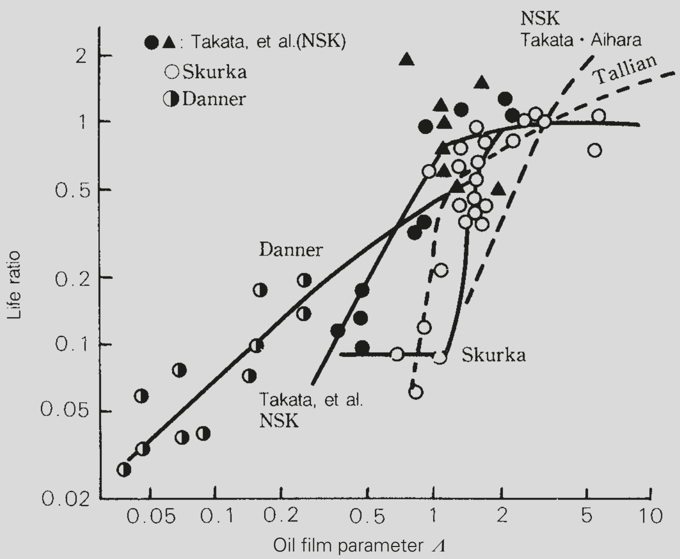


Fig. 4.40 Typical Experiment With Oil Film Parameter Λ and Rolling Fatigue Life
(Expressed with reference to the life at Λ =3)

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 (Λ) 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.

$$\Lambda = h/\sigma \quad \cdots\cdots \quad (\mathbf{4.60})$$

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

σ_1, σ_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:

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

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:

$$\Lambda = t \cdot R \cdot A \cdot F \cdot J \quad \cdots\cdots \quad (\mathbf{4.62})$$

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:

$$\Lambda = T \cdot R \cdot A \cdot D \quad \cdots\cdots \quad (\mathbf{4.63})$$

where T : Factor determined by the bearing **T**ype
R : Factor related to **R**otation speed
A : Factor related to viscosity (viscosity grade α: **A**lpha)
D : Factor related to bearing **D**imensions

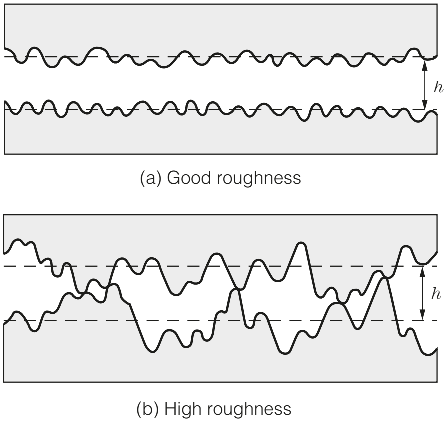


Fig. 4.41 Oil Film and Surface Roughness

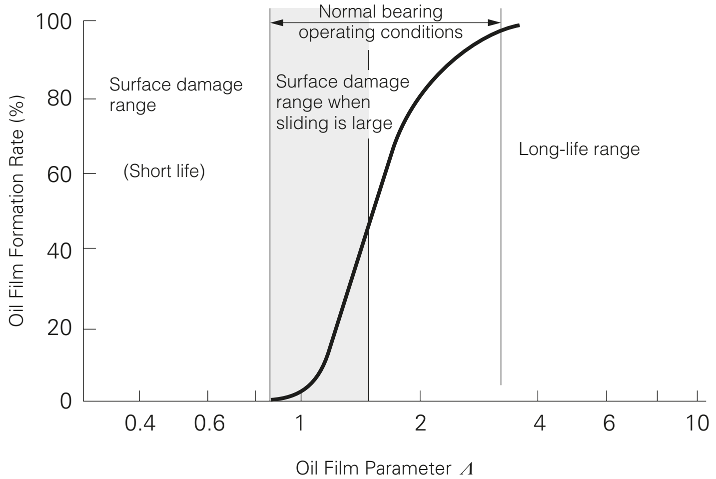


Fig. 4.42 Effect of Oil Film on Bearing Performance

The vitally important oil film parameter Λ is expressed by a simplified equation shown below. The fatigue life of rolling bearings becomes shorter when Λ is smaller. In the equation $\Lambda = T \cdot R \cdot A \cdot D$ variables include A for oil viscosity η_0 (mPa·s, {cp}), R for speed n (min^{-1}), 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^{-1}) 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 ν_0 (mm^2/s, {cSt}) is used and conversion is made as follows:

$$\eta_0 = \rho \cdot \nu_0 \quad \cdots\cdots \textbf{(4.64)}$$

ρ refers to oil density ($\mathrm{g/cm}^3$) 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

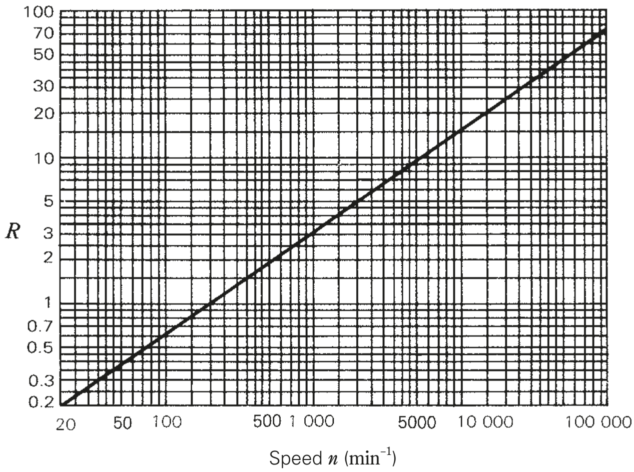


Fig. 4.43 Speed R

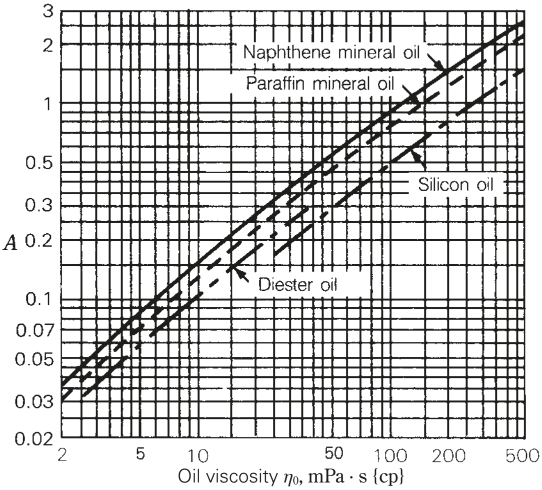


Fig. 4.44 Lubricant Viscosity A

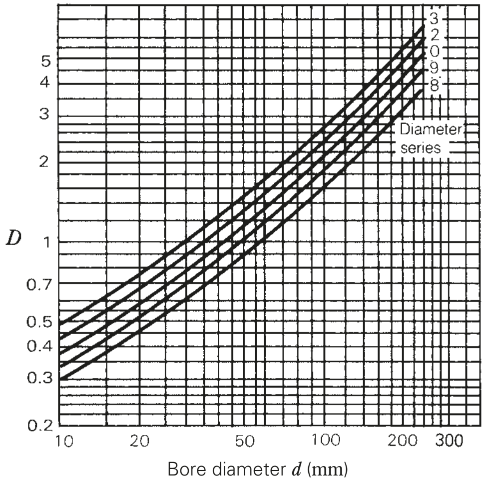


Fig. 4.45 Bearing Specifications D

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 (η_0 = 30 mPa·s, {cp}) at a speed of n = 1 000 min^{-1}.

Solution

d = 60 mm and D = 130 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, Λ = 2.5

Example 2

Determine the oil film parameter when cylindrical roller bearing NU240 is operated with paraffin mineral oil (η_0 = 10 mPa·s, {cp}) at a speed of n = 2 500 min^{-1}.

Solution

d = 200 mm and D = 360 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, Λ = 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} × 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:

$$\Lambda = Hi \cdot T \cdot R \cdot A \cdot D \quad \cdots\cdots \quad (\mathbf{4.65})$$

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 × 10^4 and η_0 = 30 mPa·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 $d_m n$ = 7×10^5 and η_0 = 10 mPa·s, {cp} and Hi = 0.76, meaning that the oil film parameter is smaller by about 25%. Accordingly, Λ is actually 2.7, not 3.6.

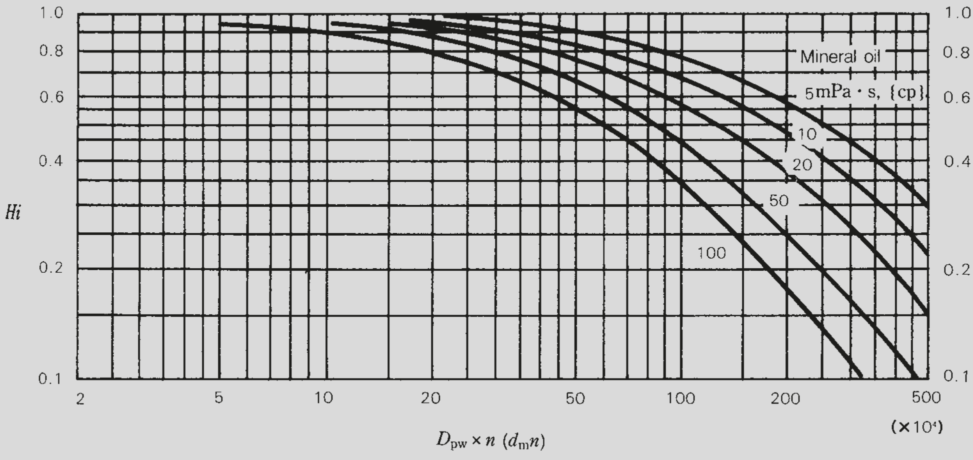


Fig. 4.46 Decrease of Oil Film Thickness Hi Due to Shearing Heat Generation

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:

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

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

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

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:

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

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

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

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

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:

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

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

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

where
P : Tangential force (N), {kgf}
S : Separating force (N), {kgf}
T : Thrust (N), {kgf}
H : Transmitted power (kW)
n : Speed (min^{-1})
d_p : Pitch diameter (mm)
α : Gear pressure angle
α_n : Gear normal pressure angle
β : 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.

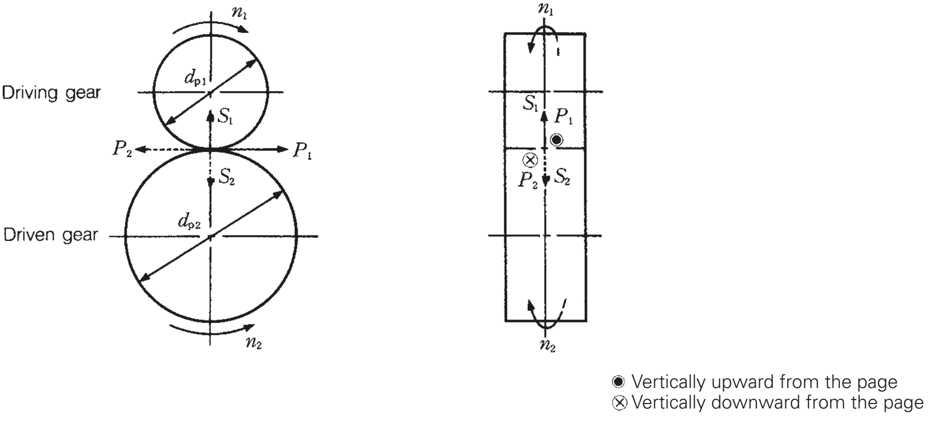


Fig. 4.47 Spur Gear

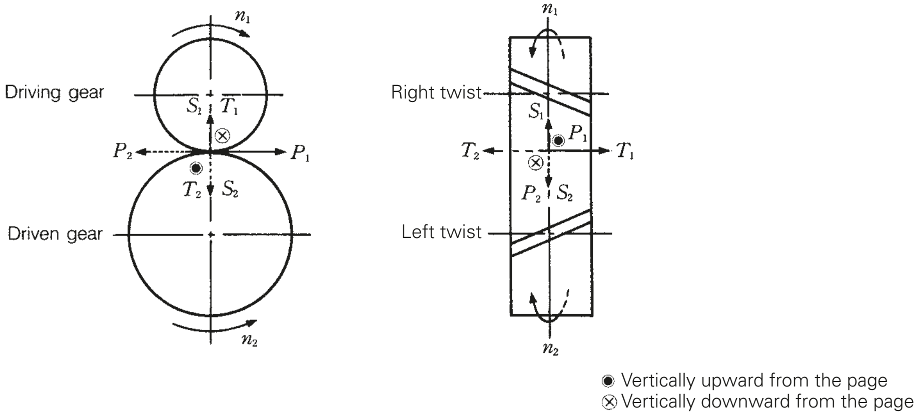


Fig. 4.48 Helical Gear

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:

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

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

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

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	$P_A = \frac{b}{a+b} P_1$ ⊗	$P_B = \frac{a}{a+b} P_1$ ⊗
	From S_1	$S_A = \frac{b}{a+b} S_1$ ⬆	$S_B = \frac{a}{a+b} S_1$ ⬆
	From T_1	$U_A = \frac{d_{p1}/2}{a+b} T_1$ ⬆	$U_B = \frac{d_{p1}/2}{a+b} T_1$ ⬇
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		$F_a = T_1$ ⬅	

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

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⊗ Vertically downward from the page

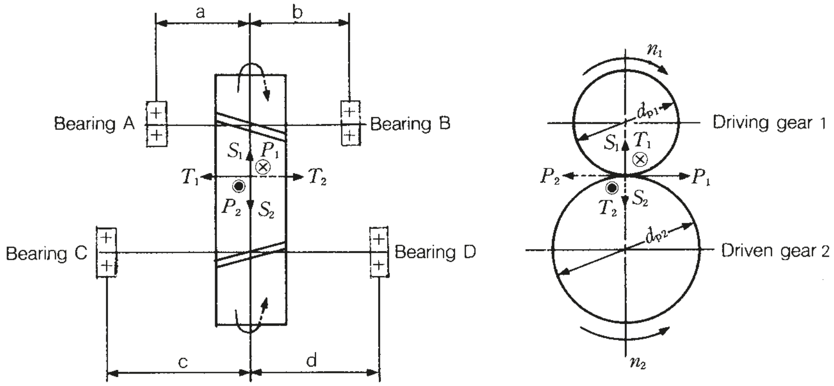


Fig. 4.49

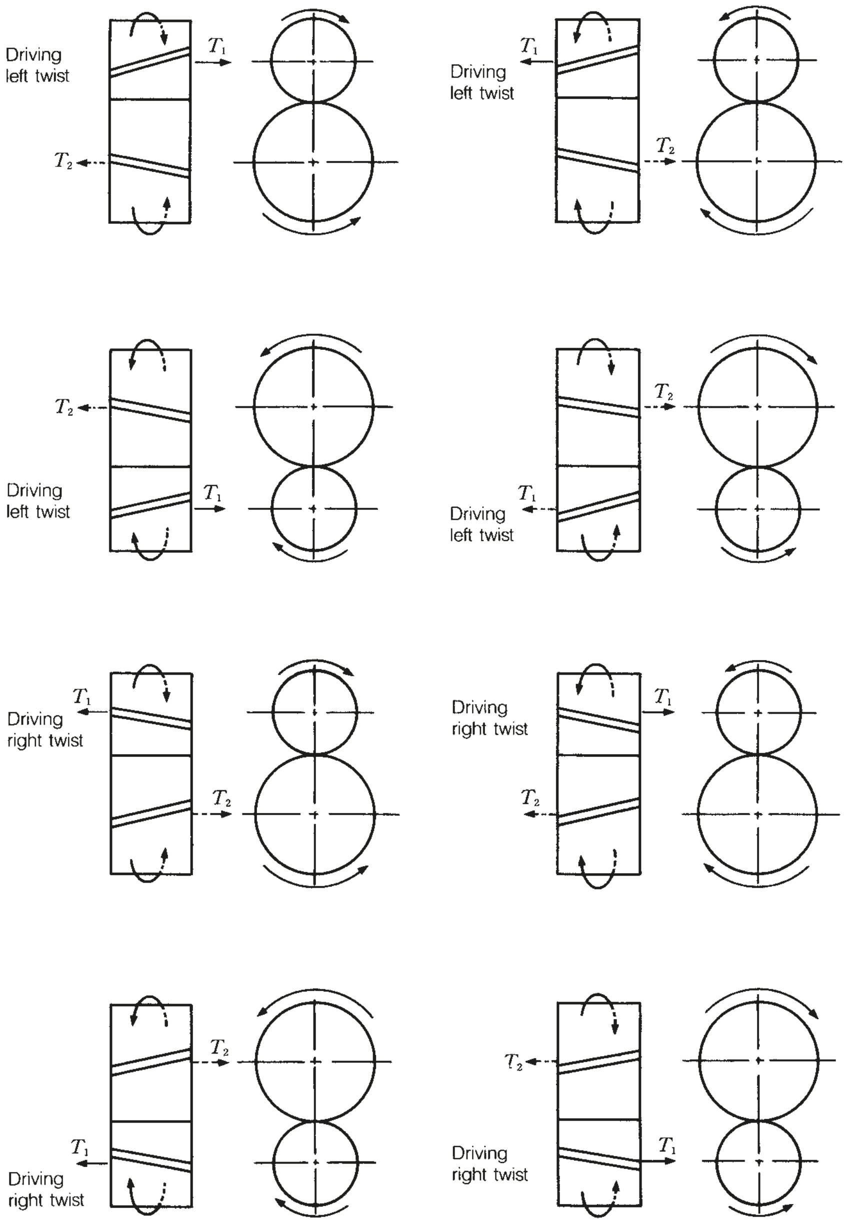


Fig. 4.50 Thrust Direction

(2) ***Calculation of Load on Straight Bevel Gears***
The load at the meshing point of straight bevel gears is calculated as follows:

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

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

$$D_{m1} = d_{p1} - w\sin\delta_1$$
$$D_{m2} = d_{p2} - w\sin\delta_2$$

$$S_1 = P_1\tan\alpha_n\cos\delta_1$$
$$S_2 = P_2\tan\alpha_n\cos\delta_2$$

$$T_1 = P_1\tan\alpha_n\cos\delta_1$$
$$T_2 = P_2\tan\alpha_n\cos\delta_2$$

where D_m : Average pitch diameter (mm)
d_p : Pitch diameter (mm)
w : Gear width (pitch line length) (mm)
α_n : Gear normal pressure angle
δ : Pitch cone angle

Generally, $\delta_1+\delta_2$ = 90°. 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 δ 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	$U_A = \frac{D_{m1}}{2\cdot a}T_1$ ⬆	$U_B = \frac{D_{m1}}{2\cdot a}T_1$ ⬇	$U_C = \frac{D_{m2}}{2(c+d)}T_2$ ⬅	$U_D = \frac{D_{m2}}{2(c+d)}T_2$ ➡
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.

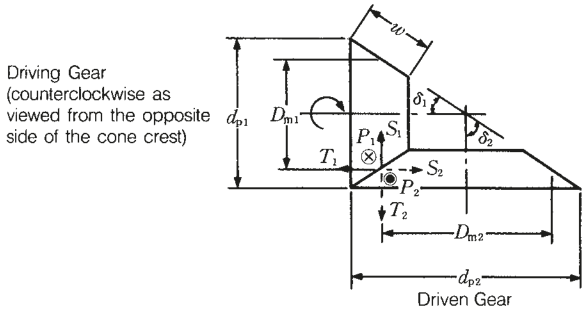


Fig. 4.51

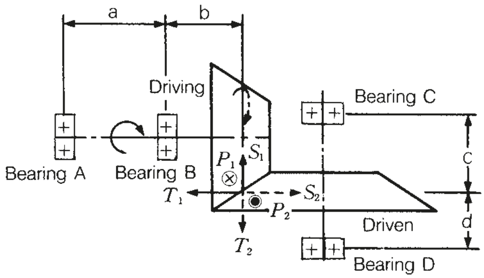


Fig. 4.52

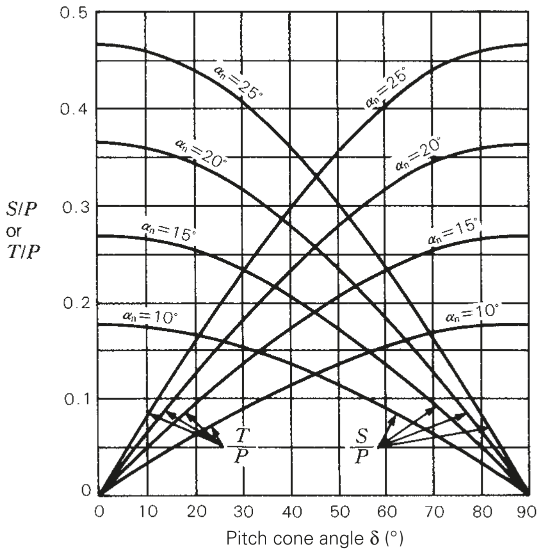


Fig. 4.53

(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:

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

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

where α_n : Gear normal pressure angle
β : Twisting angle
δ : 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, $\delta_1 + \delta_2 = 90°$. 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*."

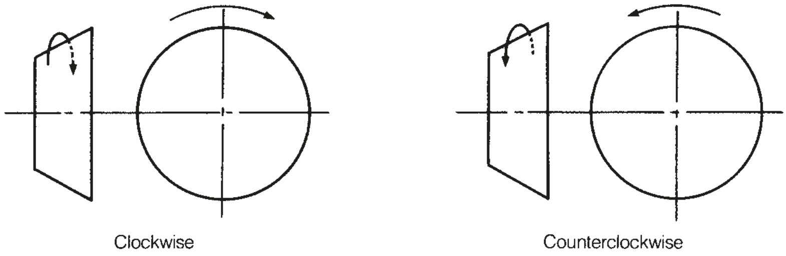


Fig. 4.54 Gear Running Direction

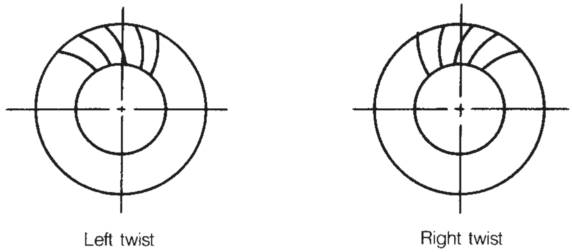


Fig. 4.55 Gear Twist Direction

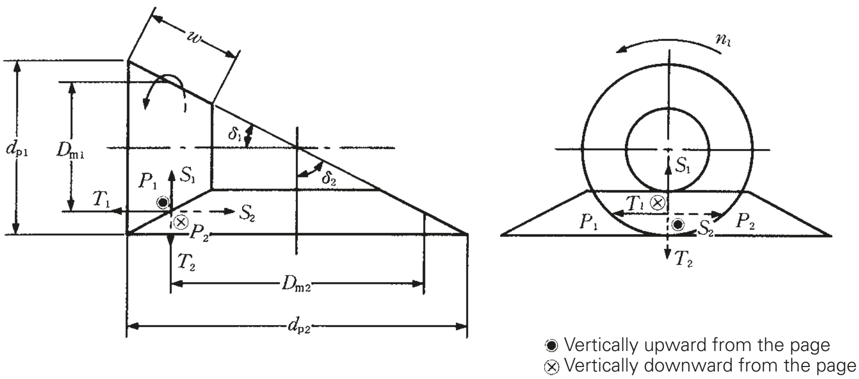


Fig. 4.56

(4) ***Calculation of Load on Hypoid Gears***

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

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

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

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

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

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

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

where α_n : Gear normal pressure angle
β : Twisting angle
δ : 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

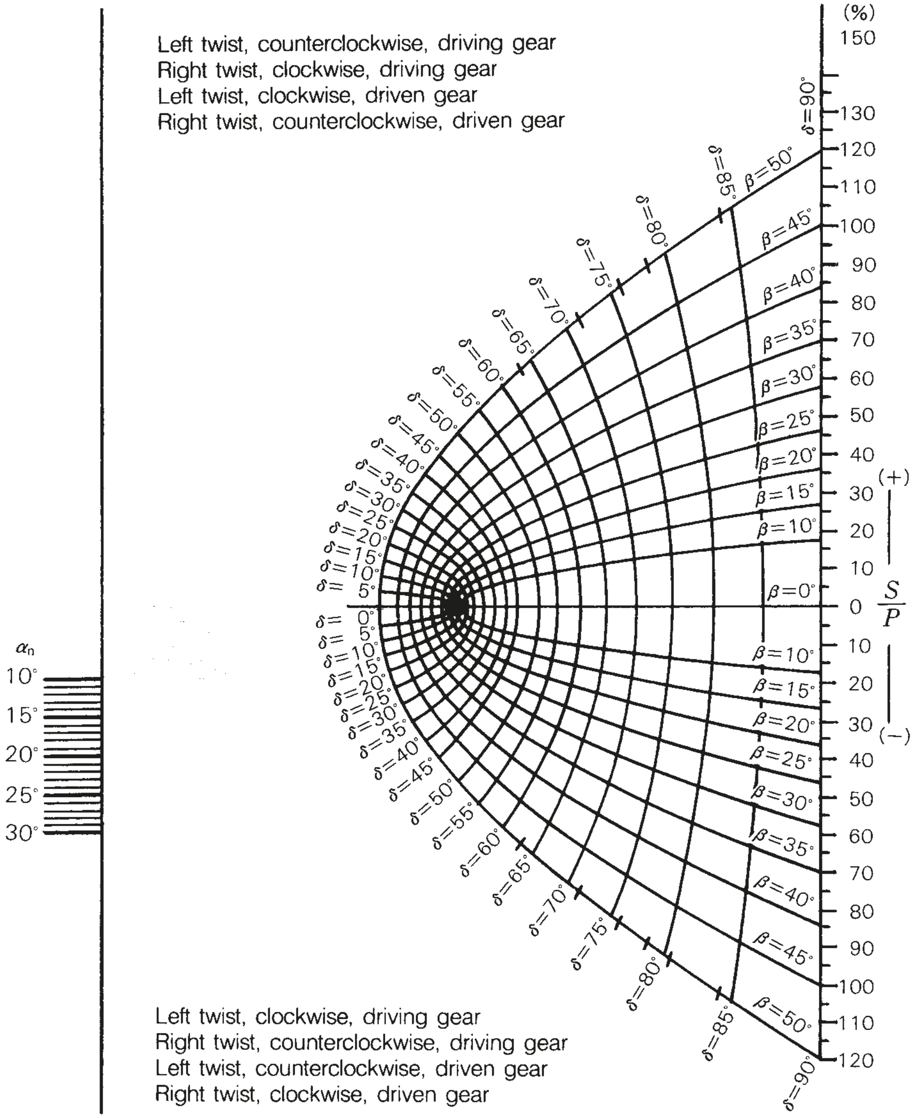
$$T_2=\frac{P_2}{\cos\beta_2}(\tan\alpha_n\sin\delta_2-\sin\beta_2\cos\delta_2)$$

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*."

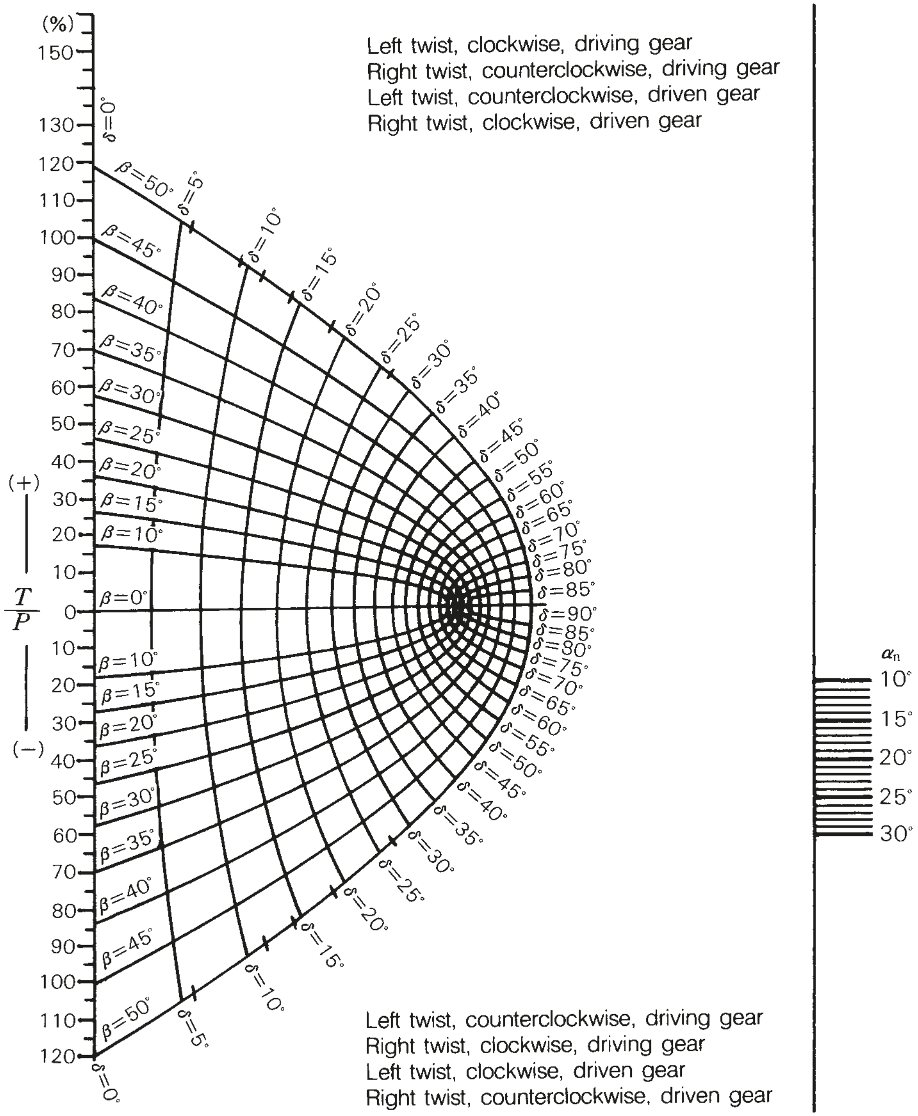
The following calculation diagrams are used to determine the approximate value and direction of separating force S and thrust T.

How To Use

1. Mark the gear normal pressure angle α_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 δ and twist angle β. Match your gear configuration to the text on either side of the β = 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.



Calculation Diagram for Separating Force S



Calculation Diagram for Thrust T

(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 $\left(i = \dfrac{Z_2}{Z_w}\right)$

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

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

ψ: 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, $\psi = 8°$.
When V_R exceeds 6 m/s, $\psi = 1°4'$.

α_n : Gear normal pressure angle
α_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	$\dfrac{9\,550\,000H}{n_1\left(\dfrac{d_{p1}}{2}\right)}$ …………(N) $\dfrac{974\,000H}{n_1\left(\dfrac{d_{p1}}{2}\right)}$ …………{kgf}	$\dfrac{9\,550\,000Hi\eta}{n_1\left(\dfrac{d_{p2}}{2}\right)} = \dfrac{P_1\ \eta}{\tan\gamma} = \dfrac{P_1}{\tan(\gamma+\psi)}$ …………(N) $\dfrac{974\,000Hi\eta}{n_1\left(\dfrac{d_{p2}}{2}\right)} = \dfrac{P_1\ \eta}{\tan\gamma} = \dfrac{P_1}{\tan(\gamma+\psi)}$ ………{kgf}
Thrust T	$\dfrac{9\,550\,000H\eta}{n_1\left(\dfrac{d_{p2}}{2}\right)} = \dfrac{P_1\ \eta}{\tan\gamma} = \dfrac{P_1}{\tan(\gamma+\psi)}$ …………(N) $\dfrac{974\,000H\eta}{n_1\left(\dfrac{d_{p2}}{2}\right)} = \dfrac{P_1\ \eta}{\tan\gamma} = \dfrac{P_1}{\tan(\gamma+\psi)}$ ………{kgf}	$\dfrac{9\,550\,000H}{n_1\left(\dfrac{d_{p1}}{2}\right)}$ …………(N) $\dfrac{974\,000H}{n_1\left(\dfrac{d_{p1}}{2}\right)}$ …………{kgf}
Separating S	$\dfrac{P_1\tan\alpha_n}{\sin(\gamma+\psi)} = \dfrac{P_1\tan\alpha_a}{\tan(\gamma+\psi)}$ …………(N), {kgf}	$\dfrac{P_1\tan\alpha_n}{\sin(\gamma+\psi)} = \dfrac{P_1\tan\alpha_a}{\tan(\gamma+\psi)}$ …………(N), {kgf}

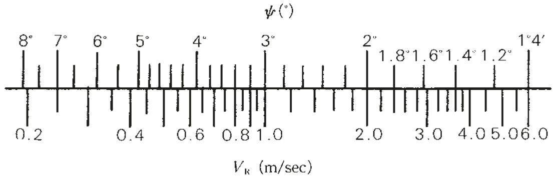
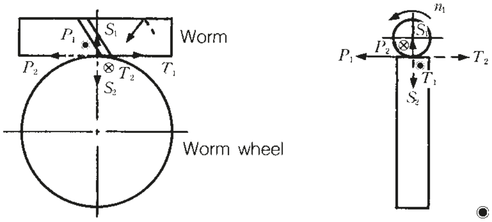


Fig. 4.57



◉ Vertically upward from the page
⊗ Vertically downward from the page

Fig. 4.58 Right Twist Worm Gear

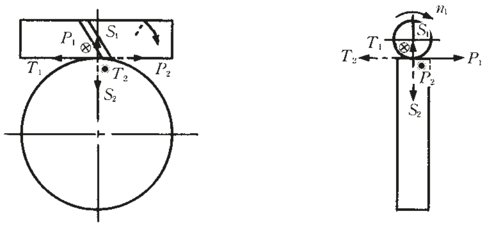


Fig. 4.59 Right Twist Worm Gear (Worm Rotation is Opposite Fig. 4.58)

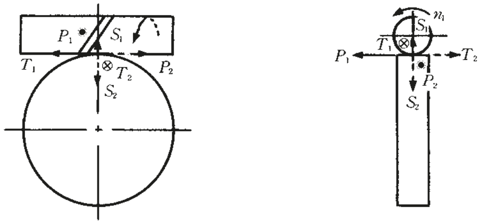


Fig. 4.60 Left Twist Worm Gear

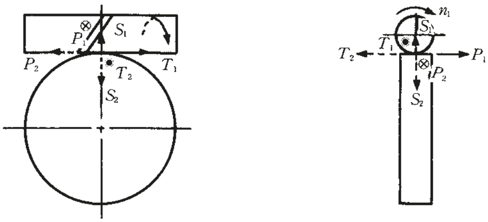
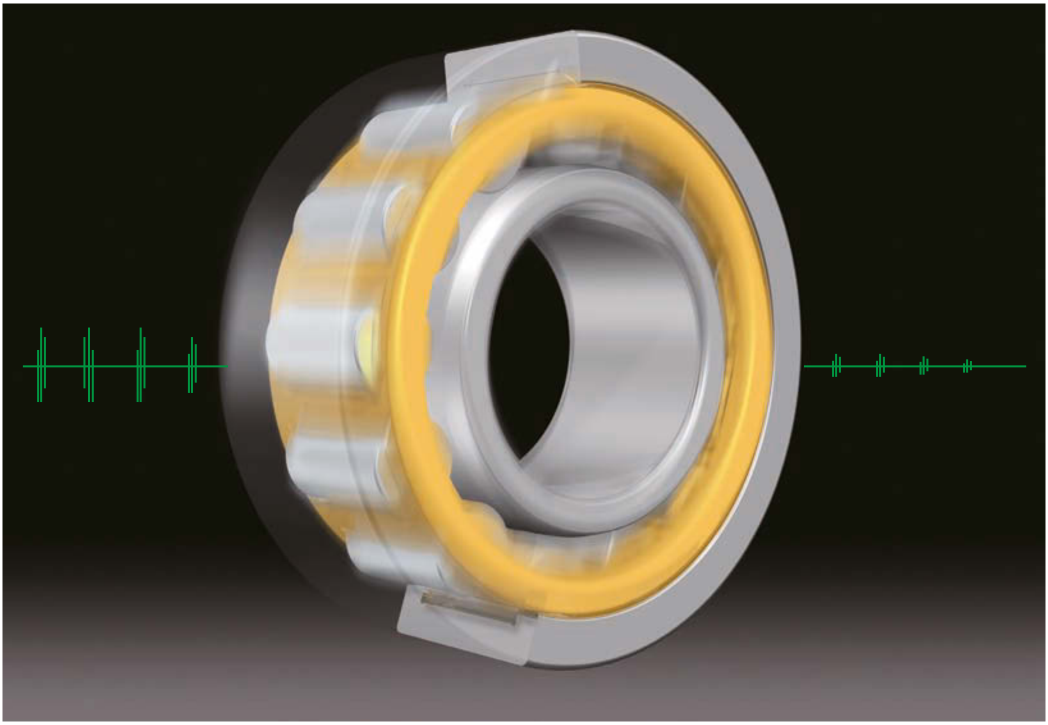


Fig. 4.61 Left Twist Worm Gear (Worm Rotation is Opposite Fig. 4.60)



5. SPEEDS

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(1)	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)(1)	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 (1) 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. $C/P \geqq 12$ and $F_a/F_r \leqq$ 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.

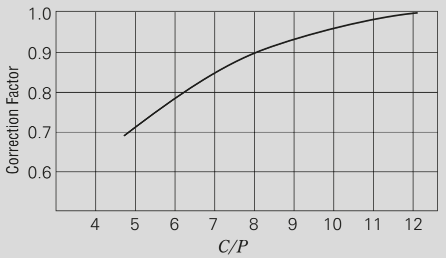


Fig. 5.1 Limiting Speed Correction Factor Variation With Load Ratio

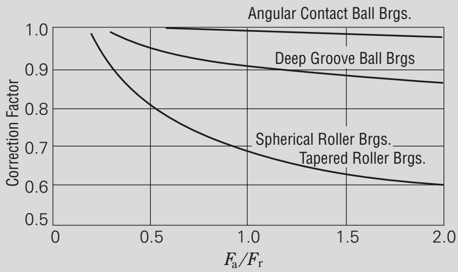


Fig. 5.2 Limiting Speed Correction Factor for Combined Radial and Axial Loads

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 Grooove Ball Brgs.	2.5
Angular Contact Ball Brgs.(except matched bearings)	1.5

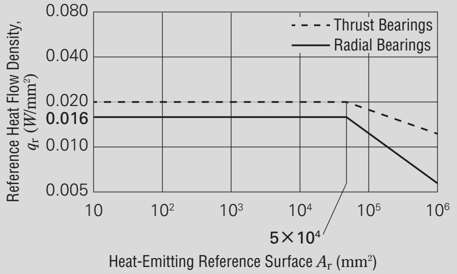


Fig. 5.3 Reference Heat Flow Density

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^2) 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^2) 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

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

Rotational circumferential speed

$$v_a = \frac{\pi D_w}{60\times10^3}\left(\frac{D_{pw}}{D_w} - \frac{D_w \cos^2\alpha}{D_{pw}}\right)\frac{n_e - n_i}{2} \quad (\mathrm{m/s}) \cdots\cdots \quad (\mathbf{5.2})$$

No. of revolutions (No. of cage rotations)

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

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

$$v_c = \frac{\pi D_{pw}}{60\times10^3}\left[\left(1 - \frac{D_w \cos\alpha}{D_{pw}}\right)\frac{n_i}{2} + \left(1 + \frac{D_w \cos\alpha}{D_{pw}}\right)\frac{n_e}{2}\right] (\mathrm{m/s}) \cdots\cdots \quad (\mathbf{5.4})$$

where D_{pw} : Pitch diameter of rolling elements (mm)
D_w : Diameter of rolling element (mm)
α : Contact angle (°)
n_e : Outer ring speed (min^{-1})
n_i : Inner ring speed (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 $0° \leqq \alpha < 90°$ and at $\alpha = 90°$.
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
$0° \leqq \alpha < 90°$	n_a (min^{-1})
	v_a (m/s)
	n_c (min^{-1})
	v_c (m/s)
$\alpha = 90°$	n_a (min^{-1})
	v_a (m/s)
	n_c (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	γ	n_a	n_c
6210	0.181	$-2.67n_i$	$0.41n_i$
6310	0.232	$-2.04n_i$	$0.38n_i$

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

Table 5.3 Rolling Element Rotation Speed n_a, Rotational Circumferential Speed v_a, Revolution Speed n_c, and Revolutional Circumferential Speed v_c

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

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

2. $\gamma = \dfrac{D_w \cos\alpha}{D_{pw}}$ $(0^\circ \leqq \alpha < 90^\circ)$, $\gamma = \dfrac{D_w}{D_{pw}}$ $(\alpha = 90^\circ)$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6. BOUNDARY DIMENSIONS AND BEARING DESIGNATIONS

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).

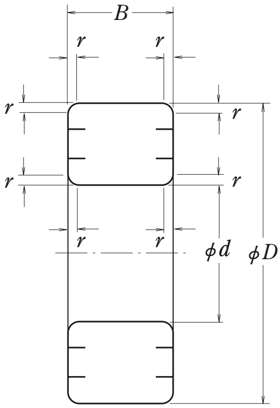


Fig. 6.1 Boundary Dimensions of Radial Ball and Roller Bearings

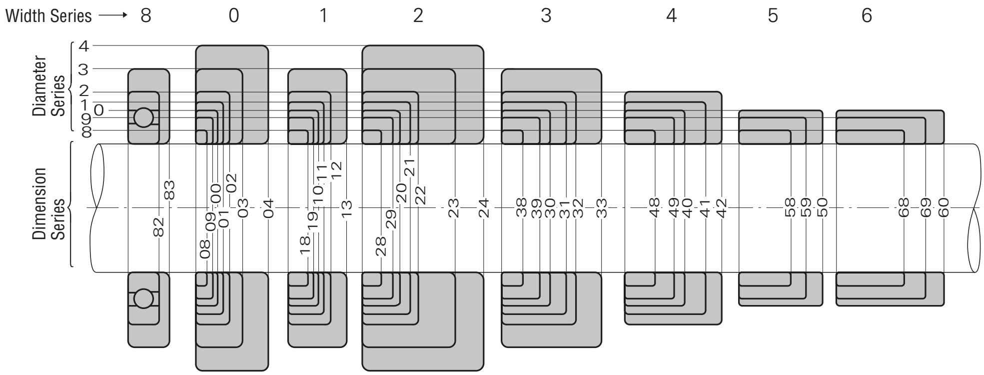


Fig. 6.6 Comparison of Cross Sections of Radial Bearings (Excluding Tapered Roller Bearings) for Various Dimensional Series

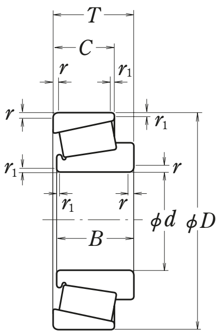


Fig. 6.2 Tapered Roller Bearings

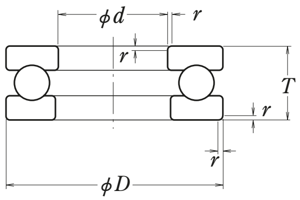


Fig. 6.3 Single-Direction Thrust Ball Bearings

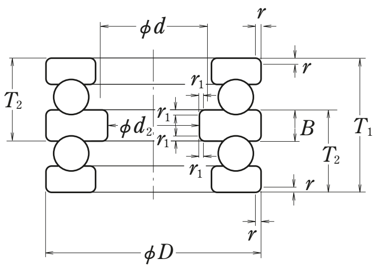


Fig. 6.4 Double-Direction Thrust Ball Bearings

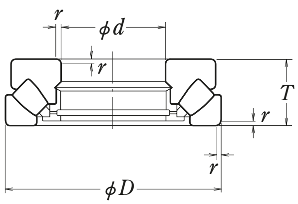


Fig. 6.5 Spherical Thrust Roller Bearings

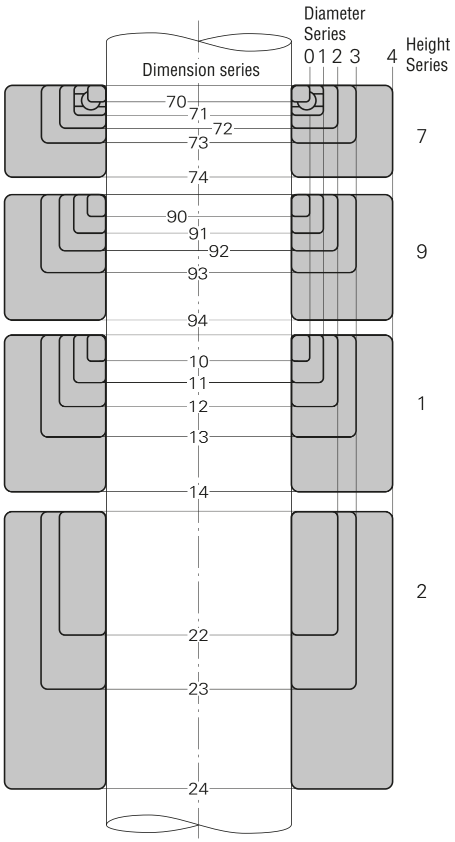


Fig. 6.7 Comparison of Cross Sections of Thrust Bearings (Excluding Diameter Series 5) for Various Dimension Series

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

Units: mm

Diameter Series 7

Bore Number	d	D	B: Dimension Series 17	B: 27	B: 37	r (min.) 17~37
Single-Row Ball Bearings						
Double-Row Ball Bearings						
Cylindrical Roller Bearings						
Needle Roller Bearings						
Spherical Roller Bearings						
—	0.6	2	0.8	—	—	0.05
1	1	2.5	1	—	—	0.05
—	1.5	3	1	—	1.8	0.05
2	2	4	1.2	—	2	0.05
—	2.5	5	1.5	—	2.3	0.08
3	3	6	2	2.5	3	0.08
4	4	7	2	2.5	3	0.08
5	5	8	2	2.5	3	0.08
6	6	10	2.5	3	3.5	0.1
7	7	11	2.5	3	3.5	0.1
8	8	12	2.5	—	3.5	0.1
9	9	14	3	—	4.5	0.1
00	10	15	3	—	4.5	0.1
01	12	18	4	—	5	0.2
02	15	21	4	—	5	0.2
03	17	23	4	—	5	0.2
04	20	27	4	—	5	0.2
/22	22	—	—	—	—	—
05	25	32	4	—	5	0.2
/28	28	—	—	—	—	—
06	30	37	4	—	5	0.2
/32	32	—	—	—	—	—
07	35	—	—	—	—	—
08	40	—	—	—	—	—
09	45	—	—	—	—	—
10	50	—	—	—	—	—
11	55	—	—	—	—	—
12	60	—	—	—	—	—
13	65	—	—	—	—	—
14	70	—	—	—	—	—
15	75	—	—	—	—	—
16	80	—	—	—	—	—
17	85	—	—	—	—	—
18	90	—	—	—	—	—
19	95	—	—	—	—	—
20	100	—	—	—	—	—

Diameter Series 8

Bore Number	d	D	B: Dimension Series 08	B: 18	B: 28	B: 38	B: 48	B: 58	B: 68	r (min.) 08	r (min.) 18~68
Single-Row Ball Bearings				68							
Double-Row Ball Bearings											
Cylindrical Roller Bearings					N28	NN38	NN48				
Needle Roller Bearings							NA48				
Spherical Roller Bearings											
—	0.6	2.5	—	1	—	1.4	—	—	—	—	0.05
1	1	3	—	1	—	1.5	—	—	—	—	0.05
—	1.5	4	—	1.2	—	2	—	—	—	—	0.05
2	2	5	—	1.5	—	2.3	—	—	—	—	0.08
—	2.5	6	—	1.8	—	2.6	—	—	—	—	0.08
3	3	7	—	2	—	3	—	—	—	—	0.1
4	4	9	—	2.5	3.5	4	—	—	—	—	0.1
5	5	11	—	3	4	5	—	—	—	—	0.15
6	6	13	—	3.5	5	6	—	—	—	—	0.15
7	7	14	—	3.5	5	6	—	—	—	—	0.15
8	8	16	—	4	5	6	8	—	—	—	0.2
9	9	17	—	4	5	6	8	—	—	—	0.2
00	10	19	—	5	6	7	9	—	—	—	0.3
01	12	21	—	5	6	7	9	—	—	—	0.3
02	15	24	—	5	6	7	9	—	—	—	0.3
03	17	26	—	5	6	7	9	—	—	—	0.3
04	20	32	4	7	8	10	12	16	22	0.3	0.3
/22	22	34	4	7	—	10	—	16	22	0.3	0.3
05	25	37	4	7	8	10	12	16	22	0.3	0.3
/28	28	40	4	7	—	10	—	16	22	0.3	0.3
06	30	42	4	7	8	10	12	16	22	0.3	0.3
/32	32	44	4	7	—	10	—	16	22	0.3	0.3
07	35	47	4	7	8	10	12	16	22	0.3	0.3
08	40	52	4	7	8	10	12	16	22	0.3	0.3
09	45	58	4	7	8	10	13	18	23	0.3	0.3
10	50	65	5	7	10	12	15	20	27	0.3	0.3
11	55	72	7	9	11	13	17	23	30	0.3	0.3
12	60	78	7	10	12	14	18	24	32	0.3	0.3
13	65	85	7	10	13	15	20	27	36	0.3	0.6
14	70	90	8	10	13	15	20	27	36	0.3	0.6
15	75	95	8	10	13	15	20	27	36	0.3	0.6
16	80	100	8	10	13	15	20	27	36	0.3	0.6
17	85	110	9	13	16	19	25	34	45	0.3	1
18	90	115	9	13	16	19	25	34	45	0.3	1
19	95	120	9	13	16	19	25	34	45	0.3	1
20	100	125	9	13	16	19	25	34	45	0.3	1

Diameter Series 9

Bore Number	d	D	B: Dimension Series 09	B: 19	B: 29	B: 39	B: 49	B: 59	B: 69	r (min.) 09	r (min.) 19~39	r (min.) 49~69
Single-Row Ball Bearings				69 79								
Double-Row Ball Bearings												
Cylindrical Roller Bearings				N19	N29	NN39	NN49					
Needle Roller Bearings							NA49	NA59	NA69			
Spherical Roller Bearings						239						
—	0.6	—	—	—	—	—	—	—	—	—	—	—
1	1	4	—	1.6	—	2.3	—	—	—	—	0.1	—
—	1.5	5	—	2	—	2.6	—	—	—	—	0.15	—
2	2	6	—	2.3	—	3	—	—	—	—	0.15	—
—	2.5	7	—	2.5	—	3.5	—	—	—	—	0.15	—
3	3	8	—	3	—	4	—	—	—	—	0.15	—
4	4	11	—	4	—	5	—	—	—	—	0.15	—
5	5	13	—	4	—	6	10	—	—	—	0.2	0.15
6	6	15	—	5	—	7	10	—	—	—	0.2	0.15
7	7	17	—	5	—	7	10	—	—	—	0.3	0.15
8	8	19	—	6	—	9	11	—	—	—	0.3	0.2
9	9	20	—	6	—	9	11	—	—	—	0.3	0.3
00	10	22	—	6	8	10	13	16	22	—	0.3	0.3
01	12	24	—	6	8	10	13	16	22	—	0.3	0.3
02	15	28	—	7	8.5	10	13	18	23	—	0.3	0.3
03	17	30	—	7	8.5	10	13	18	23	—	0.3	0.3
04	20	37	7	9	11	13	17	23	30	0.3	0.3	0.3
/22	22	39	7	9	11	13	17	23	30	0.3	0.3	0.3
05	25	42	7	9	11	13	17	23	30	0.3	0.3	0.3
/28	28	45	7	9	11	13	17	23	30	0.3	0.3	0.3
06	30	47	7	9	11	13	17	23	30	0.3	0.3	0.3
/32	32	52	7	10	13	15	20	27	36	0.3	0.6	0.6
07	35	55	7	10	13	15	20	27	36	0.3	0.6	0.6
08	40	62	8	12	14	16	22	30	40	0.3	0.6	0.6
09	45	68	8	12	14	16	22	30	40	0.3	0.6	0.6
10	50	72	8	12	14	16	22	30	40	0.3	0.6	0.6
11	55	80	9	13	16	19	25	34	45	0.3	1	1
12	60	85	9	13	16	19	25	34	45	0.3	1	1
13	65	90	9	13	16	19	25	34	45	0.3	1	1
14	70	100	10	16	19	23	30	40	54	0.6	1	1
15	75	105	10	16	19	23	30	40	54	0.6	1	1
16	80	110	10	16	19	23	30	40	54	0.6	1	1
17	85	120	11	18	22	26	35	46	63	0.6	1.1	1.1
18	90	125	11	18	22	26	35	46	63	0.6	1.1	1.1
19	95	130	11	18	22	26	35	46	63	0.6	1.1	1.1
20	100	140	13	20	24	30	40	54	71	0.6	1.1	1.1

Diameter Series 0

Bore Number	d	D	B: Dimension Series 00	B: 10	B: 20	B: 30	B: 40	B: 50	B: 60	r (min.) 00	r (min.) 10~60
Single-Row Ball Bearings			160	60 70							
Double-Row Ball Bearings											
Cylindrical Roller Bearings				N10	N20	NN30	NN40				
Needle Roller Bearings											
Spherical Roller Bearings						230	240				
—	0.6	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—
—	1.5	6	—	2.5	—	3	—	—	—	—	0.15
2	2	7	—	2.8	—	3.5	—	—	—	—	0.15
—	2.5	8	—	2.8	—	4	—	—	—	—	0.15
3	3	9	—	3	—	5	—	—	—	—	0.15
4	4	12	—	4	—	6	—	—	—	—	0.2
5	5	14	—	5	—	7	—	—	—	—	0.2
6	6	17	—	6	—	9	—	—	—	—	0.3
7	7	19	—	6	8	10	—	—	—	—	0.3
8	8	22	—	7	9	11	14	19	25	—	0.3
9	9	24	—	7	10	12	15	20	27	—	0.3
00	10	26	—	8	10	12	16	21	29	—	0.3
01	12	28	7	8	10	12	16	21	29	0.3	0.3
02	15	32	8	9	11	13	17	23	30	0.3	0.3
03	17	35	8	10	12	14	18	24	32	0.3	0.3
04	20	42	8	12	14	16	22	30	40	0.3	0.6
/22	22	44	8	12	14	16	22	30	40	0.3	0.6
05	25	47	8	12	14	16	22	30	40	0.3	0.6
/28	28	52	8	12	15	18	24	32	43	0.3	0.6
06	30	55	9	13	16	19	25	34	45	0.3	1
/32	32	58	9	13	16	20	26	35	47	0.3	1
07	35	62	9	14	17	20	27	36	48	0.3	1
08	40	68	9	15	18	21	28	38	50	0.3	1
09	45	75	10	16	19	23	30	40	54	0.6	1
10	50	80	10	16	19	23	30	40	54	0.6	1
11	55	90	11	18	22	26	35	46	63	0.6	1.1
12	60	95	11	18	22	26	35	46	63	0.6	1.1
13	65	100	11	18	22	26	35	46	63	0.6	1.1
14	70	110	13	20	24	30	40	54	71	0.6	1.1
15	75	115	13	20	24	30	40	54	71	0.6	1.1
16	80	125	14	22	27	34	45	60	80	0.6	1.1
17	85	130	14	22	27	34	45	60	80	0.6	1.1
18	90	140	16	24	30	37	50	67	90	1	1.5
19	95	145	16	24	30	37	50	67	90	1	1.5
20	100	150	16	24	30	37	50	67	90	1	1.5

21	**105**	—	—	—	—	—	**130**	9	13	16	19	25	34	45	0.3	1	**145**	13	20	24	30	40	54	71	0.6	1.1	1.1	**160**	18	26	33	41	56	75	100	1	2
22	**110**	—	—	—	—	—	**140**	10	16	19	23	30	40	54	0.6	1	**150**	13	20	24	30	40	54	71	0.6	1.1	1.1	**170**	19	28	36	45	60	80	109	1	2
24	**120**	—	—	—	—	—	**150**	10	16	19	23	30	40	54	0.6	1	**165**	14	22	27	34	45	60	80	0.6	1.1	1.1	**180**	19	28	36	46	60	80	109	1	2
26	**130**	—	—	—	—	—	**165**	11	18	22	26	35	46	63	0.6	1.1	**180**	16	24	30	37	50	67	90	1	1.5	1.5	**200**	22	33	42	52	69	95	125	1.1	2
28	**140**	—	—	—	—	—	**175**	11	18	22	26	35	46	63	0.6	1.1	**190**	16	24	30	37	50	67	90	1	1.5	1.5	**210**	22	33	42	53	69	95	125	1.1	2
30	**150**	—	—	—	—	—	**190**	13	20	24	30	40	54	71	0.6	1.1	**210**	19	28	36	45	60	80	109	1	2	2	**225**	24	35	45	56	75	100	136	1.1	2.1
32	**160**	—	—	—	—	—	**200**	13	20	24	30	40	54	71	0.6	1.1	**220**	19	28	36	45	60	80	109	1	2	2	**240**	25	38	48	60	80	109	145	1.5	2.1
34	**170**	—	—	—	—	—	**215**	14	22	27	34	45	60	80	0.6	1.1	**230**	19	28	36	45	60	80	109	1	2	2	**260**	28	42	54	67	90	122	160	1.5	2.1
36	**180**	—	—	—	—	—	**225**	14	22	27	34	45	60	80	0.6	1.1	**250**	22	33	42	52	69	95	125	1.1	2	2	**280**	31	46	60	74	100	136	180	2	2.1
38	**190**	—	—	—	—	—	**240**	16	24	30	37	50	67	90	1	1.5	**260**	22	33	42	52	69	95	125	1.1	2	2	**290**	31	46	60	75	100	136	180	2	2.1
40	**200**	—	—	—	—	—	**250**	16	24	30	37	50	67	90	1	1.5	**280**	25	38	48	60	80	109	145	1.5	2.1	2.1	**310**	34	51	66	82	109	150	200	2	2.1
44	**220**	—	—	—	—	—	**270**	16	24	30	37	50	67	90	1	1.5	**300**	25	38	48	60	80	109	145	1.5	2.1	2.1	**340**	37	56	72	90	118	160	218	2.1	3
48	**240**	—	—	—	—	—	**300**	19	28	36	45	60	80	109	1	2	**320**	25	38	48	60	80	109	145	1.5	2.1	2.1	**360**	37	56	72	92	118	160	218	2.1	3
52	**260**	—	—	—	—	—	**320**	19	28	36	45	60	80	109	1	2	**360**	31	46	60	75	100	136	180	2	2.1	2.1	**400**	44	65	82	104	140	190	250	3	4
56	**280**	—	—	—	—	—	**350**	22	33	42	52	69	95	125	1.1	2	**380**	31	46	60	75	100	136	180	2	2.1	2.1	**420**	44	65	82	106	140	190	250	3	4
60	**300**	—	—	—	—	—	**380**	25	38	48	60	80	109	145	1.5	2.1	**420**	37	56	72	90	118	160	218	2.1	3	3	**460**	50	74	95	118	160	218	290	4	4
64	**320**	—	—	—	—	—	**400**	25	38	48	60	80	109	145	1.5	2.1	**440**	37	56	72	90	118	160	218	2.1	3	3	**480**	50	74	95	121	160	218	290	4	4
68	**340**	—	—	—	—	—	**420**	25	38	48	60	80	109	145	1.5	2.1	**460**	37	56	72	90	118	160	218	2.1	3	3	**520**	57	82	106	133	180	243	325	4	5
72	**360**	—	—	—	—	—	**440**	25	38	48	60	80	109	145	1.5	2.1	**480**	37	56	72	90	118	160	218	2.1	3	3	**540**	57	82	106	134	180	243	325	4	5
76	**380**	—	—	—	—	—	**480**	31	46	60	75	100	136	180	2	2.1	**520**	44	65	82	106	140	190	250	3	4	4	**560**	57	82	106	135	180	243	325	4	5
80	**400**	—	—	—	—	—	**500**	31	46	60	75	100	136	180	2	2.1	**540**	44	65	82	106	140	190	250	3	4	4	**600**	63	90	118	148	200	272	355	5	5
84	**420**	—	—	—	—	—	**520**	31	46	60	75	100	136	180	2	2.1	**560**	44	65	82	106	140	190	250	3	4	4	**620**	63	90	118	150	200	272	355	5	5
88	**440**	—	—	—	—	—	**540**	31	46	60	75	100	136	180	2	2.1	**600**	50	74	95	118	160	218	290	4	4	4	**650**	67	94	122	157	212	280	375	5	6
92	**460**	—	—	—	—	—	**580**	37	56	72	90	118	160	218	2.1	3	**620**	50	74	95	118	160	218	290	4	4	4	**680**	71	100	128	163	218	300	400	5	6
96	**480**	—	—	—	—	—	**600**	37	56	72	90	118	160	218	2.1	3	**650**	54	78	100	128	170	230	308	4	5	5	**700**	71	100	128	165	218	300	400	5	6
/500	**500**	—	—	—	—	—	**620**	37	56	72	90	118	160	218	2.1	3	**670**	54	78	100	128	170	230	308	4	5	5	**720**	71	100	128	167	218	300	400	5	6
/530	**530**	—	—	—	—	—	**650**	37	56	72	90	118	160	218	2.1	3	**710**	57	82	106	136	180	243	325	4	5	5	**780**	80	112	145	185	250	335	450	6	6
/560	**560**	—	—	—	—	—	**680**	37	56	72	90	118	160	218	2.1	3	**750**	60	85	112	140	190	258	345	5	5	5	**820**	82	115	150	195	258	355	462	6	6
/600	**600**	—	—	—	—	—	**730**	42	60	78	98	128	175	236	3	3	**800**	63	90	118	150	200	272	355	5	5	5	**870**	85	118	155	200	272	365	488	6	6
/630	**630**	—	—	—	—	—	**780**	48	69	88	112	150	200	272	3	4	**850**	71	100	128	165	218	300	400	5	6	6	**920**	92	128	170	212	290	388	515	6	7.5
/670	**670**	—	—	—	—	—	**820**	48	69	88	112	150	200	272	3	4	**900**	73	103	136	170	230	308	412	5	6	6	**980**	100	136	180	230	308	425	560	6	7.5
/710	**710**	—	—	—	—	—	**870**	50	74	95	118	160	218	290	4	4	**950**	78	106	140	180	243	325	438	5	6	6	**1030**	103	140	185	236	315	438	580	6	7.5
/750	**750**	—	—	—	—	—	**920**	54	78	100	128	170	230	308	4	5	**1000**	80	112	145	185	250	335	450	6	6	6	**1090**	109	150	195	250	335	462	615	7.5	7.5
/800	**800**	—	—	—	—	—	**980**	57	82	106	136	180	243	325	4	5	**1060**	82	115	150	195	258	355	462	6	6	6	**1150**	112	155	200	258	345	475	630	7.5	7.5
/850	**850**	—	—	—	—	—	**1030**	57	82	106	136	180	243	325	4	5	**1120**	85	118	155	200	272	365	488	6	6	6	**1220**	118	165	212	272	365	500	670	7.5	7.5
/900	**900**	—	—	—	—	—	**1090**	60	85	112	140	190	258	345	5	5	**1180**	88	122	165	206	280	375	500	6	6	6	**1280**	122	170	218	280	375	515	690	7.5	7.5
/950	**950**	—	—	—	—	—	**1150**	63	90	118	150	200	272	355	5	5	**1250**	95	132	175	224	300	400	545	6	7.5	7.5	**1360**	132	180	236	300	412	560	730	7.5	7.5
/1000	**1000**	—	—	—	—	—	**1220**	71	100	128	165	218	300	400	5	6	**1320**	103	140	185	236	315	438	580	6	7.5	7.5	**1420**	136	185	243	308	412	560	750	7.5	7.5
/1060	**1060**	—	—	—	—	—	**1280**	71	100	128	165	218	300	400	5	6	**1400**	109	150	195	250	335	462	615	7.5	7.5	7.5	**1500**	140	195	250	325	438	600	800	9.5	9.5
/1120	**1120**	—	—	—	—	—	**1360**	78	106	140	180	243	325	438	5	6	**1460**	109	150	195	250	335	462	615	7.5	7.5	7.5	**1580**	145	200	265	345	462	615	825	9.5	9.5
/1180	**1180**	—	—	—	—	—	**1420**	78	106	140	180	243	325	438	5	6	**1540**	115	160	206	272	355	488	650	7.5	7.5	7.5	**1660**	155	212	272	355	475	650	875	9.5	9.5
/1250	**1250**	—	—	—	—	—	**1500**	80	112	145	185	250	335	450	6	6	**1630**	122	170	218	280	375	515	690	7.5	7.5	7.5	**1750**	—	218	290	375	500	—	—	—	9.5
/1320	**1320**	—	—	—	—	—	**1600**	88	122	165	206	280	375	500	6	6	**1720**	128	175	230	300	400	545	710	7.5	7.5	7.5	**1850**	—	230	300	400	530	—	—	—	12
/1400	**1400**	—	—	—	—	—	**1700**	95	132	175	224	300	400	545	6	7.5	**1820**	—	185	243	315	425	—	—	—	9.5	9.5	**1950**	—	243	315	412	545	—	—	—	12
/1500	**1500**	—	—	—	—	—	**1820**	—	140	185	243	315	—	—	—	7.5	**1950**	—	195	258	335	450	—	—	—	9.5	9.5	**2120**	—	272	355	462	615	—	—	—	12
/1600	**1600**	—	—	—	—	—	**1950**	—	155	200	265	345	—	—	—	7.5	**2060**	—	200	265	345	462	—	—	—	9.5	9.5	**2240**	—	280	365	475	630	—	—	—	12
/1700	**1700**	—	—	—	—	—	**2060**	—	160	206	272	355	—	—	—	7.5	**2180**	—	212	280	355	475	—	—	—	9.5	9.5	**2360**	—	290	375	500	650	—	—	—	15
/1800	**1800**	—	—	—	—	—	**2180**	—	165	218	290	375	—	—	—	9.5	**2300**	—	218	290	375	500	—	—	—	12	12	**2500**	—	308	400	530	690	—	—	—	15
/1900	**1900**	—	—	—	—	—	**2300**	—	175	230	300	400	—	—	—	9.5	**2430**	—	230	308	400	530	—	—	—	12	12	—	—	—	—	—	—	—	—	—	—
/2000	**2000**	—	—	—	—	—	**2430**	—	190	250	325	425	—	—	—	9.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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. 1 Boundary Dimensions of Radial Bearings (Excluding Tapered Roller Bearings) — (2)

Units: mm

		Diameter Series 1								Diameter Series 2									Diameter Series 3								Diameter Series 4			
Single-Row Ball Bearings												62 72		622	632						63 73		623	633				64 74		
Double-Row Ball Bearings												12		42 22	52 53						13		43 23	53 33				104		
Cylindrical Roller Bearings						NN 31						N 2		N 22	N 32						N 3		N 23	N 33				N 4		
Needle Roller Bearings																														
Spherical Roller Bearings						231	241							222	232						213		223							
Bore Number	*d*	*D*	Dimension Series 01	11	21	31	41	Dimension Series 01	11~41	*D*	Dimension Series 82	02	12	22	32	42	Dimension Series 82	02~42	*D*	Dimension Series 83	03	13	23	33	Dimension Series 83	03~33	*D*	Dimension Series 04	24	Dimension Series 04~24
			B					*r* (min.)			*B*						*r* (min.)			*B*					*r* (min.)			*B*		*r* (min.)
—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	3	—	—	—	—	—	—	—	—	10	2.5	4	—	—	5	—	0.1	0.15	13	—	5	—	—	7	—	0.2	—	—	—	—
4	4	—	—	—	—	—	—	—	—	13	3	5	—	—	7	—	0.15	0.2	16	—	5	—	—	9	—	0.3	—	—	—	—
5	5	—	—	—	—	7	—	—	—	16	3.5	5	—	—	8	—	0.15	0.3	19	—	6	—	—	10	—	0.3	—	—	—	—
6	6	—	—	—	8	10	—	—	—	19	4	6	—	—	10	—	0.2	0.3	22	—	7	—	11	13	—	0.3	—	—	—	—
7	7	—	—	—	9	11	14	—	—	22	5	7	—	—	11	—	0.3	0.3	26	—	9	—	13	15	—	0.3	—	—	—	—
8	8	—	—	—	10	12	15	—	—	24	5	8	—	—	12	—	0.3	0.3	28	—	9	—	13	15	—	0.3	30	10	14	0.6
9	9	—	—	—	10	12	16	—	—	26	6	8	—	—	13	—	0.3	0.3	30	—	10	—	14	16	—	0.6	32	11	15	0.6
00	10	—	—	—	12	14	18	—	—	30	7	9	—	14	14.3	—	0.3	0.6	35	9	11	—	17	19	0.3	0.6	37	12	16	0.6
01	12	—	—	—	12	14	18	—	—	32	7	10	—	14	15.9	—	0.3	0.6	37	9	12	—	17	19	0.3	1	42	13	19	1
02	15	—	—	—	12	14	18	—	—	35	8	11	—	14	15.9	20	0.3	0.6	42	9	13	—	17	19	0.3	1	52	15	24	1.1
03	17	—	—	—	13	15	20	—	—	40	8	12	—	16	17.5	22	0.3	0.6	47	10	14	—	19	22.2	0.6	1	62	17	29	1.1
04	20	—	—	—	15	18	24	—	—	47	9	14	—	18	20.6	27	0.3	1	52	10	15	—	21	22.2	0.6	1.1	72	19	33	1.1
/22	22	—	—	—	16	19	25	—	—	50	9	14	—	18	20.6	27	0.3	1	56	11	16	—	21	25	0.6	1.1	—	—	—	—
05	25	—	—	—	16	19	25	—	—	52	10	15	—	18	20.6	27	0.3	1	62	12	17	—	24	25.4	0.6	1.1	80	21	36	1.5
/28	28	—	—	—	17	20	27	—	—	58	10	16	—	19	23	30	0.6	1	68	13	18	—	24	30	0.6	1.1	—	—	—	—
06	30	—	—	—	18	21	28	—	—	62	10	16	—	20	23.8	32	0.6	1	72	13	19	—	27	30.2	0.6	1.1	90	23	40	1.5
/32	32	—	—	—	19	23	30	—	—	65	11	17	—	21	25	33	0.6	1	75	14	20	—	28	32	0.6	1.1	—	—	—	—
07	35	—	—	—	21	25	33	—	—	72	12	17	—	23	27	37	0.6	1.1	80	14	21	—	31	34.9	0.6	1.5	100	25	43	1.5
08	40	—	—	—	22	26	35	—	—	80	13	18	—	23	30.2	40	0.6	1.1	90	16	23	—	33	36.5	1	1.5	110	27	46	2
09	45	—	—	—	22	26	35	—	—	85	13	19	—	23	30.2	40	0.6	1.1	100	17	25	—	36	39.7	1	1.5	120	29	50	2
10	50	—	—	—	22	26	35	—	—	90	13	20	—	23	30.2	40	0.6	1.1	110	19	27	—	40	44.4	1	2	130	31	53	2.1
11	55	—	—	—	24	30	40	—	—	100	14	21	—	25	33.3	45	0.6	1.5	120	21	29	—	43	49.2	1.1	2	140	33	57	2.1
12	60	—	—	—	24	30	40	—	—	110	16	22	—	28	36.5	50	1	1.5	130	22	31	—	46	54	1.1	2.1	150	35	60	2.1
13	65	—	—	—	27	34	45	—	—	120	18	23	—	31	38.1	56	1	1.5	140	24	33	—	48	58.7	1.1	2.1	160	37	64	2.1
14	70	—	—	—	27	34	45	—	—	125	18	24	—	31	39.7	56	1	1.5	150	25	35	—	51	63.5	1.5	2.1	180	42	74	3
15	75	—	—	—	30	37	50	—	—	130	18	25	—	31	41.3	56	1	1.5	160	27	37	—	55	68.3	1.5	2.1	190	45	77	3
16	80	—	—	—	30	37	50	—	—	140	19	26	—	33	44.4	60	1	2	170	28	39	—	58	68.3	1.5	2.1	200	48	80	3
17	85	—	—	—	31	41	56	—	—	150	21	28	—	36	49.2	65	1.1	2	180	30	41	—	60	73	2	3	210	52	86	4
18	90	150	—	—	33	45	60	—	2	160	22	30	—	40	52.4	69	1.1	2	190	30	43	—	64	73	2	3	225	54	90	4
19	95	160	—	—	39	52	65	—	2	170	24	32	—	43	55.6	75	1.1	2.1	200	33	45	—	67	77.8	2	3	240	55	95	4
20	100	165	21	30	39	52	65	1.1	2	180	25	34	—	46	60.3	80	1.5	2.1	215	36	47	51	73	82.6	2.1	3	250	58	98	4

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**	42	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	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**	78	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	2.1	**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**	42	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	82	112	140	3	3	**360**	—	58	70	98	128	160	—	4	**420**	—	80	97	138	165	—	5	**480**	102	160	6
44	**220**	**370**	48	69	88	120	150	3	4	**400**	—	65	78	108	144	180	—	4	**460**	—	88	106	145	180	—	5	**540**	115	180	6
48	**240**	**400**	50	74	95	128	160	4	4	**440**	—	72	85	120	160	200	—	4	**500**	—	95	114	155	195	—	5	**580**	122	190	6
52	**260**	**440**	57	82	106	144	180	4	4	**480**	—	80	90	130	174	218	—	5	**540**	—	102	123	165	206	—	6	**620**	132	206	7.5
56	**280**	**460**	57	82	106	146	180	4	5	**500**	—	80	90	130	176	218	—	5	**580**	—	108	132	175	224	—	6	**670**	140	224	7.5
60	**300**	**500**	63	90	118	160	200	5	5	**540**	—	85	98	140	192	243	—	5	**620**	—	109	140	185	236	—	7.5	**710**	150	236	7.5
64	**320**	**540**	71	100	128	176	218	5	5	**580**	—	92	105	150	208	258	—	5	**670**	—	112	155	200	258	—	7.5	**750**	155	250	9.5
68	**340**	**580**	78	106	140	190	243	5	5	**620**	—	92	118	165	224	280	—	6	**710**	—	118	165	212	272	—	7.5	**800**	165	265	9.5
72	**360**	**600**	78	106	140	192	243	5	5	**650**	—	95	122	170	232	290	—	6	**750**	—	125	170	224	290	—	7.5	**850**	180	280	9.5
76	**380**	**620**	78	106	140	194	243	5	5	**680**	—	95	132	175	240	300	—	6	**780**	—	128	175	230	300	—	7.5	**900**	190	300	9.5
80	**400**	**650**	80	112	145	200	250	6	6	**720**	—	103	140	185	256	315	—	6	**820**	—	136	185	243	308	—	7.5	**950**	200	315	12
84	**420**	**700**	88	122	165	224	280	6	6	**760**	—	109	150	195	272	335	—	7.5	**850**	—	136	190	250	315	—	9.5	**980**	206	325	12
88	**440**	**720**	88	122	165	226	280	6	6	**790**	—	112	155	200	280	345	—	7.5	**900**	—	145	200	265	345	—	9.5	**1030**	212	335	12
92	**460**	**760**	95	132	175	240	300	6	7.5	**830**	—	118	165	212	296	365	—	7.5	**950**	—	155	212	280	365	—	9.5	**1060**	218	345	12
96	**480**	**790**	100	136	180	248	308	6	7.5	**870**	—	125	170	224	310	388	—	7.5	**980**	—	160	218	290	375	—	9.5	**1120**	230	365	15
/500	**500**	**830**	106	145	190	264	325	7.5	7.5	**920**	—	136	185	243	336	412	—	7.5	**1030**	—	170	230	300	388	—	12	**1150**	236	375	15
/530	**530**	**870**	109	150	195	272	335	7.5	7.5	**980**	—	145	200	258	355	450	—	9.5	**1090**	—	180	243	325	412	—	12	**1220**	250	400	15
/560	**560**	**920**	115	160	206	280	355	7.5	7.5	**1030**	—	150	206	272	365	475	—	9.5	**1150**	—	190	258	335	438	—	12	**1280**	258	412	15
/600	**600**	**980**	122	170	218	300	375	7.5	7.5	**1090**	—	155	212	280	388	488	—	9.5	**1220**	—	200	272	355	462	—	15	**1360**	272	438	15
/630	**630**	**1030**	128	175	230	315	400	7.5	7.5	**1150**	—	165	230	300	412	515	—	12	**1280**	—	206	280	375	488	—	15	**1420**	280	450	15
/670	**670**	**1090**	136	185	243	336	412	7.5	7.5	**1220**	—	175	243	315	438	545	—	12	**1360**	—	218	300	400	515	—	15	**1500**	290	475	15
/710	**710**	**1150**	140	195	250	345	438	9.5	9.5	**1280**	—	180	250	325	450	560	—	12	**1420**	—	224	308	412	530	—	15	—	—	—	—
/750	**750**	**1220**	150	206	272	365	475	9.5	9.5	**1360**	—	195	265	345	475	615	—	15	**1500**	—	236	325	438	560	—	15	—	—	—	—
/800	**800**	**1280**	155	212	272	375	475	9.5	9.5	**1420**	—	200	272	355	488	615	—	15	**1600**	—	258	355	462	600	—	15	—	—	—	—
/850	**850**	**1360**	165	224	290	400	500	12	12	**1500**	—	206	280	375	515	650	—	15	**1700**	—	272	375	488	630	—	19	—	—	—	—
/900	**900**	**1420**	165	230	300	412	515	12	12	**1580**	—	218	300	388	515	670	—	15	**1780**	—	280	388	500	650	—	19	—	—	—	—
/950	**950**	**1500**	175	243	315	438	545	12	12	**1660**	—	230	315	412	530	710	—	15	**1850**	—	290	400	515	670	—	19	—	—	—	—
/1000	**1000**	**1580**	185	258	335	462	580	12	12	**1750**	—	243	330	425	560	750	—	15	**1950**	—	300	412	545	710	—	19	—	—	—	—
/1060	**1060**	**1660**	190	265	345	475	600	12	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1120	**1120**	**1750**	—	280	365	475	630	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1180	**1180**	**1850**	—	290	388	500	670	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1250	**1250**	**1950**	—	308	400	530	710	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1320	**1320**	**2060**	—	325	425	560	750	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1400	**1400**	**2180**	—	345	450	580	775	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/1500	**1500**	**2300**	—	355	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					
		Diameter Series 9									Diameter Series 0									Diameter Series 1					
			Dimension Series 29						Chamfer Dimension			Dimension Series			Dimension Series			Chamfer Dimension			Dimension Series			Chamfer Dimension	
			I			II			I.R.	O.R.		20			30			I.R.	O.R.		31			I.R.	O.R.
Bore Number	*d*	*D*	*B*	*C*	*T*	*B*	*C*	*T*	*r* (min.)		*D*	*B*	*C*	*T*	*B*	*C*	*T*	*r* (min.)		*D*	*B*	*C*	*T*	*r* (min.)	
00	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
01	12	—	—	—	—	—	—	—	—	—	28	11	—	11	13	—	13	0.3	0.3	—	—	—	—	—	—
02	15	—	—	—	—	—	—	—	—	—	32	12	—	12	14	—	14	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														
	Dimension Series 02			Dimension Series 22			Dimension Series 32			Chamfer Dimension			Dimension Series 03				Dimension Series 13			Dimension Series 23			Chamfer Dimension			
										I.R.	O.R.												I.R.	O.R.		
D	*B*	*C*	*T*	*B*	*C*	*T*	*B*	*C*	*T*	*r* (min.)		*D*	*B*	*C*	*C* (1)	*T*	*B*	*C*	*T*	*B*	*C*	*T*	*r* (min.)		*d*	Bore Number
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**

Note (1) Steep-slope bearing 303D in DIN corresponds to 313 in JIS. Series 13 bearings with bore diameters larger than 100 mm are designated as 313.

Table 6. 3 Boundary Dimensions of

Thrust Ball Brgs.										511					512	522				
Spherical Thrust Roller Brgs.														292						
Bore Number	d	Diameter Series 0					Diameter Series 1					Diameter Series 2								
		D	Dimension Series			r (min.)	D	Dimension Series			r (min.)	D	Dimension Series						r (min.)	r_1 (min.)
			70	90	10			71	91	11			72	92	12	22	22			
			T					T					T				Central Washer			
																	d_2	B		
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				
	Dimension Series									Dimension Series									Dimension Series			
	73	93	13	23	23					74	94	14	24	24					95			
					Central Washer									Central Washer								
D	T				d_2	B	r (min.)	r_1 (min.)	D	T				d_2	B	r (min.)	r_1 (min.)	D	T	r (min.)	d	Bore Number
20	7	—	11	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**4**	**4**
24	8	—	12	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**6**	**6**
26	8	—	12	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**8**	**8**
30	9	—	14	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**10**	**00**
32	9	—	14	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**12**	**01**
37	10	—	15	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	**15**	**02**
40	10	—	16	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	**52**	21	1	**17**	**03**
47	12	—	18	—	—	—	1	—	—	—	—	—	—	—	—	—	—	**60**	24	1	**20**	**04**
52	12	—	18	34	20	8	1	0.3	**60**	16	21	24	45	15	11	1	0.6	**73**	29	1.1	**25**	**05**
60	14	—	21	38	25	9	1	0.3	**70**	18	24	28	52	20	12	1	0.6	**85**	34	1.1	**30**	**06**
68	15	—	24	44	30	10	1	0.3	**80**	20	27	32	59	25	14	1.1	0.6	**100**	39	1.1	**35**	**07**
78	17	22	26	49	30	12	1	0.6	**90**	23	30	36	65	30	15	1.1	0.6	**110**	42	1.5	**40**	**08**
85	18	24	28	52	35	12	1	0.6	**100**	25	34	39	72	35	17	1.1	0.6	**120**	45	2	**45**	**09**
95	20	27	31	58	40	14	1.1	0.6	**110**	27	36	43	78	40	18	1.5	0.6	**135**	51	2	**50**	**10**
105	23	30	35	64	45	15	1.1	0.6	**120**	29	39	48	87	45	20	1.5	0.6	**150**	58	2.1	**55**	**11**
110	23	30	35	64	50	15	1.1	0.6	**130**	32	42	51	93	50	21	1.5	0.6	**160**	60	2.1	**60**	**12**
115	23	30	36	65	55	15	1.1	0.6	**140**	34	45	56	101	50	23	2	1	**170**	63	2.1	**65**	**13**
125	25	34	40	72	55	16	1.1	1	**150**	36	48	60	107	55	24	2	1	**180**	67	3	**70**	**14**
135	27	36	44	79	60	18	1.5	1	**160**	38	51	65	115	60	26	2	1	**190**	69	3	**75**	**15**
140	27	36	44	79	65	18	1.5	1	**170**	41	54	68	120	65	27	2.1	1	**200**	73	3	**80**	**16**
150	29	39	49	87	70	19	1.5	1	**180**	42	58	72	128	65	29	2.1	1.1	**215**	78	4	**85**	**17**
155	29	39	50	88	75	19	1.5	1	**190**	45	60	77	135	70	30	2.1	1.1	**225**	82	4	**90**	**18**
170	32	42	55	97	85	21	1.5	1	**210**	50	67	85	150	80	33	3	1.1	**250**	90	4	**100**	**20**
190	36	48	63	110	95	24	2	1	**230**	54	73	95	166	90	37	3	1.1	**270**	95	5	**110**	**22**
210	41	54	70	123	100	27	2.1	1.1	**250**	58	78	102	177	95	40	4	1.5	**300**	109	5	**120**	**24**
225	42	58	75	130	110	30	2.1	1.1	**270**	63	85	110	192	100	42	4	2	**320**	115	5	**130**	**26**
240	45	60	80	140	120	31	2.1	1.1	**280**	63	85	112	196	110	44	4	2	**340**	122	5	**140**	**28**
250	45	60	80	140	130	31	2.1	1.1	**300**	67	90	120	209	120	46	4	2	**360**	125	6	**150**	**30**
270	50	67	87	153	140	33	3	1.1	**320**	73	95	130	226	130	50	5	2	**380**	132	6	**160**	**32**
280	50	67	87	153	150	33	3	1.1	**340**	78	103	135	236	135	50	5	2.1	**400**	140	6	**170**	**34**
300	54	73	95	165	150	37	3	2	**360**	82	109	140	245	140	52	5	3	**420**	145	6	**180**	**36**
320	58	78	105	183	160	40	4	2	**380**	85	115	150	—	—	—	5	—	**440**	150	6	**190**	**38**
340	63	85	110	192	170	42	4	2	**400**	90	122	155	—	—	—	5	—	**460**	155	7.5	**200**	**40**
360	63	85	112	—	—	—	4	—	**420**	90	122	160	—	—	—	6	—	**500**	170	7.5	**220**	**44**
380	63	85	112	—	—	—	4	—	**440**	90	122	160	—	—	—	6	—	**540**	180	7.5	**240**	**48**
420	73	95	130	—	—	—	5	—	**480**	100	132	175	—	—	—	6	—	**580**	190	9.5	**260**	**52**
440	73	95	130	—	—	—	5	—	**520**	109	145	190	—	—	—	6	—	**620**	206	9.5	**280**	**56**
480	82	109	140	—	—	—	5	—	**540**	109	145	190	—	—	—	6	—	**670**	224	9.5	**300**	**60**
500	82	109	140	—	—	—	5	—	**580**	118	155	205	—	—	—	7.5	—	**710**	236	9.5	**320**	**64**

Table 6. 3 Boundary Dimensions of

Thrust Ball Brgs.										511					512	522				
Spherical Thrust Roller Brgs.														292						
Bore Number	d	Diameter Series 0					Diameter Series 1					Diameter Series 2								
		D	Dimension Series			r (min.)	D	Dimension Series			r (min.)	D	Dimension Series						r (min.)	r_1 (min.)
			70	90	10			71	91	11			72	92	12	22	22			
			T					T					T				Central Washer			
																	d_2	B		
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	—	—	—	—	—	—	—	—	—

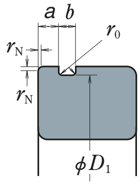
Remarks 1. Dimension Series 22, 23, and 24 are double-direction bearings.
2. The maximum permissible outside diameter of shaft and central washers and minimum permissible bore diameter of housing washers are omitted here (refer to the bearings tables for thrust bearings).

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				
D	Dimension Series 73	93	13	23	23 Central Washer		*r* (min.)	r_1 (min.)	*D*	Dimension Series 74	94	14	24	24 Central Washer		*r* (min.)	r_1 (min.)	*D*	Dimension Series 95	*r* (min.)	*d*	Bore Number
	T	*T*	*T*	*T*	d_2	*B*				*T*	*T*	*T*	*T*	d_2	*B*				*T*			
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

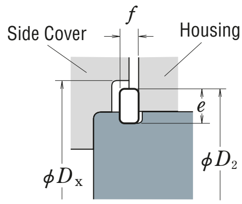


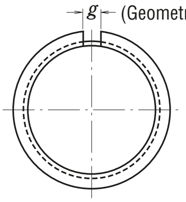
Applicable Bearings			Snap Ring Groove								
d (Dimension Series)		*D*	Snap Ring Groove Diameter D_1		Snap Ring Groove Position *a* (Bearing Dimension Series)				Snap Ring Groove Width *b*		Radius of Bottom Corners r_0
					18		19				
18	19		max.	min.	max.	min.	max.	min.	max.	min.	max.
—	10	**22**	20.8	20.5	—	—	1.05	0.9	1.05	0.8	0.2
—	12	**24**	22.8	22.5	—	—	1.05	0.9	1.05	0.8	0.2
—	15	**28**	26.7	26.4	—	—	1.3	1.15	1.2	0.95	0.25
—	17	**30**	28.7	28.4	—	—	1.3	1.15	1.2	0.95	0.25
20	—	**32**	30.7	30.4	1.3	1.15	—	—	1.2	0.95	0.25
22	—	**34**	32.7	32.4	1.3	1.15	—	—	1.2	0.95	0.25
25	20	**37**	35.7	35.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
—	22	**39**	37.7	37.4	—	—	1.7	1.55	1.2	0.95	0.25
28	—	**40**	38.7	38.4	1.3	1.15	—	—	1.2	0.95	0.25
30	25	**42**	40.7	40.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
32	—	**44**	42.7	42.4	1.3	1.15	—	—	1.2	0.95	0.25
—	28	**45**	43.7	43.4	—	—	1.7	1.55	1.2	0.95	0.25
35	30	**47**	45.7	45.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
40	32	**52**	50.7	50.4	1.3	1.15	1.7	1.55	1.2	0.95	0.25
—	35	**55**	53.7	53.4	—	—	1.7	1.55	1.2	0.95	0.25
45	—	**58**	56.7	56.4	1.3	1.15	—	—	1.2	0.95	0.25
—	40	**62**	60.7	60.3	—	—	1.7	1.55	1.2	0.95	0.25
50	—	**65**	63.7	63.3	1.3	1.15	—	—	1.2	0.95	0.25
—	45	**68**	66.7	66.3	—	—	1.7	1.55	1.2	0.95	0.25
55	50	**72**	70.7	70.3	1.7	1.55	1.7	1.55	1.2	0.95	0.25
60	—	**78**	76.2	75.8	1.7	1.55	—	—	1.6	1.3	0.4
—	55	**80**	77.9	77.5	—	—	2.1	1.9	1.6	1.3	0.4
65	60	**85**	82.9	82.5	1.7	1.55	2.1	1.9	1.6	1.3	0.4
70	65	**90**	87.9	87.5	1.7	1.55	2.1	1.9	1.6	1.3	0.4
75	—	**95**	92.9	92.5	1.7	1.55	—	—	1.6	1.3	0.4
80	70	**100**	97.9	97.5	1.7	1.55	2.5	2.3	1.6	1.3	0.4
—	75	**105**	102.6	102.1	—	—	2.5	2.3	1.6	1.3	0.4
85	80	**110**	107.6	107.1	2.1	1.9	2.5	2.3	1.6	1.3	0.4
90	—	**115**	112.6	112.1	2.1	1.9	—	—	1.6	1.3	0.4
95	85	**120**	117.6	117.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
100	90	**125**	122.6	122.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
105	95	**130**	127.6	127.1	2.1	1.9	3.3	3.1	1.6	1.3	0.4
110	100	**140**	137.6	137.1	2.5	2.3	3.3	3.1	2.2	1.9	0.6
—	105	**145**	142.6	142.1	—	—	3.3	3.1	2.2	1.9	0.6
120	110	**150**	147.6	147.1	2.5	2.3	3.3	3.1	2.2	1.9	0.6
130	120	**165**	161.8	161.3	3.3	3.1	3.7	3.5	2.2	1.9	0.6
140	—	**175**	171.8	171.3	3.3	3.1	—	—	2.2	1.9	0.6
—	130	**180**	176.8	176.3	—	—	3.7	3.5	2.2	1.9	0.6
150	140	**190**	186.8	186.3	3.3	3.1	3.7	3.5	2.2	1.9	0.6
160	—	**200**	196.8	196.3	3.3	3.1	—	—	2.2	1.9	0.6

Remarks The minimum permissible chamfer dimensions r_N 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).

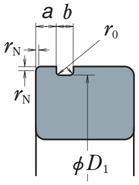




Units: mm

Locating Snap Ring Number	Locating Snap Ring: Cross Sectional Height e max.	min.	Thickness f max.	min.	Geometry of Snap Ring Fitted in Groove (Reference): Slit Width g approx.	Snap Ring Outside Diameter D_2 max.	Side Cover: Stepped Bore Diameter (Reference) D_X min.
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

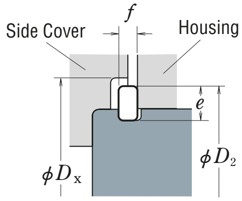


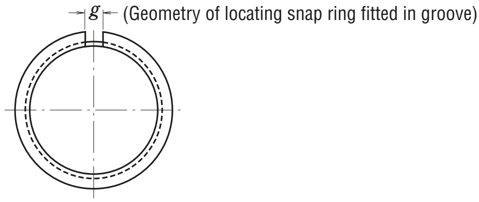
Applicable Bearings					Snap Ring Groove								
d				*D*	Snap Ring Groove Diameter D_1		Snap Ring Groove Position *a*				Snap Ring Groove Width *b*		Radius of Bottom Corners r_0
Diameter Series							Bearing Diameter Series						
							0		2, 3, 4				
0	2	3	4		max.	min.	max.	min.	max.	min.	max.	min.	max.
10	—	—	—	**26**	24.5	24.25	1.35	1.19	—	—	1.17	0.87	0.2
12	—	—	—	**28**	26.5	26.25	1.35	1.19	—	—	1.17	0.87	0.2
—	10	9	8	**30**	28.17	27.91	—	—	2.06	1.9	1.65	1.35	0.4
15	12	—	9	**32**	30.15	29.9	2.06	1.9	2.06	1.9	1.65	1.35	0.4
17	15	10	—	**35**	33.17	32.92	2.06	1.9	2.06	1.9	1.65	1.35	0.4
—	—	12	10	**37**	34.77	34.52	—	—	2.06	1.9	1.65	1.35	0.4
—	17	—	—	**40**	38.1	37.85	—	—	2.06	1.9	1.65	1.35	0.4
20	—	15	12	**42**	39.75	39.5	2.06	1.9	2.06	1.9	1.65	1.35	0.4
22	—	—	—	**44**	41.75	41.5	2.06	1.9	—	—	1.65	1.35	0.4
25	20	17	—	**47**	44.6	44.35	2.06	1.9	2.46	2.31	1.65	1.35	0.4
—	22	—	—	**50**	47.6	47.35	—	—	2.46	2.31	1.65	1.35	0.4
28	25	20	15	**52**	49.73	49.48	2.06	1.9	2.46	2.31	1.65	1.35	0.4
30	—	—	—	**55**	52.6	52.35	2.08	1.88	—	—	1.65	1.35	0.4
—	—	22	—	**56**	53.6	53.35	—	—	2.46	2.31	1.65	1.35	0.4
32	28	—	—	**58**	55.6	55.35	2.08	1.88	2.46	2.31	1.65	1.35	0.4
35	30	25	17	**62**	59.61	59.11	2.08	1.88	3.28	3.07	2.2	1.9	0.6
—	32	—	—	**65**	62.6	62.1	—	—	3.28	3.07	2.2	1.9	0.6
40	—	28	—	**68**	64.82	64.31	2.49	2.29	3.28	3.07	2.2	1.9	0.6
—	35	30	20	**72**	68.81	68.3	—	—	3.28	3.07	2.2	1.9	0.6
45	—	32	—	**75**	71.83	71.32	2.49	2.29	3.28	3.07	2.2	1.9	0.6
50	40	35	25	**80**	76.81	76.3	2.49	2.29	3.28	3.07	2.2	1.9	0.6
—	45	—	—	**85**	81.81	81.31	—	—	3.28	3.07	2.2	1.9	0.6
55	50	40	30	**90**	86.79	86.28	2.87	2.67	3.28	3.07	3	2.7	0.6
60	—	—	—	**95**	91.82	91.31	2.87	2.67	—	—	3	2.7	0.6
65	55	45	35	**100**	96.8	96.29	2.87	2.67	3.28	3.07	3	2.7	0.6
70	60	50	40	**110**	106.81	106.3	2.87	2.67	3.28	3.07	3	2.7	0.6
75	—	—	—	**115**	111.81	111.3	2.87	2.67	—	—	3	2.7	0.6
—	65	55	45	**120**	115.21	114.71	—	—	4.06	3.86	3.4	3.1	0.6
80	70	—	—	**125**	120.22	119.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6
85	75	60	50	**130**	125.22	124.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6
90	80	65	55	**140**	135.23	134.72	3.71	3.45	4.9	4.65	3.4	3.1	0.6
95	—	—	—	**145**	140.23	139.73	3.71	3.45	—	—	3.4	3.1	0.6
100	85	70	60	**150**	145.24	144.73	3.71	3.45	4.9	4.65	3.4	3.1	0.6
105	90	75	65	**160**	155.22	154.71	3.71	3.45	4.9	4.65	3.4	3.1	0.6
110	95	80	—	**170**	163.65	163.14	3.71	3.45	5.69	5.44	3.8	3.5	0.6
120	100	85	70	**180**	173.66	173.15	3.71	3.45	5.69	5.44	3.8	3.5	0.6
—	105	90	75	**190**	183.64	183.13	—	—	5.69	5.44	3.8	3.5	0.6
130	110	95	80	**200**	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							Side Cover
Locating Snap Ring Number	Cross Sectional Height e		Thickness f		Geometry of Snap Ring Fitted in Groove (Reference): Slit Width g	Geometry of Snap Ring Fitted in Groove (Reference): Snap Ring Outside Diameter D_2	Stepped Bore Diameter (Reference) D_X
	max.	min.	max.	min.	approx.	max.	min.
NR 26 [1]	2.06	1.91	0.84	0.74	3	28.7	29.4
NR 28 [1]	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:

(Example 1) 6 3 08 ZZ C3

- C3 — Radial Clearance **C3** (Internal Clearance Designation)
- ZZ — Shields on Both Sides (Shield Designation)
- 08 — Nominal Bore Diameter **40 mm** (Bore Number)
- 3 — Diameter Series **3**
- 6 — Single-Row Deep Groove Ball Bearing

(Diameter Series 3 and Single-Row Deep Groove Ball Bearing: Bearing Series Designation)

(Example 2) 7 2 20 A DB C3

- C3 — Axial Clearance **C3**
- DB — Back-to-Back Arrangement
- A — Contact Angle **30°**
- 20 — Nominal Bore Diameter **100 mm**
- 2 — Diameter Series **2**
- 7 — Single-Row Angular Contact Ball Bearing

(Example 3) 1 2 06 K +H206X

- +H206X — Adapter with **25 mm** Bore
- K — Tapered Bore (Taper **1:12**)
- 06 — Nominal Bore Diameter **30 mm**
- 2 — Diameter Series **2**
- 1 — Self-Aligning Ball Bearing

(Example 4) NU 3 18 M CM

- CM — Radial Clearance for Electric-Motor Bearings **CM**
- M — Machined Brass Cage
- 18 — Nominal Bore Diameter **90 mm**
- 3 — Diameter Series **3**
- NU — **NU** Type Cylindrical Roller Bearing

(Example 5) NN 3 0 17 K CC1 P4

- P4 — Accuracy of ISO **Class 4**
- CC1 — Radial Clearance in Non-Interchangeable Cylindrical Roller Bearings **CC1**
- K — Tapered Bore (Taper **1:12**)
- 17 — Nominal Bore Diameter **85 mm**
- 0 — Diameter Series **0**
- 3 — Width Series **3**
- NN — **NN** Type Cylindrical Roller Bearing

(Example 6) HR 3 0 2 07 J

- J — Small Diameter of Outer Ring Raceway and Contact Angle Conform to ISO
- 07 — Nominal Bore Diameter **35 mm**
- 2 — Diameter Series **2**
- 0 — Width Series **0**
- 3 — Tapered Roller Bearing
- HR — High Capacity Bearing

(Example 7) 2 4 0 /1000 CA M K30 E4 C3

- C3 — Radial Clearance **C3**
- E4 — Outer Ring with Oil Groove and Oil Holes
- K30 — Tapered Bore (Taper **1:30**)
- M — Machined Brass Cage
- CA — Spherical Roller Bearing
- /1000 — Nominal Bore Diameter **1 000 mm**
- 0 — Diameter Series **0**
- 4 — Width Series **4**
- 2 — Spherical Roller Bearing

(Example 8) 5 1 2 15

- 15 — Nominal Bore Diameter **75 mm**
- 2 — Diameter Series **2**
- 1 — Height Series **1**
- 5 — Thrust Ball Bearing

Table 6. 5 Bearing Series Designations

Bearing Type	Bearing Series	Type	Dimensions: Width	Dimensions: Diameter
Single-Row Deep Groove Ball Bearings	**68**	6	(1)	8
	69	6	(1)	9
	60	6	(1)	0
	62	6	(0)	2
	63	6	(0)	3
Single-Row Angular Contact Ball Bearings	**79**	7	(1)	9
	70	7	(1)	0
	72	7	(0)	2
	73	7	(0)	3
Self-Aligning Ball Bearings	**12**	1	(0)	2
	13	1	(0)	3
	22	(1)	2	2
	23	(1)	2	3
Single-Row Cylindrical Roller Bearings	**NU10**	NU	1	0
	NU2	NU	(0)	2
	NU22	NU	2	2
	NU3	NU	(0)	3
	NU23	NU	2	3
	NU4	NU	(0)	4
	NJ2	NJ	(0)	2
	NJ22	NJ	2	2
	NJ3	NJ	(0)	3
	NJ23	NJ	2	3
	NJ4	NJ	(0)	4
	NUP2	NUP	(0)	2
	NUP22	NUP	2	2
	NUP3	NUP	(0)	3
	NUP23	NUP	2	3
	NUP4	NUP	(0)	4
	N10	N	1	0
	N2	N	(0)	2
	N3	N	(0)	3
	N4	N	(0)	4
	NF2	NF	(0)	2
	NF3	NF	(0)	3
	NF4	NF	(0)	4

Bearing Type	Bearing Series	Type	Dimensions: Width or Height	Dimensions: Diameter
Double-Row Cylindrical Roller Bearings	**NNU49**	NNU	4	9
	NN30	NN	3	0
Needle Roller Bearings	**NA48**	NA	4	8
	NA49	NA	4	9
	NA59	NA	5	9
	NA69	NA	6	9
Tapered Roller Bearings	**329**	3	2	9
	320	3	2	0
	330	3	3	0
	331	3	3	1
	302	3	0	2
	322	3	2	2
	332	3	3	2
	303	3	0	3
	323	3	2	3
Spherical Roller Bearings	**230**	2	3	0
	231	2	3	1
	222	2	2	2
	232	2	3	2
	213 (1)	2	0	3
	223	2	2	3
Thrust Ball Bearings with Flat Seats	**511**	5	1	1
	512	5	1	2
	513	5	1	3
	514	5	1	4
	522	5	2	2
	523	5	2	3
	524	5	2	4
Spherical Thrust Roller Bearings	**292**	2	9	2
	293	2	9	3
	294	2	9	4

Note (1) 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 (1)		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 69 60 :	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 ZS	Shield on One Side Only
		2	2	A	Standard Contact Angle of 30°								
		3	3			J	Smaller Diameter of Outer Ring Raceway, Contact Angle, and Outer Ring Width of Tapered Roller Bearings (Conforms to ISO 355)						
70 72 73 :	Single-Row Angular Contact Ball Bearings	⋮	⋮										
		9	9	A5	Standard Contact Angle of 25°					W	Pressed-Steel Cage	ZZ ZZS	Shields on Both Sides
		00	10					h	Stainless Steel Used in Rings, Rolling Elements				
12 13 22 :	Self-Aligning Ball Bearings	01	12	B	Standard Contact Angle of 40°								
		02	15									DU	Rubber Contact Seal on One Side Only
		03	17							T	Synthetic Resin Cage		
NU10 NJ 2 N 3 NN 30 :	Cylindrical Roller Bearings			C	Standard Contact Angle of 15°		(For High Capacity Bearings)						
		/22	22									DDU	Rubber Contact Seals on Both Sides
		/28	28										
		/32	32			C				V	Without Cage		
NA48 NA49 NA69 :	Needle Roller Bearings				Tapered Roller Bearings	CA							
		04(3)	20									V	Rubber Non-Contact Seal on One Side Only
		05	25			CD	Spherical Roller Bearings						
320 322 323 :	Tapered Roller Bearings (2)	06	30	Omitted	Contact Angle Less Than 17°								
		⋮	⋮			EA						VV	Rubber Non-Contact Seals on Both Sides
		88	440	C	Approx. 20° Contact Angle	E	Cylindrical Roller Bearings						
230 222 223 :	Spherical Roller Bearings	92	460										
		96	480	D	Approx. 28° Contact Angle	E	Spherical Thrust Roller Bearings						
		/500	500										
511 512 513 :	Thrust Ball Bearing With Flat Seats	/530	530			EA	Angular Contact Ball Bearings						
		/560	560										
		⋮	⋮										
292 293 294 :	Thrust Spherical Roller Bearings	/2 360	2 360										
		/2 500	2 500										
HR(4)	High Capacity Tapered Roller Bearings and Others												
Designations and Numbers Conform to JIS(5)						NSK Designations						NSK Designations	
Marked on Bearings										Not Marked on Bearings			

Notes
(1) Bearing Series designations conform to Table 6.5.
(2) For basic designations of tapered roller bearings in ISO's new series, refer to Page C182.
(3) The bore size (mm) is five times the bore number for Bore Numbers 04 through 96 (except double-direction thrust ball bearings).
(4) HR is an NSK Bearing Series designation.

Bearing Designations

Auxiliary Designations

External Features / Design of Rings (Partially Match JIS(5))

Code	Meaning
K	Tapered Bore of Inner Ring (Taper 1:12)
K30	Tapered Bore of Inner Ring (Taper 1:30)
E	Notch or Lubricating Groove in Ring
E4	Lubricating Groove in Outside Surface and Holes in Outer Ring
N	Snap Ring Groove in Outer Ring
NR	Snap Ring Groove With Snap Ring in Outer Ring

Arrangement (Match JIS(5))

Code	Meaning
DB	Back-to-Back Arrangement
DF	Face-to-Face Arrangement
DT	Tandem Arrangement

Internal Clearance / Preload (NSK Designations; Partially Match JIS(5)/ BAS(6))

Code	Meaning (radial clearance)	Applies to
C1	Clearance Less Than C2	For All Radial Brgs.
C2	Clearance Less Than CN	For All Radial Brgs.
Omitted	CN Clearance	For All Radial Brgs.
C3	Clearance Greater Than CN	For All Radial Brgs.
C4	Clearance Greater Than C3	For All Radial Brgs.
C5	Clearance Greater Than C4	For All Radial Brgs.
CC1	Clearance Less Than CC2	For Non-Interchangeable Cylindrical Roller Brgs.
CC2	Clearance Less Than CC	For Non-Interchangeable Cylindrical Roller Brgs.
CC	Normal Clearance	For Non-Interchangeable Cylindrical Roller Brgs.
CC3	Clearance Greater Than CC	For Non-Interchangeable Cylindrical Roller Brgs.
CC4	Clearance Greater Than CC3	For Non-Interchangeable Cylindrical Roller Brgs.
CC5	Clearance Greater Than CC4	For Non-Interchangeable Cylindrical Roller Brgs.
MC1	Clearance Less Than MC2	For Extra-Small and Miniature Ball Brgs.
MC2	Clearance Less Than MC3	For Extra-Small and Miniature Ball Brgs.
MC3	Normal Clearance	For Extra-Small and Miniature Ball Brgs.
MC4	Clearance Greater Than MC3	For Extra-Small and Miniature Ball Brgs.
MC5	Clearance Greater Than MC4	For Extra-Small and Miniature Ball Brgs.
MC6	Clearance Greater Than MC5	For Extra-Small and Miniature Ball Brgs.
CM	Clearance in Deep Groove Ball Bearings for Electric Motors	
CT, CM	Clearance in Cylindrical Roller Bearings for Electric Motors	

(Preload of Angular Contact Ball Bearing)

Code	Meaning
EL	Extra Light Preload
L	Light Preload
M	Medium Preload
H	Heavy Preload

Tolerance Class (Match JIS(5))

Code	Meaning
Omitted	ISO Normal
P6	ISO Class 6
P6X	ISO Class 6X
P5	ISO Class 5
P4	ISO Class 4
P2	ISO Class 2

ABMA(7) Tapered Roller Bearing

Code	Meaning
Omitted	Class 4
PN2	Class 2
PN3	Class 3
PN0	Class 0
PN00	Class 00

Special Specification (NSK Designations, Partially Match JIS(5))

Bearings Treated with Dimensional Stabilization

Code	Meaning
X26	Working Temperature Lower Than 150 °C
X28	Working Temperature Lower Than 200 °C
X29	Working Temperature Lower Than 250 °C

Spherical Roller Bearings

Code	Meaning
S11	Dimensional Stabilizing Treatment Working Temperature Lower Than 200 °C

Spacer / Sleeve (NSK Designations, Partially Match JIS(5))

Code	Meaning
+K	Bearings With Outer Ring Spacers
+L	Bearings With Inner Ring Spacers
+KL	Bearings With Both Inner and Outer Ring Spacers
H	Adapter
AH	Withdrawal Sleeve
HJ	Thrust Collar

Grease (NSK Designations, Partially Match JIS(5))

Code	Meaning
AS2	SHELL ALVANIA GREASE S2
ENS	ENS GREASE
NS7	NS HI-LUBE
PS2	MULTEMP PS No. 2

External Features / Design of Rings, Arrangement, Internal Clearance / Preload, Tolerance Class, Special Specification: In General, Marked on Bearings

Spacer / Sleeve, Grease: Not Marked on Bearings

Notes (5) JIS : Japanese Industrial Standards.
(6) BAS : The Japan Bearing Industrial Association Standard.
(7) ABMA : The American Bearing Manufacturers Association.


MAG

7. BEARING TOLERANCES

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.

Accuracy of Rolling Bearings

- Tolerances for Dimensions (Items necessary to mount bearings on shafts or in housings)
  - Tolerances for bore and outside diameters, ring width, and bearing width
  - Tolerances for inscribed and circumscribed circle diameters of rollers
  - Tolerances for chamfer dimensions
  - Tolerances for width variation
  - Tolerances for tapered bore diameters
- Running Accuracy (Items necessary to specify the runout of rotating machine parts)
  - Permissible radial runout of inner and outer rings
  - Permissible face runout with raceway inner and outer rings
  - Permissible perpendicularity of inner ring face with respect to the bore
  - Permissible perpendicularity of outer ring outside surface with respect to the face
  - Permissible raceway to back face thickness variation of thrust bearings

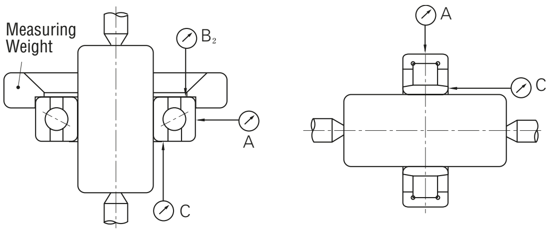
Table 7. 1 Bearing Types and Tolerance Classes

Bearing type		Standard						
Deep Groove Ball Bearing		ISO 492	Normal	—	Class 6	Class 5	Class 4	Class 2
Angular Contact Ball Bearings		ISO 492	Normal	—	Class 6	Class 5	Class 4	Class 2
Self-Aligning Ball Bearings		ISO 492	Normal	—	Class 6 Equivalent	Class 5 Equivalent	—	—
Cylindrical Roller Bearings		ISO 492	Normal	—	Class 6	Class 5	Class 4	Class 2
Needle Roller Bearings		ISO 492	Normal	—	Class 6	Class 5	Class 4	—
Spherical Roller Bearings		ISO 492	Normal	—	Class 6	Class 5	—	—
Tapered Roller Bearings	Metric Design	ISO 492	Normal	Class 6X	Class 6	Class 5	Class 4	—
Tapered Roller Bearings	Inch Design	ANSI/AFBMA Std.19.2	Class 4	—	Class 2	Class 3	Class 0	Class 00
Tapered Roller Bearings	J Series	ANSI/AFBMA Std.19.1	Class K	Class N	—	Class C	Class B	—
Magneto Ball Bearings		BAS1061	Normal	—	Class 6	Class 5	—	—
Thrust Ball Bearings		ISO 199	Normal	—	Class 6	Class 5	Class 4	—
Thrust Roller Bearings		ISO 199	Normal	—	—	—	—	—
Thrust Spherical Roller Bearings		ISO 199	Normal	—	—	—	—	—
Equivalent Standards (Reference): JIS		JIS B 1514, 1536	Class 0	—	Class 6	Class 5	Class 4	Class 2
Equivalent Standards (Reference): JIS	Tapered Roller Bearings, Metric Design	JIS B 1514	Class 0	Class 6X	(Class 6)	Class 5	Class 4	—
Equivalent Standards (Reference): DIN		DIN620	P0	—	P6	P5	P4	P2
Equivalent Standards (Reference): ANSI/AFBMA	Ball Bearings	ANSI/AFBMA Std.20	ABEC1	—	ABEC3	ABEC5	ABEC7	ABEC9
Equivalent Standards (Reference): ANSI/AFBMA	Roller Bearings	ANSI/AFBMA Std.20	RBEC1	—	RBEC3	RBEC5	—	—
Equivalent Standards (Reference): ANSI/AFBMA	Instrument Ball Bearings	ANSI/AFBMA Std.12.2	—	—	—	Class 5P	Class 7P	Class 9P
Equivalent Standards (Reference): ANSI/AFBMA	Tapered Roller Bearings, Metric Design	ANSI/AFBMA Std.19.1	Class K	Class N	—	Class C	Class B	Class A
Equivalent Standards (Reference): 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_1
S_{ea}	Stationary	Rotating	B_2
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



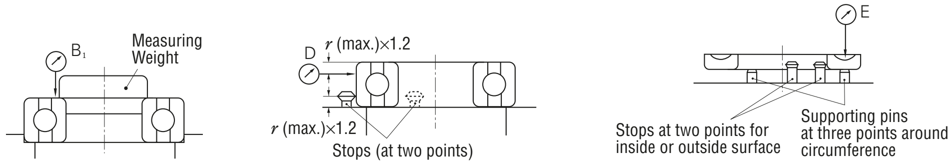


Fig. 7.1 Measuring Methods for Running Accuracy (Summarized)

Symbols for Boundary Dimensions and Running Accuracy

d	Nominal bore diameter
Δ_{ds}	Deviation of a single bore diameter
Δ_{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
Δ_{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
Δ_{Ts}	Deviation of the actual brg. width
Δ_{T1s}	Deviation of the actual effective width of inner subunit
Δ_{T2s}	Deviation of the actual effective width of outer ring
D	Nominal outside diameter
Δ_{Ds}	Deviation of a single outside diameter
Δ_{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
Δ_{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

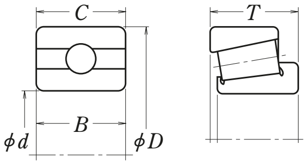


Table 7. 2 Tolerances for Radial Bearings

Table 7. 2. 1 Tolerances for Inner Rings and

Nominal Bore Diameter d (mm)		Δ_{dmp} (2)										Δ_{ds} (2)			
		Normal Class		Class 6		Class 5		Class 4		Class 2		Class 4 Diameter Series 0, 1, 2, 3, 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
0.6(1)	**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	—	—	—	—	—	—	—	—	—	—	—	—

	Δ_{Bs} (or Δ_{Cs})(3)																V_{Bs} (or V_{Cs})				
	Single Bearing								Combined Bearings								Inner Ring (or Outer Ring) (3)		Inner Ring		
	Normal Class		Class 6		Class 5		Class 4 Class 2		Class Normal (4) (5)		Class 6 (4) (5)		Class 5 (4) (5)		Class 4 (4) Class 2 (4)		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	Max.	Max.	Max.	Max.	Max.
	0	− 40	0	− 40	0	− 40	0	− 40	—	—	—	—	0	−250	0	−250	12	12	5	2.5	1.5
	0	− 120	0	−120	0	− 40	0	− 40	0	−250	0	−250	0	−250	0	−250	15	15	5	2.5	1.5
	0	− 120	0	−120	0	− 80	0	− 80	0	−250	0	−250	0	−250	0	−250	20	20	5	2.5	1.5
	0	− 120	0	−120	0	−120	0	−120	0	−250	0	−250	0	−250	0	−250	20	20	5	2.5	1.5
	0	− 120	0	−120	0	−120	0	−120	0	−250	0	−250	0	−250	0	−250	20	20	5	3	1.5
	0	− 150	0	−150	0	−150	0	−150	0	−380	0	−380	0	−250	0	−250	25	25	6	4	1.5
	0	− 200	0	−200	0	−200	0	−200	0	−380	0	−380	0	−380	0	−380	25	25	7	4	2.5
	0	− 250	0	−250	0	−250	0	−250	0	−500	0	−500	0	−380	0	−380	30	30	8	5	2.5
	0	− 250	0	−250	0	−250	0	−250	0	−500	0	−500	0	−380	0	−380	30	30	8	5	4
	0	− 300	0	−300	0	−300	0	−300	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
(1) 0.6mm is included in this group.
(2) Applicable to bearings with cylindrical bores.
(3) 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.
(4) Applicable to individual rings manufactured for combined bearings.
(5) Also applicable to inner ring tapered bores with $d \geqq 50$ mm.
(6) Applicable to ball bearings such as deep groove ball bearings and angular contact ball bearings.

(Excluding Tapered Roller Bearings)

Widths of Outer Rings

V_{dsp} (2)											V_{dmp} (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 : μm

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 1. 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.).

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.

Table 7. 2 Tolerances for Radial Bearings

Table 7. 2. 2 Tolerances

Nominal Outside Diameter D (mm)		Δ_{Dmp}										Δ_{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
2.5(1)	**6**	0	− 8	0	− 7	0	− 5	0	− 4	0	− 2.5	0	− 4	0	− 2.5
6	**18**	0	− 8	0	− 7	0	− 5	0	− 4	0	− 2.5	0	− 4	0	− 2.5
18	**30**	0	− 9	0	− 8	0	− 6	0	− 5	0	− 4	0	− 5	0	− 4
30	**50**	0	− 11	0	− 9	0	− 7	0	− 6	0	− 4	0	− 6	0	− 4
50	**80**	0	− 13	0	−11	0	− 9	0	− 7	0	− 4	0	− 7	0	− 4
80	**120**	0	− 15	0	−13	0	−10	0	− 8	0	− 5	0	− 8	0	− 5
120	**150**	0	− 18	0	−15	0	−11	0	− 9	0	− 5	0	− 9	0	− 5
150	**180**	0	− 25	0	−18	0	−13	0	−10	0	− 7	0	−10	0	− 7
180	**250**	0	− 30	0	−20	0	−13	0	−11	0	− 8	0	−11	0	− 8
250	**315**	0	− 35	0	−25	0	−18	0	−13	0	− 8	0	−13	0	− 8
315	**400**	0	− 40	0	−28	0	−20	0	−15	0	−10	0	−15	0	−10
400	**500**	0	− 45	0	−33	0	−23	—	—	—	—	—	—	—	—
500	**630**	0	− 50	0	−38	0	−28	—	—	—	—	—	—	—	—
630	**800**	0	− 75	0	−45	0	−35	—	—	—	—	—	—	—	—
800	**1 000**	0	−100	0	−60	—	—	—	—	—	—	—	—	—	—
1 000	**1 250**	0	−125	—	—	—	—	—	—	—	—	—	—	—	—
1 250	**1 600**	0	−160	—	—	—	—	—	—	—	—	—	—	—	—
1 600	**2 000**	0	−200	—	—	—	—	—	—	—	—	—	—	—	—
2 000	**2 500**	0	−250	—	—	—	—	—	—	—	—	—	—	—	—

Notes (1) 2.5 mm is included in this group.
(2) Applicable only when a locating snap ring is not used.
(3) Applicable to ball bearings, such as deep groove ball bearings and angular contact ball bearings.
(4) Not applicable to bearings with flanges.
(5) 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_{Dsp} (2)													V_{Dmp} (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.	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 : m

K_{ea}					S_D (4)			S_{ea} (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 *d* (mm)		Δ_{dmp}								Δ_{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	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[1]	**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 (1) 10 mm is included in this group.

Remarks 1. 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.).

2. Some of these tolerances conform to NSK standards.

Table 7. 3. 2 Tolerances for Outer Ring Outside Diameter and Running Accuracy

Nominal Outside Diameter *D* (mm)		Δ_{Dmp}								Δ_{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	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[1]	**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 (1) 18 mm is included in this group.

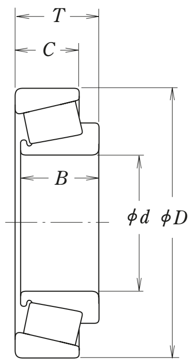
(2) Not applicable to bearings with flanges.

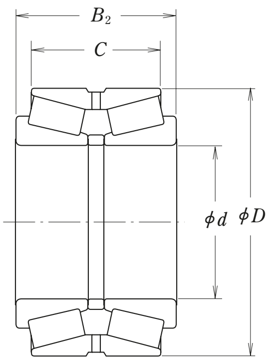
Remarks 1. The outside diameter "no-go side" tolerances (low) specified in this table do not necessarily apply within a distance from the ring face to 1.2 times the chamfer dimension *r* (max.).

2. 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_{ea}				S_D ([2])		S_{ea} ([2])
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	—	—	—	—	—	—

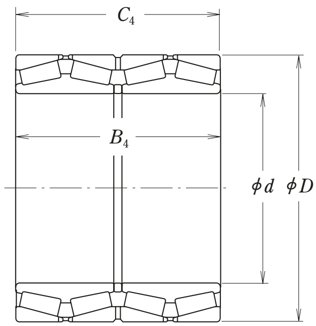


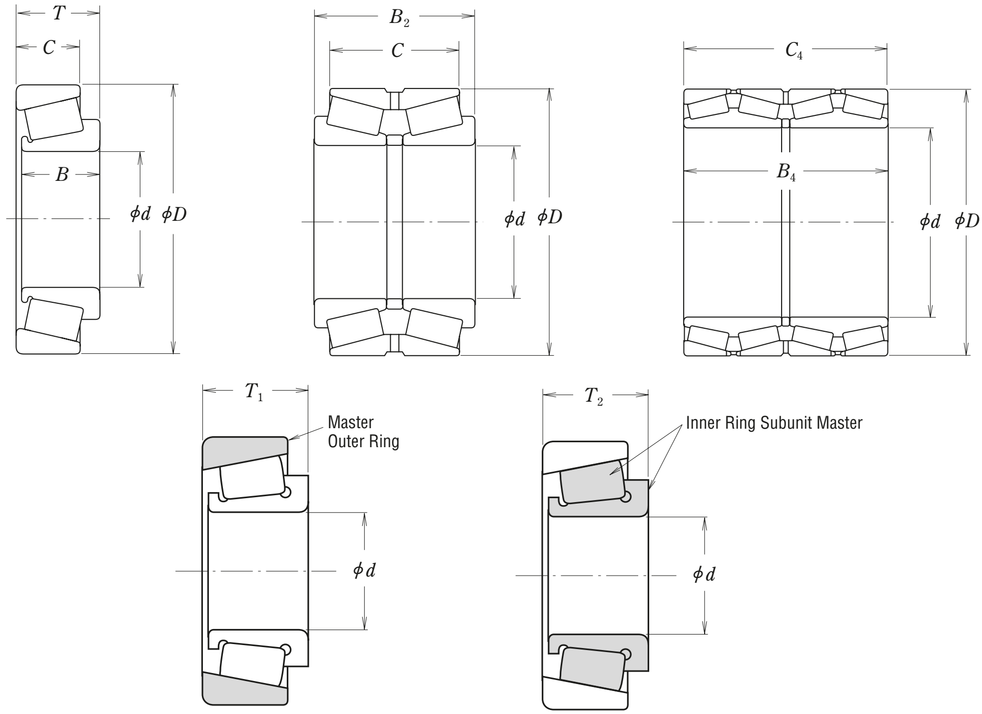
Table 7. 3 Tolerances for Metric Series

Table 7. 3. 3 Tolerances for Width, Overall Bearing Width,

Nominal Bore Diameter d (mm)		Δ_{Bs}										Δ_{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
10[1]	**18**	0	− 120	0	−120	0	−50	0	− 200	0	−200	0	− 120	0	−120	0	−100	0	− 200	0	−200
18	**30**	0	− 120	0	−120	0	−50	0	− 200	0	−200	0	− 120	0	−120	0	−100	0	− 200	0	−200
30	**50**	0	− 120	0	−120	0	−50	0	− 240	0	−240	0	− 120	0	−120	0	−100	0	− 240	0	−240
50	**80**	0	− 150	0	−150	0	−50	0	− 300	0	−300	0	− 150	0	−150	0	−100	0	− 300	0	−300
80	**120**	0	− 200	0	−200	0	−50	0	− 400	0	−400	0	− 200	0	−200	0	−100	0	− 400	0	−400
120	**180**	0	− 250	0	−250	0	−50	0	− 500	0	−500	0	− 250	0	−250	0	−100	0	− 500	0	−500
180	**250**	0	− 300	0	−300	0	−50	0	− 600	0	−600	0	− 300	0	−300	0	−100	0	− 600	0	−600
250	**315**	0	− 350	—	—	0	−50	0	− 700	0	−700	0	− 350	—	—	0	−100	0	− 700	0	−700
315	**400**	0	− 400	—	—	0	−50	0	− 800	—	—	0	− 400	—	—	0	−100	0	− 800	—	—
400	**500**	0	− 450	—	—	0	−50	0	− 900	—	—	0	− 450	—	—	0	−100	—	− 900	—	—
500	**630**	0	− 500	—	—	—	—	0	−1 100	—	—	0	− 500	—	—	—	—	—	−1 100	—	—
630	**800**	0	− 750	—	—	—	—	0	−1 600	—	—	0	− 750	—	—	—	—	—	−1 600	—	—
800	**1 000**	0	−1 000	—	—	—	—	0	−2 000	—	—	0	−1 000	—	—	—	—	—	−2 000	—	—
1 000	**1 250**	0	−1 250	—	—	—	—	0	−2 000	—	—	0	−1 250	—	—	—	—	—	−2 000	—	—
1 250	**1 600**	0	−1 600	—	—	—	—	0	−2 000	—	—	0	−1 600	—	—	—	—	—	−2 000	—	—
1 600	**2 000**	0	−2 000	—	—	—	—	—	—	—	—	0	−2 000	—	—	—	—	—	—	—	—

Notes (1) 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.



Tapered Roller Bearings and Combined Bearing Width

Δ_{Ts}										Δ_{T1s}							
Normal Class		(Class 6)		Class 6X		Class 5		Class 4		Normal Class		Class 6X		Class 5		Class 4	
high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low
+ 200	0	+200	0	+100	0	+200	−200	+200	−200	+100	0	+ 50	0	+100	−100	+100	−100
+ 200	0	+200	0	+100	0	+200	−200	+200	−200	+100	0	+ 50	0	+100	−100	+100	−100
+ 200	0	+200	0	+100	0	+200	−200	+200	−200	+100	0	+ 50	0	+100	−100	+100	−100
+ 200	0	+200	0	+100	0	+200	−200	+200	−200	+100	0	+ 50	0	+100	−100	+100	−100
+ 200	− 200	+200	−200	+100	0	+200	−200	+200	−200	+100	−100	+ 50	0	+100	−100	+100	−100
+ 350	− 250	+350	−250	+150	0	+350	−250	+350	−250	+150	−150	+ 50	0	+150	−150	+150	−150
+ 350	− 250	+350	−250	+150	0	+350	−250	+350	−250	+150	−150	+ 50	0	+150	−150	+150	−150
+ 350	− 250	+350	−250	+200	0	+350	−250	+350	−250	+150	−150	+100	0	+150	−150	+150	−150
+ 400	− 400	—	—	+200	0	+400	−400	—	—	+200	−200	+100	0	+200	−200	—	—
+ 400	− 400	—	—	+200	0	+400	−400	—	—	+225	−225	+100	0	+225	−225	—	—
+ 500	− 500	—	—	—	—	+500	−500	—	—	—	—	—	—	—	—	—	—
+ 600	− 600	—	—	—	—	+600	−600	—	—	—	—	—	—	—	—	—	—
+ 750	− 750	—	—	—	—	+750	−750	—	—	—	—	—	—	—	—	—	—
+ 900	− 900	—	—	—	—	+750	−750	—	—	—	—	—	—	—	—	—	—
+1 050	−1 050	—	—	—	—	+900	−900	—	—	—	—	—	—	—	—	—	—
+1 200	−1 200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Units : m

Δ_{T2s}								Overall Combined Bearing Width Deviation				Nominal Bore Diameter *d* (mm)	
Normal Class		Class 6X		Class 5		Class 4		Δ_{B2s} All Classes of Double-Row Bearings		Δ_{B4s}, Δ_{C4s} All Classes of Four-Row Bearings			
high	low	high	low	high	low	high	low	high	low	high	low	over	incl.
+100	0	+ 50	0	+100	−100	+100	−100	+ 200	− 200	—	—	**10**	**18**
+100	0	+ 50	0	+100	−100	+100	−100	+ 200	− 200	—	—	**18**	**30**
+100	0	+ 50	0	+100	−100	+100	−100	+ 200	− 200	—	—	**30**	**50**
+100	0	+ 50	0	+100	−100	+100	−100	+ 300	− 300	+ 300	− 300	**50**	**80**
+100	−100	+ 50	0	+100	−100	+100	−100	+ 300	− 300	+ 400	− 400	**80**	**120**
+200	−100	+100	0	+200	−100	+200	−100	+ 400	− 400	+ 500	− 500	**120**	**180**
+200	−100	+100	0	+200	−100	+200	−100	+ 450	− 450	+ 600	− 600	**180**	**250**
+200	−100	+100	0	+200	−100	+200	−100	+ 550	− 550	+ 700	− 700	**250**	**315**
+200	−200	+100	0	+200	−200	—	—	+ 600	− 600	+ 800	− 800	**315**	**400**
+225	−225	+100	0	+225	−225	—	—	+ 700	− 700	+ 900	− 900	**400**	**500**
—	—	—	—	—	—	—	—	+ 800	− 800	+ 1000	−1 000	**500**	**630**
—	—	—	—	—	—	—	—	+1 200	−1 200	+ 1500	−1 500	**630**	**800**
—	—	—	—	—	—	—	—	—	—	—	—	**800**	**1 000**
—	—	—	—	—	—	—	—	—	—	—	—	**1 000**	**1 250**
—	—	—	—	—	—	—	—	—	—	—	—	**1 250**	**1 600**
—	—	—	—	—	—	—	—	—	—	—	—	**1 600**	**2 000**

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

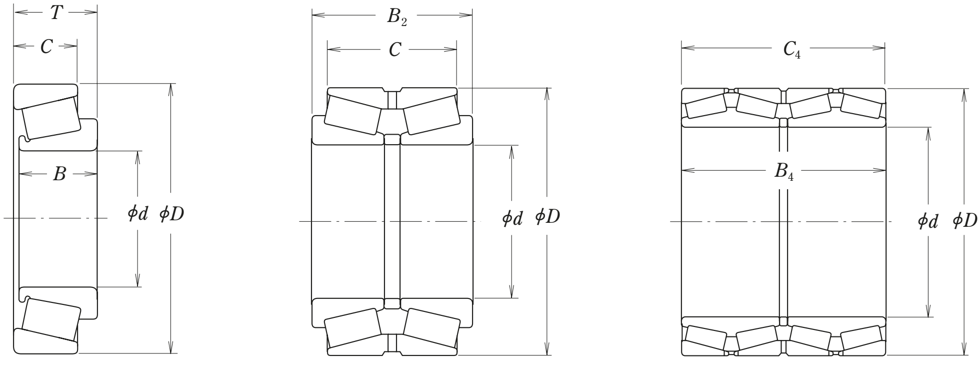
Nominal Bore Diameter d				Δ_{ds}					
over		incl.		CLASS 4, 2		CLASS 3, 0		CLASS 00	
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low
–	–	**76.200**	3.0000	+ 13	0	+13	0	+8	0
76.200	3.0000	**266.700**	10.5000	+ 25	0	+13	0	+8	0
266.700	10.5000	**304.800**	12.0000	+ 25	0	+13	0	–	–
304.800	12.0000	**609.600**	24.0000	+ 51	0	+25	0	–	–
609.600	24.0000	**914.400**	36.0000	+ 76	0	+38	0	–	–
914.400	36.0000	**1 219.200**	48.0000	+102	0	+51	0	–	–
1 219.200	48.0000	–	–	+127	0	+76	0	–	–

Table 7. 4. 2 Tolerances for Outer Ring Outside Diameter

Nominal Outside Diameter D				Δ_{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
–	–	**266.700**	10.5000	+ 25	0	+13	0	+8	0
266.700	10.5000	**304.800**	12.0000	+ 25	0	+13	0	+8	0
304.800	12.0000	**609.600**	24.0000	+ 51	0	+25	0	–	–
609.600	24.0000	**914.400**	36.0000	+ 76	0	+38	0	–	–
914.400	36.0000	**1 219.200**	48.0000	+102	0	+51	0	–	–
1 219.200	48.0000	–	–	+127	0	+76	0	–	–

Table 7. 4. 3 Tolerances for

Nominal Bore Diameter d				Δ_{Ts}									
over		incl.		CLASS 4		CLASS 2		CLASS 3				CLASS 0, 00	
								$D \leqq 508.000$ (mm)		$D > 508.000$ (mm)			
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low	high	low	high	low
–	–	**101.600**	4.0000	+203	0	+203	0	+203	−203	+203	−203	+203	−203
101.600	4.0000	**304.800**	12.0000	+356	−254	+203	0	+203	−203	+203	−203	+203	−203
304.800	12.0000	**609.600**	24.0000	+381	−381	+381	−381	+203	−203	+381	−381	–	–
609.600	24.0000	–	–	+381	−381	–	–	+381	−381	+381	−381	–	–



KBE

KV

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 51 51	38 38 38	8 8 18	4 4 –	2 2 –
76 76 76	51 – –	51 76 76	– – –	– – –

Overall Width and Combined Width

Units : m

Double-Row Bearings (KBE Type) Δ_{B2s}										Four-Row Bearings (KV Type) Δ_{B4s}, Δ_{C4s}	
CLASS 4		CLASS 2		CLASS 3				CLASS 0,00		CLASS 4, 3	
				$D \leqq 508.000$ (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)		Δ_{dmp}						V_{dp}			V_{dmp}			Δ_{Bs} (or Δ_{Cs}) [1]			
		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
2.5	**10**	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 40
10	**18**	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 80
18	**30**	0	−10	0	−8	0	−6	8	6	5	8	6	3	0	−120	0	−120

Note (1) 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)		Δ_{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.
6	**18**	+ 8	0	+7	0	+5	0	0	− 8	0	−7	0	−5	6	5	4
18	**30**	+ 9	0	+8	0	+6	0	0	− 9	0	−8	0	−6	7	6	5
30	**50**	+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}) (1)		Δ_{Ts}		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

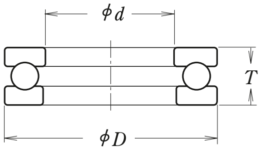
Table 7. 6 Tolerances for Thrust Ball Bearings

Table 7. 6. 1 Tolerances for Shaft Washer Bore Diameter and Running Accuracy

Units : m

Nominal Bore Diameter d or d_2 (mm)		$\Delta_{d\mathrm{mp}}$ or $\Delta_{d2\mathrm{mp}}$				$V_{d\mathrm{sp}}$ or $V_{d2\mathrm{sp}}$		S_i or S_e (1)			
		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 (1) 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.



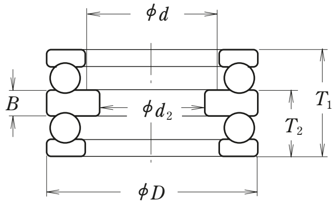
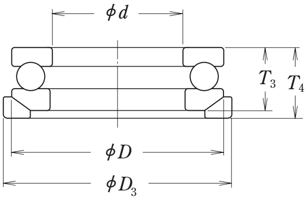


Table 7. 6. 2 Tolerances for Outside Diameter of Housing Washers and Aligning Seat Washers

Units : m

Nominal Outside Diameter of Bearing or Aligning Seat Washer D or D_3 (mm)		Δ_{Dmp}						V_{Dsp}		Aligning Seat Washer Outside Diameter Deviation Δ_{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	
over	incl.	high	low	high	low	high	low	max.	max.	high	low
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	−	−	−	−	−	−	−	−



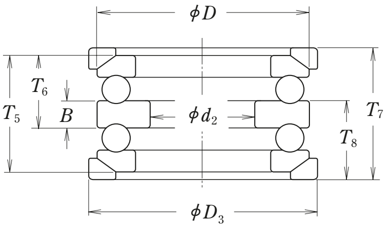


Table 7. 6. 3 Tolerances for Thrust Ball Bearing Height and Central Washer Height

Units : m

Nominal Bore Diameter d (1) (mm)		Flat Seat Type				Aligning Seat Washer Type				With Aligning Seat Washer				Height Deviation of Central Washer Δ_{Bs}	
		Δ_{Ts} or Δ_{T2s}		Δ_{T1s}		Δ_{T3s} or Δ_{T6s}		Δ_{T5s}		Δ_{T4s} or Δ_{T8s}		Δ_{T7s}			
		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 (1) For double-direction bearings, classification depends on d for single-direction bearings with the same D in the same Diameter Series.

Remark Δ_{Ts} in the table is the deviation in the respective heights T in the figures below.

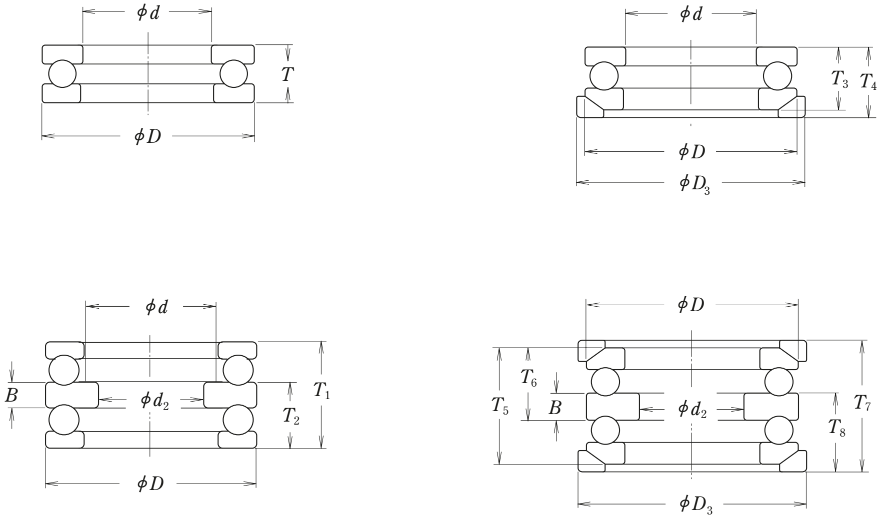


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

Table 7. 7. 1 Tolerances for Bore Diameters of Shaft Washers and Height (Metric, Normal Class)

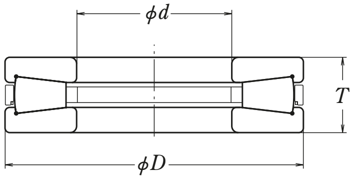
Units : m

Nominal Bore Diameter d (mm)		Δ_{dmp}		Δ_{Ts}	
over	incl	high	low	high	low
80	**120**	0	−20	0	−150
120	**180**	0	−25	0	−175
180	**250**	0	−30	0	−200
250	**315**	0	−35	0	−225
315	**400**	0	−40	0	−300
400	**500**	0	−45	0	−350
500	**630**	0	−50	0	−450
630	**800**	0	−75	0	−550
800	**1 000**	0	−100	0	−700
1 000	**1 250**	0	−125	0	−900
1 250	**1 600**	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)		Δ_{Dmp}	
over	incl	high	low
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
1 000	**1 250**	0	−125
1 250	**1 600**	0	−160
1 600	**2 000**	0	−200



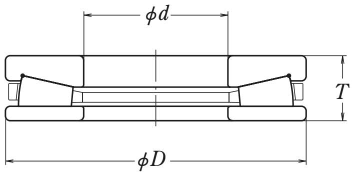


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

Table 7. 7. 3 Tolerances for Bore Diameters of Shaft Washers and Height (Inch, Class 4)

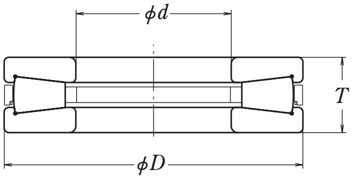
Units : m

Nominal Bore Diameter d				$\Delta_{d\mathrm{mp}}$		Δ_{Ts}	
over		incl					
(mm)	(inch)	(mm)	(inch)	high	low	high	low
—	—	**304.800**	12.0000	+25	0	+381	−381
304.800	12.0000	**609.600**	24.0000	+51	0	+381	−381
609.600	24.0000	**914.400**	36.0000	+76	0	+381	−381
914.400	36.0000	**1 219.200**	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				$\Delta_{D\mathrm{mp}}$	
over		incl			
(mm)	(inch)	(mm)	(inch)	high	low
—	—	**304.800**	12.0000	+25	0
304.800	12.0000	**609.600**	24.0000	+51	0
609.600	24.0000	**914.400**	36.0000	+76	0
914.400	36.0000	**1 219.200**	48.0000	+102	0
1 219.200	48.0000	—	—	+127	0



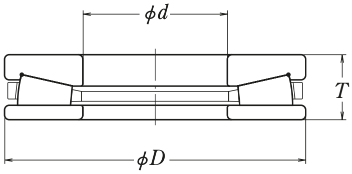


Table 7. 8 Tolerances for Thrust Spherical Roller Bearings

Table 7. 8. 1 Tolerances for Bore Diameters of Shaft Rings and Height (Normal Class)

Units : m

Nominal Bore Diameter d (mm)		Δ_{dmp}		V_{dsp}	Reference		
					S_d	Δ_{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)		Δ_{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.).

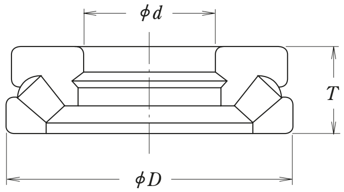


Table 7. 9 Tolerances of CLASS 5P, CLASS 7P, and CLASS 9P

(1) Tolerances for Inner Rings

Nominal Bore Diameter d (mm)		Δ_{dmp}				Δ_{ds}				V_{dp}		V_{dmp}		Δ_{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	
over	incl.	high	low	high	low	high	low	high	low	max.	max.	max.	max.	high	low
–	**10**	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4
10	**18**	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4
18	**30**	0	−5.1	0	−2.5	0	−5.1	0	−2.5	2.5	1.3	2.5	1.3	0	−25.4

Note (1) 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)		Δ_{Dmp}				Δ_{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
						Open		Shielded Sealed		Open		Open	Shielded Sealed	Open	Open	Shielded Sealed	Open
over	incl.	high	low	high	low	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.
–	**18**	0	−5.1	0	−2.5	0	−5.1	+1	−6.1	0	−2.5	2.5	5.1	1.3	2.5	5.1	1.3
18	**30**	0	−5.1	0	−3.8	0	−5.1	+1	−6.1	0	−3.8	2.5	5.1	2	2.5	5.1	2
30	**50**	0	−5.1	0	−3.8	0	−5.1	+1	−6.1	0	−3.8	2.5	5.1	2	2.5	5.1	2

Notes (1) Applicable to flange width variation for flanged bearings.
(2) Applicable to the flange back face.

Instrument Ball Bearings (Inch Series)

(ANSI/ABMA Equivalent)

and Width of Outer Rings

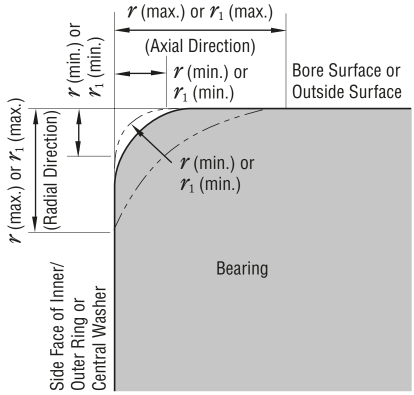
Units : m

(or Δ_{Cs})		V_{Bs}			K_{ia}			S_{ia}			S_{d}		
Combined Brgs ([1]) CLASS 5P CLASS 7P CLASS 9P		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} ([1])			S_{D}			K_{ea}			S_{ea}			Deviation of Flange Outside Diameter Δ_{D1s}		Deviation of Flange Width Δ_{C1s}		Flange Backface Runout with Raceway ([2]) 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	CLASS 5P CLASS 7P		CLASS 5P CLASS 7P		CLASS 5P CLASS 7P
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
	over	incl.	Radial Direction	Axial Direction [1]	max.
0.05	–	–	0.1	0.2	0.05
0.08	–	–	0.16	0.3	0.08
0.1	–	–	0.2	0.4	0.1
0.15	–	–	0.3	0.6	0.15
0.2	–	–	0.5	0.8	0.2
0.3	–	40	0.6	1	0.3
	40	–	0.8	1	
0.6	–	40	1	2	0.6
	40	–	1.3	2	
1	–	50	1.5	3	1
	50	–	1.9	3	
1.1	–	120	2	3.5	1
	120	–	2.5	4	
1.5	–	120	2.3	4	1.5
	120	–	3	5	
2	–	80	3	4.5	2
	80	220	3.5	5	
	220	–	3.8	6	
2.1	–	280	4	6.5	2
	280	–	4.5	7	
2.5	–	100	3.8	6	2
	100	280	4.5	6	
	280	–	5	7	
3	–	280	5	8	2.5
	280	–	5.5	8	
4	–	–	6.5	9	3
5	–	–	8	10	4
6	–	–	10	13	5
7.5	–	–	12.5	17	6
9.5	–	–	15	19	8
12	–	–	18	24	10
15	–	–	21	30	12
19	–	–	25	38	15

Note (1) 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 ([1]) 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.
0.15	–	–	0.3	0.6	0.15
0.3	– 40	40 –	0.7 0.9	1.4 1.6	0.3
0.6	– 40	40 –	1.1 1.3	1.7 2	0.6
1	– 50	50 –	1.6 1.9	2.5 3	1
1.5	– 120 250	120 250 –	2.3 2.8 3.5	3 3.5 4	1.5
2	– 120 250	120 250 –	2.8 3.5 4	4 4.5 5	2
2.5	– 120 250	120 250 –	3.5 4 4.5	5 5.5 6	2
3	– 120 250 400	120 250 400 –	4 4.5 5 5.5	5.5 6.5 7 7.5	2.5
4	– 120 250 400	120 250 400 –	5 5.5 6 6.5	7 7.5 8 8.5	3
5	– 180	180 –	6.5 7.5	8 9	4
6	– 180	180 –	7.5 9	10 11	5

Note ([1]) Inner rings are classified by d and outer rings by D.

Table 7. 10. 3 Chamfer Dimension Limits for Thrust Bearings

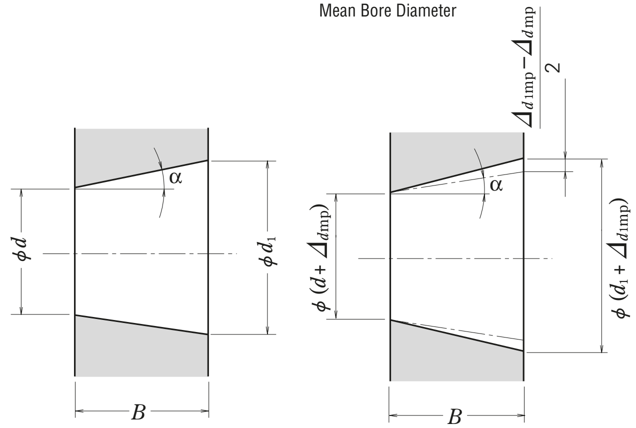
Units : mm

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.
0.05	0.1	0.05
0.08	0.16	0.08
0.1	0.2	0.1
0.15	0.3	0.15
0.2	0.5	0.2
0.3	0.8	0.3
0.6	1.5	0.6
1	2.2	1
1.1	2.7	1
1.5	3.5	1.5
2	4	2
2.1	4.5	2
3	5.5	2.5
4	6.5	3
5	8	4
6	10	5
7.5	12.5	6
9.5	15	8
12	18	10
15	21	12
19	25	15

Table 7.11 Tolerances for Tapered Bores (Normal Class)

Nominal Tapered Bore

Tapered Bore With Deviation in Single Plane Mean Bore Diameter



d : Nominal bore diameter
d_1 : Theoretical diameter of larger end of tapered bore
Taper 1:12 $d_1 = d + 1/12\,B$ Taper 1:30 $d_1 = d + /30\,B$
Δ_{dmp} : Single plane mean bore diameter deviation in theoretical diameter of smaller end of bore
Δ_{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
α : Half of taper angle of tapered bore

Taper 1:12
α =2°23´9.4
=2.38594°
=0.041643 rad

Taper 1:30
α =57´17.4
=0.95484°
=0.016665 rad

Taper 1 : 12

Units : μm

Nominal Bore Diameter d (mm)		Δ_{dmp}		$\Delta_{d1mp} - \Delta_{dmp}$		V_{dp} (1) (2)
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 (1) Applicable to all radial planes of tapered bores.
(2) Not applicable to Diameter Series 7 and 8.

Taper 1 : 30

Units : m

Nominal Bore Diameter d (mm)		Δ_{dmp}		$\Delta_{d1mp} - \Delta_{dmp}$		V_{dp} (1) (2)
over	incl.	high	low	high	low	max.
80	**120**	+20	0	+35	0	22
120	**180**	+25	0	+40	0	40
180	**250**	+30	0	+46	0	46
250	**315**	+35	0	+52	0	52
315	**400**	+40	0	+57	0	57
400	**500**	+45	0	+63	0	63
500	**630**	+50	0	+70	0	70

Notes (1) Applicable to all radial planes of tapered bores.
(2) Not applicable to diameter series 7 and 8.

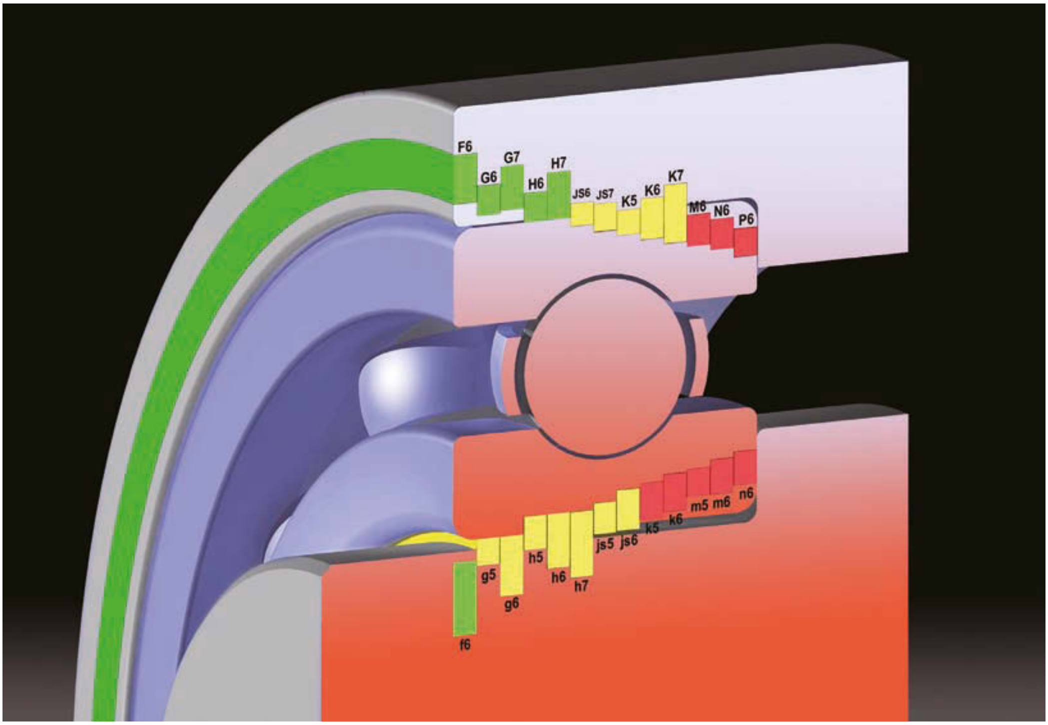
Remark For a value exceeding 630 mm, please contact NSK.

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


F6
G6
G7
H6
H7
JS6
JS7
K5
K6
K7
M6
N6
P6
f6
g5
g6
h5
h6
h7
js5
js6
k5
k6
m5
m6
n6

8. FITS AND INTERNAL CLEARANCES

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.

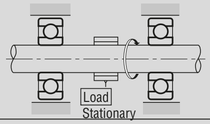
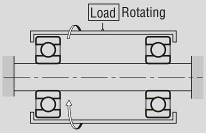
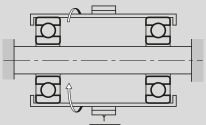
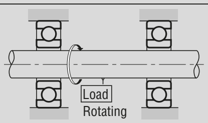
(2) ***Magnitude of Load and Interference***

The interference of the inner ring is slightly reduced by bearing load; therefore, the loss of interference should be estimated using the following equations:

$$\left.\begin{array}{l} \Delta d_F = 0.08\sqrt{\dfrac{d}{B}F_r} \times 10^{-3} \ \ldots\ldots\ldots \ (\mathrm{N}) \\ \Delta d_F = 0.25\sqrt{\dfrac{d}{B}F_r} \times 10^{-3} \ \ldots\ldots \ \{\mathrm{kgf}\} \end{array}\right\} \ldots (\mathbf{8.1})$$

where Δd_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: Inner Ring	Bearing Operation: Outer Ring	Load Conditions	Fitting: Inner Ring	Fitting: 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 Δd 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):

$$\left.\begin{array}{l}\Delta d \geqq 0.02\,\dfrac{F_r}{B}\times 10^{-3}\,\ldots\ldots\ldots\ (\mathrm{N}) \\ \Delta d \geqq 0.2\,\dfrac{F_r}{B}\times 10^{-3}\,\ldots\ldots\ldots\ \{\mathrm{kgf}\}\end{array}\right\}\ \ldots\ldots\ (\mathbf{8.2})$$

where Δd : 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).

$$\Delta d = 0.02 \times \frac{98\ 100}{32} \times 10^{-3} = 0.061\ (\mathrm{mm})$$

This result agrees well with Fig. 8.1.

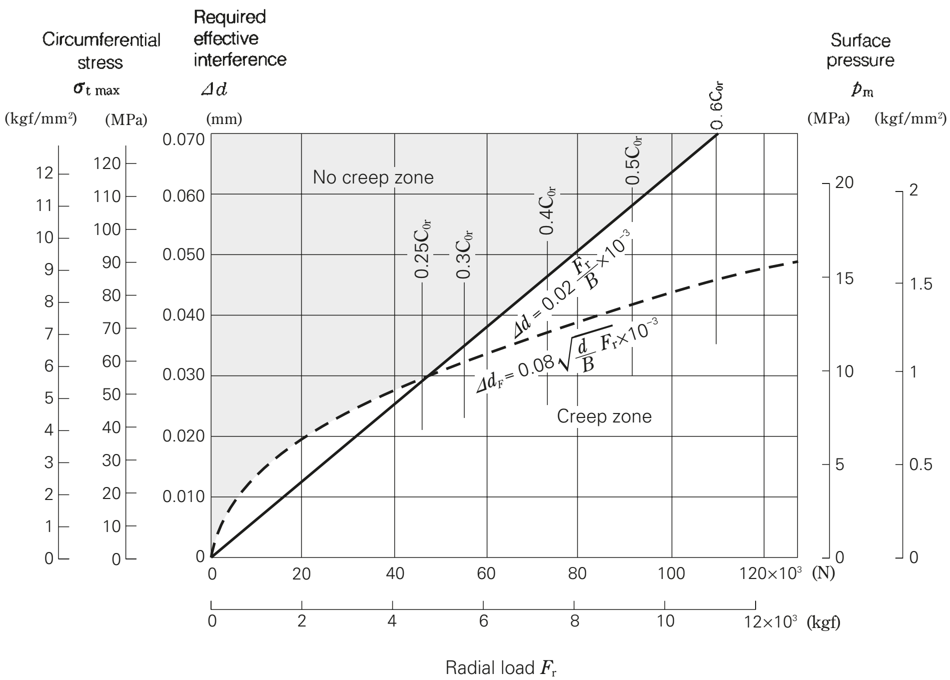


Fig. 8.1 Load and Required Effective Interference for Fit

(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 ΔT (°C), then the temperature difference between the fitted surfaces of the shaft and inner ring is estimated to be about (0.1–0.15) ΔT when the shaft is cooled. The decrease in the interference of the inner ring due to this temperature difference Δd_T may be calculated using Equation (8.3):

$$\Delta d_T = (0.10 \text{ to } 0.15) \times \Delta T \cdot \alpha \cdot d \doteqdot 0.0015 \Delta T \cdot d \times 10^{-3} \quad \text{(8.3)}$$

where
- Δd_T : Decrease in interference of inner ring due to temperature difference (mm)
- ΔT : Temperature difference between bearing interior and surrounding parts (°C)
- α : Coefficient of linear expansion of bearing steel $\doteqdot 12.5 \times 10^{-6}$ (1/°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:

For ground shafts $$\Delta d = \frac{d}{d+2} \Delta d_a \quad \text{(8.4)}$$

For machined shafts $$\Delta d = \frac{d}{d+3} \Delta d_a \quad \text{(8.5)}$$

where
- Δd : Effective interference (mm)
- Δd_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^2}	Hollow shaft $p_m=\frac{\Delta d}{d}\frac{1}{\left[\frac{m_s-1}{m_sE_s}-\frac{m_i-1}{m_iE_i}\right]+2\left[\frac{k_0^2}{E_s(1-k_0^2)}+\frac{1}{E_i(1-k^2)}\right]}$ Solid shaft $p_m=\frac{\Delta d}{d}\frac{1}{\left[\frac{m_s-1}{m_sE_s}-\frac{m_i-1}{m_iE_i}\right]+\frac{2}{E_i(1-k^2)}}$	Housing outside diameter $p_m=\frac{\Delta D}{D}\frac{1}{\left[\frac{m_e-1}{m_eE_e}-\frac{m_h-1}{m_hE_h}\right]+2\left[\frac{h^2}{E_e(1-h^2)}+\frac{1}{E_h(1-h_0^2)}\right]}$
Expansion of Inner Ring Raceway ΔD_i (mm) Contraction of Outer Ring Raceway ΔD_e (mm)	$\Delta D_i=2d\frac{p_m}{E_i}\frac{k}{1-k^2}$ $=\Delta d\cdot k\frac{1-k_0^2}{1-k^2k_0^2}$ (hollow shaft) $=\Delta d\cdot k$ (solid shaft)	$\Delta D_e=2D\frac{p_m}{E_e}\frac{h}{1-h^2}$ $=\Delta D\cdot h\frac{1-h_0^2}{1-h^2h_0^2}$
Maximum Stress $\sigma_{t\,max}$ (MPa) {kgf/mm^2}	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^2} 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 $h=D_e/D$, $h_0=D/D_0$ E_e : Outer ring Young's modulus, 208 000 MPa {21 200 kgf/mm^2} 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^2}. However, for safety, plan for a maximum fitting stress of 127 MPa {13 kgf/mm^2}. For reference, the distributions of circumferential stress σ_t and radial stress σ_r in an inner ring are shown in Fig. 8.2.

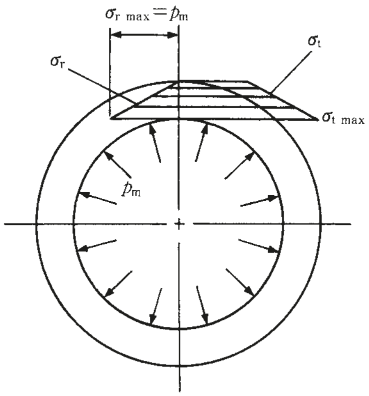


Fig. 8.2 Distribution of Circumferential Stress σ_t and Radial Stress σ_r

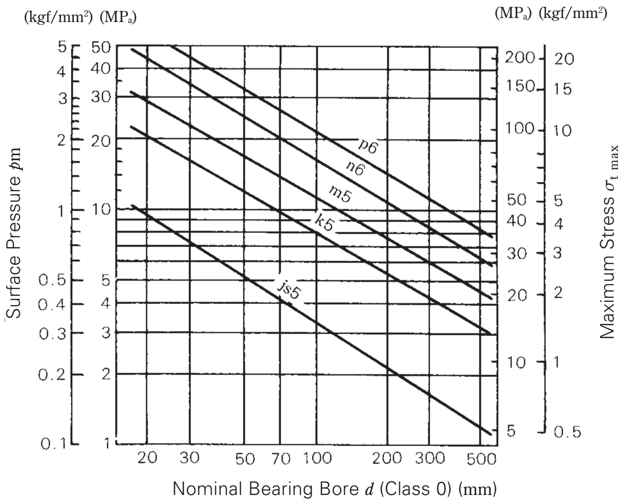


Fig. 8.3 Surface Pressure p_m and Maximum Stress $\sigma_{t\ max}$ for Mean Interference in Various Tolerance Grades

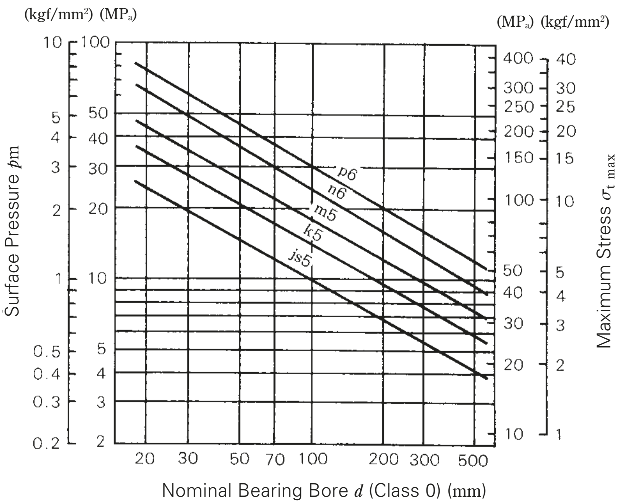


Fig. 8.4 Surface Pressure p_m and Maximum Stress $\sigma_{t\ max}$ for Maximum Interference in Various Tolerance Grades

(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).

$$K=\mu\, p_m\, \pi\, d\, B \text{ (N), \{kgf\}} \quad \cdots\cdots (\mathbf{8.6})$$

where μ: Coefficient of friction between fitting surfaces
μ=0.12 (for press-fitting)
μ=0.18 (for withdrawal)

p_m: Surface pressure (MPa), {kgf/mm²}
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)

Δd: Effective interference (mm)

E: Young's modulus of steel (MPa), {kgf/mm²}
E=208 000 MPa {21 200 kgf/mm²}

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:

$$\left.\begin{aligned} K &= 118\,000\mu\, \Delta d\, B \text{ (N)} \\ &= 12\,000\mu\, \Delta d\, B \text{ \{kgf\}} \end{aligned}\right\} \quad \cdots\cdots (\mathbf{8.7})$$

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.

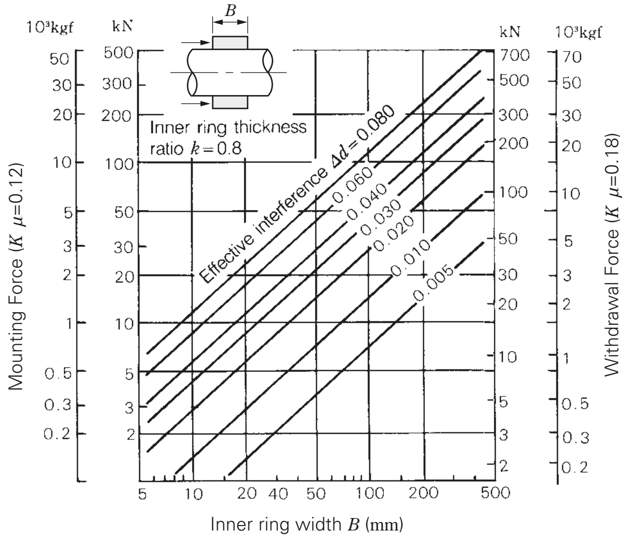


Fig. 8.5 Press-Fit and Withdrawal Forces for Inner Rings

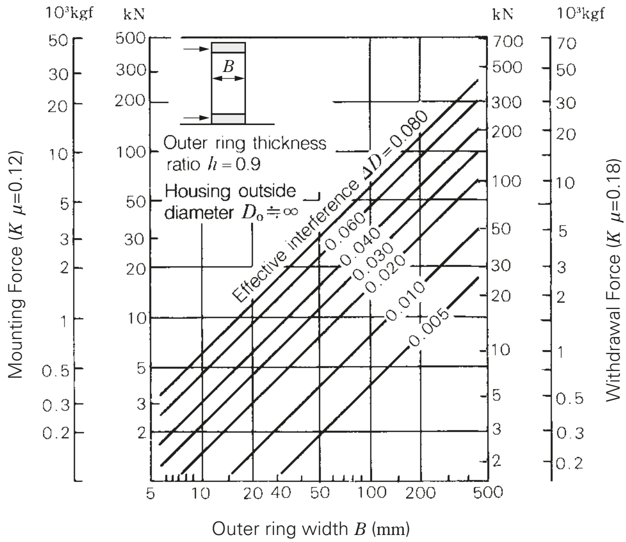


Fig. 8.6 Press-Fit and Withdrawal Forces for Outer Rings

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 (<$0.06C_r$([1]))	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 $0.13C_r$([1]))	General Bearing Applications, Medium and Large Motors([3]), Turbines, Pumps, Engine Main Bearings, Gears, Woodworking Machines	<18	—	—	js5 or js6 (j5 or j6)	
			18 to 100	<40	<40	k5 or k6	k6 and m6 can be used for single-row tapered roller bearings and single-row angular contact ball bearings instead of k5 and m5.
			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 (>$0.13C_r$([1]))	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([2])	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([2])	

Notes ([1]) C_r represents the basic load rating of the bearing.
([2]) Refer to Appendix Table 11 on Page E016 for the values of IT standard tolerance grades.
([3]) 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			
		Normal or Heavy Loads	Pumps Crankshaft Main Bearings Medium and Large Motors(1)	K7	Generally Impossible	If axial displacement of the outer ring is not required.
Solid or Split Housings		Normal or Light Loads		JS7 (J7)	Possible	Axial displacement of outer ring is necessary.
	Rotating Inner Ring Load	Any Kind of Load	General Bearing Applications, Railway Axleboxes	H7	Easily possible	—
		Normal or Light Loads	Plummer Blocks	H8		
		High Temperature Rise of Inner Ring Through Shaft	Paper Dryers	G7		
Solid Housing		Accurate Running Required Under Normal or Light Loads	Grinding Spindle Rear Ball Bearings High Speed Centrifugal Compessor Free Bearings	JS6 (J6)	Possible	—
	Indeterminate Direction of Load		Grinding Spindle Front Ball Bearings High Speed Centrifugal Compressor Fixed Bearings	K6	Generally Impossible	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.
	Rotating Inner Ring Load	Accurate Running and High Rigidity Required Under Variable Loads	Cylindrical Roller Bearings for Machine Tool Main Spindle	M6 or N6	Impossible	
		Minimal noise is required.	Electrical Home Appliances	H6	Easily Possible	—

Note (1) 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 : μm

Operating Conditions		Nominal Bore Diameters d				Bore Diameter Tolerances Δ_{ds}		Shaft Diameter Tolerances		Remarks
		over		incl.						
		(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	
Rotating Inner Ring Loads	Normal Loads	—		76.200	3.0000	+13	0	+ 38	+ 25	For bearings with d≦152.4 mm, clearance is usually larger than CN.
		76.200	3.0000	304.800	12.0000	+25	0	+ 64	+ 38	
		304.800	12.0000	609.600	24.0000	+51	0	+127	+ 76	
		609.600	24.0000	914.400	36.0000	+76	0	+190	+114	
	Heavy Loads Shock Loads High Speeds	—		76.200	3.0000	+13	0	+ 64	+ 38	In general, bearings with a clearance larger than CN are used. ※ indicates that the average interference is about 0.0005 d.
		76.200	3.0000	304.800	12.0000	+25	0	※		
		304.800	12.0000	609.600	24.0000	+51	0	※		
		609.600	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.
		76.200	3.0000	304.800	12.0000	+25	0	+ 25	0	
		304.800	12.0000	609.600	24.0000	+51	0	+ 51	0	
		609.600	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.
		76.200	3.0000	304.800	12.0000	+25	0	0	− 25	
		304.800	12.0000	609.600	24.0000	+51	0	0	− 51	
		609.600	24.0000	914.400	36.0000	+76	0	0	− 76	

(2) Bearings of Precision Classes 3 and 0 (1)

Units : μm

Operating Conditions		Nominal Bore Diameters d				Bore Diameter Tolerances Δ_{ds}		Shaft Diameter Tolerances		Remarks
		over		incl.						
		(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	
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 (1) 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 : μm

Operating Conditions		Nominal Outside Diameters D over (mm)	over 1/25.4	incl. (mm)	incl. 1/25.4	Outside Diameter Tolerances Δ_{Ds} high	low	Housing Bore Diameter Tolerances high	low	Remarks
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	
		609.600	24.0000	914.400	36.0000	+76	0	+229	+152	
	The outer ring position can be adjusted axially.	—		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	
		609.600	24.0000	914.400	36.0000	+76	0	+127	+ 51	
	The outer ring position cannot be adjusted axially.	—		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	
		609.600	24.0000	914.400	36.0000	+76	0	− 25	−102	
Rotating Outer Ring Loads	Normal Loads The outer ring position cannot be adjusted axially.	—		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 (1)

Units : μm

Operating Conditions		Nominal Outside Diameters D over (mm)	over 1/25.4	incl. (mm)	incl. 1/25.4	Outside Diameter Tolerances Δ_{Ds} high	low	Housing Bore Diameter Tolerances high	low	Remarks
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 (1) 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.

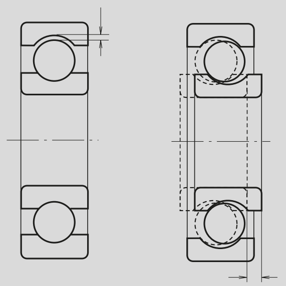


Fig. 8.7 Bearing Internal Clearance

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	For Motors	8.14.2	A170
Cylindrical Roller Bearings	With Cylindrical Bores With Cylindrical Bores (Matched) With Tapered Bores (Matched)	8.15	A171
Spherical Roller Bearings	With Cylindrical Bores With Tapered Bores	8.16	A172
Double-Row and Combined Tapered Roller Bearings		8.17	A173
Combined Angular Contact Ball Bearings (1)		8.18	A174
Four-Point-Contact Ball Bearings (1)		8.19	A174

Note (1) Values given are axial internal clearances.

Table 8.10 Radial Internal Clearances in Deep Groove Ball Bearings

Units : m

Nominal Bore Diameter *d* (mm)		Clearance									
		C2		CN		C3		C4		C5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
10 only		0	7	2	13	8	23	14	29	20	37
10	**18**	0	9	3	18	11	25	18	33	25	45
18	**24**	0	10	5	20	13	28	20	36	28	48
24	**30**	1	11	5	20	13	28	23	41	30	53
30	**40**	1	11	6	20	15	33	28	46	40	64
40	**50**	1	11	6	23	18	36	30	51	45	73
50	**65**	1	15	8	28	23	43	38	61	55	90
65	**80**	1	15	10	30	25	51	46	71	65	105
80	**100**	1	18	12	36	30	58	53	84	75	120
100	**120**	2	20	15	41	36	66	61	97	90	140
120	**140**	2	23	18	48	41	81	71	114	105	160
140	**160**	2	23	18	53	46	91	81	130	120	180
160	**180**	2	25	20	61	53	102	91	147	135	200
180	**200**	2	30	25	71	63	117	107	163	150	230
200	**225**	2	35	25	85	75	140	125	195	175	265
225	**250**	2	40	30	95	85	160	145	225	205	300
250	**280**	2	45	35	105	90	170	155	245	225	340
280	**315**	2	55	40	115	100	190	175	270	245	370
315	**355**	3	60	45	125	110	210	195	300	275	410
355	**400**	3	70	55	145	130	240	225	340	315	460
400	**450**	3	80	60	170	150	270	250	380	350	510
450	**500**	3	90	70	190	170	300	280	420	390	570
500	**560**	10	100	80	210	190	330	310	470	440	630
560	**630**	10	110	90	230	210	360	340	520	490	690
630	**710**	20	130	110	260	240	400	380	570	540	760
710	**800**	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 : m

Nominal Bore Dia. *d* (mm)		Measuring Load		Radial Clearance Correction Amount				
over	incl.	(N)	{kgf}	C2	CN	C3	C4	C5
10 (incl)	**18**	24.5	{2.5}	3 to 4	4	4	4	4
18	**50**	49	{5}	4 to 5	5	6	6	6
50	**280**	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 : m

Clear-ance Symbol	MC1		MC2		MC3		MC4		MC5		MC6	
Clear-ance	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 : m

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 : m

Nominal Bore Diameter *d* (mm)		Bearing Series	Clearance	
over	incl.		min.	max.
2.5	**30**	EN	10	50
		E	30	60

Table 8.13 Radial Internal Clearances in Self-Aligning Ball Bearings

Units : μm

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.
2.5	**6**	1	8	5	15	10	20	15	25	21	33	—	—	—	—	—	—	—	—	—	—
6	**10**	2	9	6	17	12	25	19	33	27	42	—	—	—	—	—	—	—	—	—	—
10	**14**	2	10	6	19	13	26	21	35	30	48	—	—	—	—	—	—	—	—	—	—
14	**18**	3	12	8	21	15	28	23	37	32	50	—	—	—	—	—	—	—	—	—	—
18	**24**	4	14	10	23	17	30	25	39	34	52	7	17	13	26	20	33	28	42	37	55
24	**30**	5	16	11	24	19	35	29	46	40	58	9	20	15	28	23	39	33	50	44	62
30	**40**	6	18	13	29	23	40	34	53	46	66	12	24	19	35	29	46	40	59	52	72
40	**50**	6	19	14	31	25	44	37	57	50	71	14	27	22	39	33	52	45	65	58	79
50	**65**	7	21	16	36	30	50	45	69	62	88	18	32	27	47	41	61	56	80	73	99
65	**80**	8	24	18	40	35	60	54	83	76	108	23	39	35	57	50	75	69	98	91	123
80	**100**	9	27	22	48	42	70	64	96	89	124	29	47	42	68	62	90	84	116	109	144
100	**120**	10	31	25	56	50	83	75	114	105	145	35	56	50	81	75	108	100	139	130	170
120	**140**	10	38	30	68	60	100	90	135	125	175	40	68	60	98	90	130	120	165	155	205
140	**160**	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 : μm

Nominal Bore Dia. *d* (mm)		Clearance		Remarks	
		CM		Recommended fit	
over	incl.	min.	max.	Shaft	Housing Bore
10 (incl)	**18**	4	11	js5 (j5)	H6, H7[1] or JS6, JS7 (J6, J7)[2]
18	**30**	5	12	k5	
30	**50**	9	17		
50	**80**	12	22		
80	**100**	18	30		
100	**120**	18	30	m5	
120	**160**	24	38		

Notes ([1]) Applicable to outer rings that require movement in the axial direction.
([2]) 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 : μm

Nominal Bore Dia. *d* (mm)		Clearance				Remarks	
		Interchangeable CT		Non-Interchangeable CM		Recommended Fit	
over	incl.	min.	max.	min.	max.	Shaft	Housing Bore
24	**40**	15	35	15	30	k5	JS6, JS7 (J6, J7)[1] or K6, K7[2]
40	**50**	20	40	20	35	m5	
50	**65**	25	45	25	40		
65	**80**	30	50	30	45		
80	**100**	35	60	35	55		
100	**120**	35	65	35	60		
120	**140**	40	70	40	65		
140	**160**	50	85	50	80		
160	**180**	60	95	60	90	n6	
180	**200**	65	105	65	100		

Notes ([1]) Applicable to outer rings that require movement in the axial direction.
([2]) 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 : μm

Nominal Bore Dia. *d* (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	75
24	**30**	0	25	20	45	35	60	50	75	70	95	5	15	10	25	25	35	40	50	50	60	70	80
30	**40**	5	30	25	50	45	70	60	85	80	105	5	15	12	25	25	40	45	55	55	70	80	95
40	**50**	5	35	30	60	50	80	70	100	95	125	5	18	15	30	30	45	50	65	65	80	95	110
50	**65**	10	40	40	70	60	90	80	110	110	140	5	20	15	35	35	50	55	75	75	90	110	130
65	**80**	10	45	40	75	65	100	90	125	130	165	10	25	20	40	40	60	70	90	90	110	130	150
80	**100**	15	50	50	85	75	110	105	140	155	190	10	30	25	45	45	70	80	105	105	125	155	180
100	**120**	15	55	50	90	85	125	125	165	180	220	10	30	25	50	50	80	95	120	120	145	180	205
120	**140**	15	60	60	105	100	145	145	190	200	245	10	35	30	60	60	90	105	135	135	160	200	230
140	**160**	20	70	70	120	115	165	165	215	225	275	10	35	35	65	65	100	115	150	150	180	225	260
160	**180**	25	75	75	125	120	170	170	220	250	300	10	40	35	75	75	110	125	165	165	200	250	285
180	**200**	35	90	90	145	140	195	195	250	275	330	15	45	40	80	80	120	140	180	180	220	275	315
200	**225**	45	105	105	165	160	220	220	280	305	365	15	50	45	90	90	135	155	200	200	240	305	350
225	**250**	45	110	110	175	170	235	235	300	330	395	15	50	50	100	100	150	170	215	215	265	330	380
250	**280**	55	125	125	195	190	260	260	330	370	440	20	55	55	110	110	165	185	240	240	295	370	420
280	**315**	55	130	130	205	200	275	275	350	410	485	20	60	60	120	120	180	205	265	265	325	410	470
315	**355**	65	145	145	225	225	305	305	385	455	535	20	65	65	135	135	200	225	295	295	360	455	520
355	**400**	100	190	190	280	280	370	370	460	510	600	25	75	75	150	150	225	255	330	330	405	510	585
400	**450**	110	210	210	310	310	410	410	510	565	665	25	85	85	170	170	255	285	370	370	455	565	650
450	**500**	110	220	220	330	330	440	440	550	625	735	25	95	95	190	190	285	315	410	410	505	625	720

Note (1) CC denotes normal clearance for noninterchangeable cylindrical roller bearings and solid needle roller bearings.

Units : μm

Nominal Bore Dia. *d* (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 : μm

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.
24	**30**	15	25	25	40	40	55	55	75	75	95	20	30	30	40	40	55	55	75	75	95
30	**40**	15	30	30	45	45	60	60	80	80	100	25	35	35	50	50	65	65	85	85	105
40	**50**	20	35	35	55	55	75	75	100	100	125	30	45	45	60	60	80	80	100	100	130
50	**65**	20	40	40	65	65	90	90	120	120	150	40	55	55	75	75	95	95	120	120	160
65	**80**	30	50	50	80	80	110	110	145	145	180	50	70	70	95	95	120	120	150	150	200
80	**100**	35	60	60	100	100	135	135	180	180	225	55	80	80	110	110	140	140	180	180	230
100	**120**	40	75	75	120	120	160	160	210	210	260	65	100	100	135	135	170	170	220	220	280
120	**140**	50	95	95	145	145	190	190	240	240	300	80	120	120	160	160	200	200	260	260	330
140	**160**	60	110	110	170	170	220	220	280	280	350	90	130	130	180	180	230	230	300	300	380
160	**180**	65	120	120	180	180	240	240	310	310	390	100	140	140	200	200	260	260	340	340	430
180	**200**	70	130	130	200	200	260	260	340	340	430	110	160	160	220	220	290	290	370	370	470
200	**225**	80	140	140	220	220	290	290	380	380	470	120	180	180	250	250	320	320	410	410	520
225	**250**	90	150	150	240	240	320	320	420	420	520	140	200	200	270	270	350	350	450	450	570
250	**280**	100	170	170	260	260	350	350	460	460	570	150	220	220	300	300	390	390	490	490	620
280	**315**	110	190	190	280	280	370	370	500	500	630	170	240	240	330	330	430	430	540	540	680
315	**355**	120	200	200	310	310	410	410	550	550	690	190	270	270	360	360	470	470	590	590	740
355	**400**	130	220	220	340	340	450	450	600	600	750	210	300	300	400	400	520	520	650	650	820
400	**450**	140	240	240	370	370	500	500	660	660	820	230	330	330	440	440	570	570	720	720	910
450	**500**	140	260	260	410	410	550	550	720	720	900	260	370	370	490	490	630	630	790	790	1 000
500	**560**	150	280	280	440	440	600	600	780	780	1 000	290	410	410	540	540	680	680	870	870	1 100
560	**630**	170	310	310	480	480	650	650	850	850	1 100	320	460	460	600	600	760	760	980	980	1 230
630	**710**	190	350	350	530	530	700	700	920	920	1 190	350	510	510	670	670	850	850	1 090	1 090	1 360
710	**800**	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
800	**900**	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
900	**1 000**	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
1 000	**1 120**	290	530	530	780	780	1 020	1 020	1 330	—	—	530	770	770	1 030	1 030	1 300	1 300	1 670	—	—
1 120	**1 250**	320	580	580	860	860	1 120	1 120	1 460	—	—	570	830	830	1 120	1 120	1 420	1 420	1 830	—	—
1 250	**1 400**	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 : μm

Nominal Bore Dia. d (mm)		Clearance											
Cylindrical Bore		C1		C2		CN		C3		C4		C5	
Tapered Bore		—		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 $\Delta_a = \Delta_r \cot\alpha \doteqdot \frac{1.5}{e}\Delta_r$

where Δ_r : Radial internal clearance
α : Contact angle
e : Constant (listed in bearing tables)

Table 8.18 Axial Internal Clearances in Combined Angular Contact Ball Bearings (Measured Clearance)

Units : μm

Nominal Bore Diameter. *d* (mm)		Axial Internal Clearance											
		Contact Angle 30°						Contact Angle 40°					
		CN		C3		C4		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
—	**10**	9	29	29	49	49	69	6	26	26	46	46	66
10	**18**	10	30	30	50	50	70	7	27	27	47	47	67
18	**24**	19	39	39	59	59	79	13	33	33	53	53	73
24	**30**	20	40	40	60	60	80	14	34	34	54	54	74
30	**40**	26	46	46	66	66	86	19	39	39	59	59	79
40	**50**	29	49	49	69	69	89	21	41	41	61	61	81
50	**65**	35	60	60	85	85	110	25	50	50	75	75	100
65	**80**	38	63	63	88	88	115	27	52	52	77	77	100
80	**100**	49	74	74	99	99	125	35	60	60	85	85	110
100	**120**	72	97	97	120	120	145	52	77	77	100	100	125
120	**140**	85	115	115	145	145	175	63	93	93	125	125	155
140	**160**	90	120	120	150	150	180	66	96	96	125	125	155
160	**180**	95	125	125	155	155	185	68	98	98	130	130	160
180	**200**	110	140	140	170	170	200	80	110	110	140	140	170

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 : μm

Nominal Bore Dia. *d* (mm)		Axial Internal Clearance					
		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.
10	**18**	45	85	75	125	115	165
18	**40**	56	106	96	146	136	186
40	**60**	76	126	116	166	156	206
60	**80**	86	136	126	176	166	226
80	**100**	96	156	136	196	186	246
100	**140**	116	176	156	216	206	266
140	**180**	136	196	176	246	226	296
180	**220**	156	226	206	276	256	326
220	**260**	175	245	225	305	285	365
260	**300**	195	275	255	335	315	395
300	**350**	215	305	275	365	345	425
350	**400**	245	335	315	405	385	475
400	**500**	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 ($P \doteqdot 0.1C_r$), 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 $\varDelta_0$ is called the residual clearance $\varDelta_f$.

(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:

$$\delta_t \fallingdotseq \alpha \Delta_t D_e \qquad \text{(8.8)}$$

where δ_t : Decrease in radial clearance due to temperature difference between inner and outer rings (mm)

α : Coefficient of linear expansion of bearing steel $\fallingdotseq 12.5\times10^{-6}$ (1/°C)

Δ_t : Temperature difference between inner and outer rings (°C)

D_e : Outer ring raceway diameter (mm)

For ball bearings

$$D_e \fallingdotseq \frac{1}{5}(4D+d) \qquad \text{(8.9)}$$

For roller bearings

$$D_e \fallingdotseq \frac{1}{4}(3D+d) \qquad \text{(8.10)}$$

The clearance after subtracting δ_t from the residual clearance Δ_f is called the effective clearance Δ. 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.

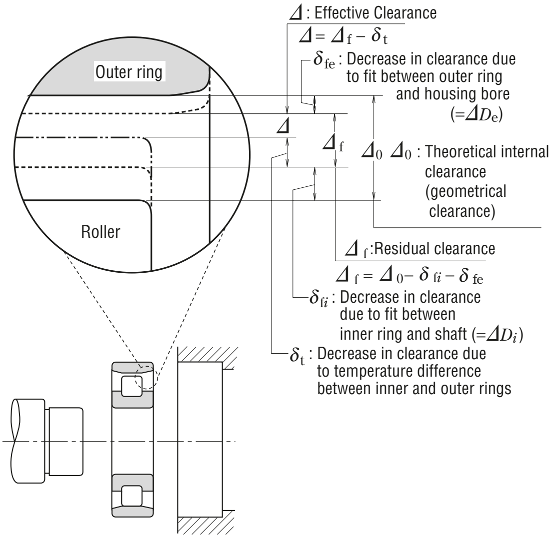


Fig. 8.8 Changes in Radial Internal Clearance of Bearings

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	C3, C4
	Table rollers for rolling mills	C3
When impact loads and vibration are severe or when both the inner and outer rings are tight-fitted	Traction motors for railways	C4
	Vibrating screens	C3, C4
	Fluid couplings	C4
	Final reduction gears for tractors	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 Δl due to temperature rise can be expressed as Equation (8.11) below:

$$\Delta l = \Delta T \, \alpha \, l \text{ (mm)} \qquad \text{(8.11)}$$

where,
- Δl: Dimensional change (mm)
- ΔT: Temperature rise (°C)
- α: Coefficient of linear expansion for bearing steel $\alpha = 12.5 \times 10^{-6}$ (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 Δl = 0.105 and the horizontal axis when l = 110 can be determined. ΔT is located in the temperature range between 70 °C and 80 °C ($\Delta T \fallingdotseq 77$°C). Therefore, it's sufficient to set the inner ring heating temperature to the room temperature +80 °C.

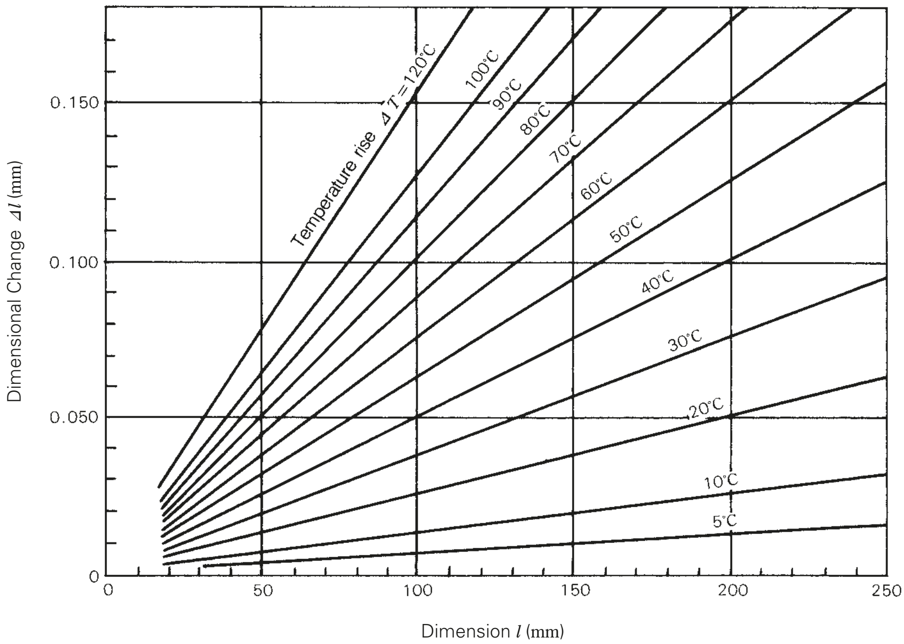


Fig. 8.9 Temperature Rise and Dimensional Change of Bearing Steel

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 ΔD_T of a bearing's outer ring due to temperature rise is expressed by the following equation:

$$\Delta D_T=(\alpha_1 \cdot \Delta T_1-\alpha_2 \cdot \Delta T_2)D \ (\mathrm{mm}) \quad \cdots\cdots (\mathbf{8.12})$$

where
- ΔD_T: Change of clearance or interference at fitting surface due to temperature rise
- α_1: Coefficient of linear expansion of housing (1/°C)
- ΔT_1: Housing temperature rise near fitting surface (°C)
- α_2: Coefficient of linear expansion of bearing outer ring
  Bearing steel .... α_2=12.5×10^{-6} (1/°C)
- ΔT_2: Outer ring temperature rise near fitting surface (°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 ($\Delta T_1 \fallingdotseq \Delta T_2 = \Delta T$), Equation (8.12) becomes Equation (8.13):

$$\Delta D_T=(\alpha_1-\alpha_2)\ \Delta T \cdot D \ (\mathrm{mm}) \quad \cdots\cdots (\mathbf{8.13})$$

where ΔT: Temperature rise of outer ring and housing near fitting surfaces (°C)

Equation (8.13) for aluminum housings (α_1 = 23.7 × 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 9×10^{-5}. Equation (8.13) for polyacetal-resin housings can be expressed as Fig. 8.11.

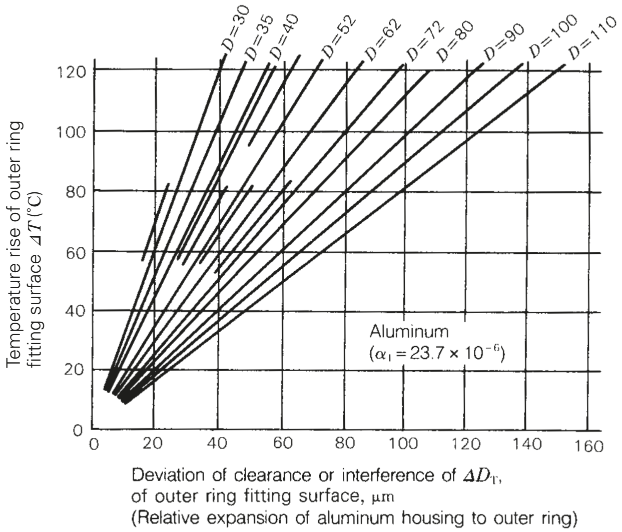


Fig. 8.10 Aluminum Housing

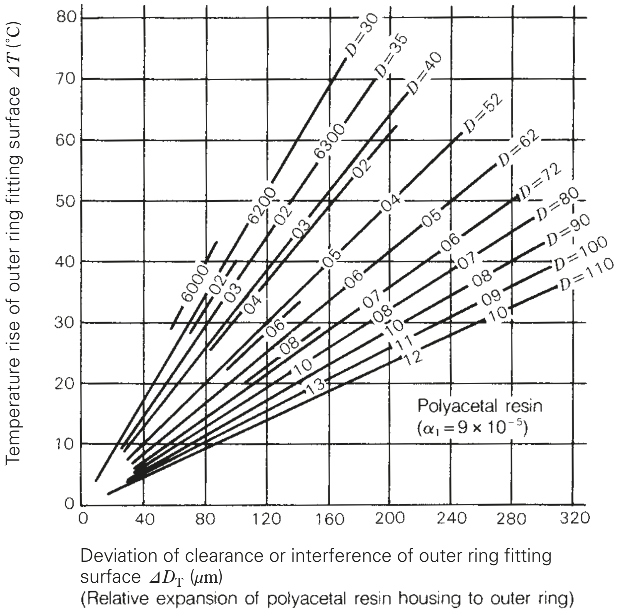


Fig. 8.11 Polyacetal-Resin Housing

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 $m_{\Delta f}$ and standard deviation of the internal clearance after mounting (residual clearance) $\sigma_{\Delta f}$ can be calculated. Measurements are given in millimeters (mm).

$$\sigma_s = \frac{R_s/2}{3} = 0.0018$$

$$\sigma_i = \frac{R_i/2}{3} = 0.0020$$

$$\sigma_{\Delta 0} = \frac{R_{\Delta 0}/2}{3} = 0.0028$$

$$\sigma_f^2 = \sigma_s^2 + \sigma_i^2$$

$$m_{\Delta f} = m_{\Delta 0} - \lambda_i\ (m_s - m_i) = 0.0035$$

$$\sigma_{\Delta f} = \sqrt{\sigma_{\Delta 0}^2 + \lambda_i^2\ \sigma_f^2} = 0.0035$$

where, σ_s: Standard deviation of shaft diameter
σ_i: Standard deviation of bore diameter
σ_f: Standard deviation of interference
$\sigma_{\Delta 0}$: Standard deviation of radial clearance (before mounting)
$\sigma_{\Delta f}$: Standard deviation of residual clearance (after mounting)
m_s: Mean value of shaft diameter (ϕ50+0.008)
m_i: Mean value of bore diameter (ϕ50–0.006)
$m_{\Delta 0}$: Mean value of radial clearance (before mounting) (0.014)
$m_{\Delta f}$: Mean value of residual clearance (after mounting)
R_s: Shaft tolerance (0.011)
R_i: Bearing bore tolerance (0.012)
$R_{\Delta 0}$: Range in radial clearance (before mounting) (0.017)
λ_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 $R_{\Delta f}$, use the following equation:

$$R_{\Delta f} = m_{\Delta f} \pm 3\sigma_{\Delta f} = +0.014 \text{ to } -0.007$$

In other words, the mean value of residual clearance ($m_{\Delta f}$) is +0.0035, and the range is from −0.007 to +0.014 for bearing 6310.

Units : mm

Shaft diameter	ϕ50 $^{+0.013}_{+0.002}$
Bearing bore diameter, (d)	ϕ50 $^{0}_{-0.012}$
Radial internal clearance (Δ_0)	0.006 to 0.023(1)

Note (1) Standard internal clearance, unmounted

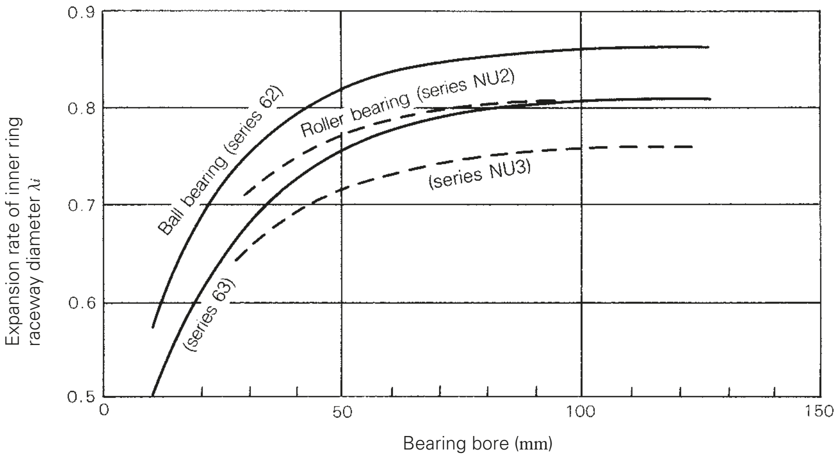


Fig. 8.12 λ_i **: Rate of Inner Ring Raceway Expansion From Apparent Interference**

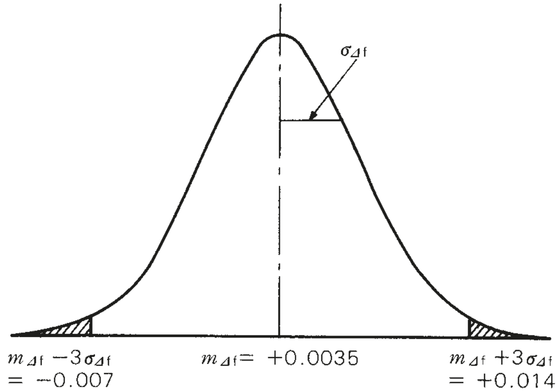


Fig. 8.13 Distribution of Residual Internal Clearance

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 ΔD_i is given in Equation (8.14) below:

$$\Delta D_i=\Delta d\ k\ \frac{1-k_0^{\ 2}}{1-k^2\ k_0^{\ 2}} \cdots\cdots\cdots\cdots\cdots\cdots (\mathbf{8.14})$$

where, Δd: 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 μm, the amount of raceway expansion, or, the amount of decrease in the radial clearance from the fit is 0.73 × 30 = 22 μm.

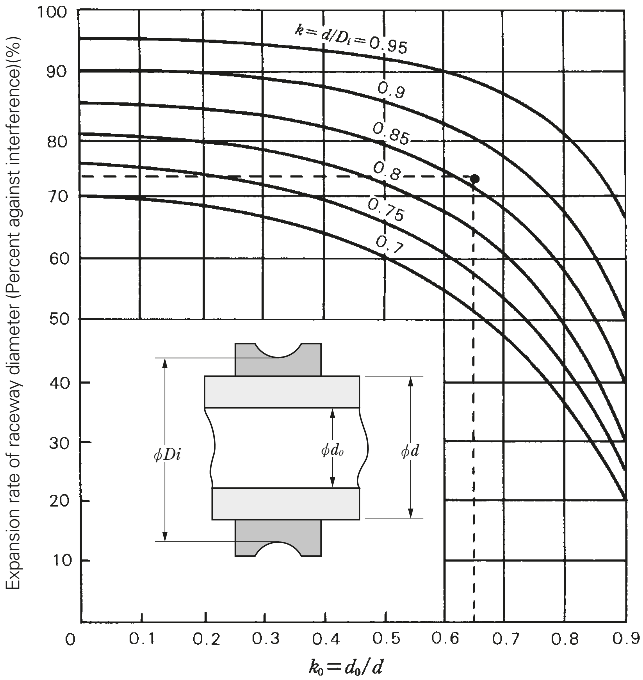


Fig. 8.14 Raceway Expansion in Relation to Bearing Fit (Inner Ring Fit on Steel Shaft)

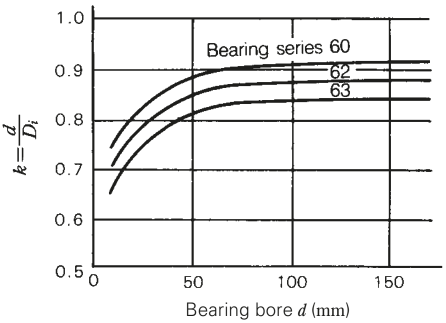


Fig. 8.15 Ratio of Bore Size to Raceway Diameter for Single-Row Deep Groove Ball Bearings

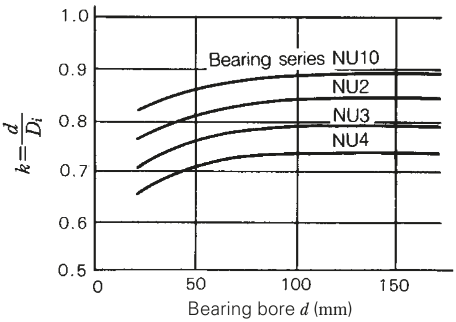


Fig. 8.16 Ratio of Bore Size to Raceway Diameter for Cylindrical Roller Bearings

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 $\varDelta D_e$ is calculated using Equation (8.15) below:

$$\varDelta D_e = \varDelta D \cdot h \frac{1-h_0^2}{1-h^2 h_0^2} \cdots\cdots\cdots (\mathbf{8.15})$$

where $\varDelta D$: 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 μm, the contraction of the outer raceway, or decrease in radial clearance is 0.71 × 18 ≒13 μm.

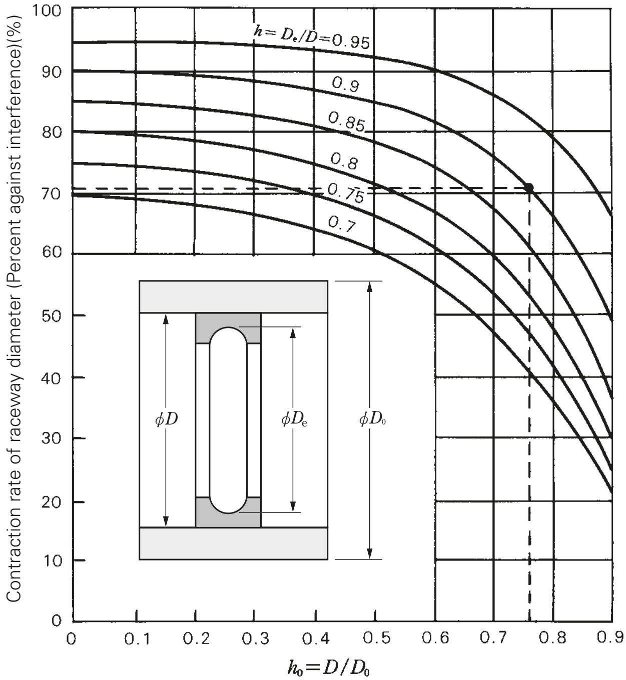


Fig. 8.17 Raceway Contraction in Relation to Bearing Fit (Outer Ring Fit in Steel Housing)

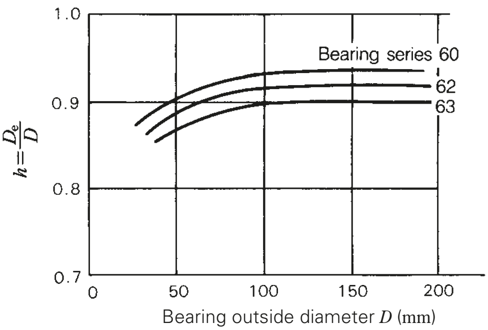


Fig. 8.18 Ratio of Outside Diameter to Raceway Diameter for Single-Row Deep Groove Ball Bearings

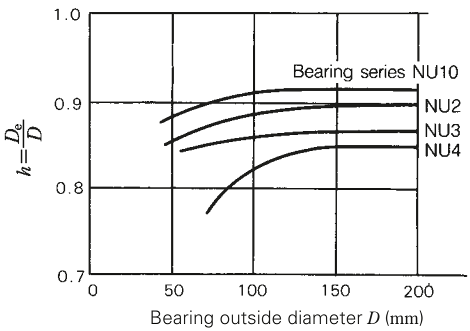


Fig. 8.19 Ratio of Outside Diameter to Raceway Diameter for Cylindrical Roller Bearings

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 Δ_a of the arrangement can be obtained by Equation (8.16):

$$\Delta_a=(L-K)-(f_A+f_B) \quad \cdots\cdots (\mathbf{8.16})$$

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 Δ_r=110 to 140 μm.
To compare this specification with the offset measurement results, convert it into axial clearance Δ_a by using Equation (8.17):

$$\Delta_a=\Delta_r\cot\alpha \doteqdot \Delta_r\frac{1.5}{e} \quad \cdots\cdots (\mathbf{8.17})$$

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:

$$\Delta_a=(110 \text{ to } 140)\times\frac{1.5}{e}$$
$$\doteqdot 380 \text{ to } 480\ \mu\text{m}$$

We can confirm that the bearing clearance is C3 by verifying that the axial clearance Δ_a of Equation (8.16) (obtained by the bearing offset measurement) is within the above-mentioned range.

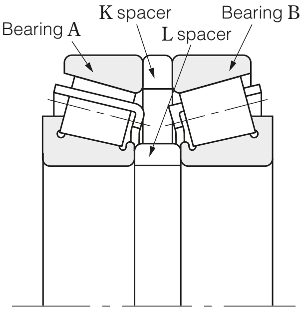


Fig. 8.20 DB **Arrangement**

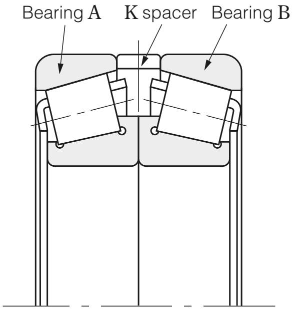


Fig. 8.21 DF **Arrangement**

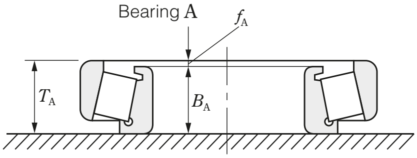


Fig. 8.22

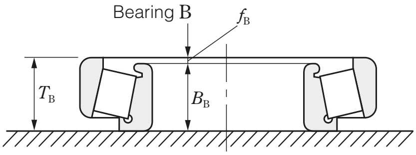


Fig. 8.23

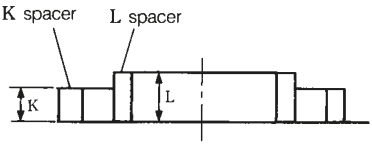


Fig. 8.24

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 Δ_r and axial clearance Δ_a is as follows:

$$\Delta_a = \Delta_r \cot\alpha \fallingdotseq \Delta_r \frac{1.5}{e}$$

where α: 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.

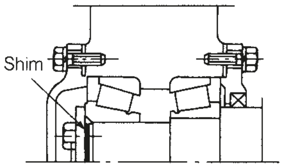


Fig. 8.25 DB Arrangement With Clearance Adjusted by Inner Rings.

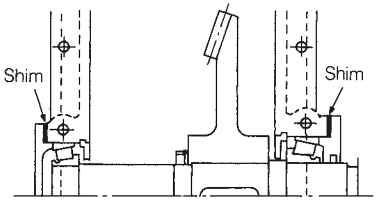


Fig. 8.26 DF Arrangement With Clearance Adjusted by Outer Rings.

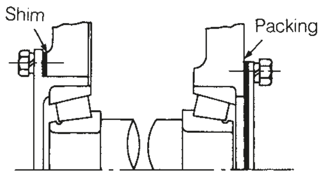


Fig. 8.27 Clearance Adjusted by Shim Thickness of Outer Ring Cover

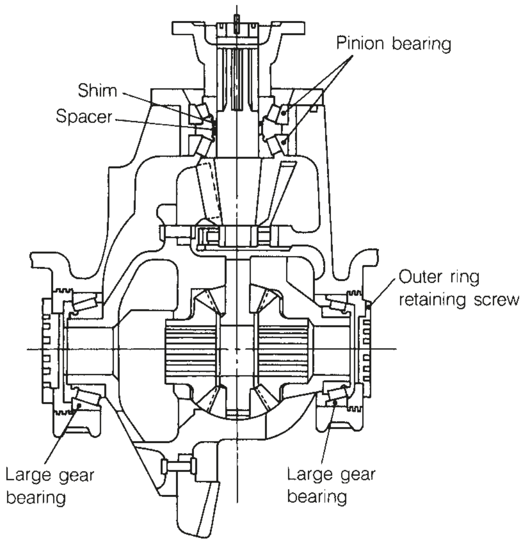


Fig. 8.28 Automotive Final Reduction Gear

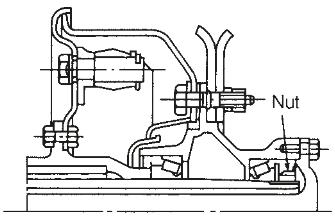


Fig. 8.29 Rear Wheel of Truck

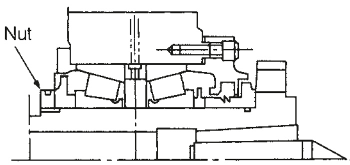


Fig. 8.30 Head Spindle of Lathe

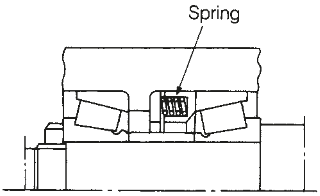
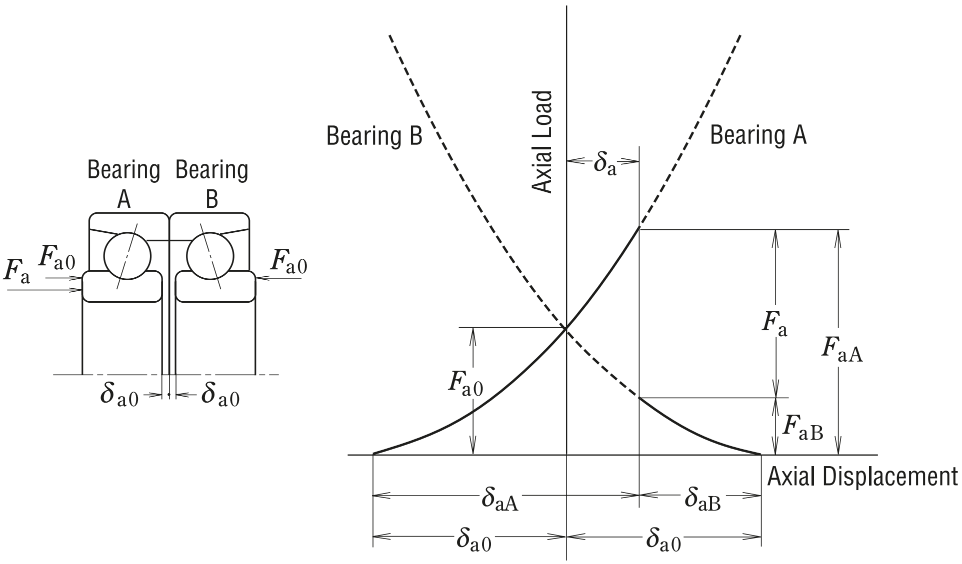


Fig. 8.31 Constant-Pressure Preload Applied by Spring


Bearing A
Bearing B
F_a
F_{a0}
F_{a0}
δ_{a0}
δ_{a0}
Bearing B
Axial Load
Bearing A
δ_a
F_a
F_{aA}
F_{a0}
F_{aB}
Axial Displacement
δ_{aA}
δ_{aB}
δ_{a0}
δ_{a0}

9. PRELOAD

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).

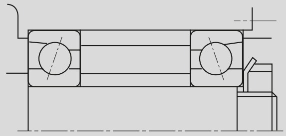


Fig. 9.1 Position Preload

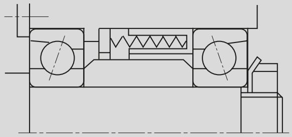


Fig. 9.2 Constant-Pressure Preload

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 δ_{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.

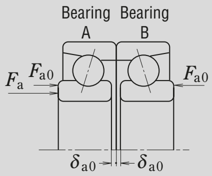


Fig. 9.3 Preloaded Back-to-Back Arrangement

9.3.2 Constant-Pressure Preload and Rigidity

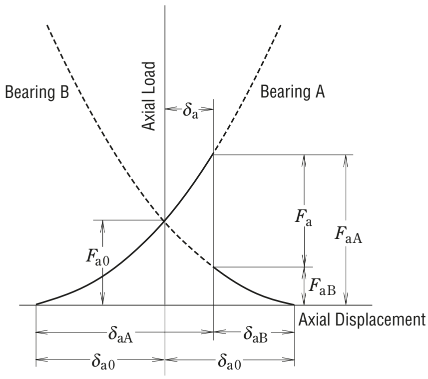
A preload diagram for paired mountings under constant-pressure preload is shown in Fig. 9.5. The deflection curve of the spring is nearly parallel to the horizontal axis because the rigidity of the spring is lower than that of the bearing. As a result, rigidity under a constant-pressure preload is approximately 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.



F_a : Axial load applied from outside the bearing
F_{aA}: Axial load imposed on Bearing A
F_{aB}: Axial load imposed on Bearing B
δ_a : Displacement of paired mounting
δ_{aA} : Displacement of Bearing A
δ_{aB} : Displacement of Bearing B

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.

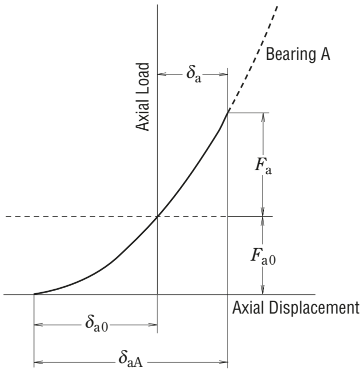


Fig. 9.5 Axial Displacement With Constant-Pressure Preload

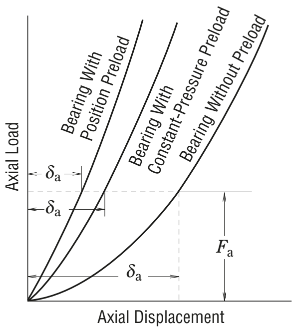


Fig. 9.6 Comparison of Rigidities and Preloading Methods

9.5 Amount of Preload

If the preload is larger than necessary, abnormal heart 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 : 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 (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)
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 (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)	Preload (N)	Axial Clearance (μm)
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)	(μm)	(N)	(μm)	(N)	(μm)	(N)	(μm)
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:

$$F_{a\,min}=\frac{C_{0a}}{100}\left(\frac{n}{N_{max}}\right)^2 \quad\cdots\cdots\cdots\cdots\cdots\cdots \ (\mathbf{9.1})$$

$$F_{a\,min}=\frac{C_{0a}}{1000} \quad\cdots\cdots\cdots\cdots\cdots\cdots \ (\mathbf{9.2})$$

where $F_{a\,min}$: Minimum axial load (N), {kgf}
C_{0a} : Basic static load rating (N), {kgf}
n : Speed (min^{-1})
N_{max} : Limiting speed (oil lubrication) (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:

$$F_{a\,min}=\frac{C_{0a}}{1000} \quad\cdots\cdots\cdots\cdots\cdots\cdots \ (\mathbf{9.3})$$

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 δ_{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 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.

$$\delta_a = c\,F_a^{2/3} \qquad \textbf{(9.4)}$$

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 δ_{a0A} and δ_{a0B} respectively and the clearance (between the inner rings) δ_{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 δ_{a1} and the displacement of B-side bearing will be reduced to the same amount as the A-side bearing displacement δ_{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 $F_{a0} - F_a'$.

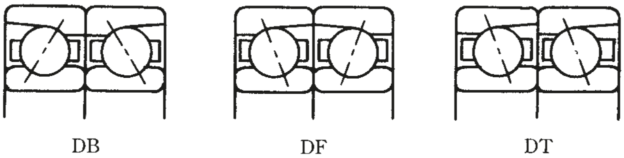


Fig. 9.7 Paired Mounting Bearing Arrangements

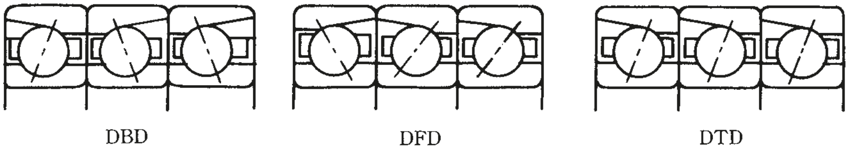


Fig. 9.8 Triplex Bearing Arrangements

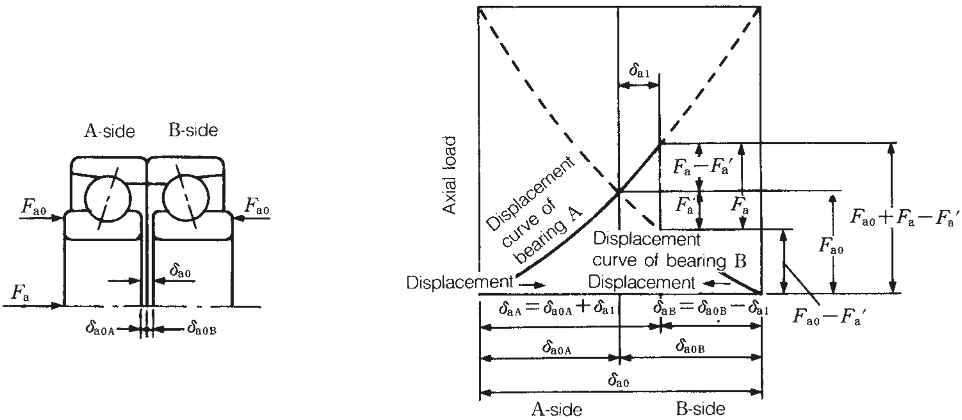


Fig. 9.9 Preload Graph of DB Back-to-Back Arrangement

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 δ_{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	$\delta_{a0B}-\delta_{a1}$	$F_{a0}-F_a'$

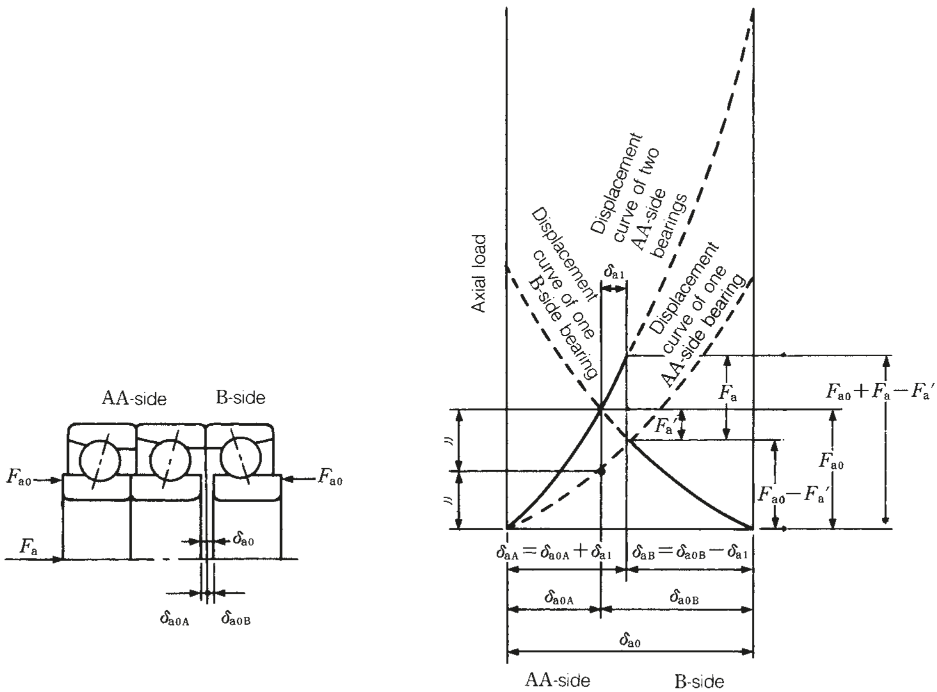


Fig. 9.10 Preload Graph for a DBD Arrangement (Axial Load Applied From the AA-Side)

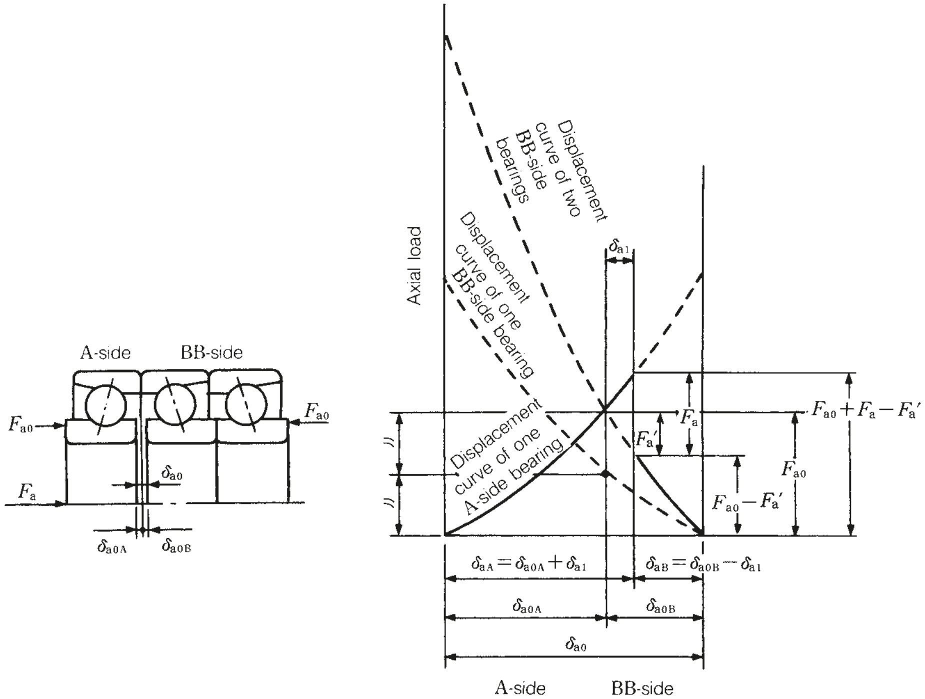


Fig. 9.11 Preload Graph for a DBD Arrangement (Axial Load Applied From A-Side)

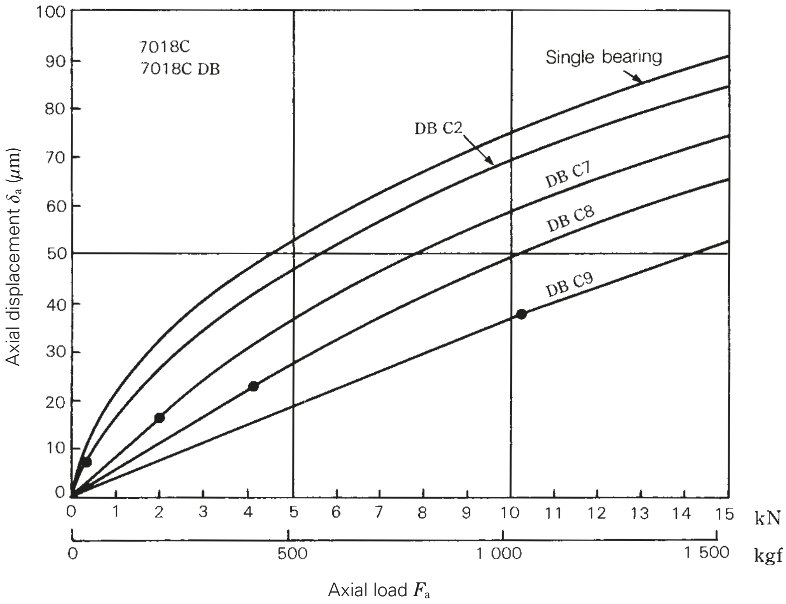


Fig. 9.12

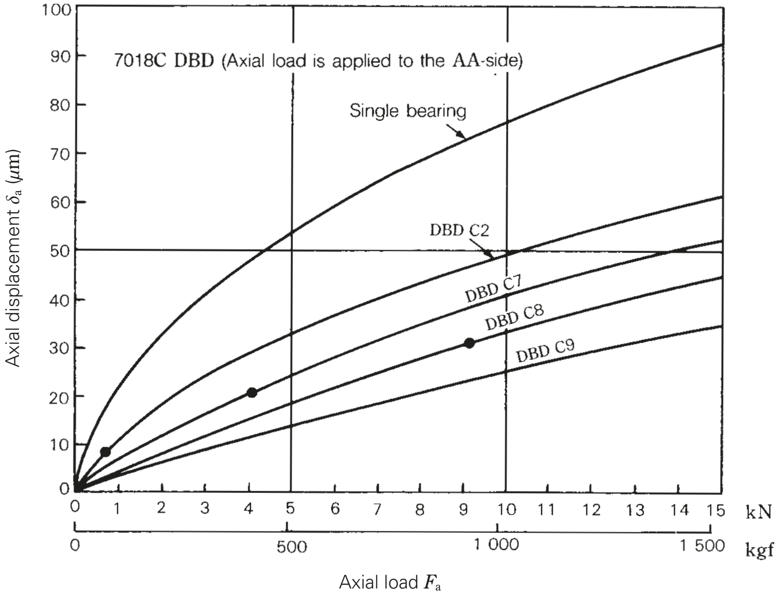


Fig. 9.13

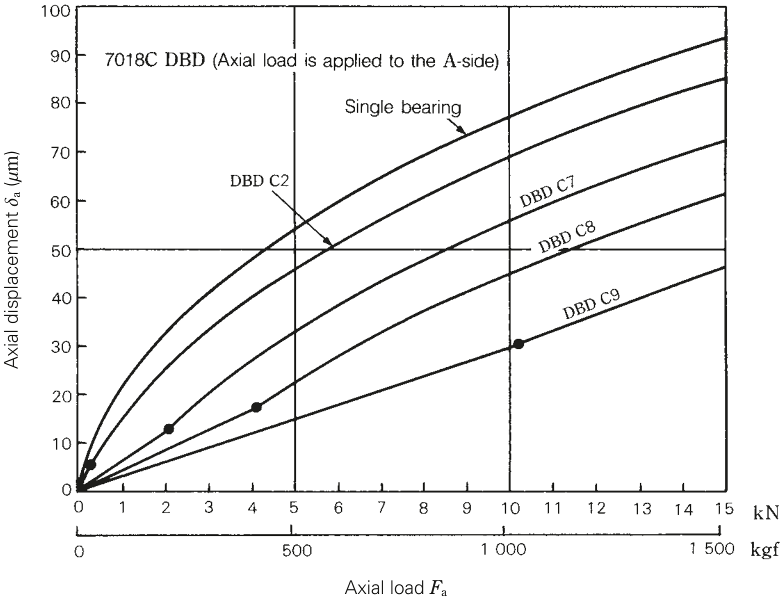


Fig. 9.14

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.

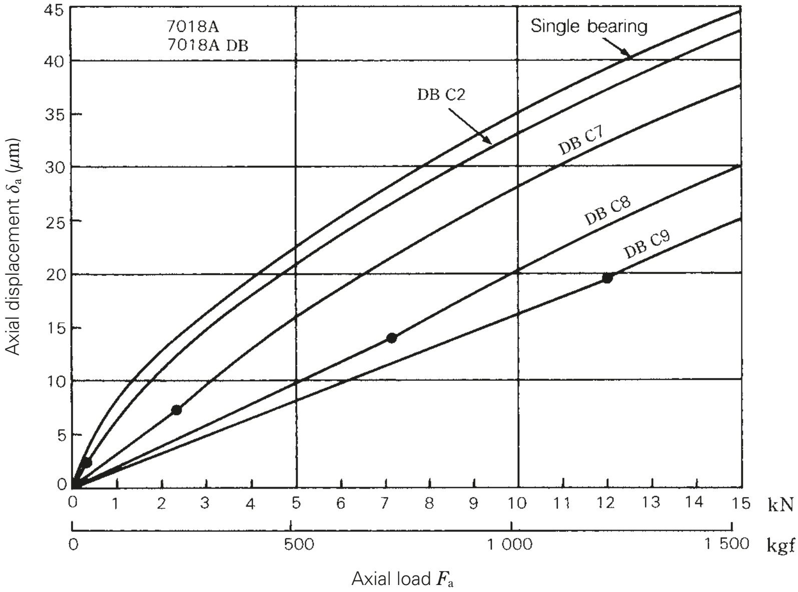


Fig. 9.15

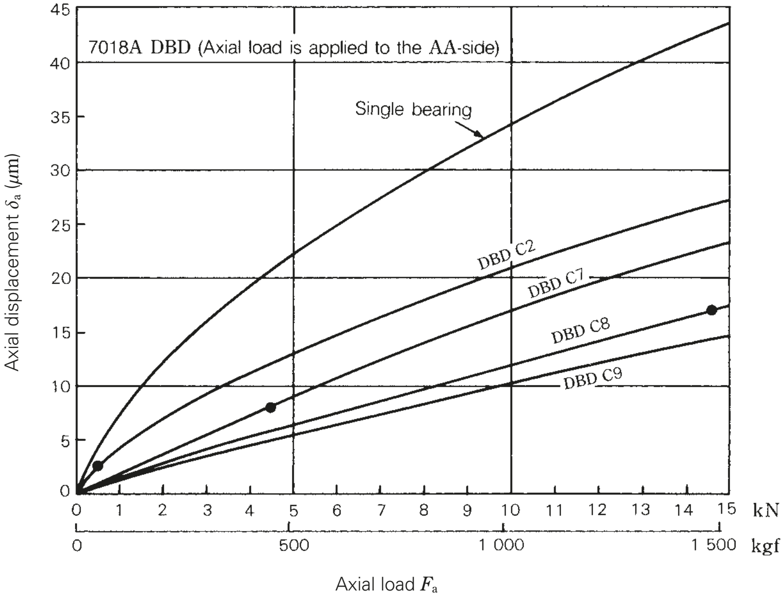


Fig. 9.16

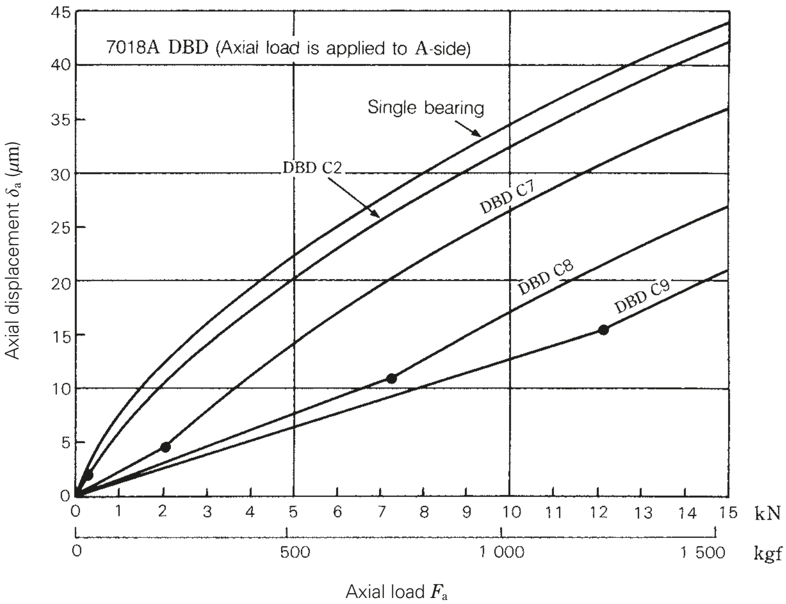


Fig. 9.17

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 α_0 and the inner ring is displaced δ_a, the center of the inner ring raceway radius Oi is also moved to Oi' resulting in contact angle α as shown in Fig. 9.18. If δ_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.

$$(m_0+\delta_N)^2=(m_0\cdot\sin\alpha_0+\delta_a)^2+(m_0\cdot\cos\alpha_0)^2$$

$$\therefore\ \delta_N=m_0\left\{\sqrt{\left(\sin\alpha_0+\frac{\delta_a}{m_0}\right)^2+\cos^2\alpha_0}-1\right\} \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.5})$$

In addition, the following relationship exists between rolling element load Q and elastic deformation δ_N.

$$Q=K_N\cdot\delta_N^{3/2} \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.6})$$

where K_N: Constant depending on bearing material, type, and dimensions

If we introduce the relation of

$$m_0=\left(\frac{r_e}{D_w}+\frac{r_i}{D_w}-1\right)D_w=B\cdot D_w$$

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 $h=\dfrac{\delta_a}{m_0}=\dfrac{\delta_a}{B\cdot D_w}$

If we introduce the relation of $K_N=K\cdot\dfrac{\sqrt{D_w}}{B^{3/2}}$

$$Q=K\cdot D_w^2\left\{\sqrt{(\sin\alpha_0+h)^2+\cos^2\alpha_0}-1\right\}^{3/2} \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.7})$$

On the other hand, the relation between bearing axial load and rolling element load is shown in Equation (9.8) using Fig. 9.19:

$$F_a=Z\cdot Q\cdot\sin\alpha \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.8})$$

Based on Fig. 9.18, we obtain,

$$(m_0+\delta_N)\ \sin\alpha=m_0\cdot\sin\alpha_0+\delta_a$$

$$\therefore\ \sin\alpha=\frac{m_0\cdot\sin\alpha_0+\delta_a}{m_0+\delta_N}=\frac{\sin\alpha_0+h}{1+\dfrac{\delta_N}{m_0}}$$

If we substitute Equation (9.5),

$$\sin\alpha=\frac{\sin\alpha_0+h}{\sqrt{(\sin\alpha_0+h)^2+\cos^2\alpha_0}} \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.9})$$

In other words, the relation between the bearing axial load F_a and axial displacement δ_a can be obtained by substituting Equations (9.7) and (9.9) for Equation (9.8).

$$F_a=K\cdot Z\cdot D_w^2\cdot\frac{\left\{\sqrt{(\sin\alpha_0+h)^2+\cos^2\alpha_0}-1\right\}^{3/2}\times(\sin\alpha_0+h)}{\sqrt{(\sin\alpha_0+h)^2+\cos^2\alpha_0}} \quad \cdots\cdots\cdots\cdots \quad (\mathbf{9.10})$$

where K: Constant depending on bearing material and design
D_w: Ball diameter
Z: Number of balls
α_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.

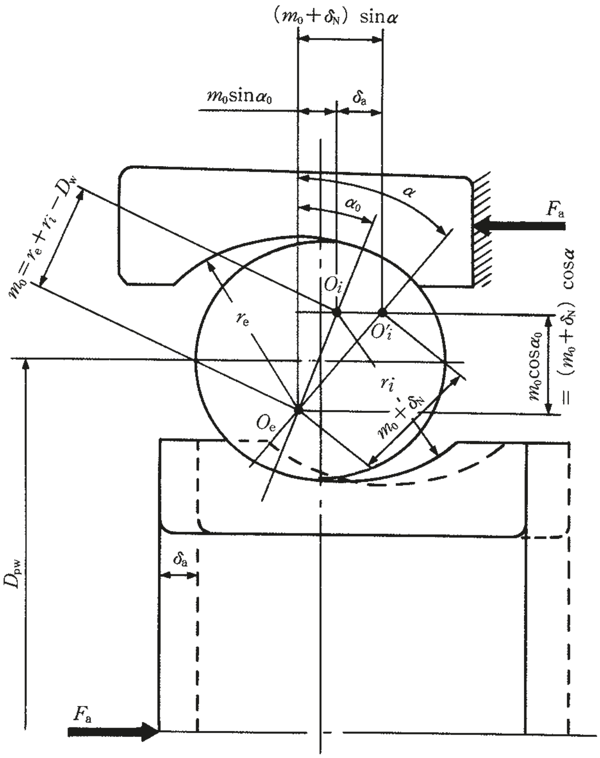


Fig. 9.18

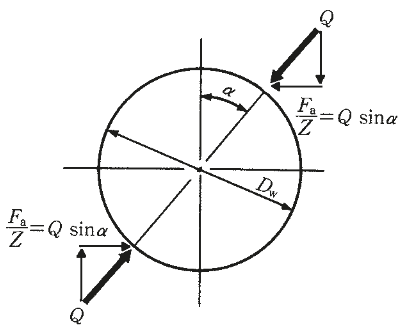


Fig. 9.19

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 α_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 α_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 δ_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.

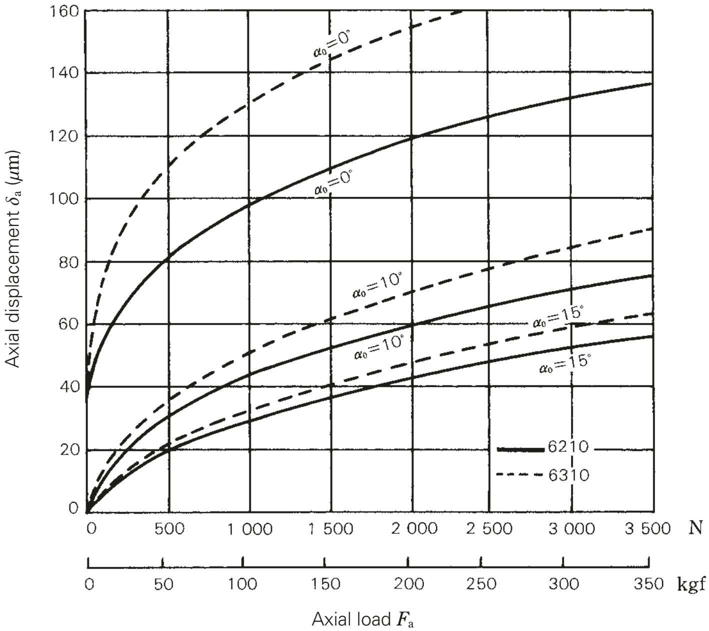


Fig. 9.20 Axial Load and Axial Displacement of Deep Groove Ball Bearings

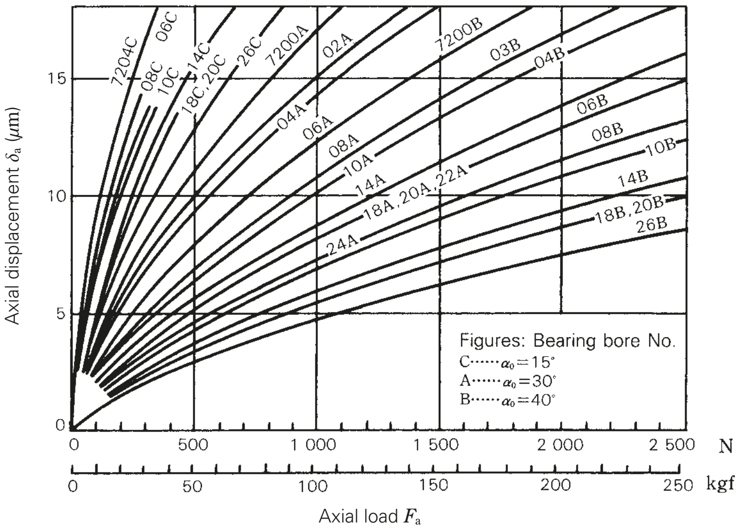


Fig. 9.21 Axial Load and Axial Displacement of Angular Contact Ball Bearings

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.

$$\left.\begin{aligned}\delta_a &= \frac{0.000077}{\sin\alpha}\cdot\frac{Q^{0.9}}{L_{we}^{0.8}} && \text{(N)}\\ &= \frac{0.0006}{\sin\alpha}\cdot\frac{Q^{0.9}}{L_{we}^{0.8}} && \{\text{kgf}\}\end{aligned}\right\} \quad \cdots\cdots \quad (\mathbf{9.11})$$

where, δ_a: Axial displacement of inner, outer ring (mm)
α: 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).

$$\delta_a = K_a \cdot F_a^{0.9} \quad \cdots\cdots \quad (\mathbf{9.12})$$

where,

$$K_a = \frac{0.000077}{(\sin\alpha)^{1.9}\, Z^{0.9}\, L_{we}^{0.8}} \quad \cdots\cdots \quad \text{(N)}$$

$$= \frac{0.0006}{(\sin\alpha)^{1.9}\, Z^{0.9}\, L_{we}^{0.8}} \quad \cdots\cdots \quad \{\text{kgf}\}$$

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.

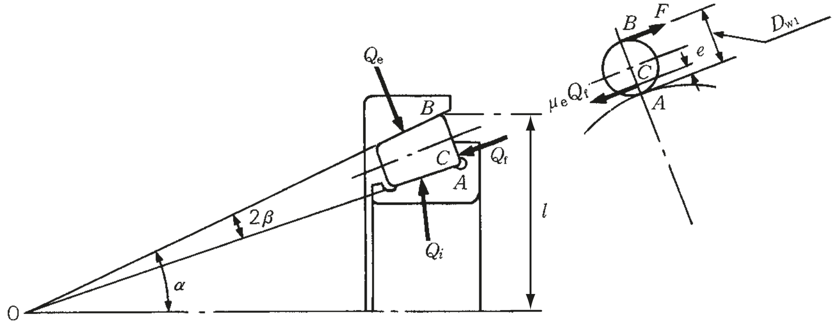


Fig. 9.22

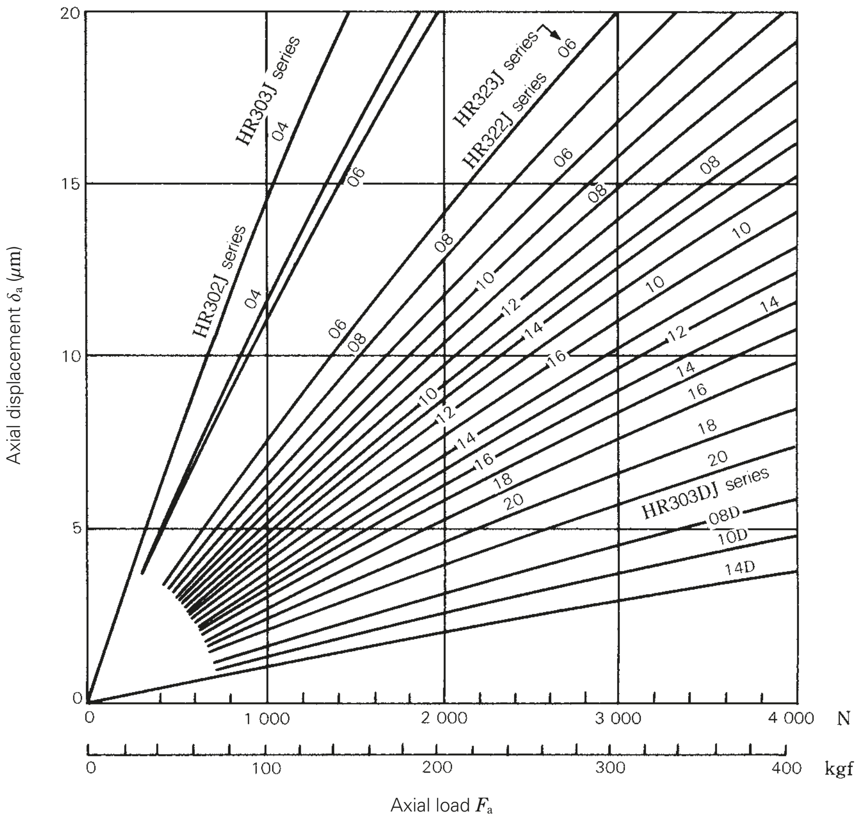
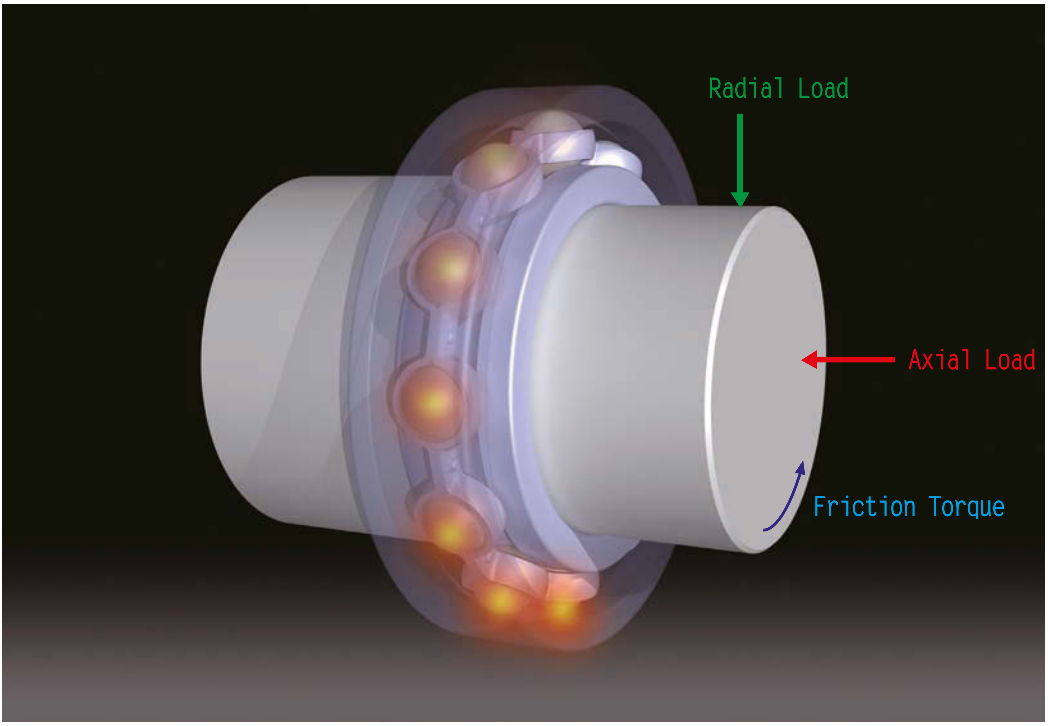


Fig. 9.23 Axial Load and Axial Displacement for Tapered Roller Bearings


Radial Load
Axial Load
Friction Torque

10. FRICTION

10. FRICTION

10.1 Coefficients of Dynamic Friction

10.1.1 Bearing Types and Their Coefficients of Dynamic Friction μ

$$\mu=\frac{M}{P\cdot\frac{d}{2}} \quad \cdots\cdots (\mathbf{10.1})$$

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 μ
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)
$M=M_l+M_v$

- Load term (determined by bearing type and load)
  $M_l=f_1 F d_m$
  where f_1 : Coefficient determined by bearing type and load
  F : Load
  d_m : Pitch circle diameter of rolling element
- Speed term (determined by oil viscosity, amount, speed)
  $M_v=f_0(\nu_0 n)^{2/3} dm^3$
  where f_0 : Coefficient determined by bearing and lubricating method
  ν_0 : Kinematic viscosity of oil
  n : Speed

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:

$$M=M_s\cdot Z\sin\alpha \text{ (mN·m), \{kgf·mm\}} \quad \cdots\cdots (\mathbf{10.2})$$

where M_s: Spin friction for contact angle α centered on the shaft,

$$M_s=\frac{3}{8}\mu_s\cdot Q\cdot a\cdot E(k)$$

(mN·m), {kgf·mm}

μ_s: Contact-surface slip friction coefficient
Q: Load on rolling elements (N), {kgf}
a: (1/2) of contact-ellipse major axis (mm)
$E(k)$: 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
α: Contact angle (°)

Actual measurements with 15° angular contact ball bearings correlate well with calculated results using μ_s = 0.15 in Equation (10.2). Fig. 10.1 shows the calculated friction torque for Series 70C and 72C bearings.

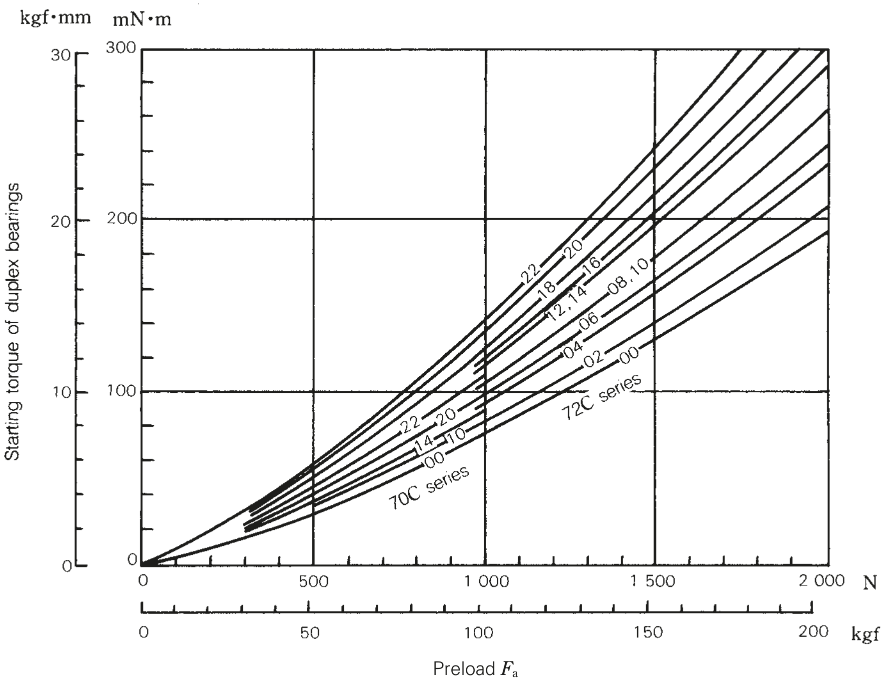


Fig. 10.1 Preload and Starting Torque for DF and DB Angular Contact Ball Bearing (α=15°) Arrangments

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:

$$M = M_l + M_v \text{ (mN·m), \{kgf·mm\}} \quad \cdots\cdots\cdots (\mathbf{10.3})$$

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).

$$\left.\begin{aligned} M_l &= 0.672 \times 10^{-3} D_{pw}^{\ 0.7} F_a^{\ 1.2} \text{ (mN·m)} \\ &= 1.06 \times 10^{-3} D_{pw}^{\ 0.7} F_a^{\ 1.2} \text{ \{kgf·mm\}} \end{aligned}\right\} \cdots\cdots (\mathbf{10.4})$$

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).

$$\begin{aligned} M_v &= 3.47 \times 10^{-10} D_{pw}^{\ 3} n_i^{\ 1.4} Z_B^{\ a} Q^b \text{ (mN·m)} \\ &= 3.54 \times 10^{-11} D_{pw}^{\ 3} n_i^{\ 1.4} Z_B^{\ a} Q^b \text{ \{kgf·mm\}} \end{aligned} \quad \cdots\cdots (\mathbf{10.5})$$

where, n_i: Inner ring speed (min^{-1})
Z_B: Absolute viscosity of oil at outer ring temperature (mPa·s), {cp}
Q: Oil flow rate (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:

$$a = 24 n_i^{-0.37} \quad \cdots\cdots\cdots (\mathbf{10.6})$$

$$b = 4 \times 10^{-9} n_i^{\ 1.6} + 0.03 \quad \cdots\cdots\cdots (\mathbf{10.7})$$

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°, 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:

$n_i = 70\,000 \text{ min}^{-1}$
$F_a = 590$ N, {60 kgf}
Lubrication: Jet, oil viscosity:
10 mPa·s {10 cp}
oil flow: 1.5 kg/min

From Equation (10.4),

$$\begin{aligned} M_l &= 0.672 \times 10^{-3} D_{pw}^{\ 0.7} F_a^{\ 1.2} \\ &= 0.672 \times 10^{-3} \times 33.5^{0.7} \times 590^{1.2} \\ &= 16.6 \text{ (mN·m)} \\ M_l &= 1.06 \times 10^{-3} \times 33.5^{0.7} \times 60^{1.2} \\ &= 1.7 \text{ \{kgf·mm\}} \end{aligned}$$

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),

$$\begin{aligned} M_v &= 3.47 \times 10^{-10} D_{pw}^{\ 3} n_i^{\ 1.4} Z_B^{\ a} Q^b \\ &= 3.47 \times 10^{-10} \times 33.5^3 \times 70\,000^{1.4} \times 10^{0.39} \times 1.5^{0.26} \\ &= 216 \text{ (mN·m)} \end{aligned}$$

$$\begin{aligned} M_v &= 3.54 \times 10^{-11} \times 33.5^3 \times 70\,000^{1.4} \times 10^{0.39} \times 1.5^{0.26} \\ &= 22.0 \text{ \{kgf·mm\}} \end{aligned}$$

$M = M_l + M_v = 16.6 + 216 = 232.6$ (mN·m)
$M = M_l + M_v = 1.7 + 22 = 23.7$ {kgf·mm}

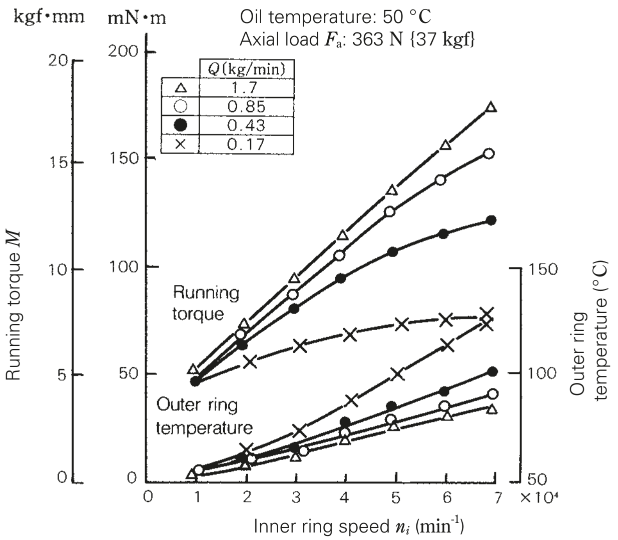


Fig. 10.2 Typical Test Example

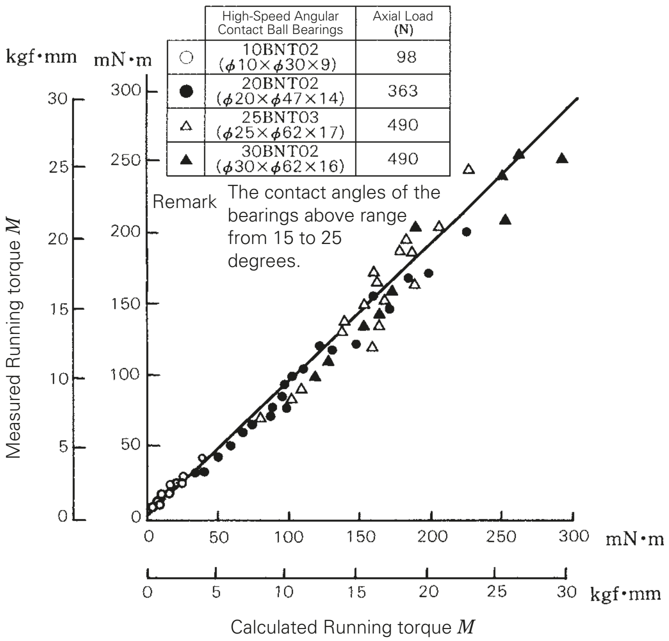


Fig. 10.3 Comparison of Actual Measurements and Calculated Values

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:

$$Q_e = \frac{F_a}{Z \sin \alpha} \quad \cdots\cdots (\mathbf{10.8})$$

$$Q_i = Q_e \cos 2\beta = \frac{\cos 2\beta}{Z \sin \alpha} F_a \quad \cdots\cdots (\mathbf{10.9})$$

$$Q_f = Q_e \sin 2\beta = \frac{\sin 2\beta}{Z \sin \alpha} F_a \quad \cdots\cdots (\mathbf{10.10})$$

where Q_e : Rolling element load on outer ring (N), {kgf}
Q_i : Rolling element load on inner ring (N), {kgf}
Q_f : Rolling element load on inner ring large end rib, (N), {kgf} (assume $Q_f \perp Q_i$)
Z : Number of rollers
α : Contact angle...one-half included outer ring angle (°)
β : One-half the tapered roller angle (°)
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 $e\,\mu_e Q_f$.

Therefore, the balance of frictional torque is

$$D_{w1} F = e\,\mu_e Q_f \text{ (mN·m), \{kgf·mm\}} \quad \cdots\cdots (\mathbf{10.11})$$

where μ_e: Friction coefficient between inner ring large rib and roller end face

Starting torque M for one bearing is given by

$$M = F Z l$$

$$= \frac{e\,\mu_e\, l \sin 2\beta}{D_{w1} \sin \alpha} F_a \text{ (mN·m), \{kgf·mm\}} \quad \cdots\cdots (\mathbf{10.12})$$

because $D_{w1} = 2\,\overline{OB} \sin \beta$, and $l = \overline{OB} \sin \alpha$.

If we substitute these into Equation (10.12), we obtain

$$M = e\,\mu_e \cos\beta\, F_a \text{ (mN·m), \{kgf·mm\}} \quad \cdots\cdots (\mathbf{10.13})$$

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 β in Equation (10.12) are determined by bearing design. Consequently, by assuming a value for μ_e, the starting torque can be calculated.

The values for μ_e 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 $\mu_e = 0.20$, which is the average value determined from various test results.

Fig. 10.5 shows the results of calculations for various tapered roller bearing series.

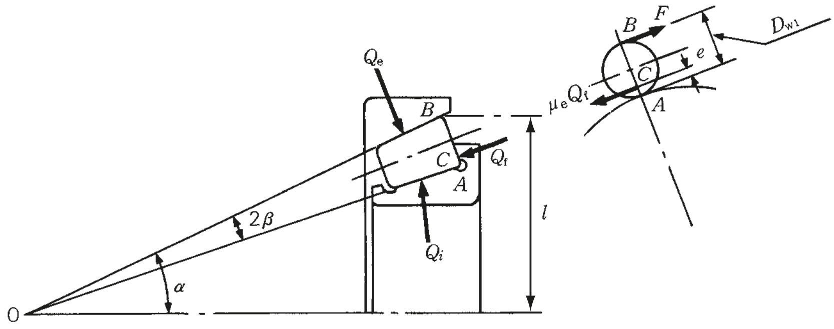


Fig. 10.4

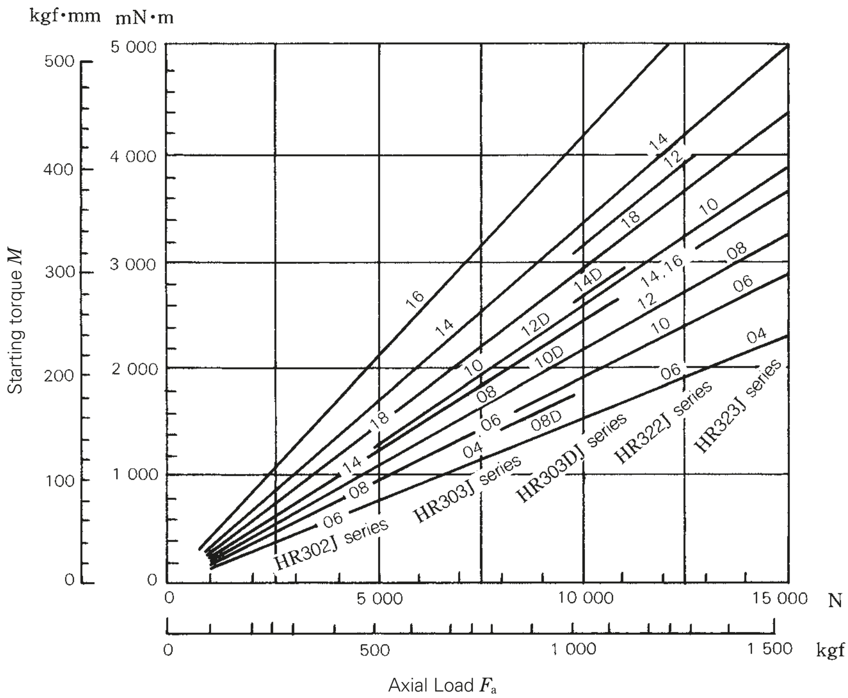


Fig. 10.5 Axial Load and Starting Torque for Tapered Roller Bearings

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.

$$Q_e \doteqdot Q_i = \frac{F_a}{Z \sin\alpha} \quad \cdots\cdots \quad (\mathbf{10.14})$$

$$Q_f = \frac{F_a \sin 2\beta}{Z \sin\alpha} \quad \cdots\cdots \quad (\mathbf{10.15})$$

where Q_e: Rolling element load on outer ring
Q_i: Rolling element load on inner ring
Q_f: Rolling element load on inner ring large end rib
Z: Number of rollers
α: Contact angle…One-half included outer ring angle
β: One-half tapered roller angle

For simplicity, Fig. 10.7 shows a model using the average diameter D_{we} 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:

$$F_{se} - F_{si} = F_{sf} \quad \cdots\cdots \quad (\mathbf{10.16})$$

$$M_i + M_e = \frac{D_w}{2} F_{se} + \frac{D_w}{2} F_{si} + \left(\frac{D_w}{2} - e\right) F_{sf} \quad \cdots\cdots \quad (\mathbf{10.17})$$

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:

$$M = Z\,(R_e\, F_{se} - M_e)$$
$$= \frac{Z}{D_w}(R_e\, M_i + R_i M_e) + \frac{Z}{D_w} R_e\, e\, F_{sf}$$
$$= M_R + M_S$$

Therefore, the rolling friction on the raceway surface M_R and sliding friction on the ribs M_S are separately obtained.

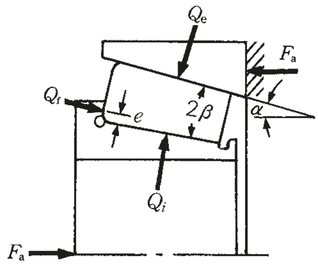


Fig. 10.6 Loads Applied on Roller

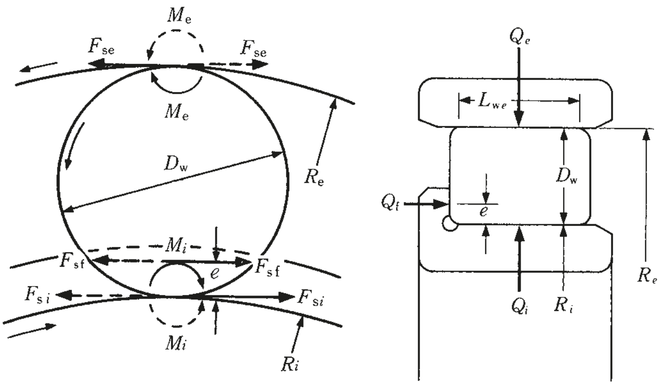


Fig. 10.7 Parts Where Friction is Generated

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.

$$M = M_R + M_S = \frac{Z}{D_w}(R_e M_i + R_i M_e) + \frac{Z}{D_w} R_e \, e \, F_{sf} \quad \cdots \quad (\mathbf{10.18})$$

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 $F_{sf} = \mu Q_f$ using the coefficient of dynamic friction μ. Further, by substituting in axial load F_a, the following equation is obtained:

$$M_S = e \, \mu \cos\beta \, F_a \quad \cdots \quad (\mathbf{10.19})$$

This is identical to the equation for starting torque, but μ is not constant and decreases depending on operating conditions and running-in. For this reason, Equation (10.19) can be rewritten as follows:

$$M_S = e \, \mu_0 \cos\beta \, F_a f'(\Lambda, t, \sigma) \quad \cdots \quad (\mathbf{10.20})$$

where μ_0 is approximately 0.2 and $f'(\Lambda, t, \sigma)$ 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:

$$M_{i,e} = \left[f(w) \left(\frac{1}{1 + 0.29 L^{0.78}} \right) \frac{4.318}{\alpha_0} (G \cdot U)^{0.658} W^{0.0126} R^2 L_{we} \right]_{i,e} \quad \cdots \quad (\mathbf{10.21})$$

$$f(w) = \left(\frac{k F_a}{E' D_w L_{we} Z \sin\alpha} \right)^{0.3} \quad \cdots \quad (\mathbf{10.22})$$

Therefore, M_R can be obtained using Equations (10.21) and (10.22) together with the following equation:

$$M_R = \frac{Z}{D_w}(R_e M_i + R_i M_e)$$

Running Torque of Bearings M

From these, the running torque of tapered roller bearings M is given by Equation (10.23).

$$M = \frac{Z}{D_w}(R_e M_i + R_i M_e) + e \, \mu_0 \cos\beta \, F_a f'(\Lambda, t, \sigma) \quad \cdots \quad (\mathbf{10.23})$$

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
- α_0: Pressure coefficient of lubricating oil viscosity
- R: Equivalent radius
- k: Constant
- E': Equivalent elastic modulus
- α: Contact angle (One-half included outer ring angle)
- R_i, R_e: Inner and outer ring raceway radii (center)
- β: Half angle of roller
- i, e: Indication of inner ring or outer ring respectively
- L_{we}: Effective roller length

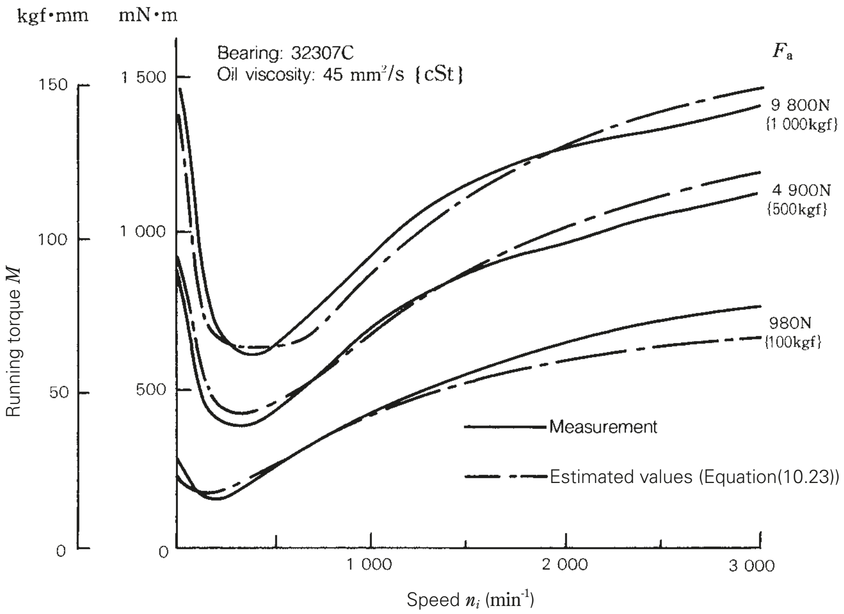


Fig. 10.8 Comparison of Estimated Values With Actual Measurements

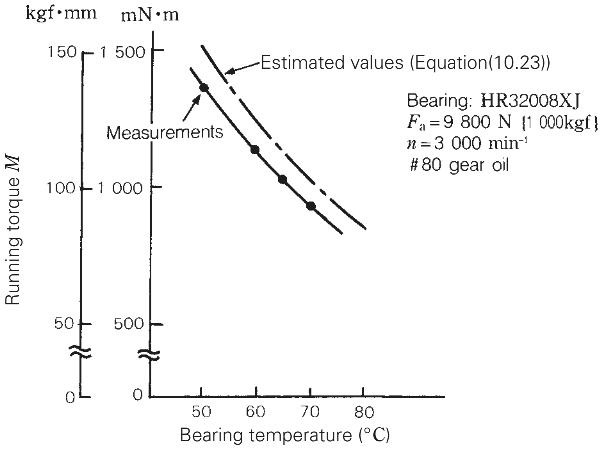


Fig. 10.9 Viscosity Variation and Running Torque


MOTION & CONTROL
NSK
NSK GREASE
LG 2 (Clean Room)
MOTION & CONTROL
NSK
NSK GREASE
LR 3
Net.80g

11. LUBRICATION

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 transter possible using forced oil circulation.
Fluidity	Poor	Good
Full Lubricant Replacement	Sometimes difficult	Conpactively easy
Removal of Foreign Matter	Removal of particles from grese 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 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 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.

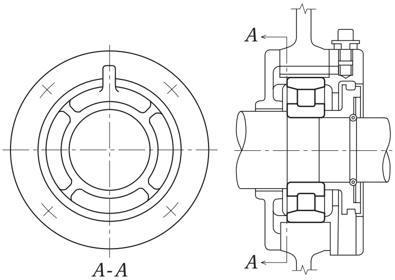


Fig. 11.1 Combination of Partitioned Grease Reservoir and Grease Valve

(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

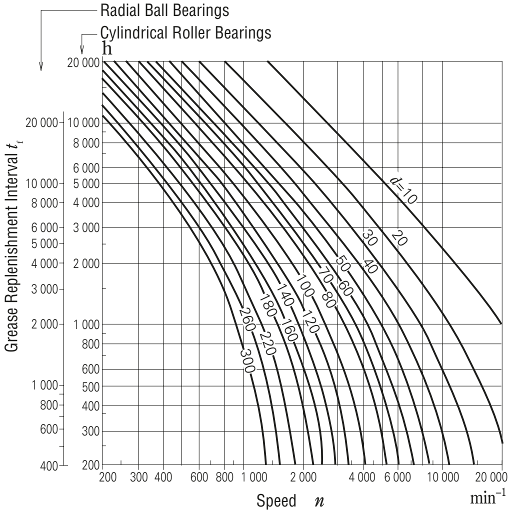
If the bearing temperature exceeds 70 °C, reduce the replenishment interval by half for every 15 °C increase.

· Grease

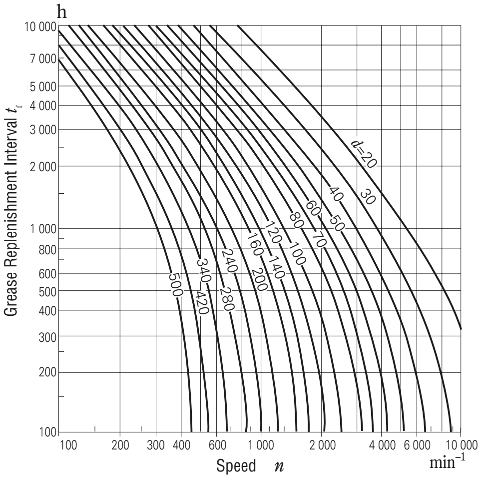
Replenishment intervals can be extended depending on used grease type, especially for ball bearings. For example, high-quality lithium-soap synthetic oil grease may roughly doubles the replenishment interval shown in Fig.11.2 (1). If the temperature of the bearings is less than 70 °C, the usage of lithium-soap 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	≦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 ([1]))

$$\log t = 6.54 - 2.6\frac{n}{N_{max}} - \left(0.025 - 0.012\frac{n}{N_{max}}\right)T \quad \cdots\cdots\textbf{(11.1)}$$

(Wide-range grease ([2]))

$$\log t = 6.12 - 1.4\frac{n}{N_{max}} - \left(0.018 - 0.006\frac{n}{N_{max}}\right)T \quad \cdots\cdots\textbf{(11.2)}$$

where t : Average grease life (h)
n : Speed (min^{-1})
N_{max} : Limiting speed with grease lubrication (min^{-1})
(values for ZZ and VV types are listed in the bearing tables)
T : Operating temperature °C

Equation (11.1), Equation (11.2), and Fig. 11.3 apply under the following conditions:

(a) Speed n

$$0.25 \leqq \frac{n}{N_{max}} \leqq 1$$

when $\frac{n}{N_{max}} < 0.25$, assume $\frac{n}{N_{max}} = 0.25$

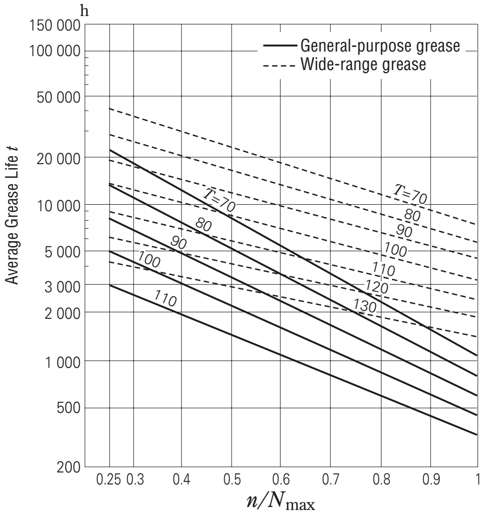


Fig. 11.3 Grease Life of Sealed Ball Bearings

(b) Operating Temperature T
For general-purpose grease ([1])

$$70\ ^\circ\text{C} \leqq T \leqq 110\ ^\circ\text{C}$$

For wide-range grease ([2])

$$70\ ^\circ\text{C} \leqq T \leqq 130\ ^\circ\text{C}$$

When $T < 70$ °C assume $T = 70$ °C

(c) Bearing Loads
The bearing loads should be about 1/10 or less the basic load rating C_r.

Notes ([1]) Mineral-oil base greases (e.g. lithium-soap base grease) often used around – 10 to 110 °C.
([2]) Synthetic-oil base greases are usable over a wide temperature range around –40 to 130 °C.

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.

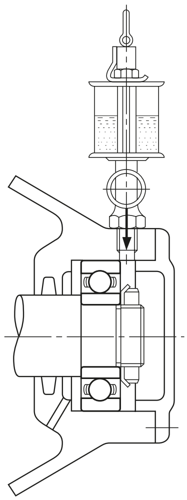


Fig. 11.5 Drip-Feed Lubrication

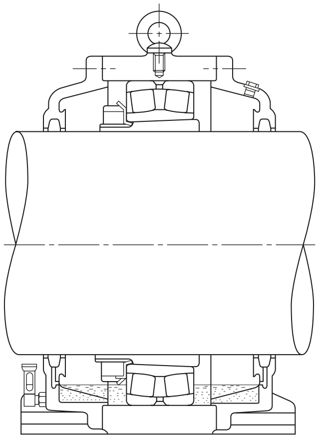


Fig. 11.4 Oil-Bath Lubrication

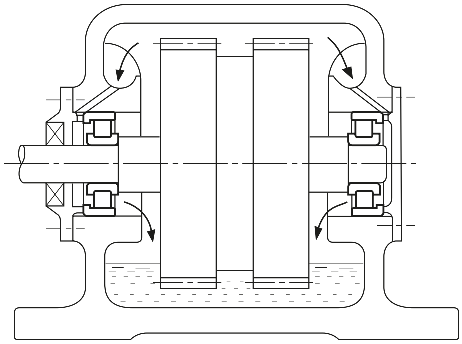


Fig. 11.6 Splash Lubrication

(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.

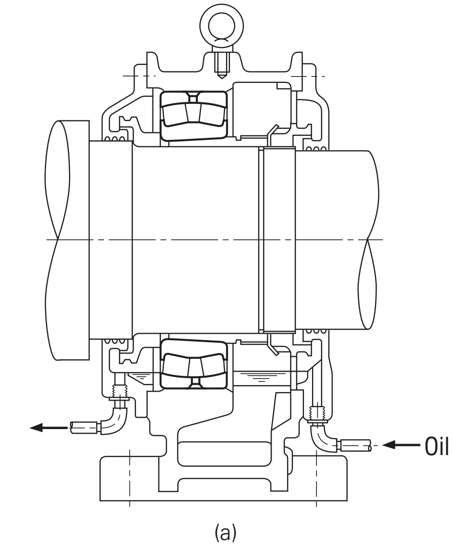


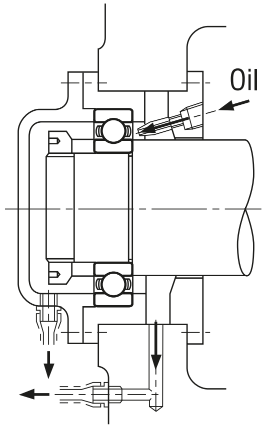
Fig. 11.7 Circulating Lubrication

(5) *Jet Lubrication*

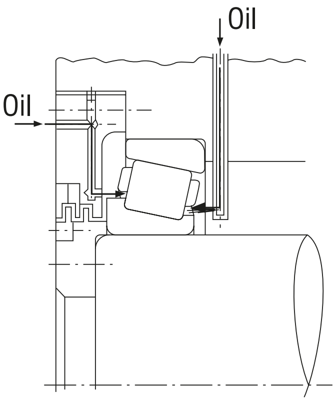
Jet lubrication is often used for ultra-high-speed bearings with a $d_m n$ valve (d_m: pitch diameter of rolling element set in mm; n: rotational speed in min^{-1}) exceeding one million, such as the bearings in jet engines. Lubricating oil is sprayed under pressure from one or more nozzles directly 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.

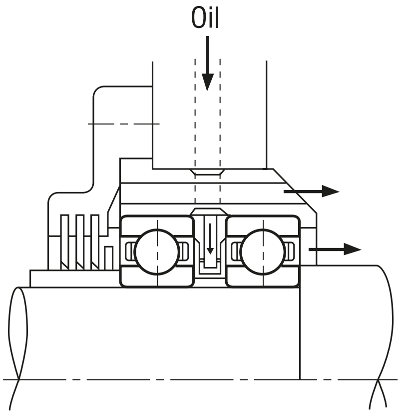
More uniform cooling and a better temperature distribution is achieved using more nozzles for a given amount of oil. The oil should be forcibly discharged so that the agitating resistance of the lubricant can be reduced and the oil can effectively carry away the heat.



(a)



(b)



(c)

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.

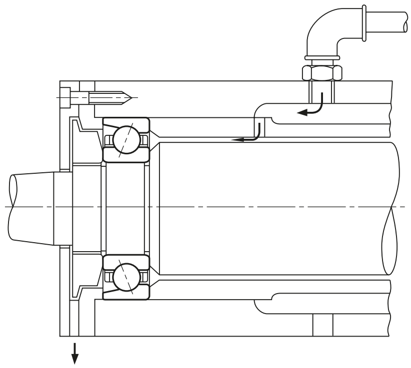


Fig. 11.9 Oil-Mist Lubrication

(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).

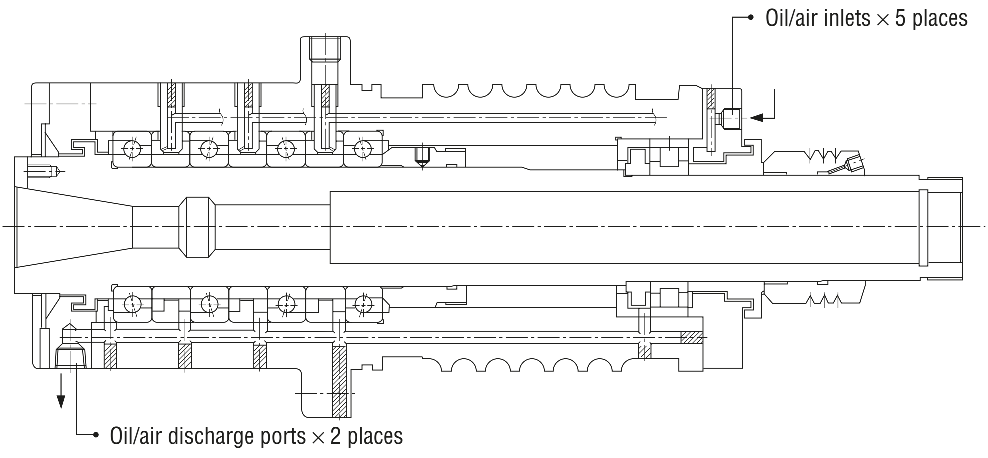


Fig. 11.10 Oil-Air Lubrication

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 fluoric compounds.
The type of thickener is closely related to the grease dropping point ([1]); 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 ([1]) 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

Name (Popular Name)	Lithium Grease		
Thickener	Li Soap		
Base Oil / Properties	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, %([1])	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 ([1]) 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	70 to 90	160 to 190	180 to 300	> 230	> 230
–20 to +130	–20 to +60	–20 to +80	–20 to +130	–10 to +130	< +220
70	40	70	70	70	40 to 100
Good	Poor	Good	Good	Good	Good
Fair	Poor	Fair to Good	Fair to Good	Fair	Fair
Poor	Good	Poor for Na Soap Grease	Good	Good	Good
Poor to Good	Good	Fair to Good	Fair to Good	Fair to 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[1] 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 (1) 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 13mm²/s
Tapered Roller Bearings and Spherical Roller Bearings	Higher than 20mm²/s
Spherical Thrust Roller Bearings	Higher than 32mm²/s

Remark 1mm²/s=1cSt (centistokes)

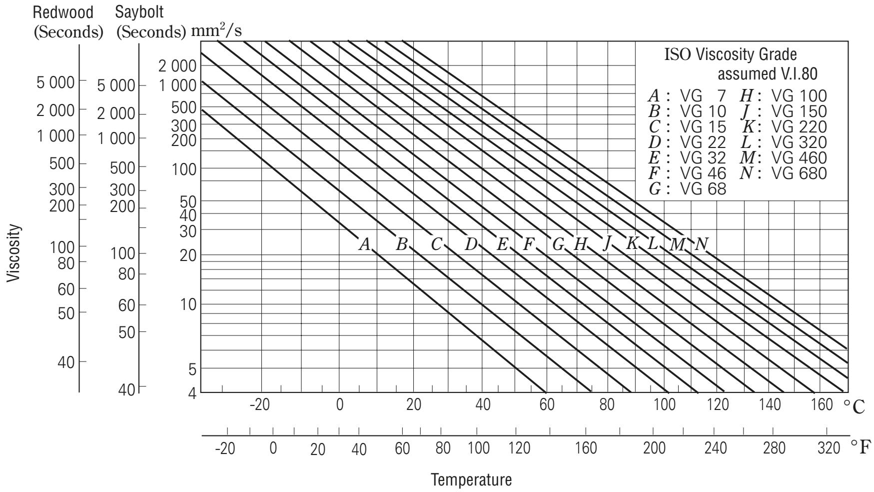


Fig. 11.11 Temperature-Viscosity Chart

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 (3)	Poly-α-olefin oil	
EA5 GREASE	Urea (3)	Poly-α-olefin oil	
EA6 GREASE	Urea (3)	Poly-α-olefin oil	
EA7 GREASE	Urea (3)	Poly-α-olefin oil	
EA9 GREASE	Urea (3)	Poly-α-olefin oil	
ENS GREASE	Urea (3)	Polyol ester oil (4)	
ECE GREASE	Lithium	Poly-α-olefin oil	
DOW CORNING(R) SH 44 M GREASE	Lithium	Silicone oil (5)	
NS HI-LUBE	Lithium	Ester oil + Diester oil (4)	
LG2 GREASE	Lithium	Poly-α-olefin oil + Mineral oil	
LGU GREASE	Urea (3)	Poly-α-olefin oil	
EMALUBE 8030	Urea (3)	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 (3)	Poly-α-olefin oil	
NIGLUBE RSH	Sodium Complex	Glycol oil	
PALMAX RBG	Lithium Complex	Mineral oil	
MULTEMP PS No.2	Lithium	Poly-α-olefin oil + Diester oil (4)	
MOLYKOTE(R) FS-3451GREASE	PTFE	Fluorosilicone oil (5)	
UME GREASE	Urea (3)	Mineral oil	
RW1 GREASE	Urea (3)	Mineral oil	
HA1 GREASE	Urea (3)	Ether oil	
HA2 GREASE	Urea (3)	Ether + Poly-α-olefin oil	
KLUBERSYNTH HB 72-52	Urea (3)	Ester oil (4)	
NOXLUB KF0921	PTFE	Perfluoropolyether oil	
ECH GREASE	Carbon Black	Perfluoropolyether oil	
FWG GREASE	Urea (3)	Mineral oil + Poly-α-olefin oil	
HT1 GREASE	Urea (3)	Poly-α-olefin oil	
ARAPEN RB320	Lithium-Calcium	Mineral oil	
SHELL GADUSRAIL S4 HIGH SPEED EUFR	Lithium	Mineral oil	

Notes (1) 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.
(2) 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.
(3) Urea-based grease causes fluorine-based material to deteriorate.
(4) Ester-based grease causes acrylic rubber material to swell.
(5) Silicone-based grease causes silicone-based material to swell.

Lubricating Grease

Dropping Point (°C)	Consistency	Working Temperature Range([1])(°C)	Pressure Resistance	Usable Limit Compared to Listed Limiting Speed (Grease)([2])(%)
≧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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12. BEARING MATERIALS

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:

Material characteristics required for bearing rings and rolling elements:
- High rolling contact fatigue strength
- High hardness
- High wear resistance
- High dimensional stability
- High mechanical strength

Characteristics required for cage material:
- High wear resistance
- High dimensional stability
- High mechanical strength

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
Bearing	SUJ2	Spheroidizing annealing
Bearing	SCr420	Quenching, low temp tempering
Bearing	SAE4320 (SNCM420)	Quenching, low temp tempering
Bearing	SNCM815	Quenching, low temp tempering
Bearing	SUS440C	Quenching, low temp tempering
Bearing	SPCC	Annealing
Bearing	S25C	Annealing
Bearing	CAC301 (HB_sC1)	—
Shaft	S45C	Quenching, 650 ℃ tempering
Shaft	SCr430	Quenching, 520 to 620 ℃ fast cooling
Shaft	SCr440	Quenching, 520 to 620 ℃ fast cooling
Shaft	SCM420	Quenching, 150 to 200 ℃ air cooling
Shaft	SNCM439	Quenching, 650 ℃ tempering
Shaft	SC46	Normalizing
Shaft	SUS420J2	1 038 ℃ oil cooling, 400 ℃ air cooling
Housing	FC200	Casting
Housing	FCD400	Casting
Housing	A1100	Annealing
Housing	AC4C	Casting
Housing	ADC10	Casting
Housing	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^3	Specific Heat kJ/(kg·K)	Thermal Conductivity W/(m·K)	Electric Resistance μΩ·cm	Linear Expansion Coeff. (0 to 100 °C) $\times 10^{-6}/°C$	Young's Modulus MPa {kgf/mm^2}	Yield Point MPa {kgf/mm^2}	Tensile Strength MPa {kgf/mm^2}	Elongation %	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-molybdenum 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-molybdenum steel
		38	30	11.3	207 000 {21 100}	920 {94}	1 030 {105}	18	320	Nickel-chrome-molybdenum 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, Brinel hardness is shown for comparison.
are 833 MPa {85 kgf/mm^2} and 440 MPa {45 kgf/mm^2} 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 ≦ 0.025, S ≦ 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 ≦ 0.030, S ≦ 0.030 *3: P ≦ 0.025, S ≦ 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.

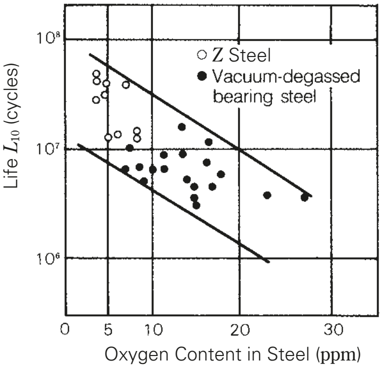


Fig. 12.1 Oxygen Content in Steel and Life of Bearing Steel

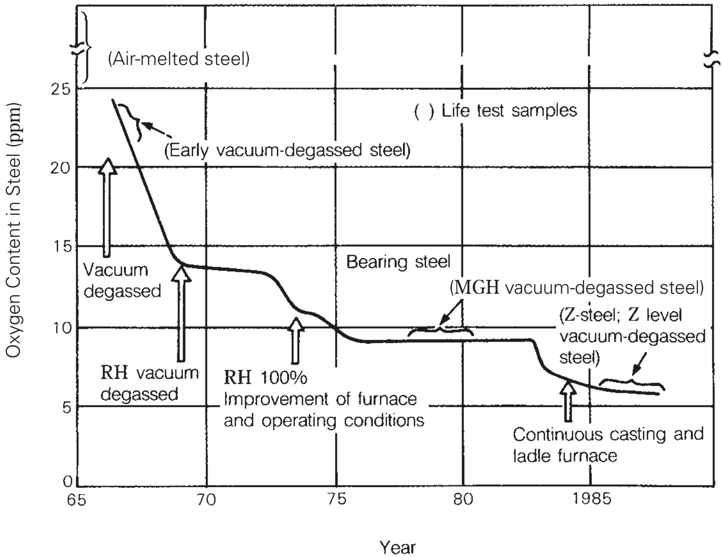
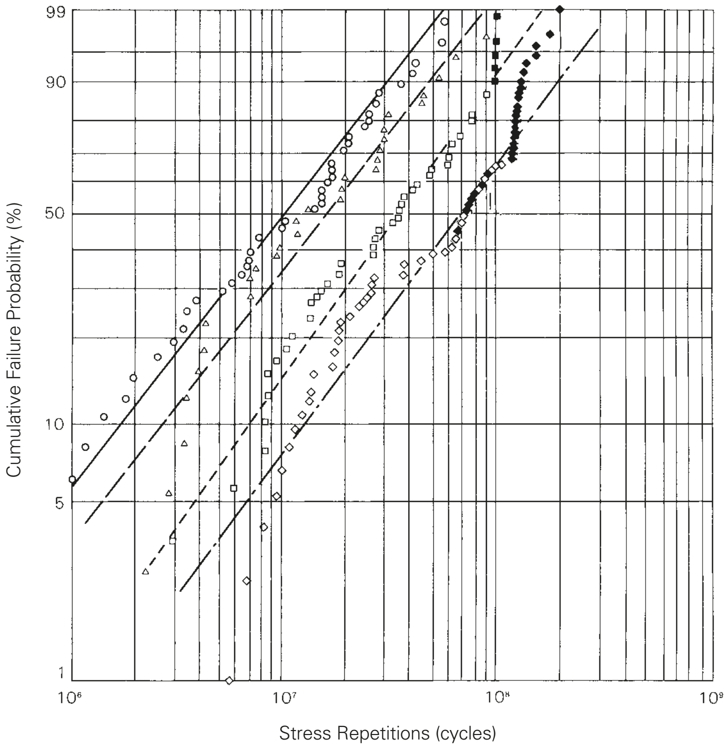


Fig. 12.2 Change in Oxygen Content of NSK Bearing Steels



Classification	Test quantity	Failured quantity	Weibull slope	L_{10}	L_{50}
○ Air-melted steel	44	44	1.02	1.67×10^6	1.06×10^7
△ Vacuum-degassed steel	30	30	1.10	2.82×10^6	1.55×10^7
□ MGH vacuum-degassed steel	46	41	1.16	6.92×10^6	3.47×10^7
◇ Z steel	70	39	1.11	1.26×10^7	6.89×10^7

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.

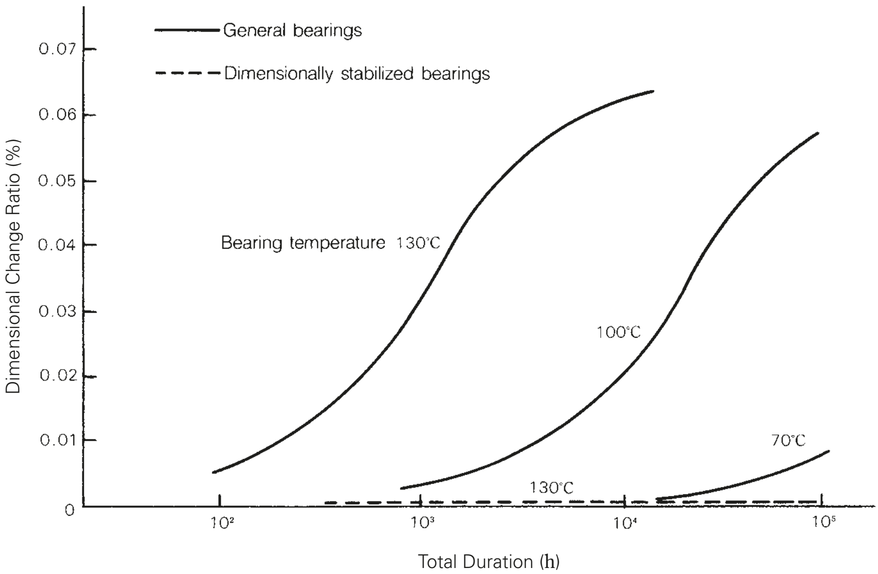
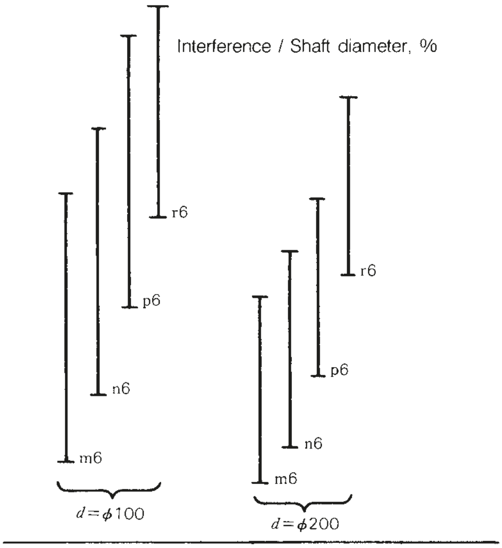


Fig. 12.4 Bearing Temperature and Dimensional Change Ratio

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.

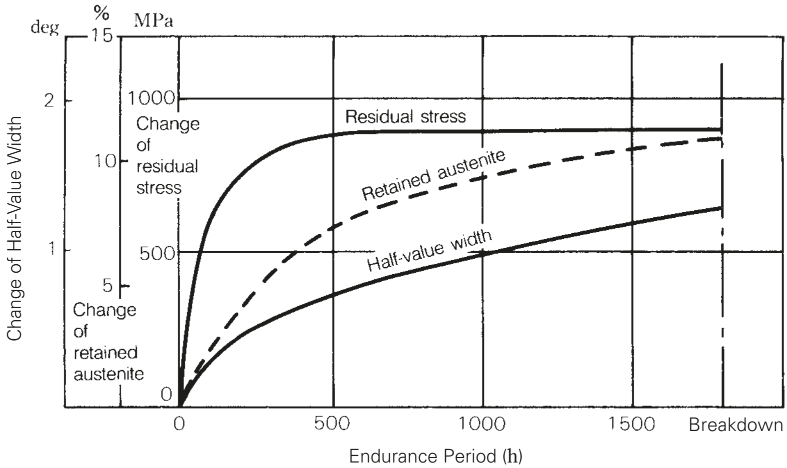


Fig. 12.5 Change in X-Ray Measurements

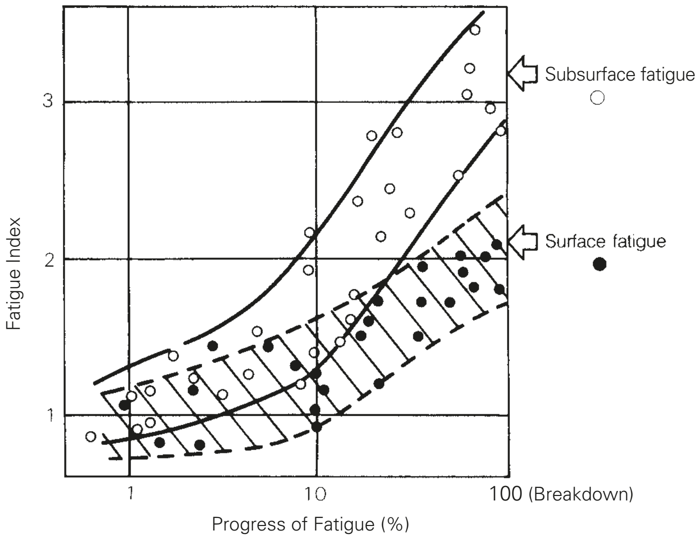


Fig. 12.6 Fatigue Progress and Fatigue Index

(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.

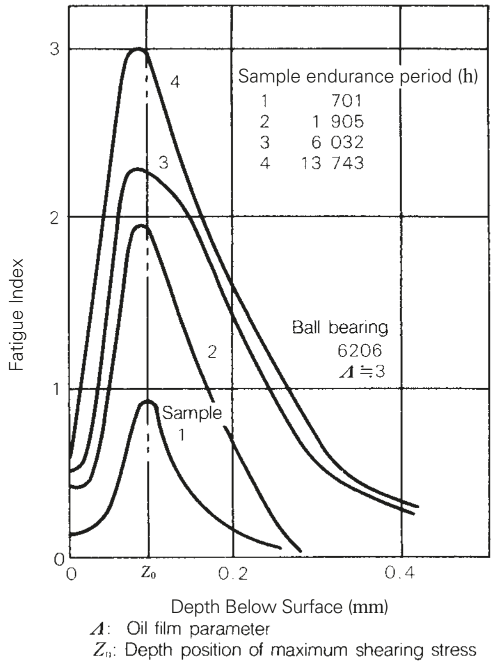


Fig. 12.7 Progress of Subsurface Fatigue

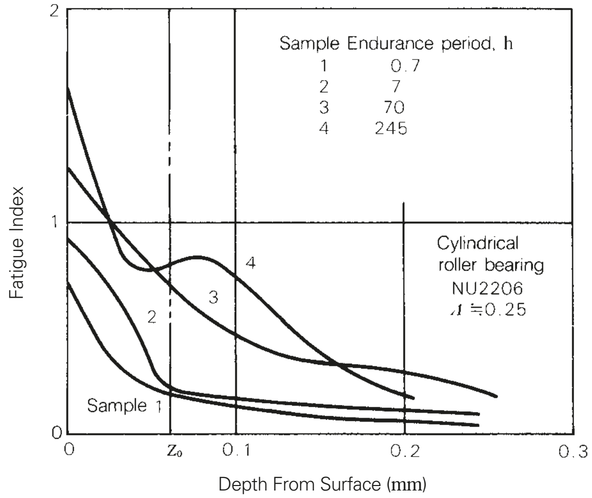


Fig. 12.8 Progress of Surface Fatigue

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.

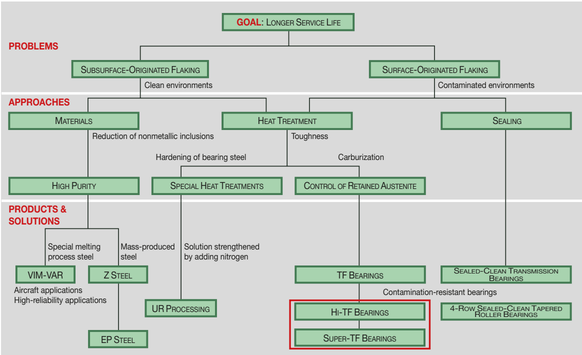


Fig. 12.9 Approaches to Achieving Longer Service Life in Bearings

(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.

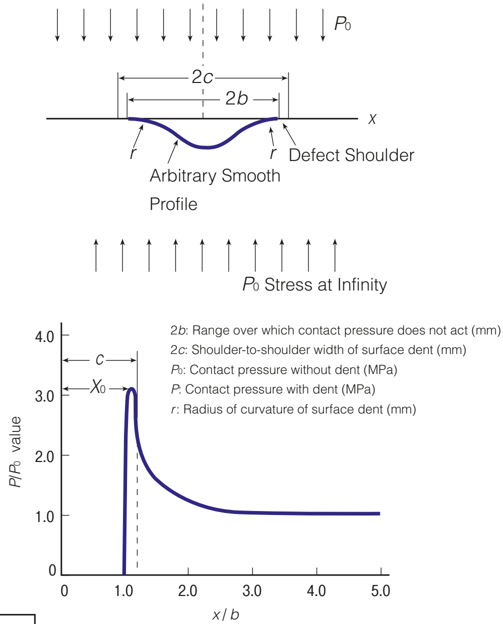


Fig. 12.10 Concentration of Stress around a Surface Dent

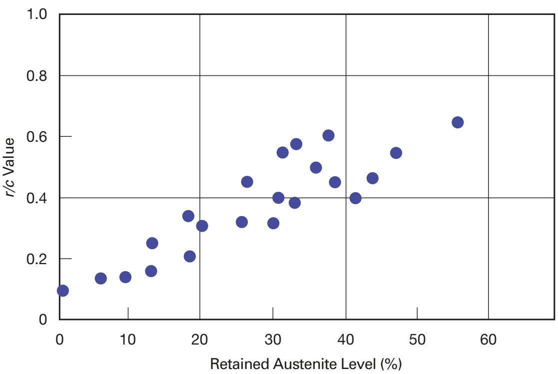


Fig. 12.11 Relationship of r/c Value to Retained Austenite Level

(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)

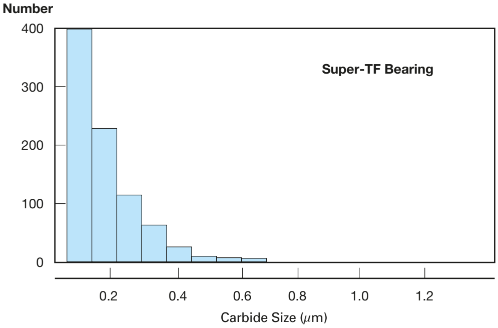


Fig. 12.12 Average Diameter of Carbide and Carbonitride Particles in a Super-TF Bearing

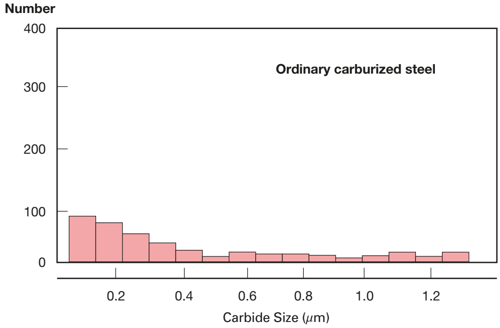


Fig. 12.13 Average Diameter of Carbide Particles in an Ordinary Carburized Steel Bearing

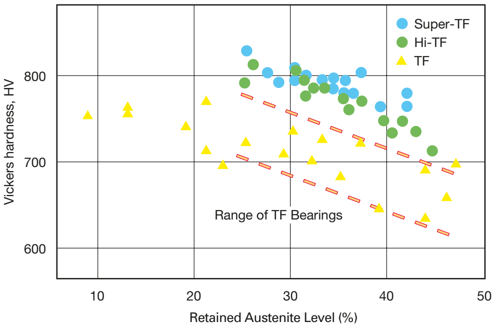


Fig. 12.14 Relationship of Material Hardness and Retained Austenite Level

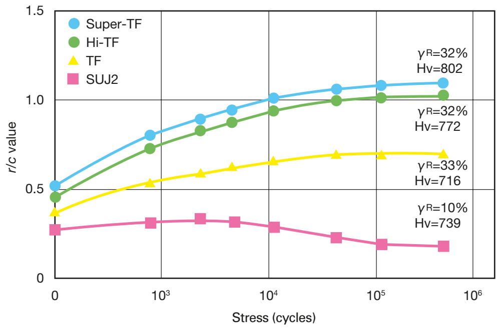


Fig. 12.15 Change of *r*/*c* Value Under Repeated Stress

(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

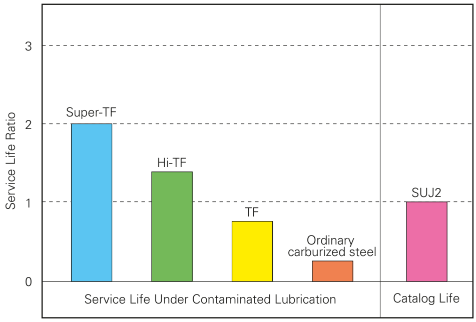


Fig. 12.16 Comparison of Service Life Under Contaminated Lubrication

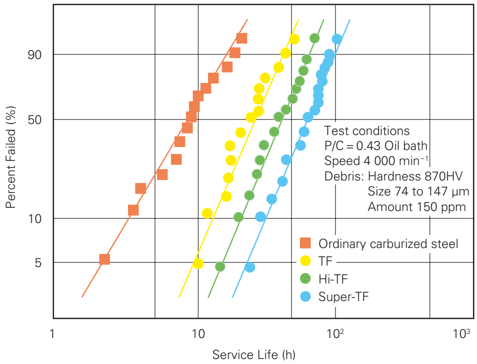


Fig. 12.17 Service Life of L44649/10 Bearings Under Contaminated Lubrication

(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.

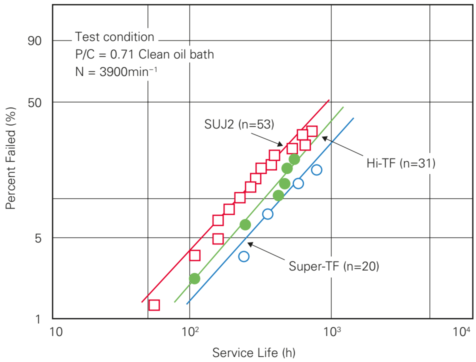


Fig. 12.18 Service Life Tests of 6206 Bearings Under Clean Lubrication

(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 Λ, which represents the ratio of the thickness of the oil film to the roughness of the surface, is very small (Λ=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.

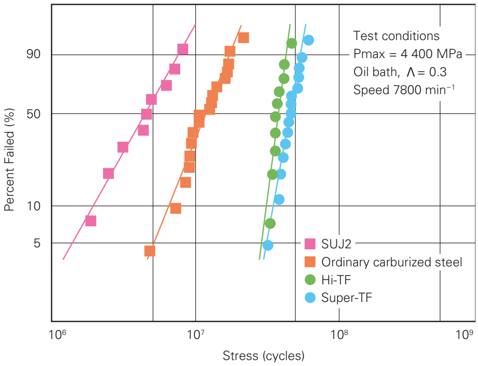


Fig. 12.19 Service Life Tests Under Boundary Lubrication Conditions

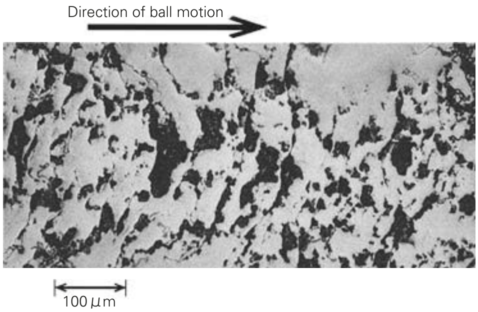


Fig. 12.20 Peeling Damage

(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.

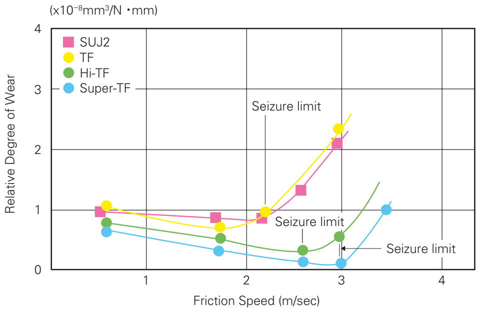


Fig. 12.21 Comparison of Wear Resistance

(8) *Heat Resistance*

Fig. 12.22 shows the results of service life tests conducted with Series 6206 ball bearings at 160 ℃ 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.

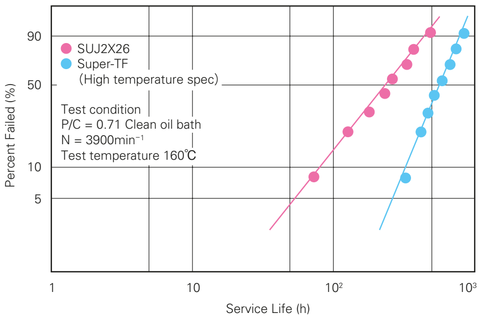


Fig. 12.22 Service Life Test of 6206 Under High Temperature Clean Lubrication

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) (1)
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 buthylene 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 (1) GPa≒10^4 kgf/cm^2=10^2 kgf/mm^2
(2) If there is a slash mark "/" in the thermal
(3) Reference value

Table 12.11 Characteristics of Representative Polymers

Strength GPa (1)	Density g/cm³	Specific Elastic Modulus ×10⁴mm	Specific Strength ×10⁴mm	Melting point ℃	Glass Transition Temp ℃	Thermal Deformation Temperature ℃ (2)	Continuous Operating Temperature ℃	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 ℃
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 ℃. 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 ℃
0.14	1.64	256.1	8.5	275	94	>260	220	Hot cured at 360 ℃
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 de-composition	417 decomposition	360/250	300 (3)	No change in inert gas up to 350 ℃
0.1	1.43	203	7.0	Heat de-composition	417 decomposition	360/250	260	Usable up to 300 ℃ for bearings. Sintering, no fusion (molded products)
0.2	1.41	333.3	14.2	—	280	260	210	Usable up to 290 ℃ 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

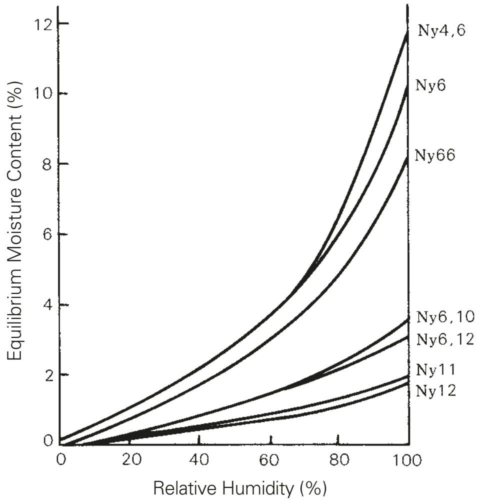


Fig. 12.23 Equilibrium Moisture Content and Relative Humidity of Various Nylons

deterioration more than phosphorous extreme-pressure agents and such deterioration occurs more rapidly with rising temperatures.

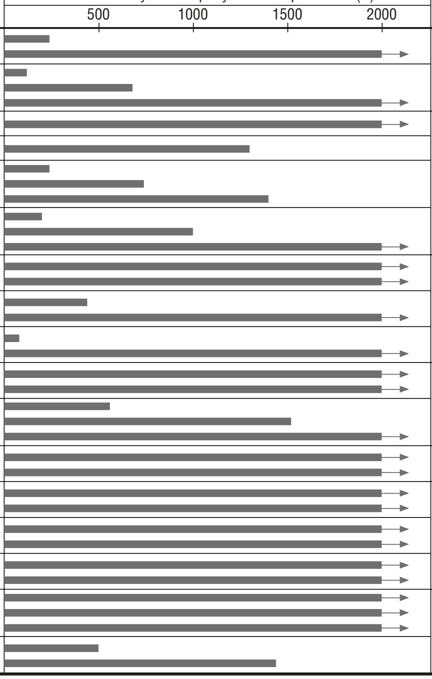
On the other hand, material deteriorates less in grease or air than in oil. In addition, materials reinforced with glass fiber can suppress deterioration by the reinforcement effect of glass fibers, thereby helping to extend the durability period.

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
Oil	Gear oil	120	0, D		Contains an extreme pressure additive
		140	0, A, 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		80	0, D		
		120	0, D		
		130	A, D		
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.

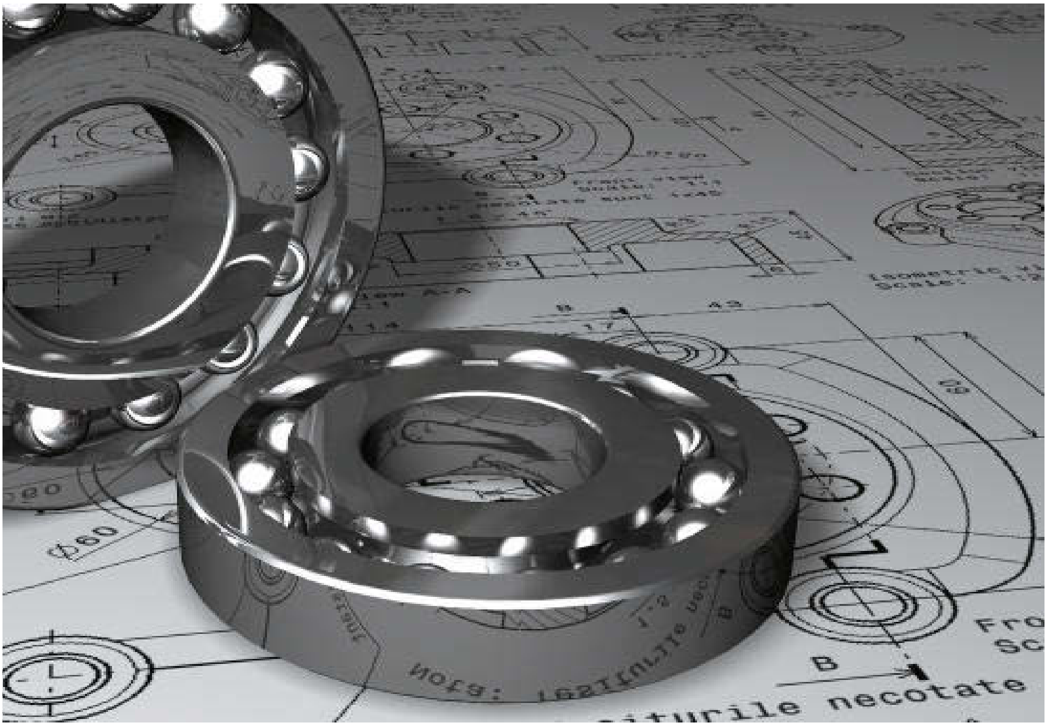
Among the materials in Table 12.14, though branch-type polyphenylene sulfide (PPS) is often used, the cage design is restricted since forced-removal from the die is difficult due to poor toughness and brittleness. Moreover, PPS is not ideal as a cage material since the claw, stay, ring, or flange of 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 ℃
Physical Properties	•Poor toughness (Care necessary regarding cage shape) •Low weld strength •Small fatigue resistance
Environmental Properties	•Water absorption (Poor dimensional stability) •Good aging resistance •Poor stress cracking resistance
Material Cost (Superiority)	3
Cage Application	•Many performance problems •High material price

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 ℃	210 ℃	240 ℃	220 ℃	220 ℃
	•Poor toughness •Low weld strength •Low fatigue resistance	•Very brittle (No forced-removal molding) •Special heat treatment before use •High rigidity, after heat treatment	•Excellent toughness, wear, and fatigue resistance •Small weld strength	•Excellent mechanical properties •Slightly low toughness	•Excellent mechanical properties •Good toughness •Good dimensional stability (No water absorption)
	•Good aging resistance •Poor stress cracking resistance	•Good environmental resistance	•Good environmental resistance	•Good environmental resistance	•Good environmental resistance (not affected by most chemicals, doesn't deteriorate in high temperature oil with extreme pressure additives).
	2	5	4	1	1
	•Many performance problems •High material cost	•Good performance •High material and molding cost (For special applications)	•Excellent performance •High material cost (For special applications)	•Problems with toughness •Cost is high compared to performance	•Reasonable cost for performance (For general applications)



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13. DESIGN OF SHAFTS AND HOUSINGS

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 Cylindricality	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 .

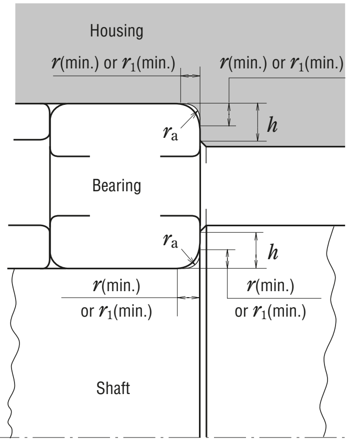


Fig. 13.1 Chamfer Dimensions, Fillet Radius of Shaft and Housing, and Shoulder Height

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 r (min.) or r_1 (min.)	Shaft or Housing		
	Fillet Radius r_a (max.)	Minimun Shoulder Heights h (min.): Deep Groove Ball Bearings (1), Self-Aligning Ball Bearings, Cylindrical Roller Bearings (1), Solid Needle Roller Bearings	Minimun Shoulder Heights h (min.): Angular Contact Ball Bearings, Tapered Roller Bearings (2), Spherical Roller Bearings
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.

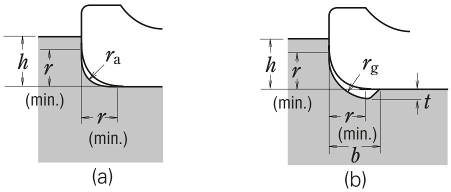


Fig. 13. 2 Chamfer Dimensions, Fillet Radius, and Shoulder Height

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.

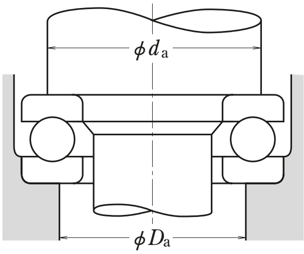


Fig. 13.3 Face-Supporting Diameters for Thrust Ball Bearings

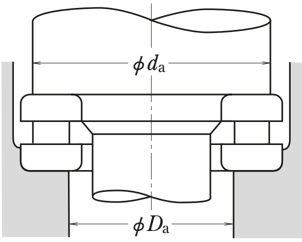


Fig. 13.4 Face-Supporting Diameters for Thrust Roller Bearings

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.

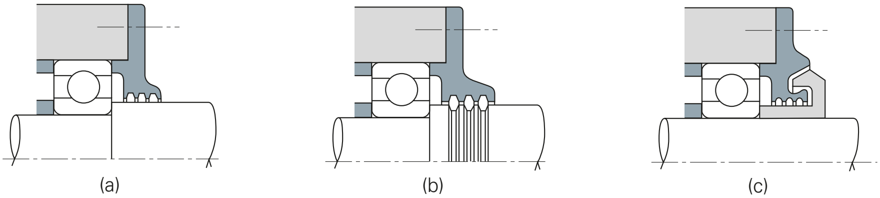


Fig. 13.5 Example Oil Grooves

(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).

(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. 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

Table 13. 5 Labyrinth Seal Gaps

Units : mm

Nominal Shaft Diameter	Labyrinth Gaps	
	Radial Gap	Axiall Gap
Under 50	0.25 to 0.4	1 to 2
50-200	0.5 to 1.5	2 to 5

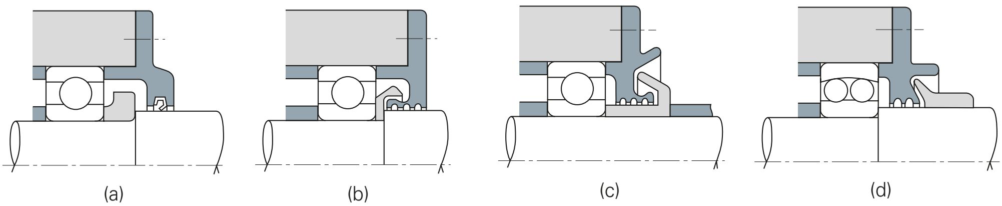


Fig. 13.6 Example Flinger Configurations

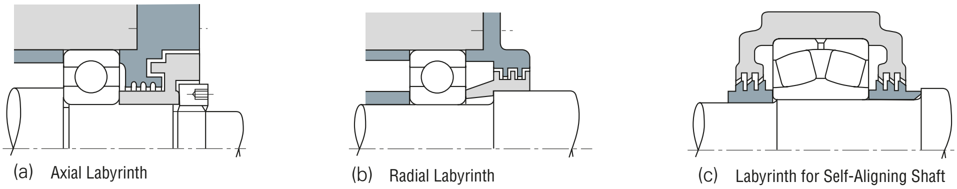


Fig. 13.7 Example Labyrinth Designs

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.

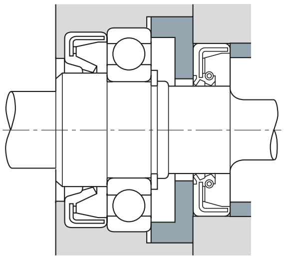


Fig. 13.8 Example of Application of Oil Seal (1)

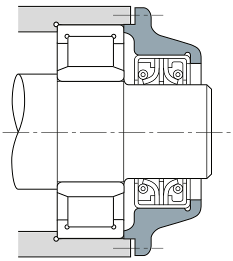


Fig. 13.9 Example of Application of Oil Seal (2)

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-containes 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 intervais.

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


NSK
TALLER
G50

Part B

BEARING HANDLING AND MAINTENANCE


MANTENGA
LIMPIO
NSK

1. BEARING HANDLING

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 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.

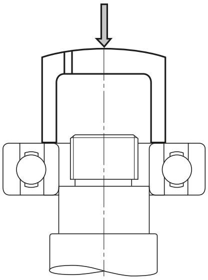


Fig. 1.1 Press Fitting Inner Ring

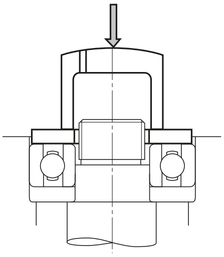


Fig. 1.2 Simultaneous Press Fitting of Inner and Outer Rings

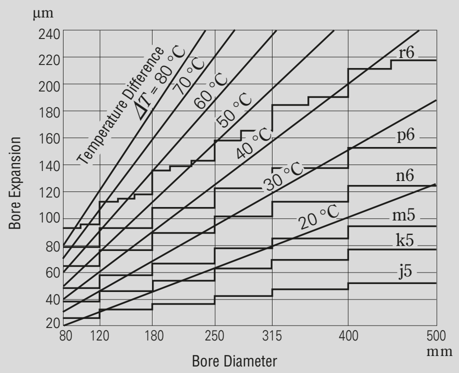


Fig. 1.3 Temperature and Thermal Expansion of Inner Ring

(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:

(a) Do not heat bearings above 120˚C.
(b) Put the bearings on a wire net or suspend them in an oil tank to prevent them from touching the tank's bottom directly.
(c) 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.
(d) 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.

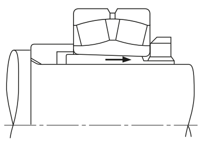


Fig. 1.4 Mounting With Adapter

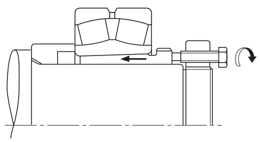


Fig. 1.5 Mounting With Withdrawal Sleeve

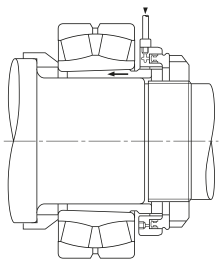


Fig. 1.6 Mounting With Hydraulic Nut

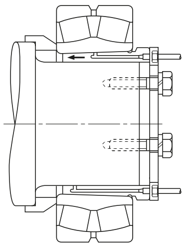


Fig. 1.7 Mounting With Special Sleeve and Hydraulic Pressure

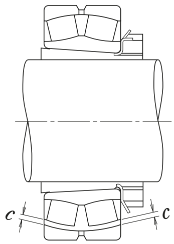


Fig. 1.8 Clearance Measurement of a Spherical Roller Bearing

Table 1.1 Mounting of Spherical Roller Bearings With Tapered Bores

Units : mm

Bearing Bore Diameter *d*		Reduction in Radial Clearance		Axial Drive-Up Distance				Minimum Permissible Residual Clearance	
				Taper 1 : 12		Taper 1 : 30		*CN*	*C3*
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.

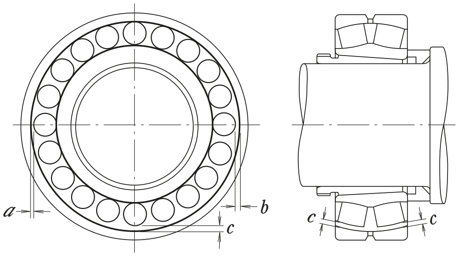


Fig. 1.9 Measuring Clearance in Large Spherical Roller Bearing

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 dismounted 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 locater 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 (1)	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 (1) 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 dismounted 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 dismounting, 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 dismounting. 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 dismounting 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.

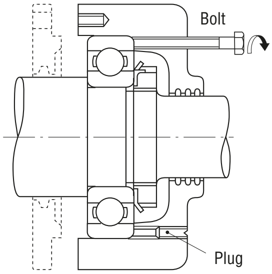


Fig. 1.10 Removal of Outer Ring With Dismounting Bolts

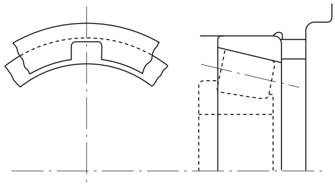


Fig. 1.11 Removal Notches

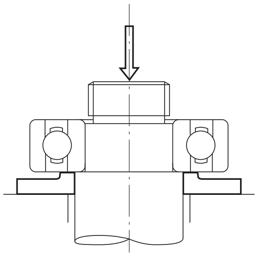


Fig. 1.12 Removal of Inner Ring Using a Press

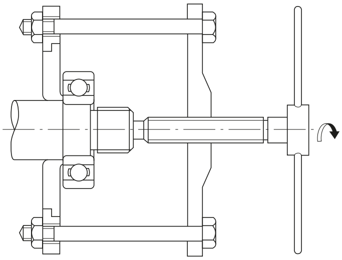


Fig. 1.13 Removal of Inner Ring Using a Withdrawal Tool (1)

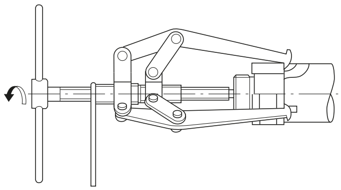


Fig. 1.14 Removal of Inner Ring Using a Withdrawal Tool (2)

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 dismounting of large bearings. Oil pressure is applied through holes in the shaft and allows for easy dismounting. 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 dismounting 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 dismounting 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.

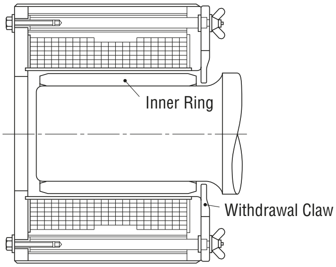


Fig. 1.15 Removal of Inner Ring Using an Induction Heater

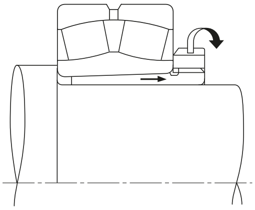


Fig. 1.16 Removal of Withdrawal Sleeve Using a Withdrawal Nut (1)

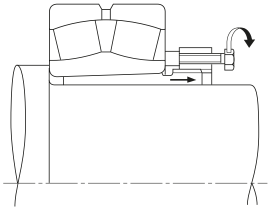


Fig. 1.17 Removal of Withdrawal Sleeve Using a Withdrawal Nut (2)

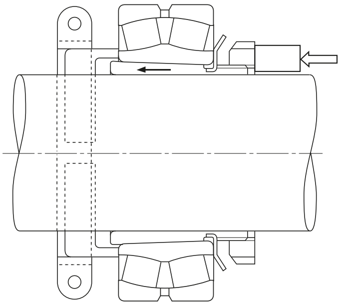


Fig. 1.18 Removal of Adapter With a Stop and Axial Pressure

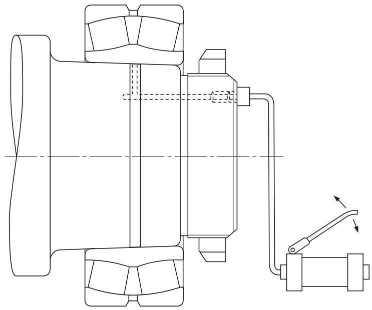


Fig. 1.19 Removal Using an Oil Injection Hydraulic Pump

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.

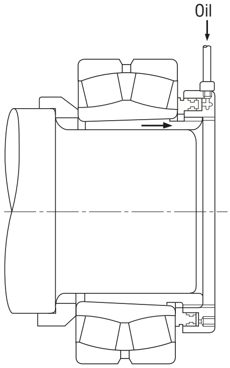


Fig. 1.20 Removal Using a Hydraulic Nut

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).

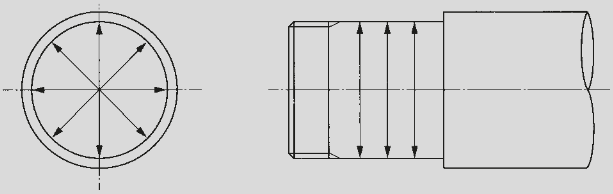


Fig. 1.21 Cylindrical Shaft

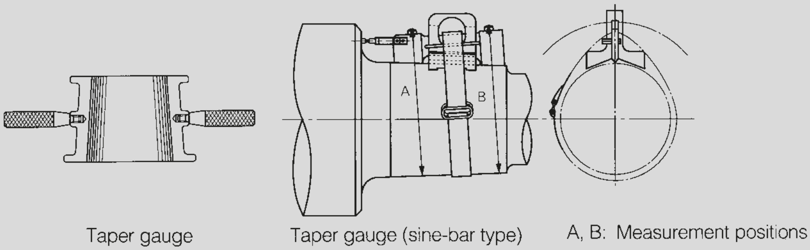


Fig. 1.22 Tapered Shaft

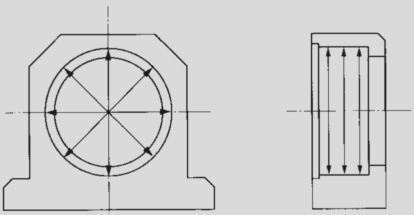


Fig. 1.23 Integrated Housing

(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.

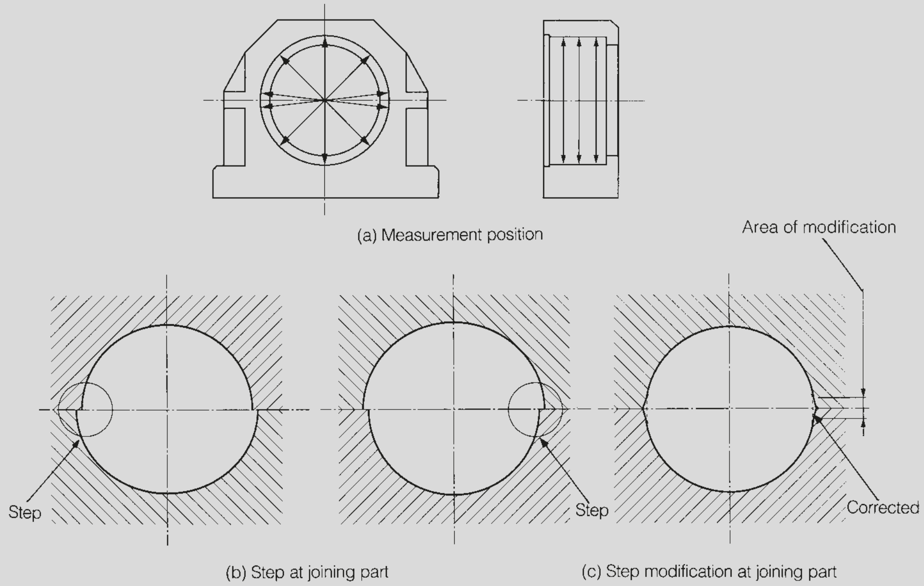


Fig. 1.24 Split Housing

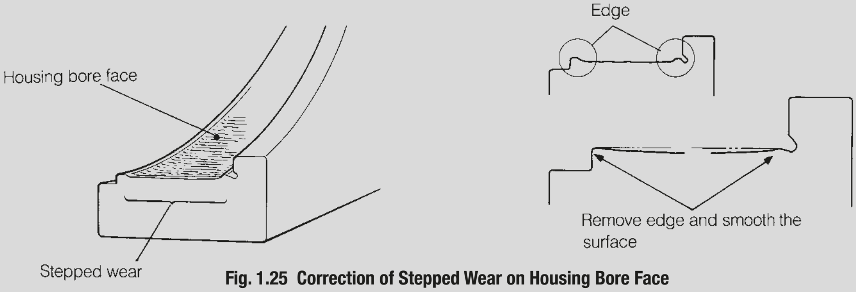


Fig. 1.25 Correction of Stepped Wear on Housing Bore Face

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 dismounted and examined in detail. Refer to Section 1.6 Inspection of Bearings for dismounting and inspection procedures.

1.8.2 Diagnosis with Sound and Vibration

Classification of sounds and vibrations

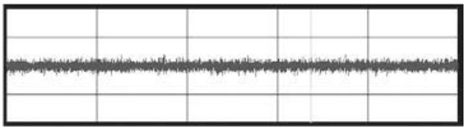
Sounds and vibration accompany the rotation of rolling bearings. The tone and amplitude of such sounds and vibration vary depending on the type of bearing, mounting conditions, operational conditions, etc. The sounds and vibration of a rolling bearing can be classified under the following four chief 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_{RIN}: 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^{-1}

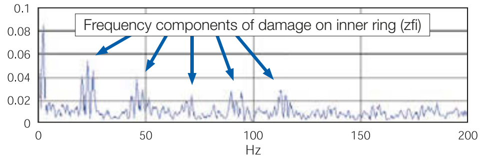


Fig. 1.27

Generated Frequency (Frequency Analysis)			Source	Countermeasures
FFT of Original Wave		FFT After Envelope (Basic No.)		
Radial (Angular) Direction	Axial Direction			
f_{RiN}, f_{MI}	f_{AiN}, f_{AM}	—	Selective resonance from waviness (rolling friction)	Improve rigidity around bearings, provide appropriate radial clearance, use high-viscosity lubricant and high-quality bearings.
f_{RiN}, f_{MI} Natural frequency of cage	f_{AiN}, f_{AM}	Zf_c	Collision of rolling elements with inner ring or cage	Reduce radial clearance, apply preload, use high-viscosity oil
$(\approx f_{R2N}, f_{R3N})$	—	?	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
$nZf_i \pm f_r$ ($nZ \pm 1$ peaks)	nZf_i (nZ peaks)	—	Inner ring raceway waviness, irregularity of shaft exterior	Use high-quality bearings, improve shaft accuracy
nZf_c ($nZ \pm 1$ peaks)	nZf_c (nZ peaks)	—	Outer ring raceway waviness, irregular housing bore	Use high-quality bearings, improve housing bore accuracy
$2nf_b \pm f_c$ ($2n$ peaks)	$2nf_b$ ($2n$ peaks)	—	Rolling element waviness	Use high-quality bearings
f_{RiN}, f_{MI}	f_{AiN}, 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}, f_{MI}	f_{AiN}, f_{AM}	Irregular	Entry of dirt and debris	Wash the bearing, improve sealing
Natural frequency of seal		(f_r)	Self-induced vibration due to friction at seal contact area	Change the seal, change the grease
?	?	Irregular	Lubricant or lubricant bubbles crushed between rolling elements and raceways	Change the grease
f_r	—	—	Irregular inner ring cross-section	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)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2. BEARING DAMAGE AND COUNTERMEASURES (Bearing Doctor)

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).

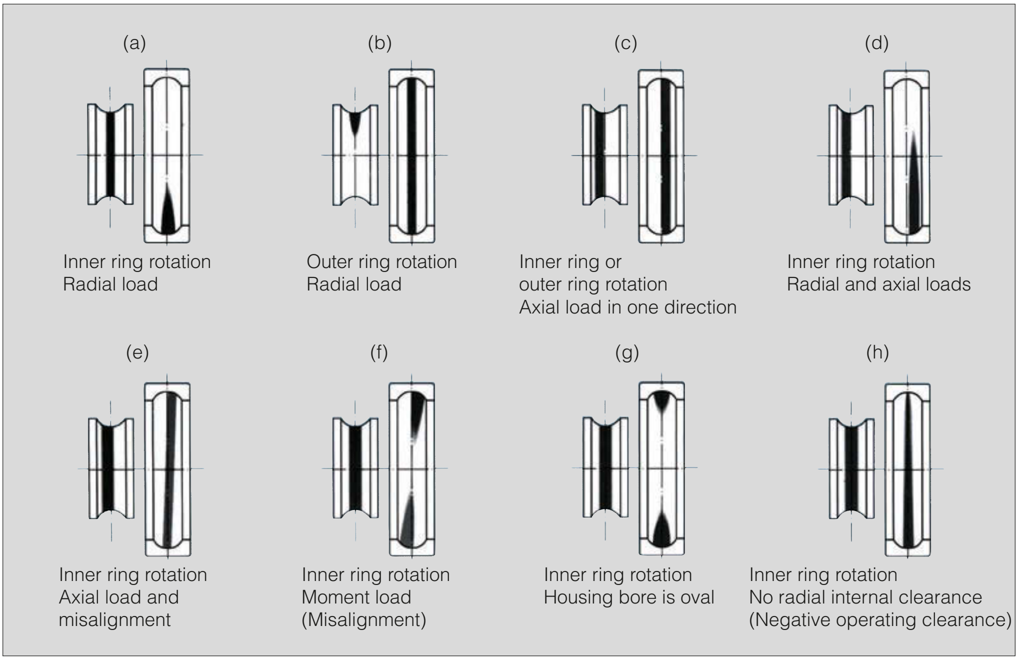


Fig. 2.2 Typical Running Traces of Deep Groove Ball Bearings

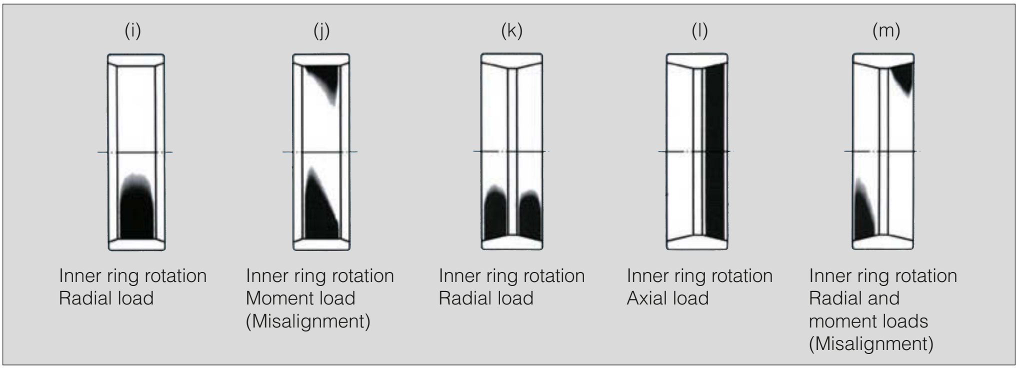


Fig. 2.2 Typical Running Traces of Roller Bearings

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.	• Excessive load • Poor mounting (misalignment) • Moment load • Entry of foreign debris or water • Poor lubrication, improper lubricant • Unsuitable bearing clearance • Improper precision of shaft or housing, unevenness in housing rigidity, large shaft bending • Rust, corrosion pits, smearing, dents (Brinelling)	➢ Reconfirm the bearing application and check load conditions ➢ Improve the mounting method ➢ Improve the sealing mechanism, prevent rusting during idle periods ➢ Use a lubricant with the proper viscosity, improve the lubrication method ➢ Check the precision of the shaft and housing ➢ Check the bearing internal clearance

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

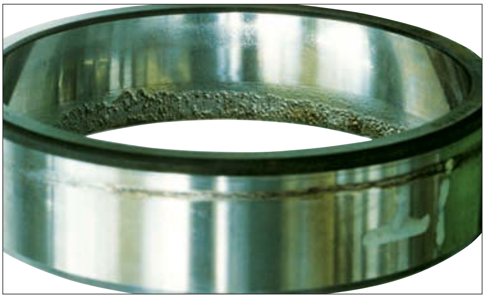


Photo 1-6
Part: Outer ring of Photo 1-5
Symptom: Flaking of only one raceway over its entire circumference
Cause: Excessive axial load

Photo 1-7
Part: Inner ring of a spherical roller bearing
Symptom: Flaking of only one raceway
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)

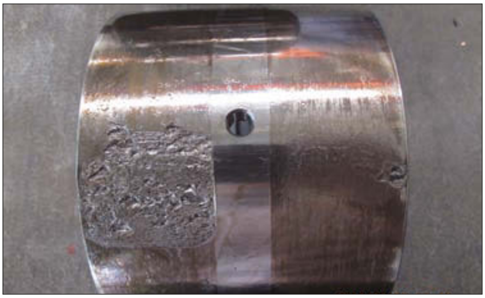


Photo 1-13
Part: Inner ring of a cylindrical roller bearing for Sendzimir mills
Symptom: Flaking of the raceway surface
Cause: Severe operating conditions and low-viscosity oil lubrication

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 μm. Small particles fall off and extensive minor flaking occurs.	• Unsuitable lubricant • Entry of debris into lubricant • Rough surface due to poor lubrication • Surface roughness of mating parts	➢ Select a different lubricant ➢ Improve the sealing mechanism ➢ Improve the surface finish of the mating parts

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
Surface damage due to accumulated small seizures caused by sliding under improper lubrication or under severe operating conditions. Linear damage appears circumferentially on the raceway surface and rolling surface. Cycloidal shaped damage appears on the roller end, while scoring on the rib surface appears on the contacting roller end.	• Excessive load, excessive preload • Poor lubrication • Particles caught in the surface • Inclination of inner and outer rings • Shaft bending • Poor precision of the shaft and housing	➢ Check the size of the load ➢ Adjust the preload ➢ Improve the lubricant and the lubrication method ➢ Check the precision of the shaft and housing

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

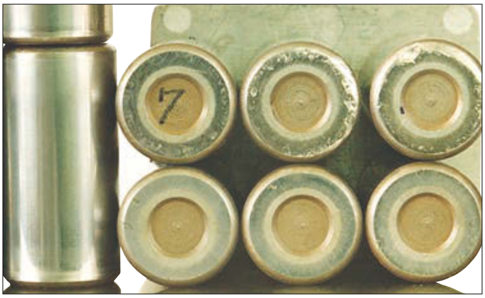


Photo 3-4
Part: Rollers of a double-row cylindrical roller bearing
Symptom: Scoring on the roller end face
Cause: Poor lubrication and excessive axial load

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

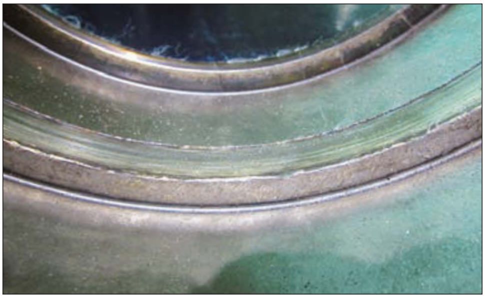


Photo 3-8
Part: Outer ring of a double-row cylindrical roller bearing
Symptom: Notable scoring on the face of an outer ring rib
Cause: Excessive axial load

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.	• High speed and light load • Sudden acceleration/deceleration • Improper lubricant • Entry of water	➢ Improve the preload ➢ Improve the bearing clearance ➢ Use a lubricant with good oil film formation ➢ Improve the lubrication method ➢ Improve the sealing mechanism

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

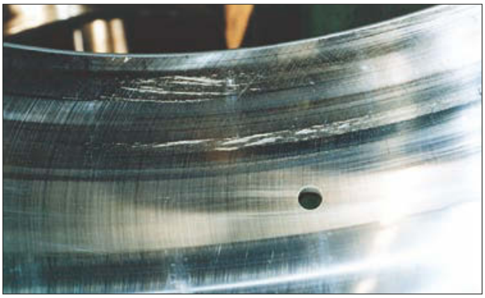


Photo 4-6
Part: Outer ring of Photo 4-5
Symptom: Partial smearing circumferentially on raceway surface
Cause: Poor lubrication

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.	• Shock during mounting • Excessive load • Poor handling, such as dropping	➢ Improve the mounting method (shrink fit, use of proper tools) ➢ Reconsider load conditions ➢ Provide enough backup and support for the bearing rib

Photo 5-1
Part: Inner ring of a double-row cylindrical roller bearing
Symptom: Chipping at the center rib
Cause: Excessive load during mounting

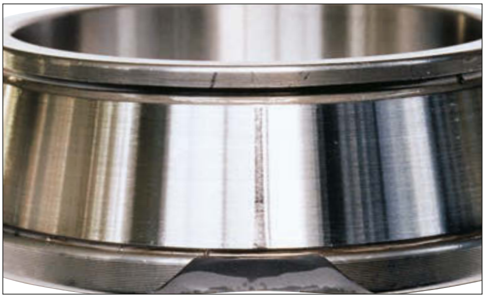


Photo 5-2
Part: Inner ring of a tapered roller bearing
Symptom: Fracture at the large rib
Cause: Large shock during mounting

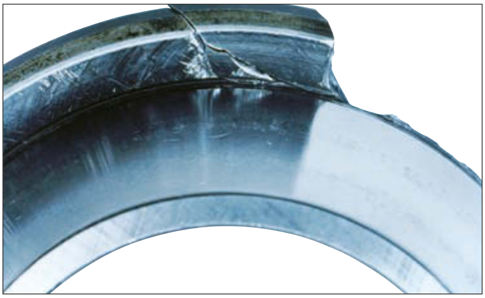


Photo 5-3
Part: Inner ring of a spherical thrust roller bearing
Symptom: Fracture at the large rib
Cause: Repeated load

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.	• Excessive interference • Excessive load, shock load • Progression of flaking • Heat generation and fretting caused by contact between mounting parts and raceway ring • Heat generation due to creep • Poor taper angle of tapered shaft • Poor cylindricality of shaft • Interference with bearing chamfer due to a large shaft corner radius	➢ Correct the interference ➢ Check load conditions ➢ Improve the mounting method ➢ Use an appropriate shaft shape

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 propageted 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

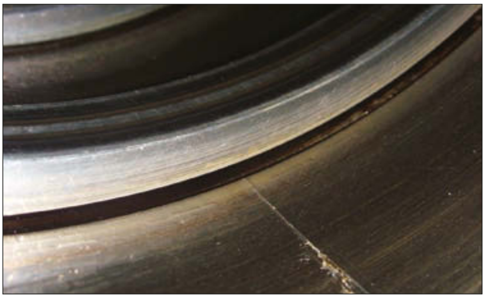


Photo 6-5
Part: Outer ring of a cylindrical roller bearing for Sendzimir mills
Symptom: Fatigue crack on outer ring raceway surface
Cause: Bending stress（large rotating outer ring load）

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

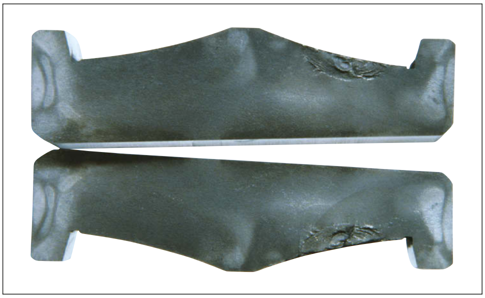


Photo 6-7
Part: Cross section of a fractured inner ring in Photo 6-6
Symptom: Flaking origin directly beneath the raceway surface

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.	• Poor mounting (bearing misalignment) • Poor handling • Large moment load • Shock and large vibration • Excessive rotation speed, sudden acceleration/deceleration • Poor lubrication • Temperature rise	➢ Check the mounting method ➢ Check the temperature, rotation, and load conditions ➢ Reduce vibration ➢ Select a different cage type ➢ Select a different lubrication method or lubricant

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

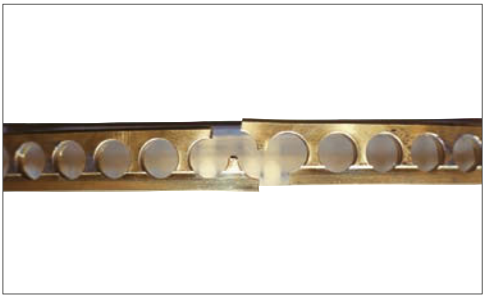


Photo 7-3
Part: Cage of an angular contact ball bearing
Symptom: Fracture of machined high-tension-brass cage

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

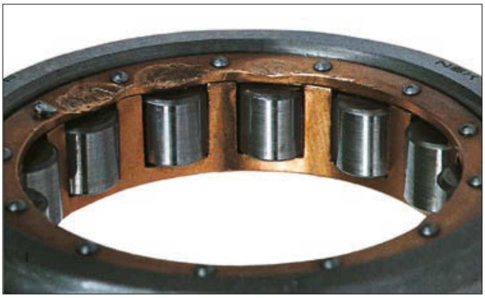


Photo 7-6
Part: Cage of a cylindrical roller bearing
Symptom: Deformation of the side face of a machined high-tension-brass cage
Cause: Large shock load during mounting

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	Countermasures
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).	• Debris such as metallic particles caught in the surface • Excessive load • Shock during transport or mounting	➢ Wash the housing ➢ Improve the sealing mechanism ➢ Filter the lubrication oil ➢ Improve the mounting and handling methods

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.	• Debris caught in the lubricant • Exposure to moisture in the atmosphere • Poor lubrication	➢ Improve the sealing mechanism ➢ Filter the lubrication oil thoroughly ➢ Use another appropriate lubricant

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.	• Entry of debris • Progression from rust and electrical corrosion • Poor lubrication • Sliding due to irregular motion of rolling elements	➢ Improve the sealing mechanism ➢ Clean the housing ➢ Filter the lubrication oil thoroughly ➢ Check the lubricant and lubrication method ➢ Prevent misalignment

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.	• Poor lubrication • Vibration with a small amplitude • Insufficient interference	➢ Use a proper lubricant ➢ Apply a preload ➢ Check the interference fit ➢ Apply a film of lubricant to the fitting surface

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.	• Oscillation and vibration of a stationary bearing during transport, etc. • Oscillating motion with a small amplitude • Poor lubrication	➢ Secure the shaft and housing during transport ➢ Transport with the inner and outer rings packed separately ➢ Reduce vibration by preloading ➢ Use another appropriate lubricant

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.	• Poor lubrication • Excessive load (excessive preload) • Excessive rotational speed • Excessively small internal clearance • Entry of water and debris • Poor precision of shaft and housing, excessive shaft bending	➢ Review the lubricant and lubrication method ➢ Re-investigate the suitability of the bearing type selected ➢ Review the preload, bearing clearance, and fitting ➢ Improve the sealing mechanism ➢ Check the precision of the shaft and housing ➢ Improve the mounting method

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

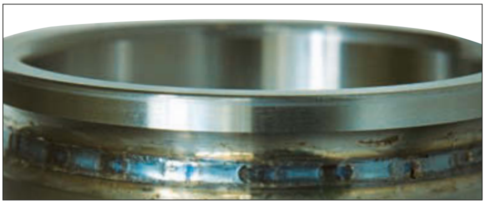


Photo 13-3
Part: Inner ring of an angular contact ball bearing
Symptom: Raceway discoloration, melting at ball pitch intervals
Cause: Excessive preload

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.	• Insufficient interference or loose fit • Insufficient sleeve tightening	➢ Check interference and prevent rotation ➢ Correct the sleeve tightening ➢ Review precision of the shaft and housing ➢ Apply axial preload ➢ Tighten the raceway ring side face ➢ Apply adhesive to the fitting surface ➢ Apply a film of lubricant to the fitting surface

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

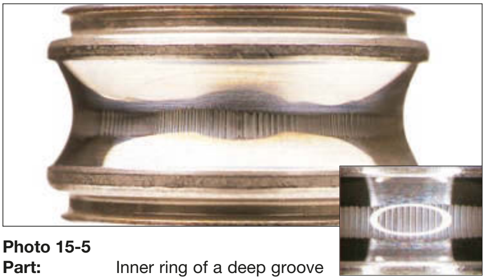
Damage	Possible Causes	Countermeasures
When electric current passes through a bearing, arcing and burning occur throughout the thin oil film at points of contact between the race and rolling elements. The points of contact are melted locally to form "fluting" or groove-like corrugations which can be seen by the naked eye. Magnification of these grooves reveals crater-like depressions that indicate melting by arcing.	• Electric potential difference between inner and outer rings • High-frequency electric potential difference generated by instruments or substrates used near a bearing.	➢ Design electric circuits that prevent current flow through the bearings ➢ Insulate the bearing

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



Enlargement

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.	• Entry of corrosive gas or water • Improper lubricant • Formation of water droplets due to condensation • High temperature and high humidity while stationary • Poor rust preventive treatment during transport • Improper storage conditions • Improper handling	➢ Improve the sealing mechanism ➢ Review the lubrication method ➢ Apply an anti-rust treatment during idle periods ➢ Improve storage methods ➢ Improve handling

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

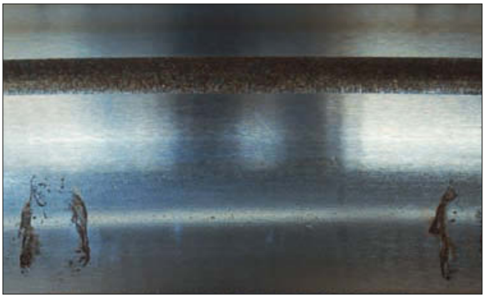


Photo 16-2
Part: Outer ring of a slewing ring
Symptom: Rust on raceway surface at ball pitch
Cause: Condensation during stationary periods

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.	• Inclination of inner and outer rings during mounting or dismounting • Shock load during mounting or dismounting	➢ Use appropriate jigs and tools ➢ Avoid shock load by using a press machine ➢ Center the relative mating parts during mounting

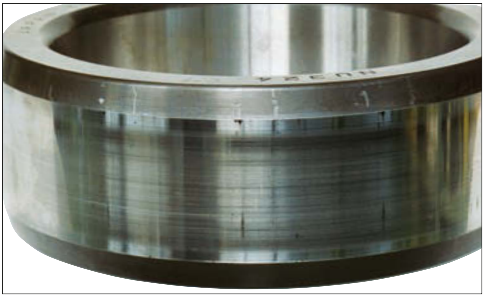


Photo 17-1
Part: Inner ring of a cylindrical roller bearing
Symptom: Axial scratches on raceway surface
Cause: Inclination of inner and outer rings during mounting

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.	• Poor lubrication • Oil stain due to a reaction with lubricant • High temperature	➢ Improve the lubrication method

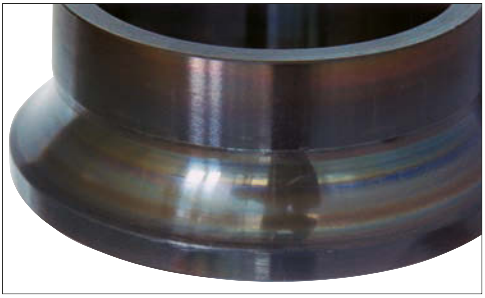


Photo 18-1
Part: Inner ring of an angular contact ball bearing
Symptom: Bluish or purplish discoloration on raceway surface
Cause: Heat generation due to poor lubrication

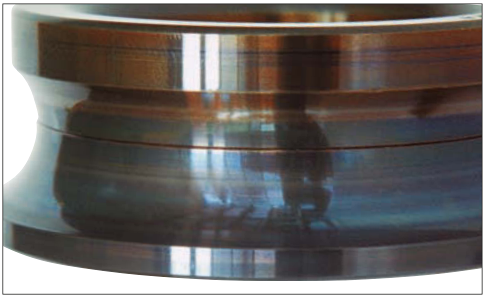


Photo 18-2
Part: Inner ring of a four-point contact ball bearing
Symptom: Bluish or purplish discoloration on raceway surface
Cause: Heat generation due to poor lubrication

Appendix: Bearing Diagnostic Chart

Damage	Location (Phenomenon)	Cause: Handling		Cause: Bearing Surroundings			Cause: Lubrication		Cause: Load			Cause: Speed			Remarks
		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	Bearing Selection	
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.

Notes

BEARING TABLES

Part C

BEARING TABLES


NSK

1. DEEP GROOVE BALL BEARINGS

DESIGN, TYPES, AND FEATURES

SINGLE-ROW DEEP GROOVE BALL BEARINGS

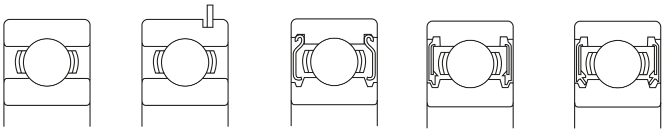
Single-row deep groove ball bearings are classified into the types shown below.

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 (1)	–10 to +110 °C	–10 to +110 °C	–10 to +100 °C

Note (1) 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.

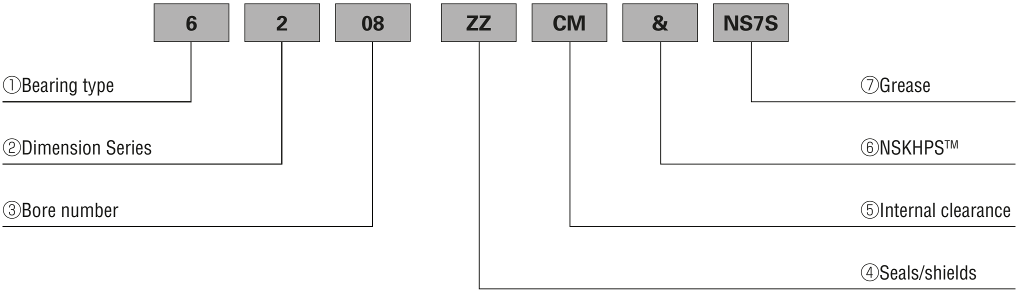
Table 2 Standard Cages for Deep Groove Ball Bearings

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:



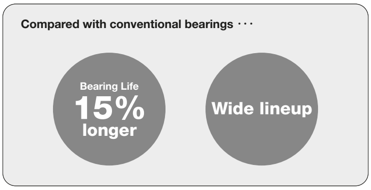
①Bearing type	6 : Single-row deep groove ball bearings
②Dimension Series	2 : 02 Series, 3 : 03 Series, 9 : 19 Series, 0 : 10 Series
③Bore number	Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore bore number X 5 (mm)
④Seals/shields	ZZ : Shield on both sides, DDU: 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
⑤Internal clearance	Omitted : CN clearance*1, C3 : Clearance greater than CN, C4 : Clearance greater than C3, CM : For electric motors*1
⑥NSKHPS™ designation	& : NSKHPS™ Bearings
⑦Grease designation*2	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.

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.

■Easy to assemble

Assembly is easy since bearings can be fitted with a loose tolerance.

■Reusable housing

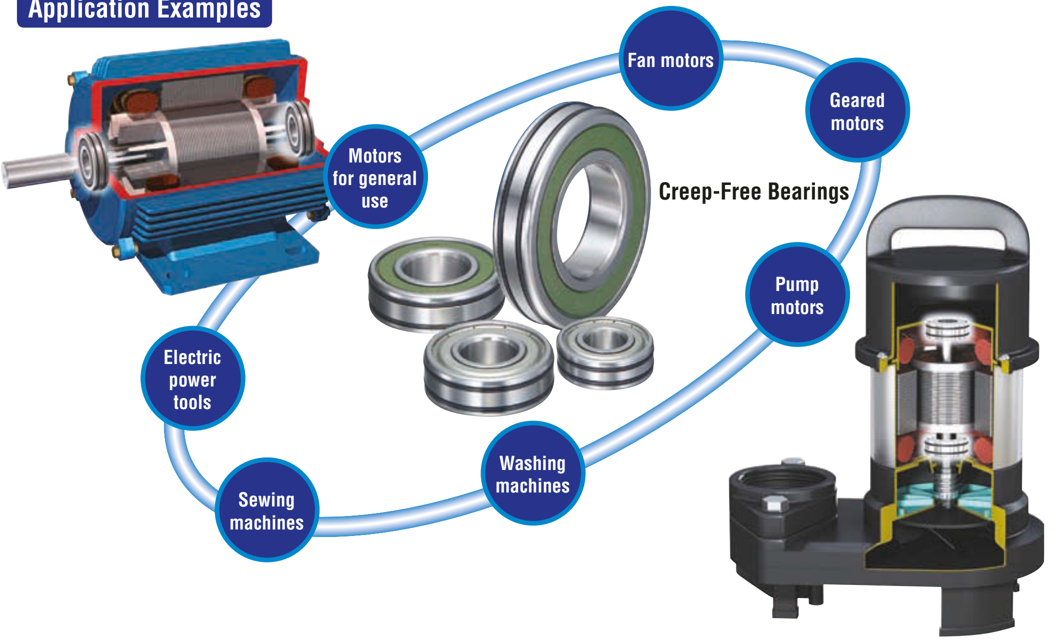
Very little abrasion occurs on the bore surface of the housing, making reuse possible.

■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



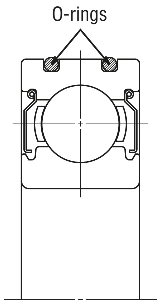


Fig. 1 Structure of Creep-Free Bearings

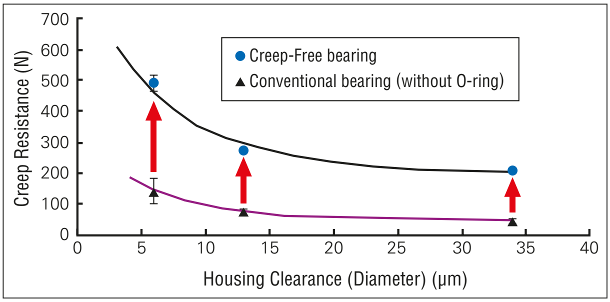


Fig. 2 Creep Limit Load Test (Example Bearing 6204)

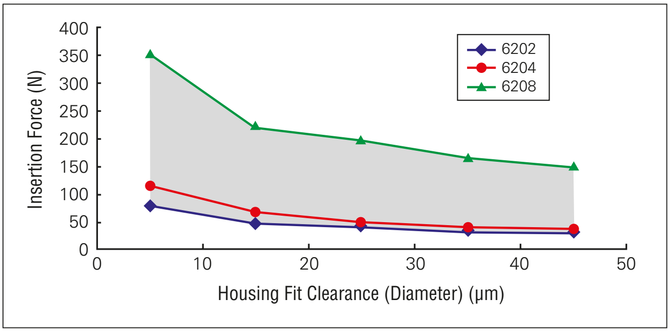


Fig. 3 Fit and Insertion Force

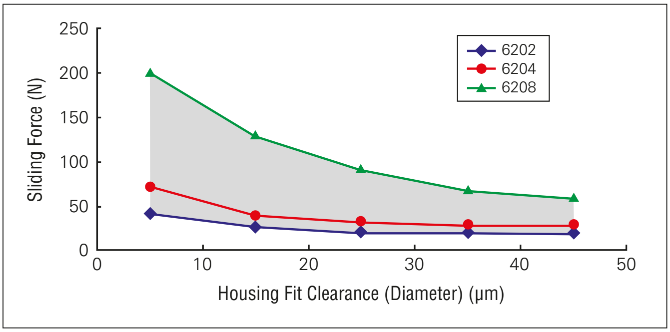


Fig. 4 Fit and Sliding Force

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.

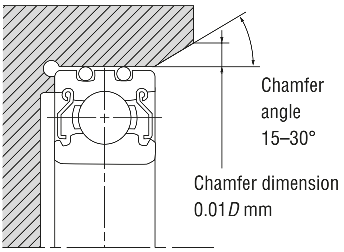
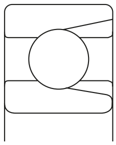


Fig. 5 Housing Shape and Dimension

Note that "free" in the product name “Creep-Free” bearings should not be understood as meaning that creep is nonexistent.



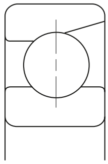
MAXIMUM BALL BEARINGS

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

SINGLE-ROW DEEP GROOVE BALL BEARINGS .... Table 7.2 (Pages A128 to A131)

NSKHPS DEEP GROOVE BALL BEARINGS
Tolerance for Dimensions : ISO Normal
Running Accuracy : ISO Normal

MAXIMUM BALL BEARINGS .... Table 7.2 (Pages A128 to A131)

MAGNETO BEARINGS .... Table 7.5 (Pages A138 and A139)

RECOMMENDED FITS

SINGLE-ROW DEEP GROOVE BALL BEARINGS .... Table 8.3 (Page A164)
Table 8.5 (Page A165)

MAXIMUM BALL BEARINGS .... Table 8.3 (Page A164)
Table 8.5 (Page A165)

MAGNETO BEARINGS .... Table 8.3 (Page A164)
Table 8.5 (Page A165)

INTERNAL CLEARANCES

SINGLE-ROW DEEP GROOVE BALL BEARINGS .... Table 8.10 (Page A169)

NSKHPS DEEP GROOVE BALL BEARINGS
INTERNAL CLEARANCE SYMBOL : CN, C3, C4, CM

MAXIMUM BALL BEARINGS .... Table 8.10 (Page A169)

MAGNETO BEARINGS .... 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.

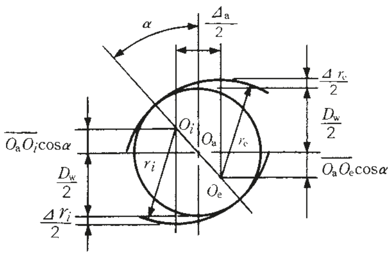


Fig. 1 Relationship Between Δ_r and Δ_a

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)
- α: Contact angle (°)
- Δ_r: Radial clearance (mm)
- Δ_a: Axial clearance (mm)

It is apparent from Fig. 1 that $\Delta_r = \Delta r_e + \Delta r_i$.

Various equations for clearance, contact angle, etc. can be derived from geometric relationships:

$$\Delta_r = 2\,(1-\cos\alpha)\,(r_e+r_i-D_w) \quad \text{(1)}$$

$$\Delta_a = 2\sin\alpha\,(r_e+r_i-D_w) \quad \text{(2)}$$

$$\frac{\Delta_a}{\Delta_r} = \cot\frac{\alpha}{2} \quad \text{(3)}$$

$$\Delta_a \doteqdot 2\,(r_e+r_i-D_w)^{1/2}\Delta_r^{1/2} \quad \text{(4)}$$

$$\alpha = \cos^{-1}\left(\frac{r_e+r_i-D_w-\dfrac{\Delta_r}{2}}{r_e+r_i-D_w}\right) \quad \text{(5)}$$

$$= \sin^{-1}\left(\frac{\Delta_a/2}{r_e+r_i-D_w}\right) \quad \text{(6)}$$

Because $(r_e+r_i-D_w)$ is a constant, fixed relationships between Δ_r, Δ_a, and α 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 Δ_r and axial clearance Δ_a is given in Equation (4). To simplify,

$$\Delta_a \doteqdot K\,\Delta_r^{1/2} \quad \text{(7)}$$

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 Δ_a is:

$\Delta = 2.09\times\sqrt{0.017} = 2.09\times0.13 = 0.27$ (mm)

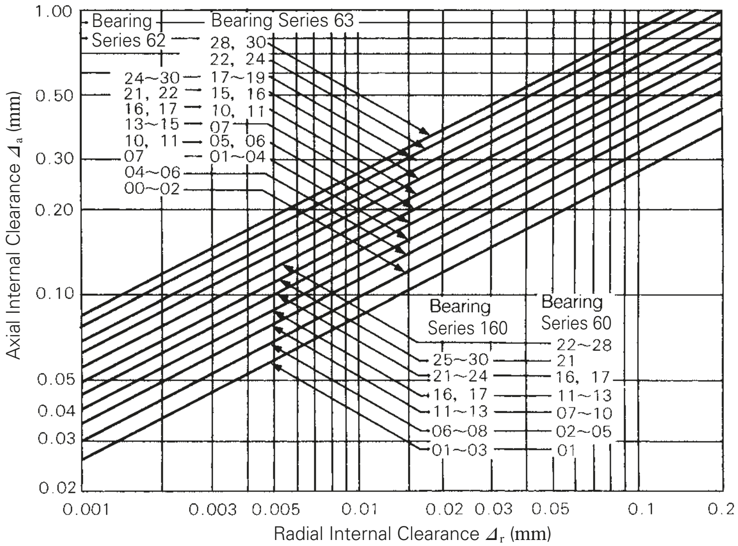


Fig. 2 Radial Clearance Δ_r and Axial Clearance Δ_a of Deep Groove Ball Bearings

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, α_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 α_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 α_0, With C3 and C4 Clearances

Bearing Designation	α_0 with C3	α_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°

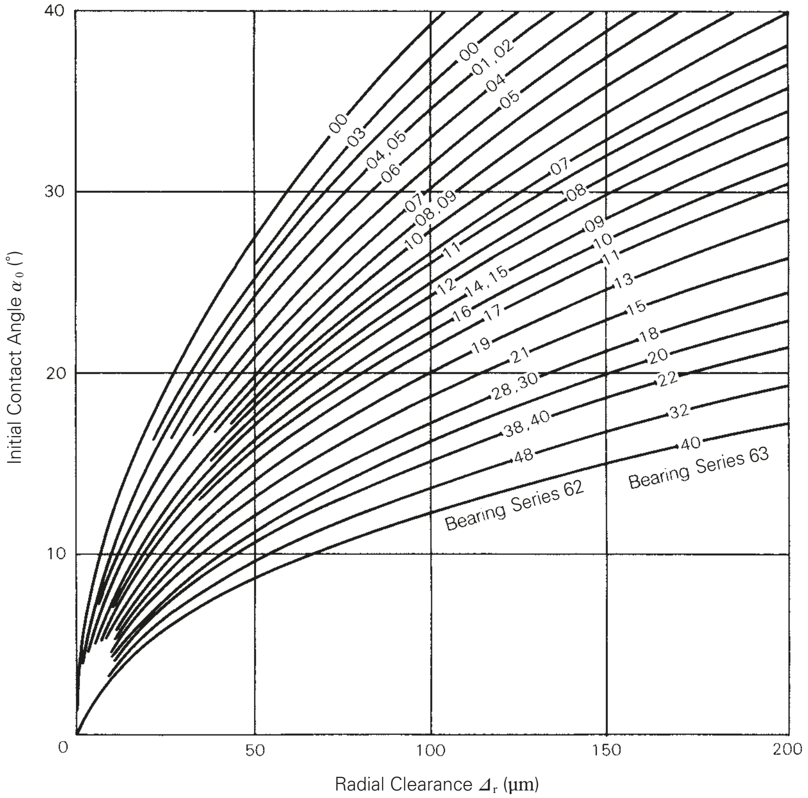


Fig. 3 Radial Clearance and Contact Angle

Features and Operating Temperature Range of Ball Bearing Seal Material

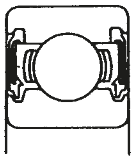
Sealed ball bearings are shown in Figs. 1 and 2. There are two seal types: non-contact seals and contact seals. Nitrile rubber is used for general-purpose applications, while polyacrylic, silicon, and fluoric rubbers are used based on operating temperature requirements. All rubbers have their own unique 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.

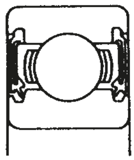
However, there are some disadvantages. Problems with friction-generated wear at the seal lip, thermal plastic deformation, and hardening may occur, causing the contact pressure between the lip and slide surface to decrease and result in a clearance. This clearance is low and does not degrade sealing 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		○Most popular seal material ○Superior mechanical properties and resistance to oil and wear ○Readily ages under direct sunlight ○Less expensive than other rubbers	○Superior heat and oil resistances ○Large compression causes permanent deformation ○Inferior cold resistance ○One of the less expensive high-temperature materials ○Swells in contact with ester oil based grease	○High heat and cold resistances ○Inferior mechanical properties besides resistance to permanent deformation by compression. Note the tear strength ○Swells in contact with low-anilinepoint mineral oil, silicone grease, and silicone oil	○High heat resistance ○Superior oil and chemical resistances ○Cold resistance similar to nitrile rubber ○Deteriorates in contact with urea grease
Operating Temperature Range (1) (°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 (1) 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, whic 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 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.

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.

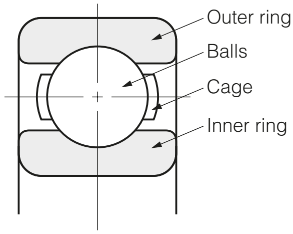


Table 1 Free Space of Open Deep Groove Ball Bearings

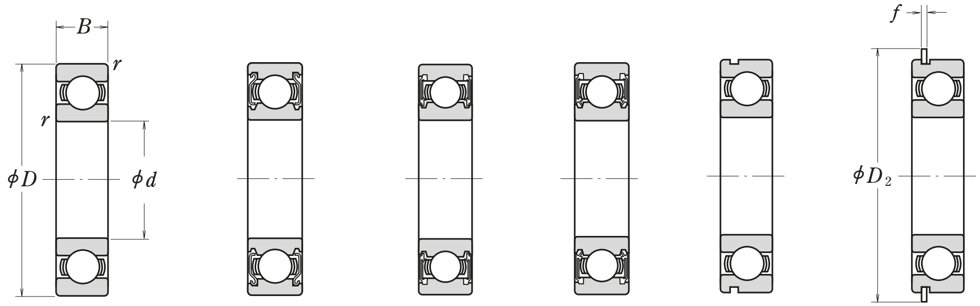
Units : cm^3

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

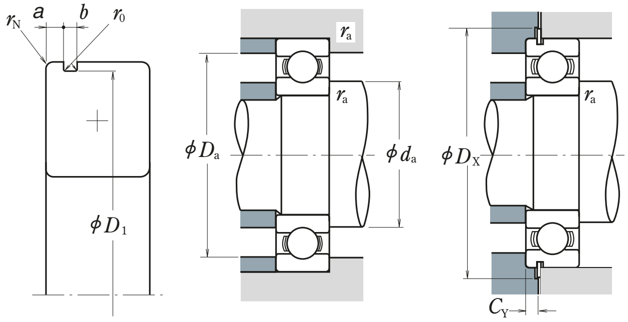
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min^{-1})			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
10	19	5	0.3	1 720	840	14.8	34 000	24 000	40 000	**6800**	**ZZ**	**VV**	**DD**
	22	6	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**
12	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**	—	—	—
	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**
15	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**
	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**
17	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**
	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_a and D_a 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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

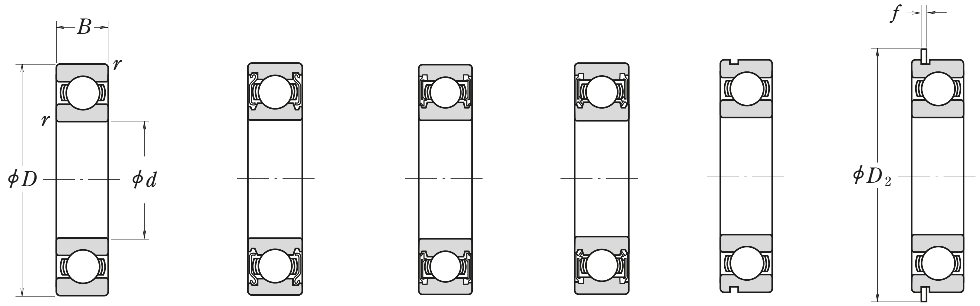
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm) a max.	b min.	D_1 max.	r_0 max.	r_N min.	Snap Ring (1) Dimensions (mm) D_2 max.	f max.	Abutment and Fillet Dimensions (mm) d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	Mass (kg) approx.
—	—	—	—	—	—	—	—	—	12	12	17	0.3	—	—	0.005
N(3)	NR(3)	1.05	0.8	20.8	0.2	0.2	24.8	0.7	12	12.5	20	0.3	25.5	1.5	0.009
N(4)	NR(4)	1.35	0.87	24.5	0.2	0.3	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(3)	NR(3)	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(4)	NR(4)	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(3)	NR(3)	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(3)	NR(3)	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



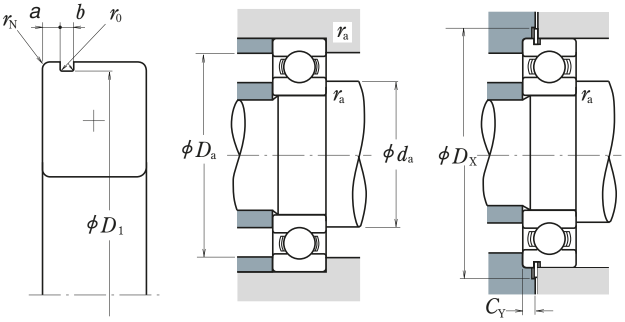
Open | Shielded ZZ | Non-Contact Sealed VV | Contact Sealed DD · DDU | With Snap Ring Groove N | With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min^{-1})			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	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**
22	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**
28	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_a and D_a 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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

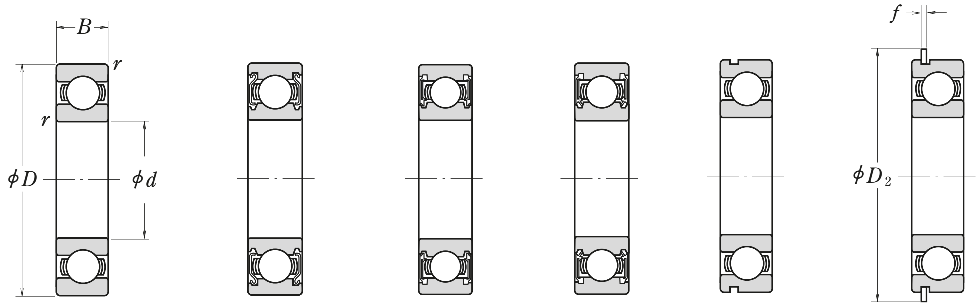
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	approx.
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(3)	NR(3)	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

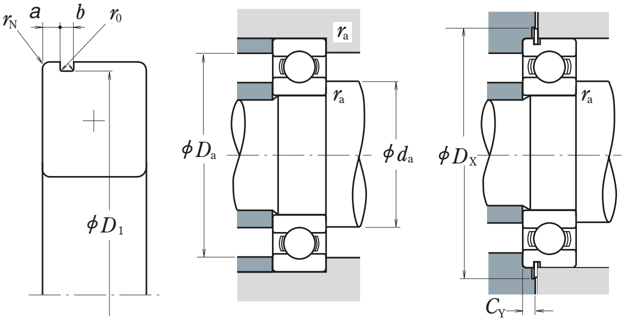


Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	Sealed
32	58	13	1	15 100	9 150	14.5	12 000	7 500	14 000	**60/32**	**ZZ**	**VV**	**DDU**
	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_a and D_a 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

$\frac{F_a}{F_r} > 0.8$, $P_0 = 0.6F_r + 0.5F_a$

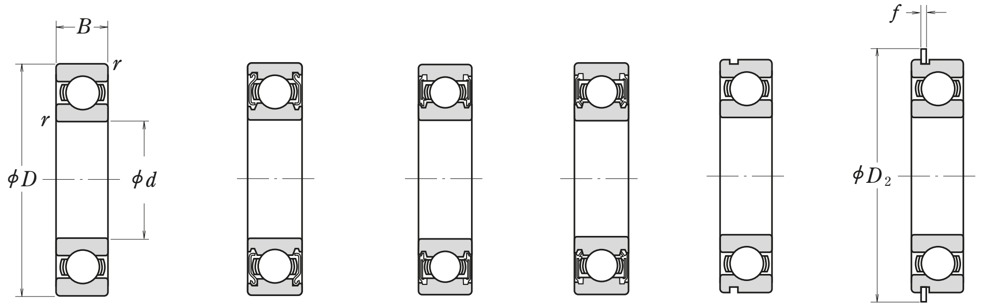
$\frac{F_a}{F_r} \leq 0.8$, $P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	approx.
N	NR	2.08	1.35	55.6	0.4	0.5	63.7	1.12	37	38.5	53	1	64.5	2.9	0.122
N	NR	3.28	1.9	62.6	0.6	0.5	70.7	1.7	37	40	60	1	71.5	4.6	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	4.6	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	1.8	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	2.3	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	3.4	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	4.6	0.284
—	—	—	—	—	—	—	—	—	43	47	72	1.5	—	—	0.464
N	NR	3.28	1.9	76.81	0.6	0.5	86.6	1.7	43	47	72	1.5	88	4.6	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	1.8	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	2.3	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	3.8	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	4.6	0.366
—	—	—	—	—	—	—	—	—	48	53	82	1.5	—	—	0.636
N	NR	3.28	2.7	86.79	0.6	0.5	96.5	2.46	48	53	82	1.5	98	5.4	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	1.8	0.038
N	NR	1.70	0.95	66.7	0.25	0.3(3)	70.8	0.85	49	50	64	0.6	72	2.3	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	3.8	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	4.6	0.42
—	—	—	—	—	—	—	—	—	53	61.5	92	1.5	—	—	0.829
N	NR	3.28	2.7	96.8	0.6	0.5	106.5	2.46	53	61.5	92	1.5	108	5.4	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

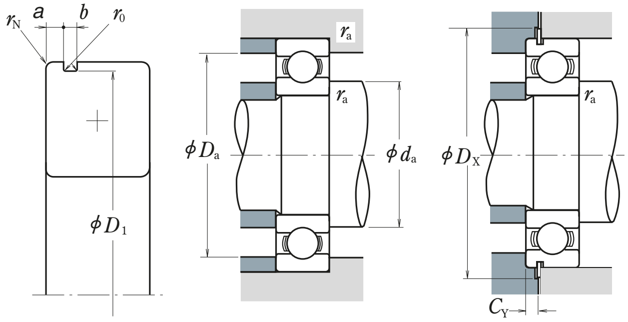


Open | Shielded ZZ | Non-Contact Sealed VV | Contact Sealed DD · DDU | With Snap Ring Groove N | With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹) Grease		Oil	Bearing Designations			
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
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**
55	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**	—	—	—
	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**
60	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**
	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

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

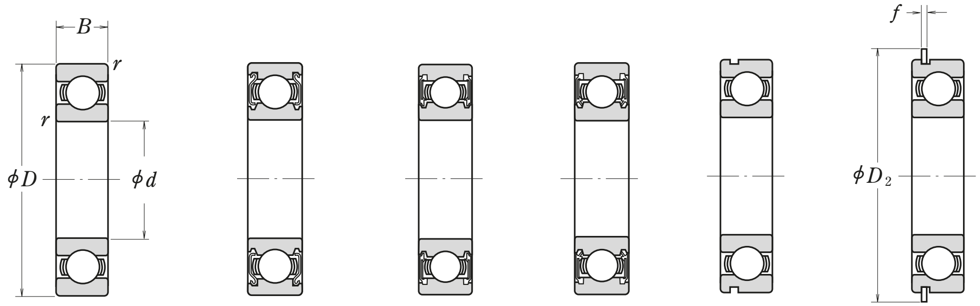
$\frac{F_a}{F_r} \leq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions ([1]) (mm)					Snap Ring ([1]) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a([2]) min.	d_a([2]) max.	D_a([2]) max.	r_a max.	D_x min.	C_Y max.	approx.
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
N	NR	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
N	NR	2.49	1.9	76.81	0.6	0.5	86.6	1.7	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
N	NR	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
N	NR	2.87	2.7	86.79	0.6	0.5	96.5	2.46	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
N	NR	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
N	NR	2.87	2.7	91.82	0.6	0.5	101.6	2.46	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

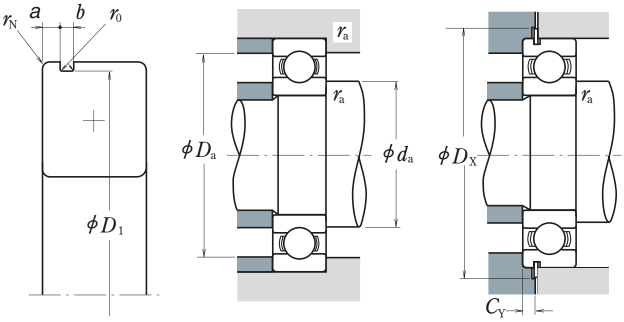


Open | Shielded ZZ | Non-Contact Sealed VV | Contact Sealed DD · DDU | With Snap Ring Groove N | With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
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	**6214**	**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	**6215**	**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**

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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

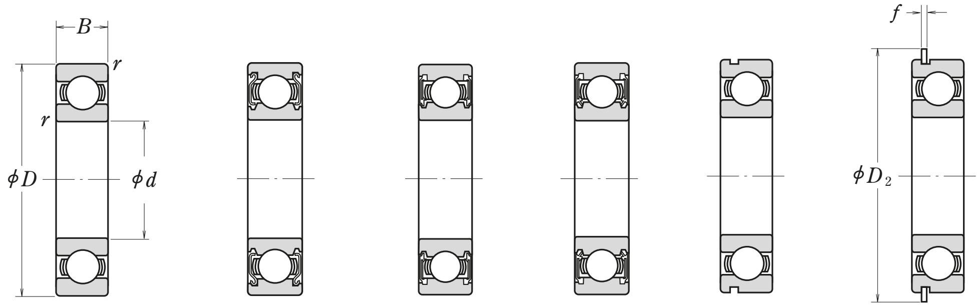
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	approx.
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
—	—	—	—	—	—	—	—	—	71.5	73	93.5	1	—	—	0.439
N	NR	2.87	2.7	96.8	0.6	0.5	106.5	2.46	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
—	—	—	—	—	—	—	—	—	76	85.5	129	2	—	—	2.11
N	NR	4.90	3.1	135.23	0.6	0.5	149.7	2.82	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
—	—	—	—	—	—	—	—	—	76.5	80.5	103.5	1	—	—	0.608
N	NR	2.87	2.7	106.81	0.6	0.5	116.6	2.46	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
—	—	—	—	—	—	—	—	—	81	92	139	2	—	—	2.57
N	NR	4.90	3.1	145.24	0.6	0.5	159.7	2.82	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
—	—	—	—	—	—	—	—	—	81.5	85.5	108.5	1	—	—	0.649
N	NR	2.87	2.7	111.81	0.6	0.5	121.6	2.46	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
—	—	—	—	—	—	—	—	—	86	98.5	149	2	—	—	3.08
N	NR	4.90	3.1	155.22	0.6	0.5	169.7	2.82	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

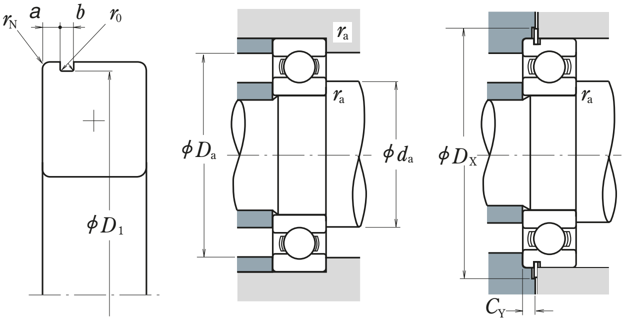


Open | Shielded ZZ | Non-Contact Sealed VV | Contact Sealed DD · DDU | With Snap Ring Groove N | With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
80	100	10	0.6	12 700	14 500	17.4	6 000	3 400	7 100	**6816**	**ZZ**	**VV**	**DDU**
	110	16	1	25 000	24 000	16.6	5 600	3 200	6 700	**6916**	**ZZ**	**VV**	**DDU**
	125	14	0.6	32 000	29 600	16.4	5 300	—	6 300	**16016**	—	—	—
	125	22	1.1	50 000	40 000	15.6	6 300	3 200	7 100	∗ **6016**	**ZZ**	**VV**	**DDU**
	125	22	1.1	47 500	40 000	15.6	5 300	3 200	6 300	**6016**	**ZZ**	**VV**	**DDU**
	140	26	2	76 500	53 000	14.6	5 300	3 000	6 300	∗ **6216**	**ZZ**	**VV**	**DDU**
	140	26	2	72 500	53 000	14.6	4 500	3 000	5 300	**6216**	**ZZ**	**VV**	**DDU**
	170	39	2.1	129 000	86 500	13.3	4 500	2 800	5 600	∗ **6316**	**ZZ**	**VV**	**DDU**
	170	39	2.1	123 000	86 500	13.3	4 000	2 800	4 800	**6316**	**ZZ**	**VV**	**DDU**
85	110	13	1	18 700	20 000	17.1	5 600	3 200	6 700	**6817**	**ZZ**	**VV**	**DDU**
	120	18	1.1	32 000	29 600	16.4	5 300	3 000	6 300	**6917**	**ZZ**	**VV**	**DDU**
	130	14	0.6	33 000	31 500	16.5	5 000	—	6 000	**16017**	—	—	—
	130	22	1.1	52 000	43 000	15.8	6 000	3 000	7 100	∗ **6017**	**ZZ**	**VV**	**DDU**
	130	22	1.1	49 500	43 000	15.8	5 000	3 000	6 000	**6017**	**ZZ**	**VV**	**DDU**
	150	28	2	88 000	62 000	14.5	4 800	2 800	6 000	∗ **6217**	**ZZ**	**VV**	**DDU**
	150	28	2	84 000	62 000	14.5	4 300	2 800	5 000	**6217**	**ZZ**	**VV**	**DDU**
	180	41	3	139 000	97 000	13.3	4 300	2 600	5 000	∗ **6317**	**ZZ**	**VV**	**DDU**
	180	41	3	133 000	97 000	13.3	3 800	2 600	4 500	**6317**	**ZZ**	**VV**	**DDU**
90	115	13	1	19 000	21 000	17.2	5 300	3 000	6 300	**6818**	**ZZ**	**VV**	**DDU**
	125	18	1.1	33 000	31 500	16.5	5 000	2 800	6 000	**6918**	**ZZ**	**VV**	**DDU**
	140	16	1	41 500	39 500	16.3	4 800	—	5 600	**16018**	—	—	—
	140	24	1.5	61 000	50 000	15.6	5 600	2 800	6 300	∗ **6018**	**ZZ**	**VV**	**DDU**
	140	24	1.5	58 000	50 000	15.6	4 800	2 800	5 600	**6018**	**ZZ**	**VV**	**DDU**
	160	30	2	101 000	71 500	14.5	4 500	2 600	5 600	∗ **6218**	**ZZ**	**VV**	**DDU**
	160	30	2	96 000	71 500	14.5	4 000	2 600	4 800	**6218**	**ZZ**	**VV**	**DDU**
	190	43	3	150 000	107 000	13.3	4 000	2 400	4 800	∗ **6318**	**ZZ**	**VV**	**DDU**
	190	43	3	143 000	107 000	13.3	3 600	2 400	4 300	**6318**	**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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

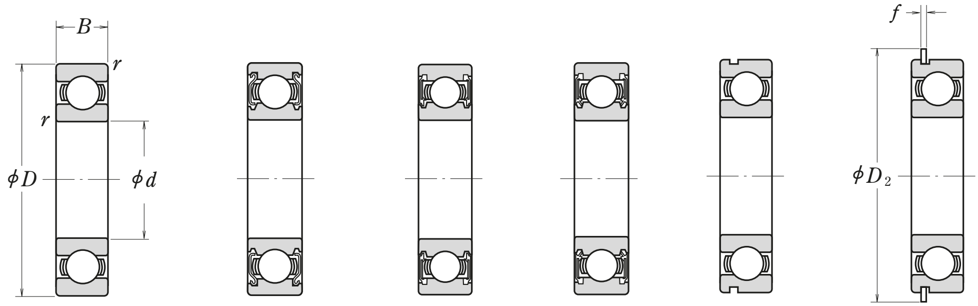
$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	approx.
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
N	NR	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
—	—	—	—	—	—	—	—	—	86.5	91	118.5	1	—	—	0.872
N	NR	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
N	NR	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
—	—	—	—	—	—	—	—	—	91.5	96	123.5	1	—	—	0.918
N	NR	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
N	NR	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
—	—	—	—	—	—	—	—	—	98	103	132	1.5	—	—	1.19
N	NR	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.

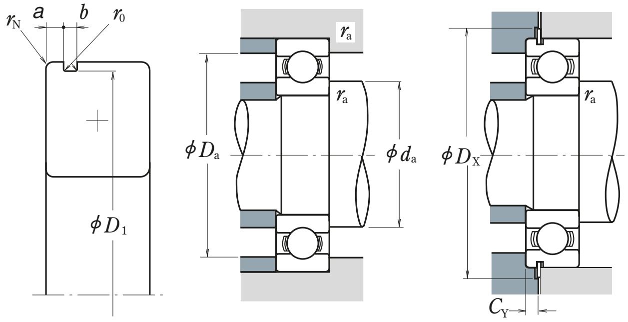
Bore Diameter 95 – 105 mm



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^{-1})			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	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	**6819**	**ZZ**	**VV**	**DD**
	130	18	1.1	33 500	33 500	16.6	4 800	2 800	5 600	**6919**	**ZZ**	**VV**	**DDU**
	145	16	1	43 000	42 000	16.4	4 500	—	5 300	**16019**	—	—	—
	145	24	1.5	63 500	54 000	15.8	5 300	2 600	6 000	* **6019**	**ZZ**	**VV**	**DDU**
	145	24	1.5	60 500	54 000	15.8	4 500	2 600	5 300	**6019**	**ZZ**	**VV**	**DDU**
	170	32	2.1	114 000	82 000	14.4	4 300	2 600	5 000	* **6219**	**ZZ**	**VV**	**DDU**
	170	32	2.1	109 000	82 000	14.4	3 800	2 600	4 500	**6219**	**ZZ**	**VV**	**DDU**
	200	45	3	160 000	119 000	13.3	3 400	2 400	4 300	* **6319**	**ZZ**	**VV**	**DDU**
	200	45	3	153 000	119 000	13.3	3 000	2 400	3 600	**6319**	**ZZ**	**VV**	**DDU**
100	125	13	1	19 600	23 000	17.3	4 800	2 800	5 600	**6820**	**ZZ**	**VV**	**DD**
	140	20	1.1	43 000	42 000	16.4	4 500	2 600	5 300	**6920**	**ZZ**	**VV**	**DDU**
	150	16	1	42 500	42 000	16.5	4 300	—	5 300	**16020**	—	—	—
	150	24	1.5	63 000	54 000	15.9	5 000	2 600	6 000	* **6020**	**ZZ**	**VV**	**DDU**
	150	24	1.5	60 000	54 000	15.9	4 300	2 600	5 300	**6020**	**ZZ**	**VV**	**DDU**
	180	34	2.1	128 000	93 000	14.4	4 000	2 400	4 800	* **6220**	**ZZ**	**VV**	**DDU**
	180	34	2.1	122 000	93 000	14.4	3 600	2 400	4 300	**6220**	**ZZ**	**VV**	**DDU**
	215	47	3	173 000	141 000	13.2	2 800	2 200	3 400	**6320**	**ZZ**	**VV**	**DDU**
105	130	13	1	19 800	23 900	17.4	4 800	2 600	5 600	**6821**	**ZZ**	**VV**	**DDU**
	145	20	1.1	42 500	42 000	16.5	4 300	—	5 300	**6921**	**ZZ**	**VV**	—
	160	18	1	52 000	50 500	16.3	4 000	—	4 800	**16021**	—	—	—
	160	26	2	76 000	66 000	15.8	4 500	2 400	5 600	* **6021**	**ZZ**	**VV**	**DDU**
	160	26	2	72 500	66 000	15.8	4 000	2 400	4 800	**6021**	**ZZ**	**VV**	**DDU**
	190	36	2.1	140 000	105 000	14.4	3 800	2 200	4 500	* **6221**	**ZZ**	**VV**	**DDU**
	190	36	2.1	133 000	105 000	14.4	3 400	2 200	4 000	**6221**	**ZZ**	**VV**	**DDU**
	225	49	3	184 000	154 000	13.2	2 600	2 000	3 200	**6321**	**ZZ**	—	**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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

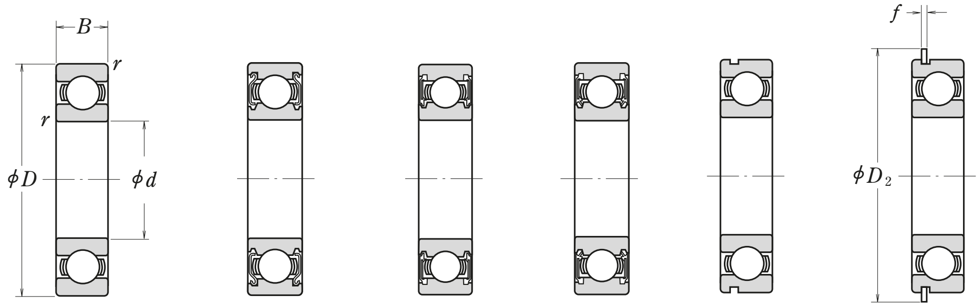
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm) a max.	b min.	D_1 max.	r_0 max.	r_N min.	Snap Ring (1) Dimensions (mm) D_2 max.	f max.	Abutment and Fillet Dimensions (mm) d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	Mass (kg) approx.
N	NR	2.10	1.3	117.6	0.4	0.5	125.7	1.12	100	101.5	115	1	127	2.9	0.297
N	NR	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
—	—	—	—	—	—	—	—	—	103	108.5	137	1.5	—	—	1.23
N	NR	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
N	NR	5.69	3.5	163.65	0.6	0.5	182.9	3.1	106	114	159	2	185	8.4	2.64
—	—	—	—	—	—	—	—	—	108	123.5	187	2.5	—	—	5.76
N	NR	5.69	3.5	193.65	0.6	0.5	212.9	3.1	108	123.5	187	2.5	215	8.4	5.76
N	NR	2.10	1.3	122.6	0.4	0.5	130.7	1.12	105	105.5	120	1	132	2.9	0.31
N	NR	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
—	—	—	—	—	—	—	—	—	108	112.5	142	1.5	—	—	1.29
N	NR	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
N	NR	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
N	NR	2.10	1.3	127.6	0.4	0.5	135.7	1.12	110	110.5	125	1	137	2.9	0.324
N	NR	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
—	—	—	—	—	—	—	—	—	114	120	151	2	—	—	1.58
N	NR	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
N	NR	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

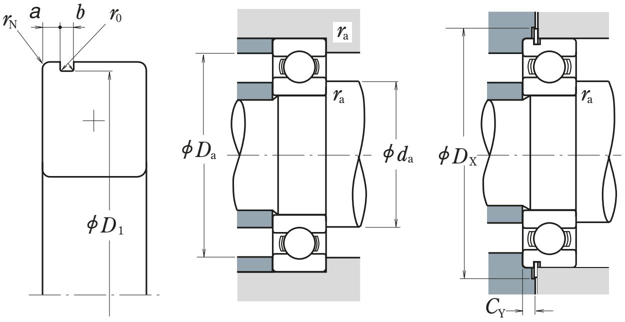


Open | Shielded ZZ · ZZS | Non-Contact Sealed VV | Contact Sealed DD · DDU | With Snap Ring Groove N | With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ 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**	—	—
120	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**	—	—	—
	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**
130	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**	—	—
	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**	—	—
140	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**	—
	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**	—	—
150	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**
	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

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

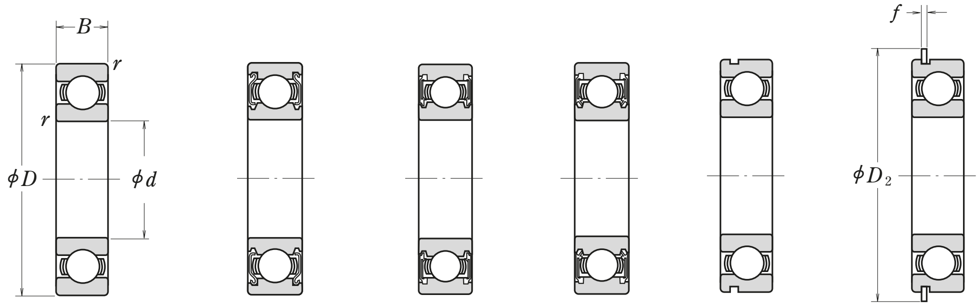
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm) a max.	b min.	D_1 max.	r_0 max.	r_N min.	Snap Ring (1) Dimensions (mm) D_2 max.	f max.	Abutment and Fillet Dimensions (mm) d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	Mass (kg) approx.
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

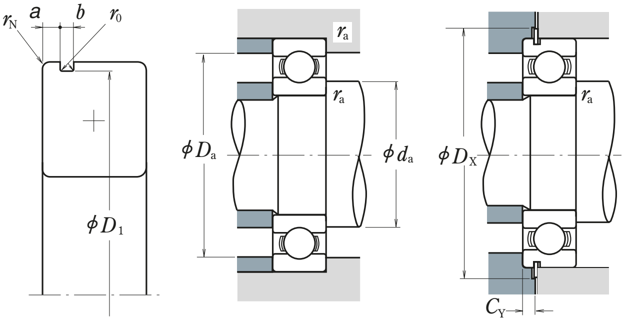


Open	Shielded ZZ · ZZS	Non-Contact Sealed VV	Contact Sealed DD · DDU	With Snap Ring Groove N	With Snap Ring NR

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min^{-1})			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed	
160	200	20	1.1	48 500	61 000	17.2	2 600	1 700	3 200	**6832**	**ZZS**	**VV**	**DDU**
	220	28	2	87 000	96 000	16.6	2 600	1 600	3 000	**6932**	**ZZS**	—	**DDU**
	240	25	1.5	99 000	108 000	16.5	2 400	—	2 800	**16032**	—	—	—
	240	38	2.1	137 000	135 000	15.9	2 400	1 600	2 800	**6032**	**ZZ**	—	**DDU**
	290	48	3	185 000	186 000	15.4	1 900	—	2 400	**6232**	**ZZS**	—	—
	340	68	4	278 000	287 000	13.9	1 700	—	2 000	**6332**	**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	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

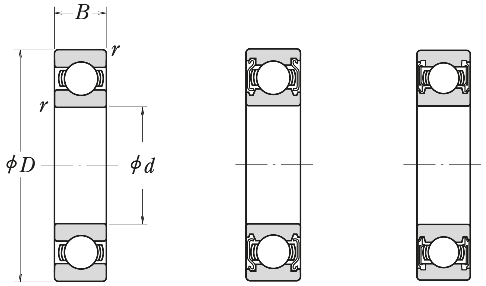
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
		a max.	b min.	D_1 max.	r_0 max.	r_N min.	D_2 max.	f max.	d_a(2) min.	d_a(2) max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	approx.
N	**NR**	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

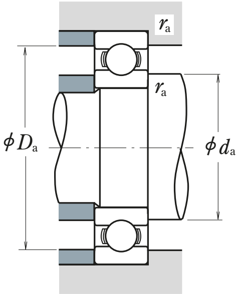


Open | Shielded ZZS | Non-Contact Sealed VV

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Designations			
							Grease		Oil				
d	D	B	r min.	C_r	C_{0r}	f_0	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 (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.

Remark When using bearings with rotating outer rings, contact NSK if they are sealed or shielded.



Dynamic Equivalent Load

$P=XF_r+YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r}\leqq e$		$\frac{F_a}{F_r}>e$	
		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

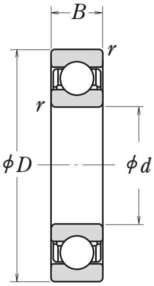
$\frac{F_a}{F_r}>0.8,\ P_0=0.6F_r+0.5F_a$

$\frac{F_a}{F_r}\leqq 0.8,\ P_0=F_r$

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

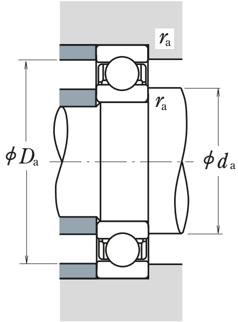
Bore Diameter 260 – 360 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)		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.



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

Dynamic Equivalent Load

$P=XF_r+YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r}\leqq e$		$\frac{F_a}{F_r}>e$	
		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

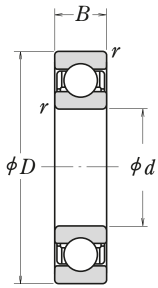
Static Equivalent Load

$$\frac{F_a}{F_r}>0.8,\ P_0=0.6F_r+0.5F_a$$

$$\frac{F_a}{F_r}\leqq 0.8,\ P_0=F_r$$

SINGLE-ROW DEEP GROOVE BALL BEARINGS

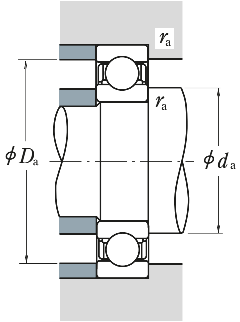
Bore Diameter 380 – 600 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)		Bearing Designations
d	D	B	r min.	C_r	C_{0r}	f_0	Grease	Oil	Open
380	480	46	2.1	238 000	375 000	17.1	1 000	1 200	**6876**
	520	65	4	325 000	510 000	16.6	950	1 200	**6976**
	560	82	5	455 000	725 000	15.9	900	1 100	**6076**
400	500	46	2.1	241 000	390 000	17.2	950	1 200	**6880**
	540	65	4	335 000	540 000	16.7	900	1 100	**6980**
	600	90	5	510 000	825 000	15.7	850	1 000	**6080**
420	520	46	2.1	245 000	410 000	17.3	900	1 100	**6884**
	560	65	4	340 000	570 000	16.8	900	1 100	**6984**
	620	90	5	530 000	895 000	15.8	800	1 000	**6084**
440	540	46	2.1	248 000	425 000	17.4	900	1 100	**6888**
	600	74	4	395 000	680 000	16.6	800	1 000	**6988**
	650	94	6	550 000	965 000	16.0	750	900	**6088**
460	580	56	3	310 000	550 000	17.1	800	1 000	**6892**
	620	74	4	405 000	720 000	16.7	800	950	**6992**
	680	100	6	605 000	1 080 000	15.8	710	850	**6092**
480	600	56	3	315 000	575 000	17.2	800	950	**6896**
	650	78	5	450 000	815 000	16.6	750	900	**6996**
	700	100	6	605 000	1 090 000	15.9	710	850	**6096**
500	620	56	3	320 000	600 000	17.3	750	900	**68/500**
	670	78	5	460 000	865 000	16.7	710	850	**69/500**
	720	100	6	630 000	1 170 000	16.0	670	800	**60/500**
530	650	56	3	325 000	625 000	17.4	710	850	**68/530**
	710	82	5	455 000	870 000	16.8	670	800	**69/530**
	780	112	6	680 000	1 300 000	16.0	600	750	**60/530**
560	680	56	3	330 000	650 000	17.4	670	800	**68/560**
	750	85	5	525 000	1 040 000	16.7	600	750	**69/560**
	820	115	6	735 000	1 500 000	16.2	560	670	**60/560**
600	730	60	3	355 000	735 000	17.5	600	710	**68/600**
	800	90	5	550 000	1 160 000	16.9	560	670	**69/600**
	870	118	6	790 000	1 640 000	16.1	530	630	**60/600**

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.



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

Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

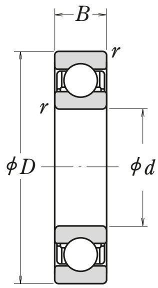
Static Equivalent Load

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

■SINGLE-ROW DEEP GROOVE BALL BEARINGS

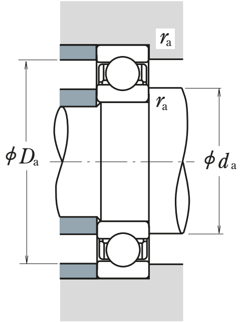
Bore Diameter 630 – 800 mm



Open

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min^{-1})		Bearing Designations
d	D	B	r min.	C_r	C_{0r}	f_0	Grease	Oil	Open
630	780	69	4	420 000	890 000	17.3	560	670	**68/630**
	850	100	6	625 000	1 350 000	16.7	530	630	**69/630**
	920	128	7.5	750 000	1 620 000	16.4	480	600	**60/630**
670	820	69	4	435 000	965 000	17.4	500	630	**68/670**
	900	103	6	675 000	1 460 000	16.7	480	560	**69/670**
	980	136	7.5	765 000	1 730 000	16.6	450	530	**60/670**
710	870	74	4	480 000	1 100 000	17.4	480	560	**68/710**
	950	106	6	715 000	1 640 000	16.8	450	530	**69/710**
750	920	78	5	525 000	1 260 000	17.4	430	530	**68/750**
	1 000	112	6	785 000	1 840 000	16.7	400	500	**69/750**
800	980	82	5	530 000	1 310 000	17.5	400	480	**68/800**
	1 060	115	6	825 000	2 050 000	16.8	380	450	**69/800**

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.



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

Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		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

$\frac{F_a}{F_r} > 0.8,\ P_0 = 0.6F_r + 0.5F_a$

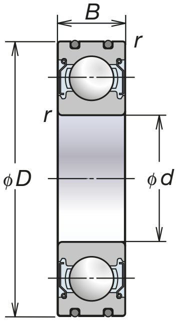
$\frac{F_a}{F_r} \leqq 0.8,\ P_0 = F_r$

Bore Diameter 10 – 100 mm

Boundary Dimensions (mm)			Basic Load Ratings (N)		Recommended Fits (1)
d	D	B	C_r	C_{0r}	
10	26	8	4 550	1 970	
	30	9	5 100	2 390	
	35	11	8 100	3 450	
12	28	8	5 100	2 370	
	32	10	6 800	3 050	
	37	12	9 700	4 200	
15	32	9	5 600	2 830	
	35	11	7 650	3 750	
	42	13	11 400	5 450	
17	35	10	6 000	3 250	
	40	12	9 550	4 800	
	47	14	13 600	6 650	
20	42	12	9 400	5 000	
	47	14	12 800	6 600	
	52	15	15 900	7 900	
25	47	12	10 100	5 850	
	52	15	14 000	7 850	
	62	17	20 600	11 200	
30	55	13	13 200	8 300	
	62	16	19 500	11 300	
	72	19	26 700	15 000	
35	62	14	16 000	10 300	
	72	17	25 700	15 300	
	80	21	33 500	19 200	
40	68	15	16 800	11 500	H7 or G6
	80	18	29 100	17 900	
	90	23	40 500	24 000	
45	75	16	20 900	15 200	
	85	19	31 500	20 400	
	100	25	53 000	32 000	
50	80	16	21 800	16 600	
	90	20	35 000	23 200	
	110	27	62 000	38 500	
55	90	18	28 300	21 200	
	100	21	43 500	29 300	
	120	29	71 500	44 500	
60	95	18	29 500	23 200	
	110	22	52 500	36 000	
	130	31	82 000	52 000	
65	100	18	30 500	25 200	
	120	23	57 500	40 000	
	140	33	92 500	60 000	
70	110	20	38 000	31 000	
	125	24	62 000	44 000	
	150	35	104 000	68 000	
75	115	20	39 500	33 500	
	130	25	66 000	49 500	
80	125	22	47 500	40 000	
	140	26	72 500	53 000	
85	130	22	49 500	43 000	
	150	28	84 000	62 000	
90	140	24	58 000	50 000	
95	145	24	60 500	54 000	
100	150	24	60 000	54 000	

Notes (1) Although recommended fits are H7 or G6, G6 is recommended when used under conditions that prioritize insertion under light preload.

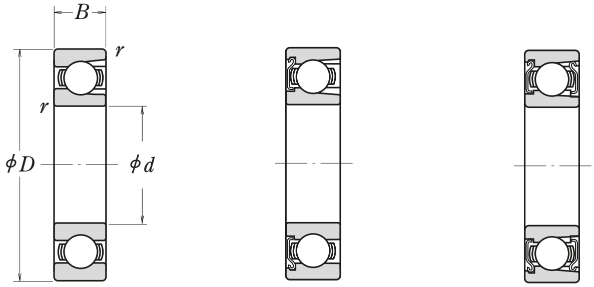
(2) Low-contact seals are available for sealed bearings; contact NSK for details.



Basic Designation (Open)	Shields	Contact Seal (2)	Non-Contact Seal
	Bearing Designations		
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

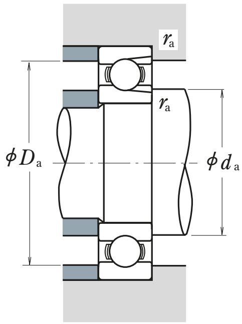
Bore Diameter 25 – 110 mm

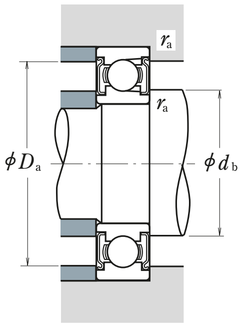


Open | Shielded (One Shield) Z | Shielded (Two Shields) ZZ

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})		
d	*D*	*B*	*r* min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open
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.

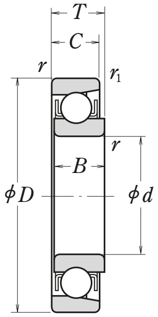




Bearing Designations		Abutment and Fillet Dimensions (mm)				Mass (kg)
With One Shield	With Two Shields	d_a min.	d_b max.	D_a max.	r_a max.	approx.
BL 205 Z	BL 205 ZZ	30	32	47	1	0.133
BL 305 Z	BL 305 ZZ	31.5	36	55.5	1	0.246
BL 206 Z	BL 206 ZZ	35	38.5	57	1	0.215
BL 306 Z	BL 306 ZZ	36.5	42	65.5	1	0.364
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



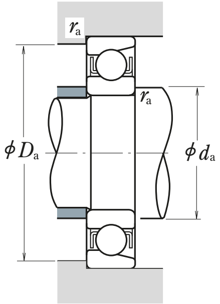
Outside Diameter Tolerance (Class N)

Units : μm

Nominal Outside Diameter D (mm)		Single Plane Mean Outside Diameter Δ_{Dmp}			
		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 (min^{-1})		Bearing Designations	
d	D	B,C,T	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil	E Series	EN Series
4	16	5	0.15	0.1	1 650	288	34 000	40 000	**E 4**	**EN 4**
5	16	5	0.15	0.1	1 650	288	34 000	40 000	**E 5**	**EN 5**
6	21	7	0.3	0.15	2 490	445	30 000	36 000	**E 6**	**EN 6**
7	22	7	0.3	0.15	2 490	445	30 000	36 000	**E 7**	**EN 7**
8	24	7	0.3	0.15	3 450	650	28 000	34 000	**E 8**	**EN 8**
9	28	8	0.3	0.15	4 550	880	24 000	30 000	**E 9**	**EN 9**
10	28	8	0.3	0.15	4 550	880	24 000	30 000	**E 10**	**EN 10**
11	32	7	0.3	0.15	4 400	845	22 000	26 000	**E 11**	**EN 11**
12	32	7	0.3	0.15	4 400	845	22 000	26 000	**E 12**	**EN 12**
13	30	7	0.3	0.15	4 400	845	22 000	26 000	**E 13**	**EN 13**
14	35	8	0.3	0.15	5 800	1 150	19 000	22 000	—	**EN 14**
15	35	8	0.3	0.15	5 800	1 150	19 000	22 000	**E 15**	**EN 15**
	40	10	0.6	0.3	7 400	1 500	17 000	20 000	**BO 15**	—
16	38	10	0.6	0.2	6 900	1 380	17 000	22 000	—	**EN 16**
17	40	10	0.6	0.3	7 400	1 500	17 000	20 000	**L 17**	—
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	—	**EN 17**
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	**BO 17**	—
18	40	9	0.6	0.2	5 050	1 030	17 000	20 000	—	**EN 18**
19	40	9	0.6	0.2	5 050	1 030	17 000	20 000	**E 19**	**EN 19**
20	47	12	1	0.6	11 000	2 380	14 000	17 000	**E 20**	**EN 20**
	47	14	1	0.6	11 000	2 380	14 000	17 000	**L 20**	—

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.

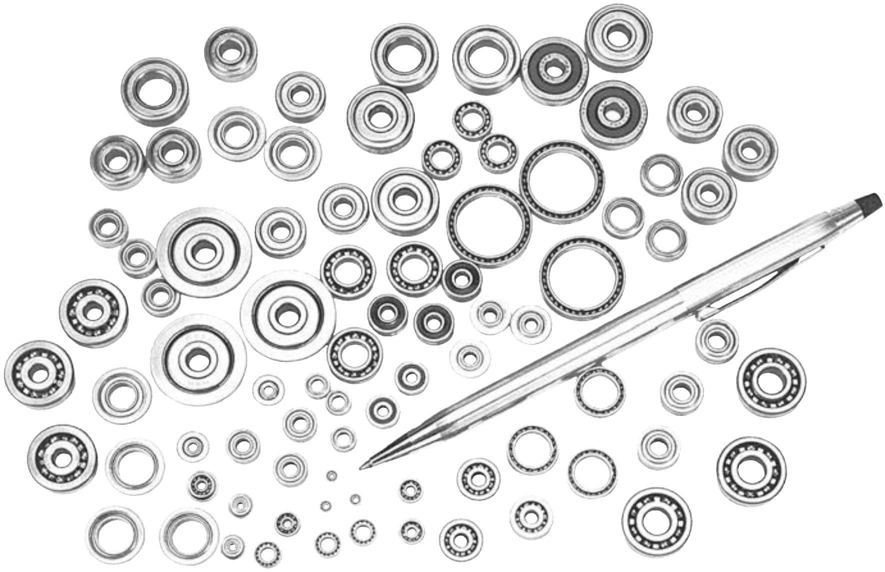


Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$		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

DESIGN AND TYPES

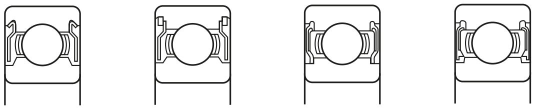
The size ranges of extra small and miniature ball bearings are shown in Table 1, and design/types and type designations are shown in Table 2. Types listed in the bearing tables are indicated by shading ▬ in Table 2.

Table 1   Size Ranges of Bearings

Units : mm

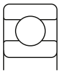
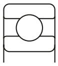
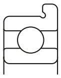
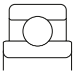
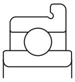
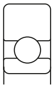
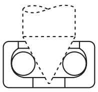
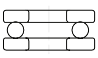
Series	Extra Small Ball Bearings	Miniature Ball Bearings
Metric	Outside diameter $D \geqq 9$ Bore diameter $d < 10$	Outside diameter $D < 9$
Inch	Outside diameter $D \geqq 9.525$ Bore diameter $d < 10$	Outside diameter $D < 9.525$

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: Metric	Type Designations: Inch	Special: Metric	Special: Inch	Remarks
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 : m

Nominal Outer Ring Flange Outside Diameter D_1(mm)		Deviation of a Single Outside Diameter of Outer Ring Flange ΔD_{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 : m

Nominal Outside Diameter D (mm)		Deviation of a Single Outer Ring Flange Width ΔC_{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(1)	6	Use the ΔB_S tolerance for d of the same bearing in the same class		Use the ΔVB_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

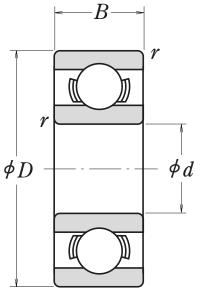
Please refer to NSK Miniature Ball Bearings (CAT.No.E126).

INTERNAL CLEARANCES............................Table 8.11 (Page A169)

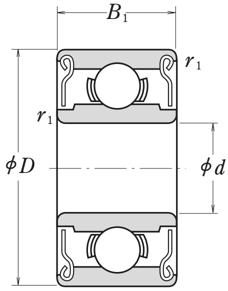
LIMITING SPEEDS

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.

Metric Series
Bore Diameter 1 – 4 mm



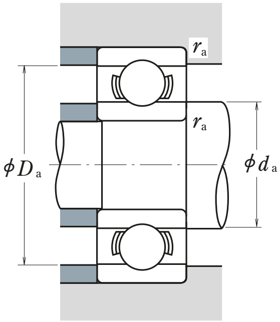
Open

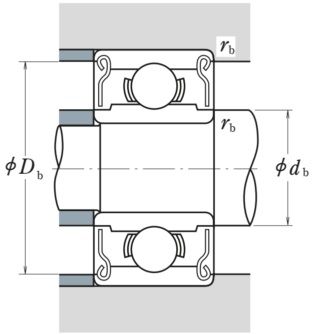


Shielded
ZZ · ZZ1

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		
d	D	B	B_1	r [1] min.	r_1 [1] min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open
1	3	1	—	0.05	—	80	23	130 000	150 000	**681**
	3	1.5	—	0.05	—	80	23	130 000	150 000	**MR 31**
	4	1.6	—	0.1	—	138	35	100 000	120 000	**691**
1.2	4	1.8	2.5	0.1	0.1	138	35	110 000	130 000	**MR 41 X**
1.5	4	1.2	2	0.05	0.05	112	33	100 000	120 000	**681 X**
	5	2	2.6	0.15	0.15	237	69	85 000	100 000	**691 X**
	6	2.5	3	0.15	0.15	330	98	75 000	90 000	**601 X**
2	5	1.5	2.3	0.08	0.08	169	50	85 000	100 000	**682**
	5	2	2.5	0.1	0.1	187	58	85 000	100 000	**MR 52 B**
	6	2.3	3	0.15	0.15	330	98	75 000	90 000	**692**
	6	2.5	2.5	0.15	0.15	330	98	75 000	90 000	**MR 62**
	7	2.5	3	0.15	0.15	385	127	63 000	75 000	**MR 72**
	7	2.8	3.5	0.15	0.15	385	127	63 000	75 000	**602**
2.5	6	1.8	2.6	0.08	0.08	208	74	71 000	80 000	**682 X**
	7	2.5	3.5	0.15	0.15	385	127	63 000	75 000	**692 X**
	8	2.5	—	0.2	—	560	179	60 000	67 000	**MR 82 X**
	8	2.8	4	0.15	0.15	550	175	60 000	71 000	**602 X**
3	6	2	2.5	0.1	0.1	208	74	71 000	80 000	**MR 63**
	7	2	3	0.1	0.1	390	130	63 000	75 000	**683 A**
	8	2.5	—	0.15	—	560	179	60 000	67 000	**MR 83**
	8	3	4	0.15	0.15	560	179	60 000	67 000	**693**
	9	2.5	4	0.2	0.15	570	187	56 000	67 000	**MR 93**
	9	3	5	0.15	0.15	570	187	56 000	67 000	**603**
	10	4	4	0.15	0.15	630	218	50 000	60 000	**623**
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	**633**
4	7	2	—	0.1	—	310	115	60 000	67 000	**MR 74**
	7	—	2.5	—	0.1	255	107	60 000	71 000	—
	8	2	3	0.15	0.1	395	139	56 000	67 000	**MR 84**
	9	2.5	4	(0.15)	(0.15)	640	225	53 000	63 000	**684 A**
	10	3	4	0.2	0.15	710	270	50 000	60 000	**MR 104 B**
	11	4	4	0.15	0.15	960	345	48 000	56 000	**694**
	12	4	4	0.2	0.2	960	345	48 000	56 000	**604**
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	**624**
	16	5	5	0.3	0.3	1 730	670	36 000	43 000	**634**

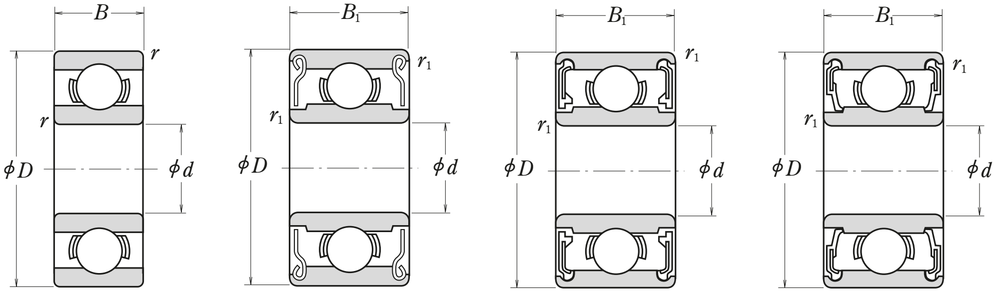
Note (1) Values in parentheses are not based on ISO 15.
Remark When using shielded bearings with a rotating outer ring, please contact NSK.





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

Metric Series
Bore Diameter 5 – 9 mm

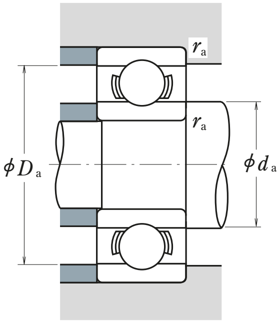


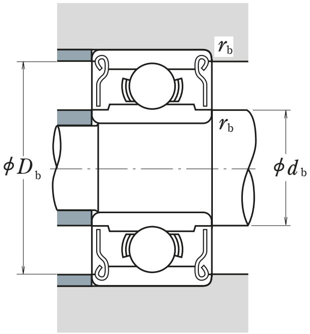
Open | Shielded ZZ · ZZ1 | Non-Contact Sealed VV | Contact Sealed DD

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹) Grease		Oil	
d	D	B	B_1	r(1) min.	r_1(1) min.	C_r	C_{0r}	Open Z · ZZ V · VV	D · DD	Open Z	Open
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**
7	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**
	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**
8	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**
	28	9	9	0.3	0.3	4 550	1 970	28 000	22 000	34 000	**638**
9	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 (1) Values in parentheses are not based on ISO 15.

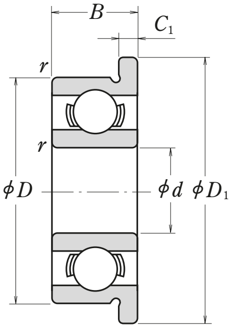
Remarks 1. When using sealed or shielded bearings with a rotating outer ring, please contact NSK.
2. Bearings with snap rings are also available, please contact NSK for details.



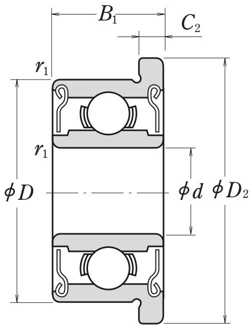


Bearing Designations			Abutment and Fillet Dimensions (mm)						Mass (g)	
Shielded	Sealed		d_a min.	d_b max.	D_a max.	D_b min.	r_a max.	r_b max.	approx. Open	Shielded
—	—	—	5.8	—	7.2	—	0.1	—	0.26	—
MR 85 ZZ	—	—	—	5.8	—	7.4	—	0.1	—	0.34
MR 95 ZZ1	—	—	6.2	6.0	7.8	8.2	0.15	0.15	0.50	0.58
MR 105 ZZ	—	—	6.2	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

Metric Series With Flange
Bore Diameter 1 – 4 mm



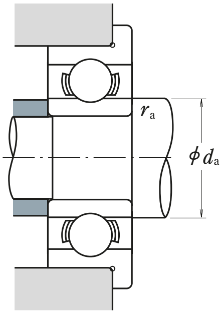
Open

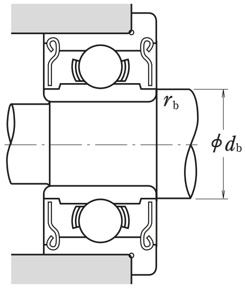


Shielded
ZZ · ZZ1

Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	D_1	D_2	B	B_1	C_1	C_2	r (1) min.	r_1 (1) min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z
1	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
1.2	4	4.8	—	1.8	—	0.4	—	0.1	—	138	35	110 000	130 000
1.5	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
2	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
2.5	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
3	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
4	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

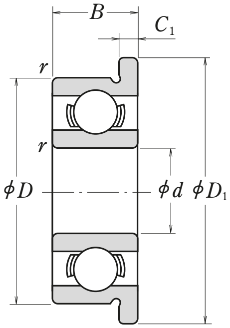
Note (1) Values in parentheses are not based on ISO 15.
Remark When using shielded bearings with a rotating outer ring, please contact NSK.



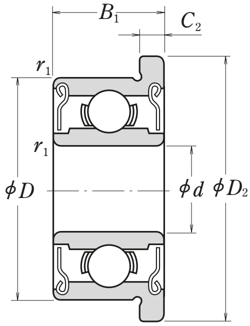


Bearing Designations				Abutment and Fillet Dimensions (mm)				Mass (g)	
Open	Shielded	Sealed		d_a min.	d_b max.	r_a max.	r_b max.	approx. Open	Shielded
F 681	—	—	—	1.4	—	0.05	—	0.04	—
F 691	—	—	—	1.8	—	0.1	—	0.14	—
MF 41 X	—	—	—	2.0	—	0.1	—	0.12	—
F 681 X	**F 681 XZZ**	—	—	1.9	2.1	0.05	0.05	0.09	0.14
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

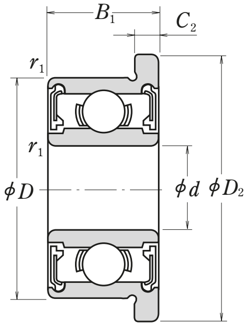
Metric Series With Flange
Bore Diameter 5 – 9 mm



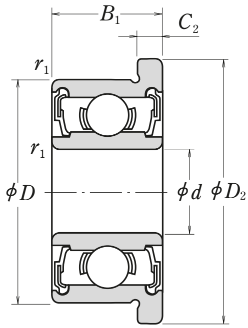
Open



Shielded
ZZ · ZZ1



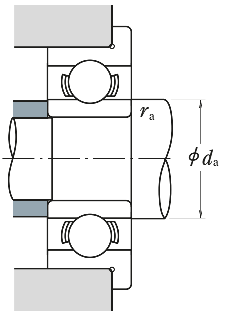
Non-Contact
Sealed
VV

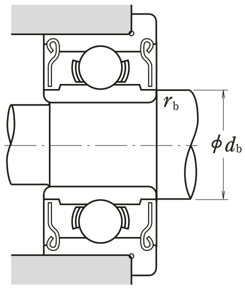


Contact
Sealed
DD

Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min^{-1}) Grease		Oil
d	D	D_1	D_2	B	B_1	C_1	C_2	r min.	r_1 min.	C_r	C_{0r}	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.



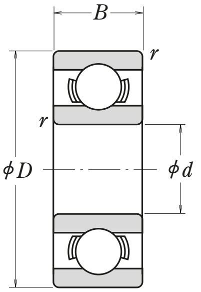


Bearing Designations				Abutment and Fillet Dimensions (mm)				Mass (g)	
Open	Shielded	Sealed		d_a min.	d_b max.	r_a max.	r_b max.	approx. Open	Shielded
MF 85	—	—	—	5.8	—	0.1	—	0.33	—
—	**MF 85 ZZ**	—	—	—	5.8	—	0.1	—	0.41
MF 95	**MF 95 ZZ1**	—	—	6.2	6.0	0.15	0.15	0.59	0.66
MF 105	**MF 105 ZZ**	—	—	6.2	6.0	0.15	0.15	1.05	1.46
F 685	**F 685 ZZ**	—	—	6.2	6.2	0.15	0.15	1.37	2.18
F 695	**F 695 ZZ**	**VV**	**DD**	6.6	6.6	0.2	0.2	2.79	2.84
F 605	**F 605 ZZ**	—	**DD**	6.6	6.9	0.2	0.2	3.9	3.85
F 625	**F 625 ZZ1**	**VV**	**DD**	7.0	7.5	0.3	0.3	5.37	5.27
F 635	**F 635 ZZ1**	**VV**	**DD**	7.0	8.5	0.3	0.3	9.49	9.49
MF 106	**MF 106 ZZ1**	—	—	7.2	7.0	0.15	0.1	0.65	0.77
MF 126	**MF 126 ZZ**	—	**DD**	7.6	7.2	0.2	0.15	1.38	1.94
F 686 A	**F 686 AZZ**	**VV**	**DD**	7.2	7.4	0.15	0.15	2.25	3.04
F 696	**F 696 ZZ1**	**VV**	**DD**	7.6	7.9	0.2	0.2	4.34	4.26
F 606	**F 606 ZZ**	**VV**	**DD**	8.0	8.2	0.3	0.3	6.58	6.61
F 626	**F 626 ZZ1**	**VV**	**DD**	8.0	8.5	0.3	0.3	9.09	9.09
F 636	**F 636 ZZ**	**VV**	**DD**	8.0	10.5	0.3	0.3	14.6	14.7
MF 117	**MF 117 ZZ**	—	—	8.2	8.0	0.15	0.1	0.72	0.82
MF 137	**MF 137 ZZ**	—	—	8.6	9.0	0.2	0.15	1.7	2.23
F 687	**F 687 ZZ1**	**VV**	**DD**	8.2	8.5	0.15	0.15	2.48	3.37
F 697	**F 697 ZZ1**	**VV**	**DD**	9.0	10.2	0.3	0.3	5.65	5.65
F 607	**F 607 ZZ1**	**VV**	**DD**	9.0	9.1	0.3	0.3	8.66	8.66
F 627	**F 627 ZZ**	**VV**	**DD**	9.0	10.5	0.3	0.3	14.2	14.2
MF 128	**MF 128 ZZ1**	—	—	9.2	9.0	0.15	0.1	0.82	1.15
MF 148	**MF 148 ZZ**	**VV**	**DD**	9.6	9.2	0.2	0.15	2.09	2.39
F 688 A	**F 688 AZZ**	**VV**	**DD**	9.6	10.2	0.2	0.2	3.54	4.47
F 698	**F 698 ZZ**	**VV**	**DD**	10.0	10.0	0.3	0.3	8.35	8.3
F 608	**F 608 ZZ**	**VV**	**DD**	10.0	10.5	0.3	0.3	13.4	13.5
F 689	**F 689 ZZ1**	**VV**	**DD**	10.6	11.5	0.2	0.2	3.97	4.91
F 699	**F 699 ZZ1**	**VV**	**DD**	11.0	12.0	0.3	0.3	9.51	9.51

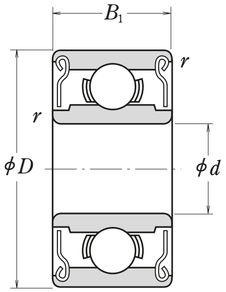
EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Inch Series

Bore Diameter 1.016 – 9.525 mm



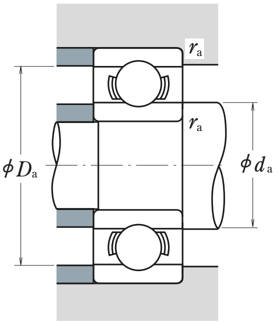
Open

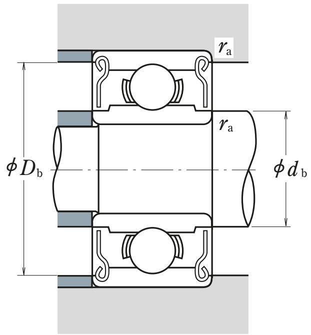


Shielded
ZZ · ZZS

Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	B	B_1	r min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open
1.016	3.175	1.191	—	0.1	80	23	130 000	150 000	**R 09**
1.191	3.967	1.588	2.380	0.1	138	35	110 000	130 000	**R 0**
1.397	4.762	1.984	2.779	0.1	231	66	90 000	110 000	**R 1**
1.984	6.350	2.380	3.571	0.1	310	108	67 000	80 000	**R 1-4**
2.380	4.762	1.588	—	0.1	188	60	80 000	95 000	**R 133**
	4.762	—	2.380	0.1	143	52	80 000	95 000	—
	7.938	2.779	3.571	0.15	550	175	60 000	71 000	**R 1-5**
3.175	6.350	2.380	2.779	0.1	283	95	67 000	80 000	**R 144**
	7.938	2.779	3.571	0.1	560	179	60 000	67 000	**R 2-5**
	9.525	2.779	3.571	0.15	640	225	53 000	63 000	**R 2-6**
	9.525	3.967	3.967	0.3	630	218	56 000	67 000	**R 2**
	12.700	4.366	4.366	0.3	640	225	53 000	63 000	**R 2A**
3.967	7.938	2.779	3.175	0.1	360	149	53 000	63 000	**R 155**
4.762	7.938	2.779	3.175	0.1	360	149	53 000	63 000	**R 156**
	9.525	3.175	3.175	0.1	710	270	50 000	60 000	**R 166**
	12.700	3.967	4.978	0.3	1 300	485	43 000	53 000	**R 3**
6.350	9.525	3.175	3.175	0.1	420	204	48 000	56 000	**R 168B**
	12.700	3.175	4.762	0.15	1 080	440	40 000	50 000	**R 188**
	15.875	4.978	4.978	0.3	1 610	660	38 000	45 000	**R 4B**
	19.050	5.558	7.142	0.4	2 620	1 060	36 000	43 000	**R 4AA**
7.938	12.700	3.967	3.967	0.15	540	276	40 000	48 000	**R 1810**
9.525	22.225	5.558	7.142	0.4	3 350	1 410	32 000	38 000	**R 6**

Remarks 1. When using shielded bearings with a rotating outer ring, please contact NSK.
2. Bearings with double shields (ZZ, ZZS) are also available with single shields (Z, ZS).

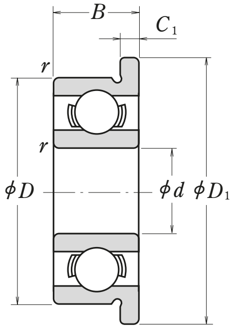




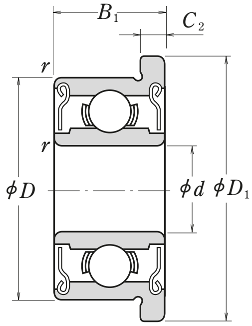
Designations Shielded	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_b min.	r_a max.	Mass (g) approx. Open	Shielded
—	1.9	—	2.3	—	0.1	0.04	—
R 0 ZZ	2.0	1.9	3.1	3.5	0.1	0.09	0.11
R 1 ZZ	2.2	2.3	3.9	4.1	0.1	0.15	0.19
R 1-4 ZZ	2.8	3.9	5.5	5.9	0.1	0.35	0.50
—	3.2	—	3.9	—	0.1	0.10	—
R 133 ZZS	—	3.0	—	4.2	0.1	—	0.13
R 1-5 ZZ	3.6	4.1	6.7	7.0	0.15	0.60	0.72
R 144 ZZ	4.0	3.9	5.5	5.9	0.1	0.25	0.27
R 2-5 ZZ	4.0	4.3	7.1	7.3	0.1	0.55	0.72
R 2-6 ZZS	4.4	4.6	8.3	8.2	0.15	0.96	1.13
R 2 ZZ	5.2	4.8	7.5	8.0	0.3	1.36	1.39
R 2A ZZ	5.2	4.6	10.7	8.2	0.3	3.3	3.23
R 155 ZZS	4.8	5.5	7.1	7.3	0.1	0.51	0.56
R 156 ZZS	5.6	5.5	7.1	7.3	0.1	0.39	0.42
R 166 ZZ	5.6	5.9	8.7	8.8	0.1	0.81	0.85
R 3 ZZ	6.8	6.5	10.7	11.2	0.3	2.21	2.79
R 168 BZZ	7.2	7.0	8.7	8.9	0.1	0.58	0.62
R 188 ZZ	7.6	7.4	11.5	11.6	0.15	1.53	2.21
R 4B ZZ	8.4	8.4	13.8	13.8	0.3	4.5	4.43
R 4AA ZZ	9.4	9.0	16.0	16.6	0.4	7.48	9.17
R 1810 ZZ	9.2	9.0	11.5	11.6	0.15	1.56	1.48
R 6 ZZ	12.6	11.9	19.2	20.0	0.4	9.02	11

Inch Series With Flange

Bore Diameter 1.191 – 9.525 mm



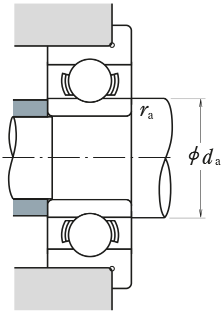
Open

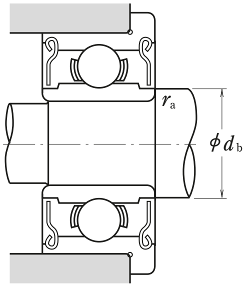


Shielded
ZZ · ZZS

Boundary Dimensions (mm)								Basic Load Ratings (N)	
d	D	D_1	B	B_1	C_1	C_2	r min.	C_r	C_{0r}
1.191	3.967	5.156	1.588	2.380	0.330	0.790	0.1	138	35
1.397	4.762	5.944	1.984	2.779	0.580	0.790	0.1	231	66
1.984	6.350	7.518	2.380	3.571	0.580	0.790	0.1	310	108
2.380	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
3.175	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
3.967	7.938	9.119	2.779	3.175	0.580	0.910	0.1	360	149
4.762	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
6.350	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
7.938	12.700	13.894	3.967	3.967	0.790	0.790	0.15	540	276
9.525	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, ZZS) are also available with single shields (Z, ZS).



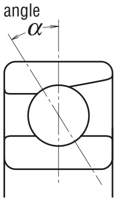


Limiting Speeds (min^{-1}) Grease Open Z · ZZ	Limiting Speeds (min^{-1}) Oil Open Z	Bearing Designations Open	Bearing Designations Shielded	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	r_a max.	Mass (g) approx. Open	Mass (g) approx. Shielded
110 000	130 000	**FR 0**	**FR 0 ZZ**	2.0	1.9	0.1	0.11	0.16
90 000	110 000	**FR 1**	**FR 1 ZZ**	2.2	2.3	0.1	0.20	0.25
67 000	80 000	**FR 1-4**	**FR 1-4 ZZ**	2.8	3.9	0.1	0.41	0.58
80 000	95 000	**FR 133**	—	3.2	—	0.1	0.13	—
80 000	95 000	—	**FR 133 ZZS**	—	3.0	0.1	—	0.19
60 000	71 000	**FR 1-5**	**FR 1-5 ZZ**	3.6	4.1	0.15	0.68	0.82
67 000	80 000	**FR 144**	**FR 144 ZZ**	4.0	3.9	0.1	0.31	0.35
60 000	67 000	**FR 2-5**	**FR 2-5 ZZ**	4.0	4.3	0.1	0.62	0.81
53 000	63 000	**FR 2-6**	**FR 2-6 ZZS**	4.4	4.6	0.15	1.04	1.25
56 000	67 000	**FR 2**	**FR 2 ZZ**	5.2	4.8	0.3	1.51	1.55
53 000	63 000	**FR 155**	**FR 155 ZZS**	4.8	5.5	0.1	0.59	0.67
53 000	63 000	**FR 156**	**FR 156 ZZS**	5.6	5.5	0.1	0.47	0.53
50 000	60 000	**FR 166**	**FR 166 ZZ**	5.6	5.9	0.1	0.90	0.98
43 000	53 000	**FR 3**	**FR 3 ZZ**	6.8	6.5	0.3	2.97	3.09
48 000	56 000	**FR 168B**	**FR 168 BZZ**	7.2	7.0	0.1	0.66	0.75
40 000	50 000	**FR 188**	**FR 188 ZZ**	7.6	7.4	0.15	1.64	2.49
38 000	45 000	**FR 4B**	**FR 4B ZZ**	8.4	8.4	0.3	4.78	4.78
40 000	48 000	**FR 1810**	**FR 1810 ZZ**	9.2	9.0	0.15	1.71	1.63
32 000	38 000	**FR 6**	**FR 6 ZZ**	12.6	11.9	0.4	10.1	12.1


NSK

3. ANGULAR CONTACT BALL BEARINGS

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° (designation **A**) or 40°(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	Material	Steel	Nylon 46		L-PPS resin	Brass	
Spec.	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.

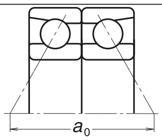
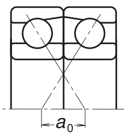
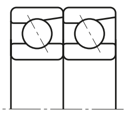
Angular contact ball bearings with contact angles of 15° (designation **C**) and 25° (designation **A5**) are primarily for high precision or high-speed applications, and molded polyamide cages (designation TYN) or machined-brass cages or synthetic resin cages (designation T) are used.

The maximum operating temperature of molded polyamide cages is 150℃.

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

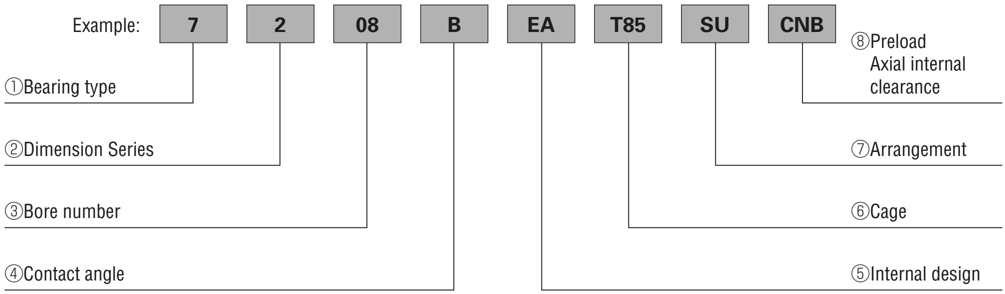
Figure	Arrangement	Features
	Back-to-Back (DB) (Example) 7208 A DB	Radial loads and axial loads in both directions can be sustained. Since the distance between the effective load centers a_0 is large, this type is suitable if moments are applied.
	Face-to-Face (DF) (Example) 7208 B DF	Radial loads and 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

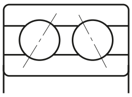
NSKHPS bearings feature high capacity, high limiting speed, and highly accurate universal matching. Molded polyamide cages are standard for the NSKHPS type.

Formulation of Bearing Designations

Single-Row Matched Angular Contact Ball Bearings



①Bearing type	7 : Single-row angular contact ball bearings, matched angular contact ball bearings
②Dimension Series	2 : 02 Series, 3 : 03 Series, 9 : 19 Series, 0 : 10 Series
③Bore number	Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore Bore number ×5 (mm)
④Contact angle	C : 15°, A5 : 25°, A : 30°, B : 40°
⑤Internal design	EA : High Load Capacity
⑥Cage	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
⑦Arrangement	SU: Universal arrangement (single-row), DU : Universal arrangement (double-row), DB : Back-to-back arrangement, DF : Face-to-face arrangement, DT : Tandem arrangement
⑧Preload / 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

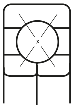
Double-Row Angular Contact Ball Bearings

Example: 5 | 2 | 01 | | VV | NS7S

①Bearing type — 5
②Dimension Series — 2
③Bore number — 01
④Internal design — (blank)
⑤Seals/shields — VV
⑥Grease — NS7S

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 ×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°, 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

Example: QJ | 2 | 16 | M | C3

①Bearing type — QJ
②Dimension Series — 2
③Bore number — 16
④Cage — M
⑤Internal clearance — C3

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 ×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 : μm

Nominal Bore Diameter d (mm)		Axial Internal Clearance			
		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

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^3

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^3

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.

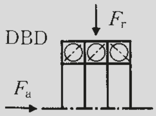
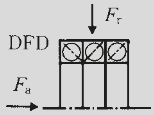
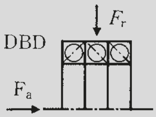
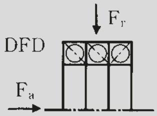
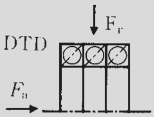
Assuming the dynamic equivalent radial load as P_r, the radial load as F_r, and axial load as F_a, the relationship between the dynamic equivalent radial load and bearing load may be approximated as follows:

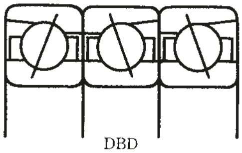
$$P_r = XF_r + YF_a \quad \cdots\cdots \quad (1)$$

where X : Radial load factor, Y : Axial load factor — See Table 1

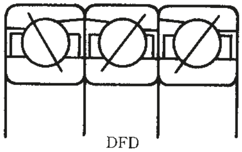
The axial load factor varies with contact angle. A small contact angle in an angular contact ball bearing varies substantially when axial load increases.

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° are shown in Table 1. If angular contact ball bearings have contact angles of 25°, 30° and 40°, 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.

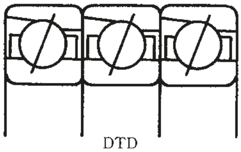
Arrangement	Load Direction
3-row matched stack, axial load is supported by 2 rows. (Symbol DBD or DFD)	 
3-row matched stack, axial load is supported by 1 row. (Symbol DBD or DFD)	 
3-row tandem matched stack (Symbol DTD)	



DBD



DFD



DTD

Table 1 Factors X and Y for Triplex Angular Contact Ball Bearing

Contact Angle α	j	$\frac{C_{0r}}{jF_a}$	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$		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:

$$\Delta_a = 2m_0\left\{\sin\alpha_0 + \frac{\theta R_i}{2m_0} - \sqrt{1-\left(\cos\alpha_0 + \frac{\theta l}{4m_0}\right)^2}\right\} \qquad \cdots\cdots (1)$$

where Δ_a : Axial clearance (mm)
m_0 : Distance between inner and outer ring groove curvature centers
$m_0 = r_e + r_i - D_w$ (mm)
r_e : Outer ring groove radius (mm)
r_i : Inner ring groove radius (mm)
α_0 : Initial contact angle (°)
θ : 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 Δ_r and axial clearance Δ_a for double-row angular contact ball bearings is listed on pages C086 and C087. Fig. 2 shows the relationship between angular clearance θ and radial clearance Δ_r based on equations from those pages.

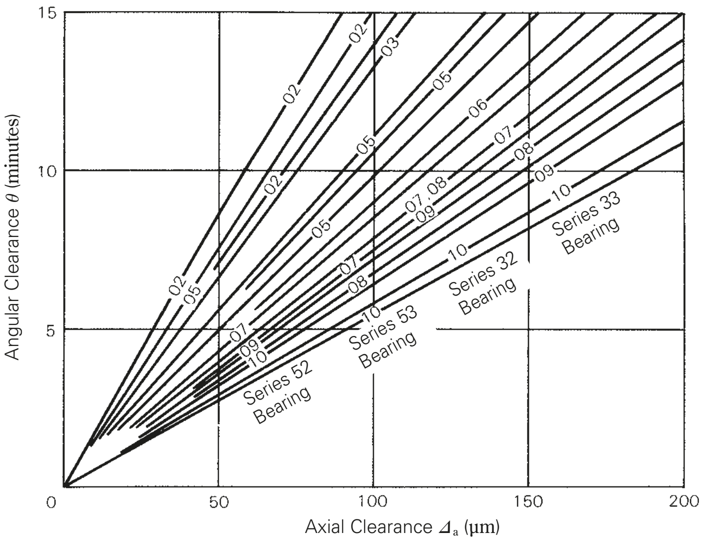


Fig. 1 Relationship Between Axial and Angular Clearances

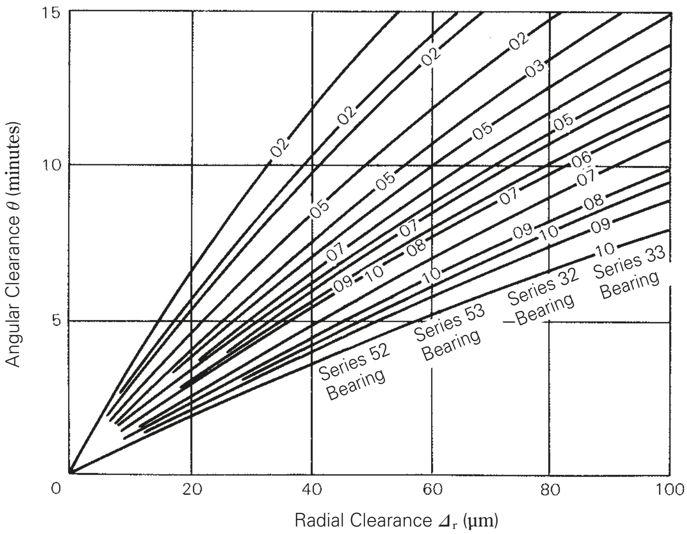


Fig. 2 Relationship Between Radial and Angular Clearances

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.

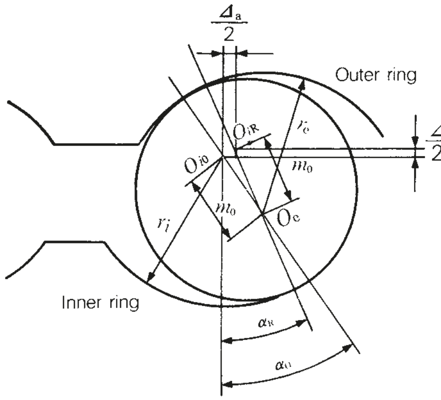


Fig. 1

where
- Δ_r : Radial clearance (mm)
- Δ_a : Axial clearance (mm)
- α_0 : Initial contact angle, inner or outer ring displaced axially
- α_R : Initial contact angle, inner or outer ring displaced radially
- O_e : Center of outer ring groove curvature (outer ring fixed)
- O_{i0} : Center of inner ring groove curvature (inner ring displaced axially)
- 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:

$$m_0 \sin \alpha_0 = m_0 \sin \alpha_R + \frac{\Delta_a}{2} \quad \cdots\cdots (1)$$

$$m_0 \cos \alpha_0 = m_0 \cos \alpha_R - \frac{\Delta_r}{2} \quad \cdots\cdots (2)$$

since $\sin^2\alpha_0 = 1-\cos^2\alpha_0$,

$$(m_0 \sin \alpha_0)^2 = m_0^2 - (m_0 \cos \alpha_0)^2 \quad \cdots\cdots (3)$$

By combining Equations (1), (2), and (3), we obtain the following:

$$\left(m_0 \sin \alpha_R + \frac{\Delta_a}{2}\right)^2 = m_0^2 - \left(m_0 \cos \alpha_R - \frac{\Delta_r}{2}\right)^2 \quad \cdots\cdots (4)$$

$$\therefore \Delta_a = 2\sqrt{m_0^2 - \left(m_0 \cos \alpha_R - \frac{\Delta_r}{2}\right)^2} - 2m_0 \sin \alpha_R \quad \cdots\cdots (5)$$

α_R is 25° for Series 52 and 53 bearings and 32° for Series 32 and 33 bearings. If we set α_R equal to 0°, 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.

$$\therefore \Delta_a \fallingdotseq 2 m_0^{1/2} \Delta_r^{1/2} \quad \cdots\cdots (6)$$

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 Δ_r and Δ_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:

$$\Delta_a \fallingdotseq \Delta_r \cot \alpha_R \quad \cdots\cdots (7)$$

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 α_R is independent of the radial clearance; however, the initial contact angle α_0 varies with the radial clearance when the inner or outer ring is displaced axially. This relationship is given by Equation (2).

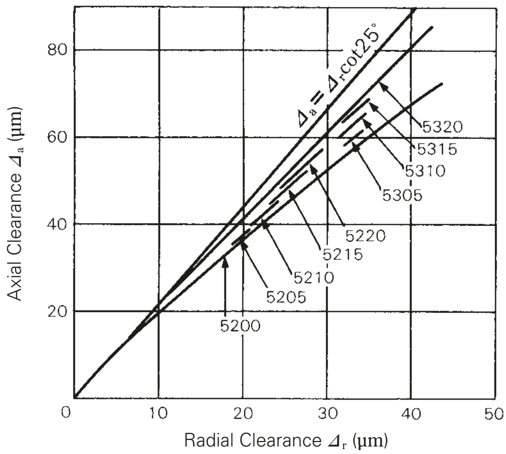


Fig. 2 Radial and Axial Clearances of Series 52 and 53 Bearings

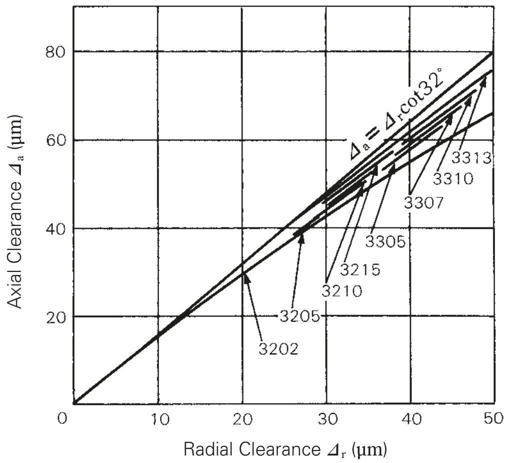
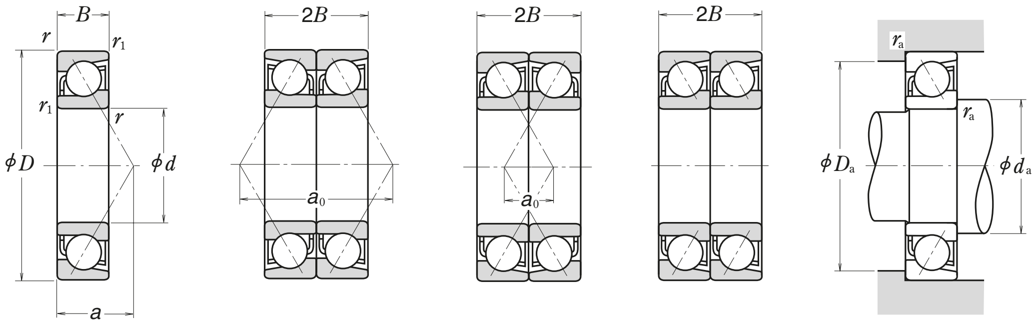


Fig. 3 Radial and Axial Clearances of Series 32 and 33 Bearings

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

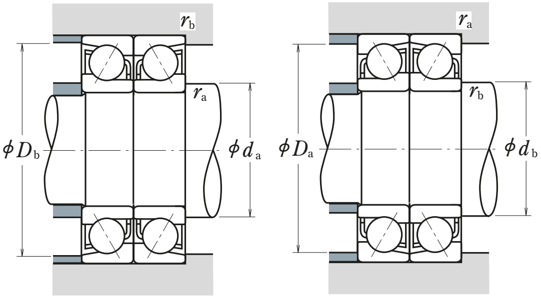
Bore Diameter 10 – 15 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a 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
12	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
	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
15	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
	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 ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	$\frac{if_0F_a}{C_{or}}$*	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
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

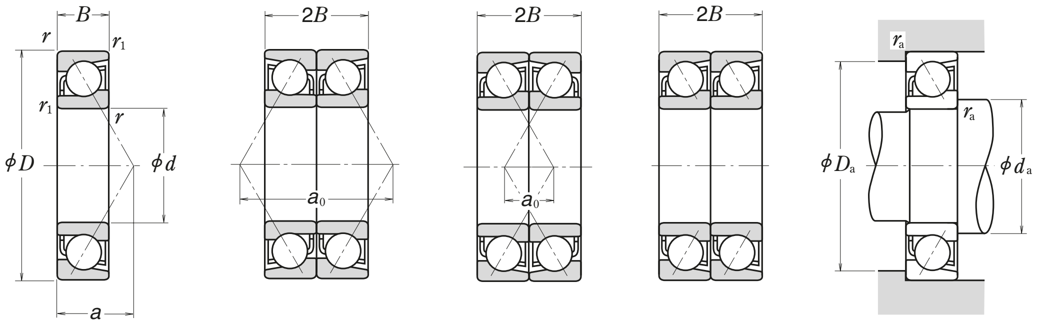
Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement	Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min⁻¹) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b (3) min.	D_b max.	r_b (3) 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 (4) 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.

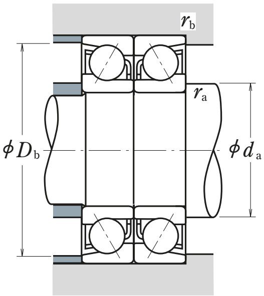
ANGULAR CONTACT BALL BEARINGS
SINGLE/MATCHED MOUNTINGS
Bore Diameter 17 – 25 mm

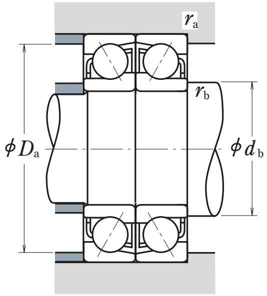


Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds (1) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a 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
20	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
	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
25	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
	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 (1) For applications operating near the limiting speed, refer to Page C077.
(2) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) 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	$\frac{if_0F_a}{C_{0r}}$*	e	Single, DT $F_a/F_r \leq e$ X	Y	Single, DT $F_a/F_r > e$ X	Y	DB or DF $F_a/F_r \leq e$ X	Y	DB or DF $F_a/F_r > e$ X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

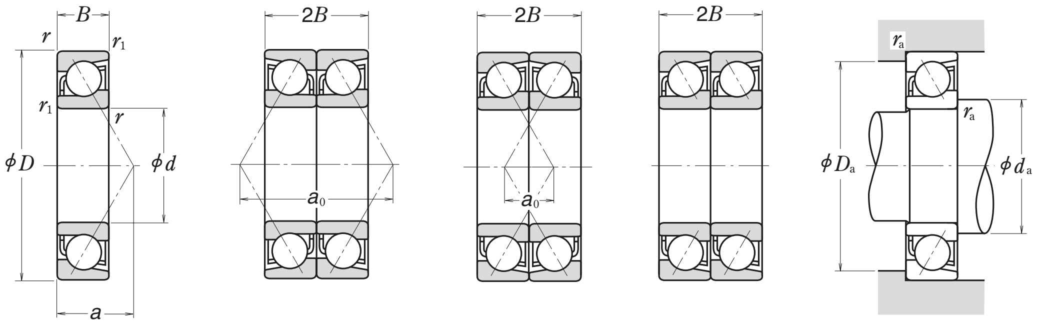
Contact Angle	Single, DT X_0	Y_0	DB or DF X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement			Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min^{-1}) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) 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 (4) 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.

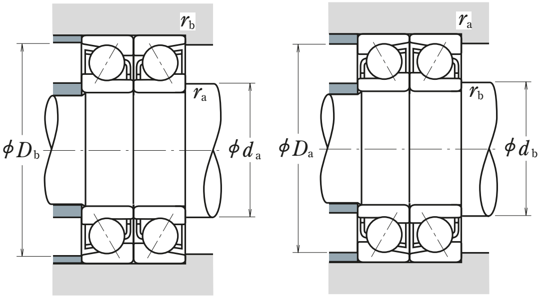
SINGLE/MATCHED MOUNTINGS
Bore Diameter 25 – 40 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
25	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
30	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
35	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
	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
40	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 ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	if_0F_a*/C_{0r}	e	Single, DT $F_a/F_r \leq e$ X	Y	$F_a/F_r > e$ X	Y	DB or DF $F_a/F_r \leq e$ X	Y	$F_a/F_r > e$ X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Contact Angle	Single, DT X_0	Y_0	DB or DF X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement			Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min⁻¹) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) 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

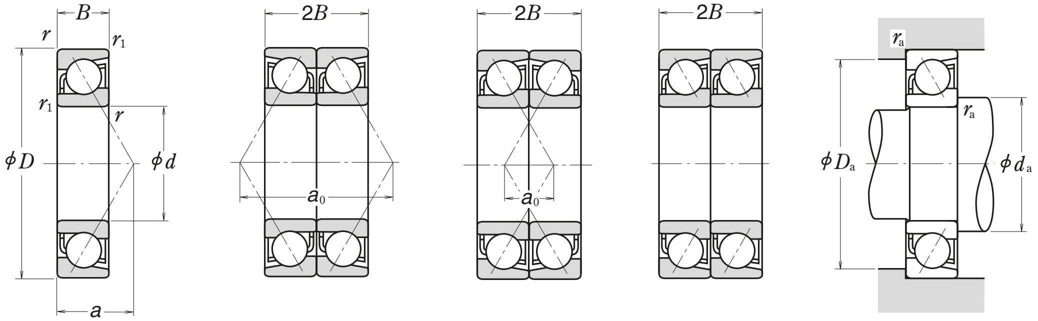
Note (4) Cage designation (M) is usually omitted from the bearing designation.

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

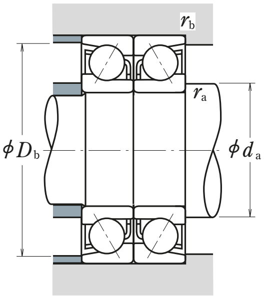
Back-to-Back DB

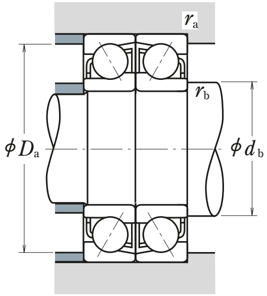
Face-to-Face DF

Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
40	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
45	68	12	0.6	0.3	15 100	12 700	—	12 000	17 000	19.2	50	63	0.6	0.130
	68	12	0.6	0.3	16 000	13 400	16.0	14 000	20 000	13.6	50	63	0.6	0.129
	75	16	1	0.6	23 100	18 700	—	7 500	10 000	25.3	51	69	1	0.250
	75	16	1	0.6	24 400	19 300	15.4	14 000	19 000	16.0	51	69	1	0.274
	85	19	1.1	0.6	39 500	28 700	—	6 700	9 500	28.3	52	78	1	0.411
	85	19	1.1	0.6	36 000	26 200	—	5 000	6 700	36.8	52	78	1	0.421
	85	19	1.1	0.6	40 500	27 100	—	7 100	10 000	36.8	52	78	1	0.400
	85	19	1.1	0.6	41 000	28 800	14.2	12 000	17 000	18.2	52	78	1	0.468
	100	25	1.5	1	63 500	43 500	—	5 000	6 700	33.4	54	91	1.5	0.848
	100	25	1.5	1	62 500	39 500	—	6 300	9 000	42.9	54	91	1.5	0.823
	100	25	1.5	1	62 500	39 500	—	4 500	6 000	42.9	54	91	1.5	0.860
50	72	12	0.6	0.3	15 900	14 200	—	11 000	15 000	20.2	55	67	0.6	0.132
	72	12	0.6	0.3	16 900	15 000	16.2	13 000	18 000	14.2	55	67	0.6	0.130
	80	16	1	0.6	24 500	21 100	—	6 700	9 500	26.8	56	74	1	0.263
	80	16	1	0.6	26 000	21 900	15.7	12 000	17 000	16.7	56	74	1	0.293
	90	20	1.1	0.6	41 500	31 500	—	6 300	9 000	30.2	57	83	1	0.466
	90	20	1.1	0.6	37 500	28 600	—	4 500	6 300	39.4	57	83	1	0.477
	90	20	1.1	0.6	42 000	29 700	—	6 300	9 500	39.4	57	83	1	0.453
	90	20	1.1	0.6	43 000	31 500	14.5	12 000	16 000	19.4	57	83	1	0.528
	110	27	2	1	74 000	52 000	—	4 500	6 000	36.6	60	100	2	1.10
	110	27	2	1	78 000	50 500	—	5 600	8 000	47.1	60	100	2	1.07
	110	27	2	1	78 000	50 500	—	4 000	5 600	47.1	60	100	2	1.11
55	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

Notes ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	if_0F_a* / C_{or}	e	Single, DT $F_a/F_r \leqq e$ X	Y	Single, DT $F_a/F_r > e$ X	Y	DB or DF $F_a/F_r \leqq e$ X	Y	DB or DF $F_a/F_r > e$ X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0=X_0F_r+Y_0F_a$

Contact Angle	Single, DT X_0	Single, DT Y_0	DB or DF X_0	DB or DF Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

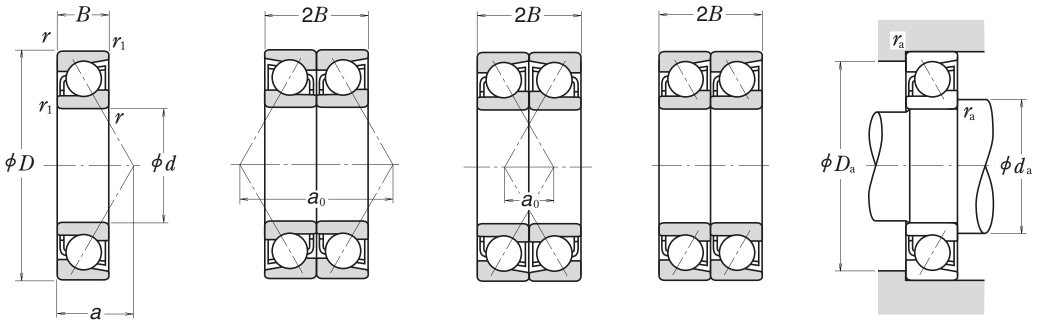
Single or DT mounting When $F_r > 0.5F_r+Y_0F_a$ use $P_0=F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement			Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min^{-1}) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) 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 (4) 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.

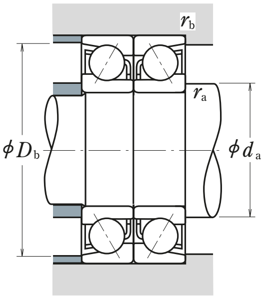
ANGULAR CONTACT BALL BEARINGS
SINGLE/MATCHED MOUNTINGS
Bore Diameter 55 – 65 mm

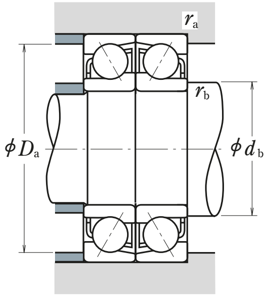


Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds (1) (min⁻¹)		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
55	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
60	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
	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
65	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
	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 (1) For applications operating near the limiting speed, refer to Page C077.
(2) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) 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	$\frac{i f_0 F_a}{C_{or}}$*	e	Single, DT $F_a/F_r \leqq e$ X	Y	Single, DT $F_a/F_r > e$ X	Y	DB or DF $F_a/F_r \leqq e$ X	Y	DB or DF $F_a/F_r > e$ X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0 F_r + Y_0 F_a$

Contact Angle	Single, DT X_0	Single, DT Y_0	DB or DF X_0	DB or DF Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

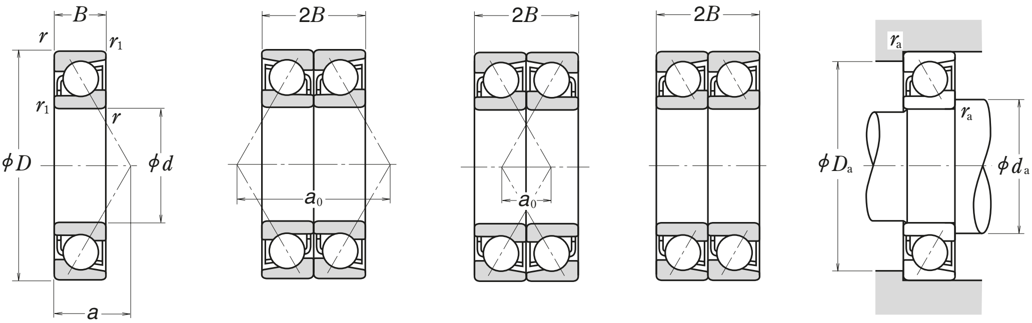
Single or DT mounting When $F_r > 0.5F_r + Y_0 F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement	Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min^{-1}) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) 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 A	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 (4) 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.

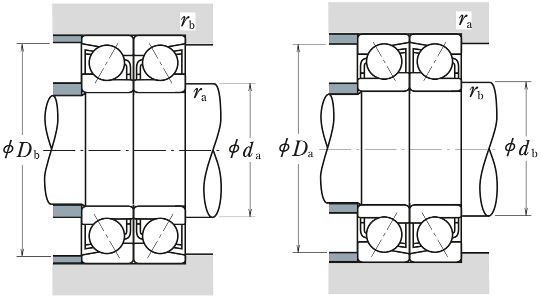
SINGLE/MATCHED MOUNTINGS
Bore Diameter 70 – 80 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
70	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
75	105	16	1	0.6	26 900	27 700	—	7 500	10 000	29.0	81	99	1	0.355
	105	16	1	0.6	28 600	29 300	16.6	9 000	12 000	20.1	81	99	1	0.357
	115	20	1.1	0.6	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
80	110	16	1	0.6	27 300	29 000	—	7 100	10 000	30.2	86	104	1	0.380
	110	16	1	0.6	29 000	30 500	16.7	8 500	12 000	20.7	86	104	1	0.376
	125	22	1.1	0.6	55 000	53 000	—	4 300	6 000	40.6	87	118	1	0.880
	125	22	1.1	0.6	58 500	55 500	15.7	8 000	11 000	24.7	87	118	1	0.966
	140	26	2	1	89 000	76 000	—	4 000	5 600	44.8	90	130	2	1.46
	140	26	2	1	80 500	69 500	—	2 800	4 000	59.1	90	130	2	1.49
	140	26	2	1	87 500	70 000	—	4 000	6 000	59.2	90	130	2	1.42
	140	26	2	1	93 000	77 500	14.7	7 500	10 000	27.7	90	130	2	1.63
	170	39	2.1	1.1	147 000	119 000	—	2 800	3 800	55.6	92	158	2	3.71
	170	39	2.1	1.1	144 000	110 000	—	3 600	5 300	71.9	92	158	2	3.59
	170	39	2.1	1.1	144 000	110 000	—	2 600	3 400	71.9	92	158	2	3.84

Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) 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	$\frac{if_0F_a}{C_{0r}}$*	e	Single, DT				DB or DF			
			$F_a/F_r \leqq e$		$F_a/F_r > e$		$F_a/F_r \leqq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0=X_0F_r+Y_0F_a$

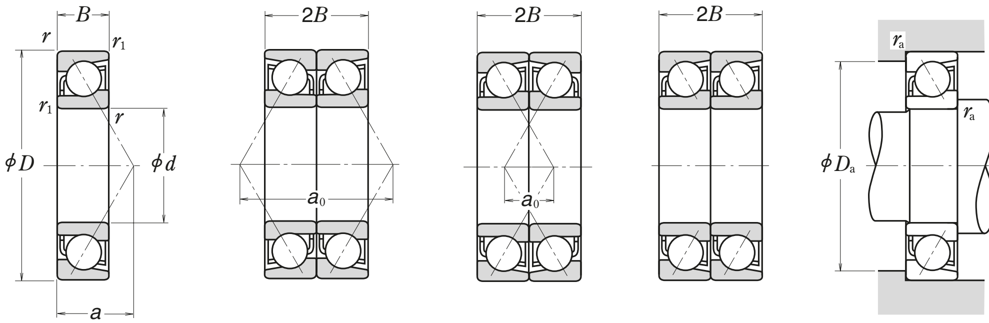
Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0=F_r$

Bearing Designations (2) Cage Designation (4)			Arrangement			Basic Load Ratings (Matched) (N)		Limiting Speeds (1) (Matched) (min^{-1})		Load Center Spacings (mm) a_0		Abutment and Fillet Dimensions (mm)		
Single	Standard	Option				C_r	C_{0r}	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 (4) 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.

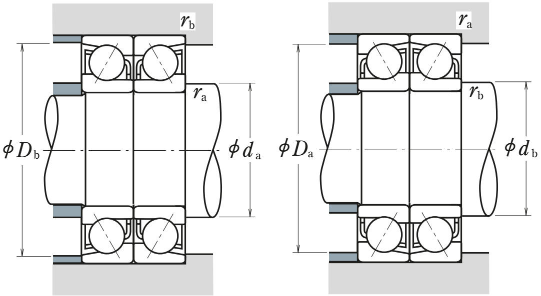
SINGLE/MATCHED MOUNTINGS
Bore Diameter 85 – 100 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a 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
90	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
	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
95	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 ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	$\frac{if_0F_a^*}{C_{or}}$	e	Single, DT $F_a/F_r \leq e$		Single, DT $F_a/F_r > e$		DB or DF $F_a/F_r \leq e$		DB or DF $F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Contact Angle	Single, DT X_0	Single, DT Y_0	DB or DF X_0	DB or DF Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

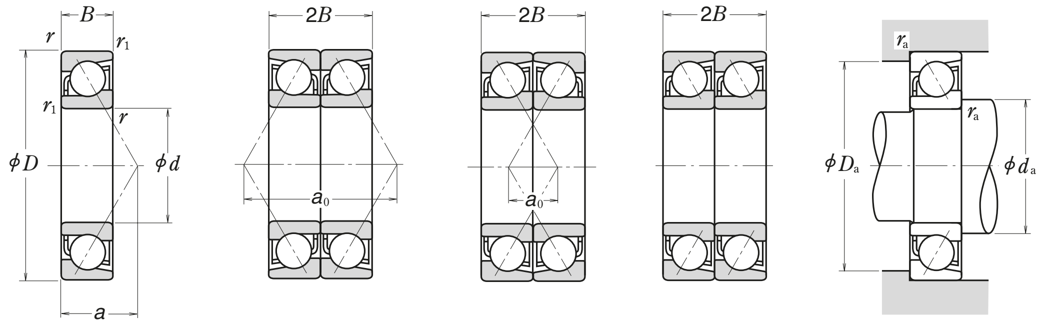
Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement	Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min⁻¹) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b (3) min.	D_b max.	r_b (3) max.
7917 A5	**(M)**	**T,TYN**	**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 (4) Cage designation (M) is usually omitted from the bearing designation.

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

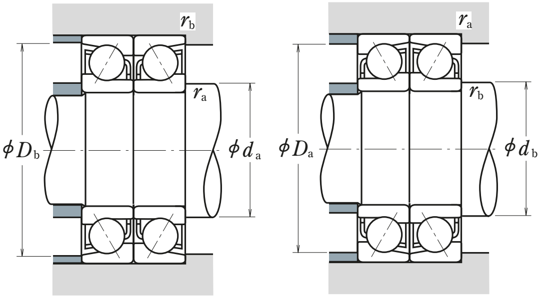
Bore Diameter 100 – 120 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
100	150	24	1.5	1	75 500	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
105	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
	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
110	150	20	1.1	0.6	49 000	56 000	—	5 300	7 100	40.3	117	143	1	0.877
	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

Notes ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	$\frac{if_0F_a^*}{C_{0r}}$	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
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0=X_0F_r+Y_0F_a$

Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r>0.5F_r+Y_0F_a$ use $P_0=F_r$

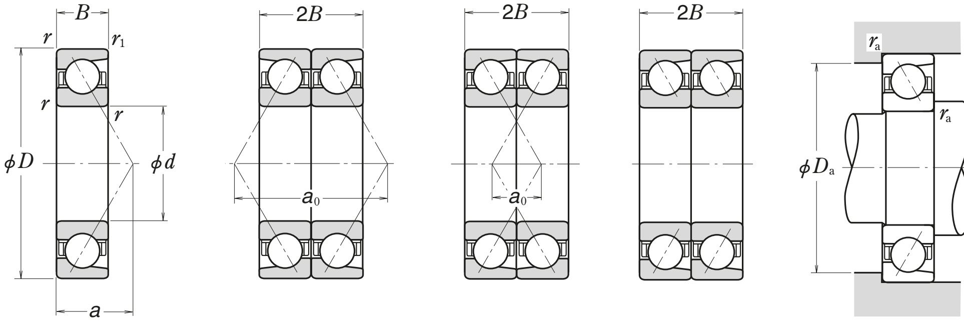
Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement			Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min⁻¹) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) max.
7020 C	**(M)**	**T, 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 (4) Cage designation (M) is usually omitted from the bearing designation.

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

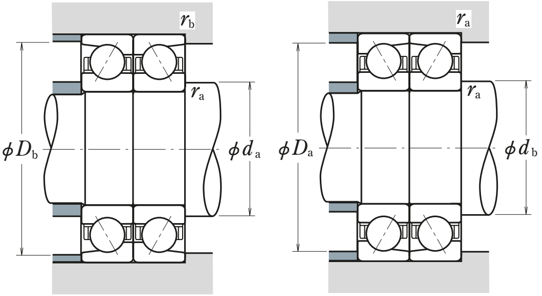
Bore Diameter 130 – 170 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds (1) (min^{-1})		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
130	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
140	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
150	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
160	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
170	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

Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) 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	if_0F_a*/C_{0r}	e	Single, DT				DB or DF			
			$F_a/F_r \le e$		$F_a/F_r > e$		$F_a/F_r \le e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0=X_0F_r+Y_0F_a$

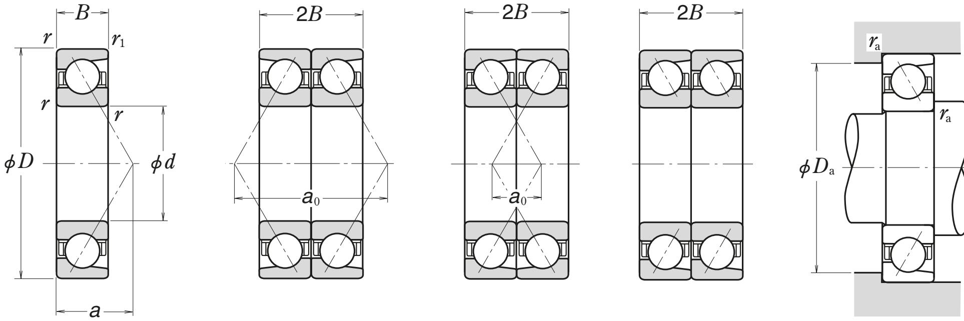
Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement	Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min⁻¹) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) 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)**	**T**	**DB DF DT**	365 000	510 000	1 500	2 000	221.2	131.2	—	263	1
7330 A	**(M)**	—	**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 (4) Cage designation (M) is usually omitted from the bearing designation.

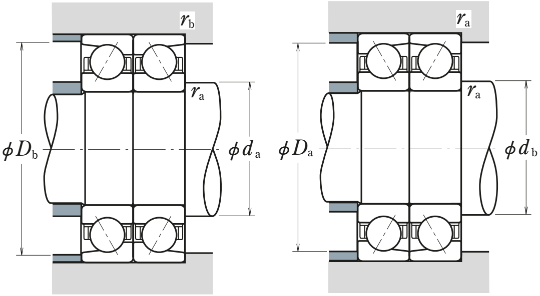
SINGLE/MATCHED MOUNTINGS
Bore Diameter 180 – 200 mm



Single — Back-to-Back DB — Face-to-Face DF — Tandem DT

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min⁻¹)		Eff.Load Center (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	r_1 min.	C_r	C_{0r}	f_0	Grease	Oil	a	d_a min.	D_a max.	r_a max.	approx.
180	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
190	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
200	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 ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) Suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) 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	$\frac{if_0F_a}{C_{or}}$*	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
15º	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
25º	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30º	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40º	—	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 DT

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
15º	0.5	0.46	1	0.92
25º	0.5	0.38	1	0.76
30º	0.5	0.33	1	0.66
40º	0.5	0.26	1	0.52

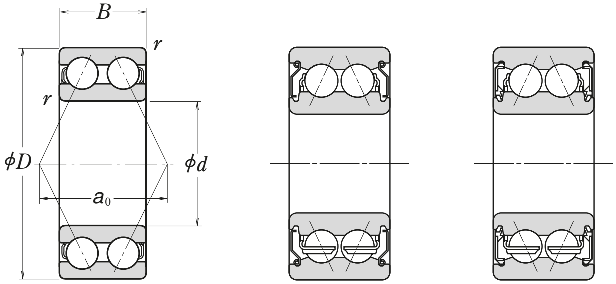
Single or DT mounting When $F_r > 0.5F_r + Y_0F_a$ use $P_0 = F_r$

Bearing Designations (2) Cage Designation (4) Single	Standard	Option	Arrangement			Basic Load Ratings (Matched) (N) C_r	C_{0r}	Limiting Speeds (1) (Matched) (min^{-1}) Grease	Oil	Load Center Spacings (mm) a_0 DB	DF	Abutment and Fillet Dimensions (mm) d_b(3) min.	D_b max.	r_b(3) 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 (4) Cage designation (M) is usually omitted from the bearing designation.

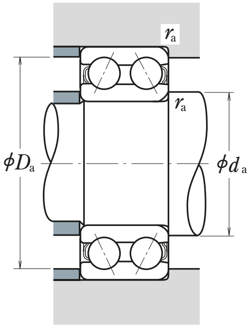
DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

Bore Diameter 10 – 45 mm



Open | Shielded (ZZ) | Sealed (DDU)

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})			Bearing Designations		
						Grease		Oil			
d	D	B	r min.	C_r	C_{0r}	Open ZZ	DDU	Open	Open	Shielded	Sealed
10	30	14.3	0.6	7 150	3 900	17 000	—	22 000	**5200**	—	—
	30	14.3	0.6	7 150	3 900	17 000	15 000	—	—	**5200ZZ**	**5200DDU**
12	32	15.9	0.6	10 500	5 800	15 000	—	20 000	**5201**	—	—
	32	15.9	0.6	8 500	5 300	15 000	12 000	—	—	**5201BZZ**	**5201BDDU**
15	35	15.9	0.6	11 700	7 050	13 000	—	17 000	**5202**	—	—
	35	15.9	0.6	8 500	5 300	13 000	12 000	—	—	**5202BZZ**	**5202BDDU**
	42	19	1	17 600	10 200	11 000	—	15 000	**5302**	—	—
	42	19	1	14 700	9 100	11 000	10 000	—	—	**5302AZZ**	**5302ADDU**
17	40	17.5	0.6	14 600	9 050	11 000	—	15 000	**5203**	—	—
	40	17.5	0.6	12 700	8 300	11 000	10 000	—	—	**5203AZZ**	**5203ADDU**
	47	22.2	1	21 000	12 600	10 000	—	13 000	**5303**	—	—
	47	22.2	1	19 600	12 400	10 000	9 500	—	—	**5303AZZ**	**5303ADDU**
20	47	20.6	1	19 600	12 400	10 000	—	13 000	**5204**	—	—
	47	20.6	1	15 900	10 700	10 000	9 000	—	—	**5204AZZ**	**5204ADDU**
	52	22.2	1.1	24 600	15 000	9 000	—	12 000	**5304**	—	—
	52	22.2	1.1	19 700	12 800	9 000	8 500	—	—	**5304AZZ**	**5304ADDU**
25	52	20.6	1	21 300	14 700	8 500	—	11 000	**5205**	—	—
	52	20.6	1	16 900	12 300	8 500	7 500	—	—	**5205BZZ**	**5205BDDU**
	62	25.4	1.1	32 500	20 700	7 500	—	10 000	**5305**	—	—
	62	25.4	1.1	25 200	18 200	7 500	6 300	—	—	**5305AZZ**	**5305ADDU**
30	62	23.8	1	29 600	21 100	7 100	—	9 500	**5206**	—	—
	62	23.8	1	25 200	18 200	7 100	6 300	—	—	**5206BZZ**	**5206BDDU**
	72	30.2	1.1	40 500	28 100	6 300	—	8 500	**5306**	—	—
	72	30.2	1.1	39 000	28 700	6 300	5 300	—	—	**5306AZZ**	**5306ADDU**
35	72	27	1.1	39 000	28 700	6 300	—	8 000	**5207**	—	—
	72	27	1.1	34 000	25 300	6 300	5 300	—	—	**5207AZZ**	**5207ADDU**
	80	34.9	1.5	51 000	36 000	5 600	—	7 500	**5307**	—	—
	80	34.9	1.5	44 000	33 500	5 600	4 800	—	—	**5307AZZ**	**5307ADDU**
40	80	30.2	1.1	44 000	33 500	5 600	—	7 100	**5208**	—	—
	80	30.2	1.1	36 500	29 000	5 600	4 800	—	—	**5208AZZ**	**5208ADDU**
	90	36.5	1.5	56 500	41 000	5 300	—	6 700	**5308**	—	—
	90	36.5	1.5	49 500	38 000	5 300	4 500	—	—	**5308AZZ**	**5308ADDU**
45	85	30.2	1.1	49 500	38 000	5 000	—	6 700	**5209**	—	—
	85	30.2	1.1	41 500	33 500	5 000	4 300	—	—	**5209A1ZZ**	**5209A1DDU**
	100	39.7	1.5	68 500	51 000	4 500	—	6 000	**5309**	—	—



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$		e
X	Y	X	Y	
1	0.92	0.67	1.41	0.68

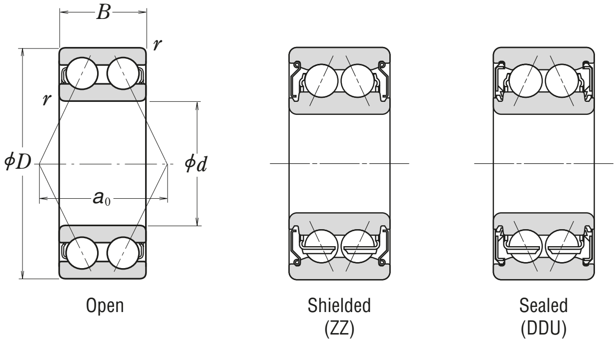
Static Equivalent Load

$P_0 = F_r + 0.76\,F_a$

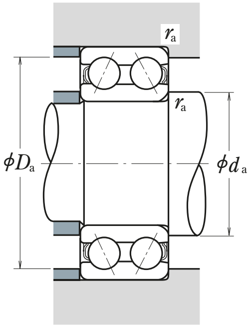
Load Center Spacings (mm) a_0	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.
14.5	15	25	0.6	0.050
14.5	14	26	0.6	0.050
16.7	17	27	0.6	0.060
16.3	16	28	0.6	0.060
18.3	20	30	0.6	0.070
16.3	19	31	0.6	0.070
22	21	36	1	0.13
21	21	36	1	0.13
20.8	22	35	0.6	0.10
20.1	21	36	0.6	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^{-1})			Bearing Designations		
						Grease		Oil			
d	*D*	*B*	*r* min.	C_r	C_{0r}	Open ZZ	DDU	Open	Open	Shielded	Sealed
50	90	30.2	1.1	53 000	43 500	4 800	—	6 000	**5210**	—	—
	90	30.2	1.1	40 500	36 000	4 800	4 000	—	—	**5210AZZ**	**5210ADDU**
	110	44.4	2	81 500	61 500	4 300	—	5 600	**5310**	—	—
55	100	33.3	1.5	56 000	49 000	4 300	—	5 600	**5211**	—	—
	100	33.3	1.5	49 500	43 500	4 300	3 600	—	—	**5211AZZ**	**5211ADDU**
	120	49.2	2	95 000	73 000	3 800	—	5 000	**5311**	—	—
60	110	36.5	1.5	69 000	62 000	3 800	—	5 000	**5212**	—	—
	130	54	2.1	125 000	98 500	3 400	—	4 500	**5312**	—	—
65	120	38.1	1.5	76 500	69 000	3 600	—	4 500	**5213**	—	—
	140	58.7	2.1	142 000	113 000	3 200	—	4 300	**5313**	—	—
70	125	39.7	1.5	94 000	82 000	3 400	—	4 500	**5214**	—	—
	150	63.5	2.1	159 000	128 000	3 000	—	3 800	**5314**	—	—
75	130	41.3	1.5	93 500	83 000	3 200	—	4 300	**5215**	—	—
80	140	44.4	2	99 000	93 000	3 000	—	3 800	**5216**	—	—
85	150	49.2	2	116 000	110 000	2 800	—	3 600	**5217**	—	—



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$		e
X	Y	X	Y	
1	0.92	0.67	1.41	0.68

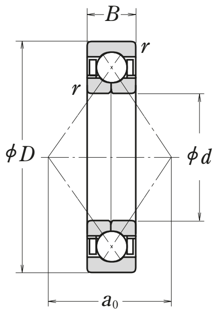
Static Equivalent Load

$P_0 = F_r + 0.76\,F_a$

Load Center Spacings (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
a_0	d_a min.	D_a max.	r_a max.	approx.
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

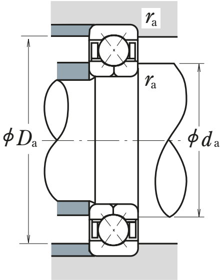
FOUR-POINT-CONTACT BALL BEARINGS

Bore Diameter 30 – 95 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	D	B	r min.	C_a	C_{0a}	Grease	Oil
30	62	16	1	31 000	45 000	8 500	12 000
	72	19	1.1	46 000	63 000	8 000	11 000
35	72	17	1.1	41 000	61 500	7 500	10 000
	80	21	1.5	55 000	80 000	7 100	9 500
40	80	18	1.1	49 000	77 500	6 700	9 000
	90	23	1.5	67 000	100 000	6 300	8 500
45	85	19	1.1	55 000	88 500	6 300	8 500
	100	25	1.5	87 500	133 000	5 600	7 500
50	90	20	1.1	57 000	97 000	5 600	8 000
	110	27	2	102 000	159 000	5 000	6 700
55	100	21	1.5	71 000	122 000	5 300	7 100
	120	29	2	118 000	187 000	4 500	6 300
60	110	22	1.5	85 500	150 000	4 800	6 300
	130	31	2.1	135 000	217 000	4 300	5 600
65	120	23	1.5	97 500	179 000	4 300	6 000
	140	33	2.1	153 000	250 000	3 800	5 300
70	125	24	1.5	106 000	197 000	4 000	5 600
	150	35	2.1	172 000	285 000	3 600	5 000
75	130	25	1.5	110 000	212 000	3 800	5 300
	160	37	2.1	187 000	320 000	3 400	4 800
80	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
85	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
90	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
95	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

$P_a = F_a$

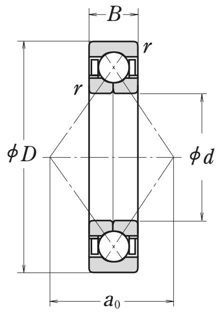
Static Equivalent Load

$P_{0a} = F_a$

Bearing Designation	Load Center Spacing (mm) a_0	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.
QJ 206	32.2	36	56	1	0.24
QJ 306	35.7	37	65	1	0.42
QJ 207	37.5	42	65	1	0.35
QJ 307	40.3	44	71	1.5	0.57
QJ 208	42.0	47	73	1	0.45
QJ 308	45.5	49	81	1.5	0.78
QJ 209	45.5	52	78	1	0.52
QJ 309	50.8	54	91	1.5	1.05
QJ 210	49.0	57	83	1	0.59
QJ 310	56.0	60	100	2	1.35
QJ 211	54.3	64	91	1.5	0.77
QJ 311	61.3	65	110	2	1.75
QJ 212	59.5	69	101	1.5	0.98
QJ 312	66.5	72	118	2	2.15
QJ 213	64.8	74	111	1.5	1.2
QJ 313	71.8	77	128	2	2.7
QJ 214	68.3	79	116	1.5	1.3
QJ 314	77.0	82	138	2	3.18
QJ 215	71.8	84	121	1.5	1.5
QJ 315	82.3	87	148	2	3.9
QJ 1016	71.8	87	118	1	1.05
QJ 216	77.0	90	130	2	1.85
QJ 316	87.5	92	158	2	4.6
QJ 1017	75.3	92	123	1	1.1
QJ 217	82.3	95	140	2	2.2
QJ 317	92.8	99	166	2.5	5.34
QJ 1018	80.5	99	131	1.5	1.45
QJ 218	87.5	100	150	2	2.75
QJ 318	98.0	104	176	2.5	6.4
QJ 1019	84.0	104	136	1.5	1.5
QJ 219	92.8	107	158	2	3.35
QJ 319	103.3	109	186	2.5	7.4

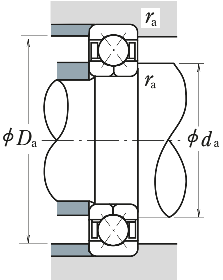
FOUR-POINT-CONTACT BALL BEARINGS

Bore Diameter 100 – 200 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*B*	*r* min.	C_a	C_{0a}	Grease	Oil
100	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
105	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
110	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
120	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
130	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
140	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
150	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
160	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
170	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
180	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
190	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
200	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) d_a min.	D_a max.	r_a max.	Mass (kg) approx.
QJ 1020	87.5	109	141	1.5	1.6
QJ 220	98.0	112	168	2	4.0
QJ 320	110.3	114	201	2.5	9.3
QJ 1021	92.8	115	150	2	2.0
QJ 221	103.3	117	178	2	4.7
QJ 321	115.5	119	211	2.5	10.5
QJ 1022	98.0	120	160	2	2.5
QJ 222	108.5	122	188	2	5.6
QJ 322	122.5	124	226	2.5	12.5
QJ 1024	105.0	130	170	2	2.65
QJ 224	117.3	132	203	2	6.9
QJ 324	133.0	134	246	2.5	15.4
QJ 1026	115.5	140	190	2	4.0
QJ 226	126.0	144	216	2.5	7.7
QJ 326	143.5	148	262	3	19
QJ 1028	122.5	150	200	2	4.3
QJ 228	136.5	154	236	2.5	9.8
QJ 328	154.0	158	282	3	24
QJ 1030	131.3	162	213	2	5.2
QJ 230	147.0	164	256	2.5	12
QJ 330	164.5	168	302	3	29
QJ 1032	140.0	172	228	2	6.4
QJ 232	157.5	174	276	2.5	15
QJ 332	175.1	178	322	3	31
QJ 1034	150.5	182	248	2	8.6
QJ 234	168.0	188	292	3	19.5
QJ 334	185.6	188	342	3	41
QJ 1036	161.0	192	268	2	11
QJ 236	175.1	198	302	3	20.5
QJ 336	196.1	198	362	3	48
QJ 1038	168.0	202	278	2	11.5
QJ 238	185.6	208	322	3	23
QJ 338	206.6	212	378	4	54.5
QJ 1040	178.6	212	298	2	15
QJ 240	196.1	218	342	3	27
QJ 340	217.1	222	398	4	61.5

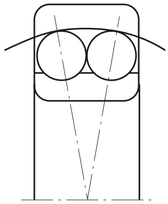

NSK

4. SELF-ALIGNING BALL BEARINGS

DESIGN, TYPES, AND FEATURES

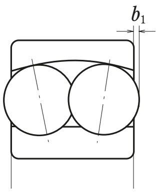
The outer ring of a self-aligning ball bearing has a spherical raceway and its center of curvature coincides with that of the bearing; therefore, the axis of the inner ring, balls and cage can deflect to some extent around the bearing center. This type is recommended when the alignment of the shaft and 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)

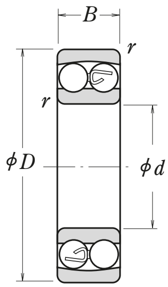
INTERNAL CLEARANCE

Table 8.13 (Page A170)

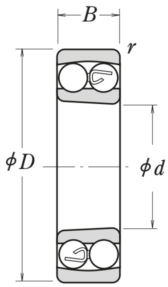
PERMISSIBLE MISALIGNMENT

The permissible misalignment of self-aligning ball bearings is approximately 0.07 to 0.12 radian (4° to 7°) 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.

Bore Diameter 5 – 30 mm



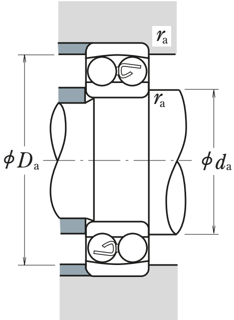
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing
d	*D*	*B*	*r* min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore
5	19	6	0.3	2 530	475	30 000	36 000	**135**
6	19	6	0.3	2 530	475	30 000	36 000	**126**
7	22	7	0.3	2 750	600	26 000	32 000	**127**
8	22	7	0.3	2 750	600	26 000	32 000	**108**
9	26	8	0.6	4 150	895	26 000	30 000	**129**
10	30	9	0.6	5 550	1 190	22 000	28 000	**1200**
	30	14	0.6	7 450	1 590	24 000	28 000	**2200**
	35	11	0.6	7 350	1 620	20 000	24 000	**1300**
	35	17	0.6	9 200	2 010	18 000	22 000	**2300**
12	32	10	0.6	5 700	1 270	22 000	26 000	**1201**
	32	14	0.6	7 750	1 730	22 000	26 000	**2201**
	37	12	1	9 650	2 160	18 000	22 000	**1301**
	37	17	1	12 100	2 730	17 000	22 000	**2301**
15	35	11	0.6	7 600	1 750	18 000	22 000	**1202**
	35	14	0.6	7 800	1 850	18 000	22 000	**2202**
	42	13	1	9 700	2 290	16 000	20 000	**1302**
	42	17	1	12 300	2 910	14 000	18 000	**2302**
17	40	12	0.6	8 000	2 010	16 000	20 000	**1203**
	40	16	0.6	9 950	2 420	16 000	20 000	**2203**
	47	14	1	12 700	3 200	14 000	17 000	**1303**
	47	19	1	14 700	3 550	13 000	16 000	**2303**
20	47	14	1	10 000	2 610	14 000	17 000	**1204**
	47	18	1	12 800	3 300	14 000	17 000	**2204**
	52	15	1.1	12 600	3 350	12 000	15 000	**1304**
	52	21	1.1	18 500	4 700	11 000	14 000	**2304**
25	52	15	1	12 200	3 300	12 000	14 000	**1205**
	52	18	1	12 400	3 450	12 000	14 000	**2205**
	62	17	1.1	18 200	5 000	10 000	13 000	**1305**
	62	24	1.1	24 900	6 600	9 500	12 000	**2305**
30	62	16	1	15 800	4 650	10 000	12 000	**1206**
	62	20	1	15 300	4 550	10 000	12 000	**2206**
	72	19	1.1	21 400	6 300	8 500	11 000	**1306**
	72	27	1.1	32 000	8 750	8 000	10 000	**2306**

Note (1) Suffix K represents bearings with tapered bores (1 : 12).
Remark For dimensions related to adapters, refer to Page C348.



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.65	Y_2

Static Equivalent Load

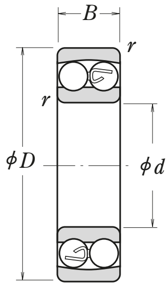
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are listed in the table below.

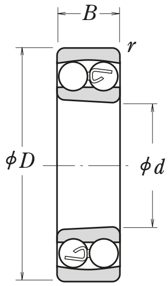
Designations	Abutment and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
Tapered Bore([1])	d_a min.	D_a max.	r_a max.	e	Y_2	Y_3	Y_0	approx.
—	7	17	0.3	0.34	2.9	1.9	1.9	0.009
—	8	17	0.3	0.34	2.9	1.9	1.9	0.008
—	9	20	0.3	0.31	3.1	2.0	2.1	0.013
—	10	20	0.3	0.31	3.1	2.0	2.1	0.016
—	13	22	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
1204 K	25	42	1	0.29	3.4	2.2	2.3	0.12
2204 K	25	42	1	0.47	2.1	1.3	1.4	0.142
1304 K	26.5	45.5	1	0.29	3.4	2.2	2.3	0.164
2304 K	26.5	45.5	1	0.50	1.9	1.2	1.3	0.210
1205 K	30	47	1	0.28	3.5	2.3	2.4	0.14
2205 K	30	47	1	0.41	2.4	1.5	1.6	0.16
1305 K	31.5	55.5	1	0.28	3.5	2.3	2.4	0.261
2305 K	31.5	55.5	1	0.47	2.1	1.4	1.4	0.340
1206 K	35	57	1	0.25	3.9	2.5	2.6	0.22
2206 K	35	57	1	0.38	2.5	1.6	1.7	0.262
1306 K	36.5	65.5	1	0.26	3.7	2.4	2.5	0.391
2306 K	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

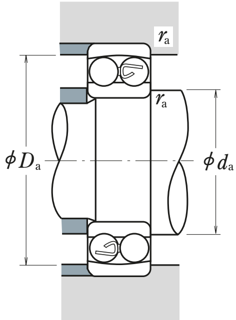


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore
35	72	17	1.1	15 900	5 100	8 500	10 000	**1207**
	72	23	1.1	21 700	6 600	8 500	10 000	**2207**
	80	21	1.5	25 300	7 850	7 500	9 500	**1307**
	80	31	1.5	40 000	11 300	7 100	9 000	**2307**
40	80	18	1.1	19 300	6 500	7 500	9 000	**1208**
	80	23	1.1	22 400	7 350	7 500	9 000	**2208**
	90	23	1.5	29 800	9 700	6 700	8 500	**1308**
	90	33	1.5	45 500	13 500	6 300	8 000	**2308**
45	85	19	1.1	22 000	7 350	7 100	8 500	**1209**
	85	23	1.1	23 300	8 150	7 100	8 500	**2209**
	100	25	1.5	38 500	12 700	6 000	7 500	**1309**
	100	36	1.5	55 000	16 700	5 600	7 100	**2309**
50	90	20	1.1	22 800	8 100	6 300	8 000	**1210**
	90	23	1.1	23 300	8 450	6 300	8 000	**2210**
	110	27	2	43 500	14 100	5 600	6 700	**1310**
	110	40	2	65 000	20 200	5 000	6 300	**2310**
55	100	21	1.5	26 900	10 000	6 000	7 100	**1211**
	100	25	1.5	26 700	9 900	6 000	7 100	**2211**
	120	29	2	51 500	17 900	5 000	6 300	**1311**
	120	43	2	76 500	24 000	4 800	6 000	**2311**
60	110	22	1.5	30 500	11 500	5 300	6 300	**1212**
	110	28	1.5	34 000	12 600	5 300	6 300	**2212**
	130	31	2.1	57 500	20 800	4 500	5 600	**1312**
	130	46	2.1	88 500	28 300	4 300	5 300	**2312**
65	120	23	1.5	31 000	12 500	4 800	6 000	**1213**
	120	31	1.5	43 500	16 400	4 800	6 000	**2213**
	140	33	2.1	62 500	22 900	4 300	5 300	**1313**
	140	48	2.1	97 000	32 500	3 800	4 800	**2313**
70	125	24	1.5	35 000	13 800	4 800	5 600	**1214**
	125	31	1.5	44 000	17 100	4 500	5 600	**2214**
	150	35	2.1	75 000	27 700	4 000	5 000	**1314**
	150	51	2.1	111 000	37 500	3 600	4 500	**2314**

Note (1) Suffix K represents bearings with tapered bores (1 : 12).

Remark For dimensions related to adapters, refer to Pages C348 and C349.



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.65	Y_2

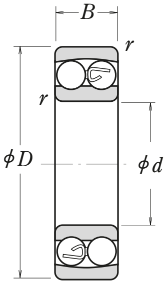
Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

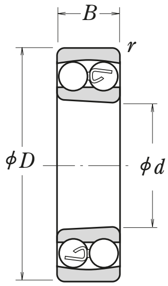
The values of e, Y_2, Y_3, and Y_0 are listed in the table below.

Designations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
1207 K	41.5	65.5	1	0.23	4.2	2.7	2.8	0.33
2207 K	41.5	65.5	1	0.37	2.6	1.7	1.8	0.403
1307 K	43	72	1.5	0.26	3.8	2.5	2.6	0.52
2307 K	43	72	1.5	0.46	2.1	1.4	1.4	0.687
1208 K	46.5	73.5	1	0.22	4.3	2.8	2.9	0.42
2208 K	46.5	73.5	1	0.33	3.0	1.9	2.0	0.506
1308 K	48	82	1.5	0.24	4.0	2.6	2.7	0.727
2308 K	48	82	1.5	0.43	2.3	1.5	1.5	0.940
1209 K	51.5	78.5	1	0.21	4.7	3.0	3.1	0.47
2209 K	51.5	78.5	1	0.30	3.2	2.1	2.2	0.556
1309 K	53	92	1.5	0.25	4.0	2.6	2.7	0.971
2309 K	53	92	1.5	0.41	2.4	1.5	1.6	1.3
1210 K	56.5	83.5	1	0.21	4.7	3.1	3.2	0.535
2210 K	56.5	83.5	1	0.28	3.4	2.2	2.3	0.598
1310 K	59	101	2	0.23	4.2	2.7	2.8	1.23
2310 K	59	101	2	0.42	2.3	1.5	1.6	1.66
1211 K	63	92	1.5	0.20	4.9	3.2	3.3	0.708
2211 K	63	92	1.5	0.28	3.5	2.3	2.4	0.807
1311 K	64	111	2	0.23	4.2	2.7	2.8	1.6
2311 K	64	111	2	0.41	2.4	1.5	1.6	2.12
1212 K	68	102	1.5	0.18	5.3	3.4	3.6	0.91
2212 K	68	102	1.5	0.28	3.5	2.3	2.4	1.1
1312 K	71	119	2	0.23	4.3	2.8	2.9	2.0
2312 K	71	119	2	0.40	2.4	1.6	1.6	2.63
1213 K	73	112	1.5	0.17	5.7	3.7	3.8	1.16
2213 K	73	112	1.5	0.28	3.5	2.3	2.4	1.5
1313 K	76	129	2	0.23	4.2	2.7	2.9	2.47
2313 K	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

Bore Diameter 75 – 110 mm



Cylindrical Bore



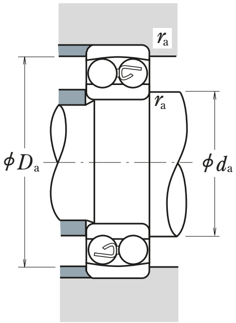
Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore
75	130	25	1.5	39 000	15 700	4 300	5 300	**1215**
	130	31	1.5	44 500	17 800	4 300	5 300	**2215**
	160	37	2.1	80 000	30 000	3 800	4 500	**1315**
	160	55	2.1	125 000	43 000	3 400	4 300	**2315**
80	140	26	2	40 000	17 000	4 000	5 000	**1216**
	140	33	2	49 000	19 900	4 000	5 000	**2216**
	170	39	2.1	89 000	33 000	3 600	4 300	**1316**
	170	58	2.1	130 000	45 000	3 200	4 000	**∗ 2316**
85	150	28	2	49 500	20 800	3 800	4 500	**1217**
	150	36	2	58 500	23 600	3 800	4 800	**2217**
	180	41	3	98 500	38 000	3 400	4 000	**1317**
	180	60	3	142 000	51 500	3 000	3 800	**2317**
90	160	30	2	57 500	23 500	3 600	4 300	**1218**
	160	40	2	70 500	28 700	3 600	4 300	**2218**
	190	43	3	117 000	44 500	3 200	3 800	**∗ 1318**
	190	64	3	154 000	57 500	2 800	3 600	**2318**
95	170	32	2.1	64 000	27 100	3 400	4 000	**1219**
	170	43	2.1	84 000	34 500	3 400	4 000	**2219**
	200	45	3	129 000	51 000	3 000	3 600	**∗ 1319**
	200	67	3	161 000	64 500	2 800	3 400	**∗ 2319**
100	180	34	2.1	69 500	29 700	3 200	3 800	**1220**
	180	46	2.1	94 500	38 500	3 200	3 800	**2220**
	215	47	3	140 000	57 500	2 800	3 400	**∗ 1320**
	215	73	3	187 000	79 000	2 400	3 200	**∗ 2320**
105	190	36	2.1	75 000	32 500	3 000	3 600	**1221**
	190	50	2.1	109 000	45 000	3 000	3 600	**2221**
	225	49	3	154 000	64 500	2 600	3 200	**∗ 1321**
	225	77	3	200 000	87 000	2 400	3 000	**∗ 2321**
110	200	38	2.1	87 000	38 500	2 800	3 400	**1222**
	200	53	2.1	122 000	51 500	2 800	3 400	**∗ 2222**
	240	50	3	161 000	72 000	2 400	3 000	**∗ 1322**
	240	80	3	211 000	94 500	2 200	2 800	**∗ 2322**

Notes (1) 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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
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 Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	 D_a max.	 r_a max.	Constant e	Axial Load Factors Y_2	 Y_3	 Y_0	Mass (kg) approx.
1215 K	83	122	1.5	0.17	5.6	3.6	3.8	1.36
2215 K	83	122	1.5	0.25	3.9	2.5	2.6	1.6
1315 K	86	149	2	0.22	4.4	2.8	2.9	3.63
2315 K	86	149	2	0.38	2.5	1.6	1.7	4.84
1216 K	89	131	2	0.16	6.0	3.9	4.1	1.68
2216 K	89	131	2	0.25	3.9	2.5	2.7	2.02
1316 K	91	159	2	0.22	4.5	2.9	3.1	4.24
∗ 2316 K	91	159	2	0.39	2.5	1.6	1.7	5.75
1217 K	94	141	2	0.17	5.7	3.7	3.8	2.1
2217 K	94	141	2	0.25	3.9	2.5	2.6	2.56
1317 K	98	167	2.5	0.21	4.6	2.9	3.1	5.03
2317 K	98	167	2.5	0.37	2.6	1.7	1.8	6.68
1218 K	99	151	2	0.17	5.8	3.8	3.9	2.56
2218 K	99	151	2	0.27	3.7	2.4	2.5	3.22
∗ 1318 K	103	177	2.5	0.22	4.3	2.8	2.9	5.83
2318 K	103	177	2.5	0.38	2.6	1.7	1.7	7.87
1219 K	106	159	2	0.17	5.8	3.7	3.9	3.12
2219 K	106	159	2	0.27	3.7	2.4	2.5	3.96
∗ 1319 K	108	187	2.5	0.23	4.3	2.8	2.9	6.79
∗ 2319 K	108	187	2.5	0.38	2.6	1.7	1.8	9.09
1220 K	111	169	2	0.17	5.6	3.6	3.8	3.74
2220 K	111	169	2	0.27	3.7	2.4	2.5	4.71
∗ 1320 K	113	202	2.5	0.24	4.1	2.7	2.8	8.4
∗ 2320 K	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
1222 K	121	189	2	0.17	5.7	3.7	3.9	5.21
∗ 2222 K	121	189	2	0.28	3.5	2.2	2.3	6.75
∗ 1322 K	123	227	2.5	0.22	4.4	2.8	3.0	11.5
∗ 2322 K	123	227	2.5	0.37	2.6	1.7	1.8	17.5

5. CYLINDRICAL ROLLER BEARINGS

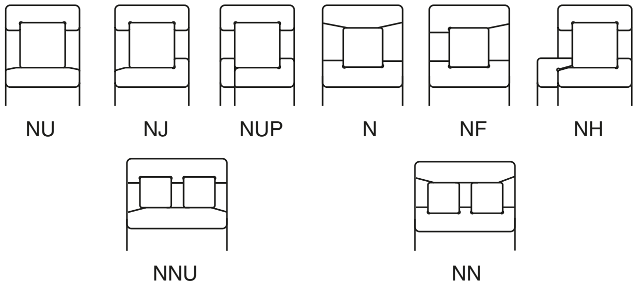
SINGLE-ROW AND DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS

SINGLE-ROW(NCF), DOUBLE-ROW(NNCF) AND FOR SHEAVES

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.		Steel	Steel	Polyamide 66 resin	L-PPS resin	Brass	
	Material	Steel	Steel	Polyamide 66 resin	L-PPS resin	Brass	
	Method	Pressed		Molded		Machined	
	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

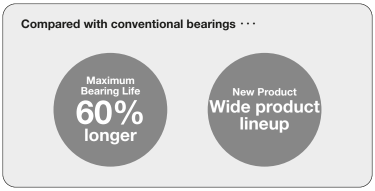
Example: NU 3 08 E M C3 P5 &

①Bearing type — NU
②Dimension Series — 3
③Bore number — 08
④Internal design — E
⑤Cage — M
⑥Internal clearance — C3
⑦Tolerance Class — P5
⑧NSKHPS™ — &

①Bearing type	NU : Single-row cylindrical roller bearings (Outer ring with both ribs + Inner ring without rib) Please refer to page C124 for detailed information.
②Dimension Series	10 : 10 Series, 2: 02 Series, 22 : 22 Series, 3 : 03 Series, 23 : 23 Series, 4 : 04 Series,
③Bore number	Less than 03, Bearing bore 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore Bore number X 5 (mm)
④Internal design	E : High load capacity
⑤Cage	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
⑥Internal 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
⑦Tolerance class	Omitted : ISO Normal, P6 : ISO Class 6, P5 : ISO Class 5, P4 : ISO Class 4
⑧NSKHPS™	& : NSKHPS™ Designation Tolerance Class : ISO Normal

NSKHPS™ Cylindrical Roller Bearings

Features



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 perfomance
- 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 °C. If the bearings are to be used in gear oil, nonflammable hydraulic oil, or ester oil at a temperature over 100 °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 ΔF_w		Tolerances for E_w of Types N, NF, and NN ΔE_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

CYLINDRICAL ROLLER BEARINGS............................Table 8.3 (Page A164)
Table 8.5 (Page A165)
DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS..................................Table 8.3 (Page A164)
Table 8.5 (Page A165)

INTERNAL CLEARANCES

CYLINDRICAL ROLLER BEARINGS............................Table 8.15 (Page A171)
NSKHPS CYLINDRICAL ROLLER BEARINGS
INTERNAL CLEARANCE DESIGNATION : CN, C3, C4
DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS....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^3. This result was obtained by multiplying the free space of the bearing (52 cm^3) 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^3

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^3

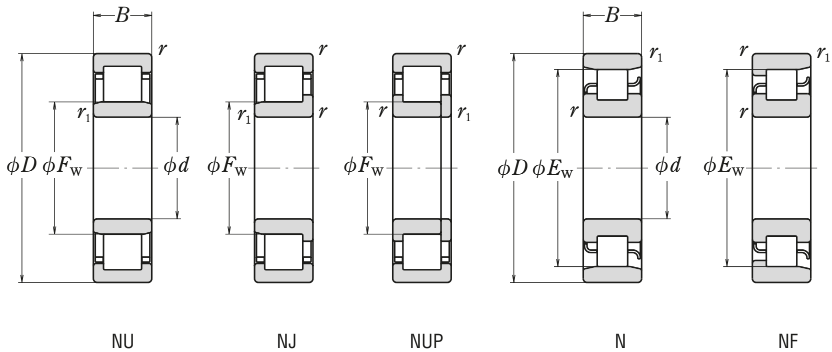
Bearing Bore No.	Bearing Free Space			
	Bearing Series			
	NU2	NU3	NU22	NU23
05	5.0	7.6	5.7	10
06	7.4	12	7.9	16
07	9.6	16	12	27
08	12	21	15	32
09	15	29	16	45
10	18	38	17	58
11	22	52	24	77
12	26	62	31	88
13	31	74	43	104
14	37	92	44	129
15	42	102	50	149
16	51	122	60	181
17	64	164	74	200
18	79	193	96	279
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

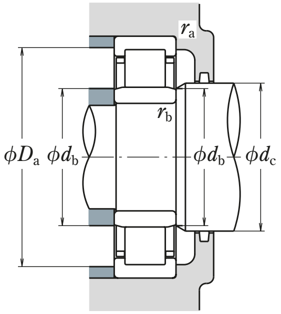
SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

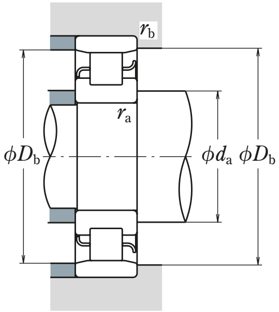
Bore Diameter 20 – 30 mm

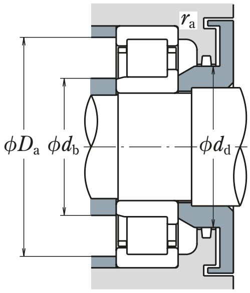


Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min^{-1})		
									Thermal Reference Speed	Limiting Speeds (5)	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		Mechanical	Grease
20	47	14	1	0.6	—	40	15 400	12 700	18 000	—	12 000
	47	14	1	0.6	26.5	—	25 700	22 600	16 000	—	13 000
	47	18	1	0.6	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.







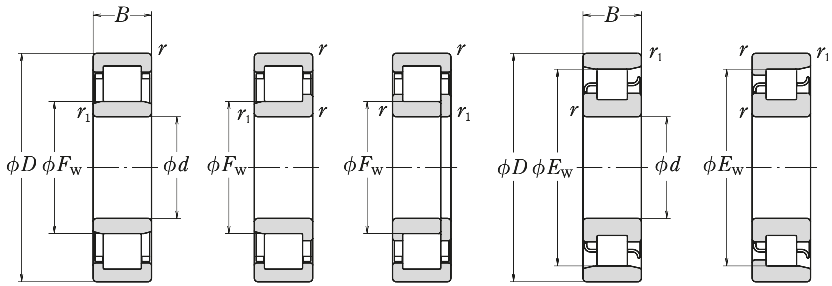
Bearing Designations	Cage[1] Standard	Cage[1] Option	NU	NJ[2]	NUP	N	NF	d_a[3] min.	d_b min.	d_b[4] max.	d_c min.	d_d min.	D_a[3] max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
N 204	W	—	—	—	—	N	NF	25	—	—	—	—	—	43	42	1	0.6	0.107
NU204E	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 (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 NSKHPS™ cylindrical roller bearings.

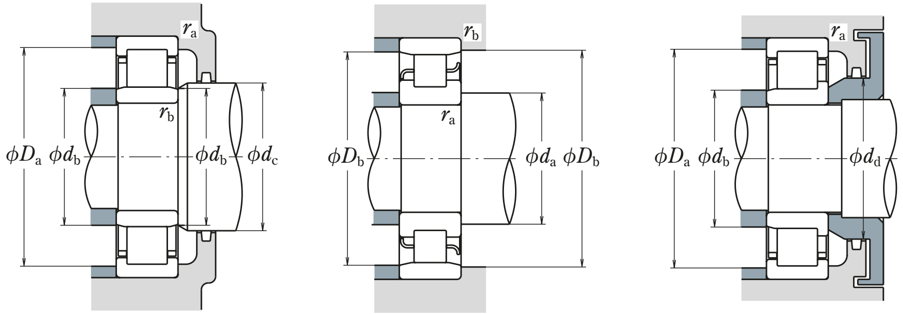
SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 35 – 40 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min^{-1})		
									Thermal Reference Speed	Limiting Speeds (5)	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		Mechanical	Grease
35	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
40	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
	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 (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.

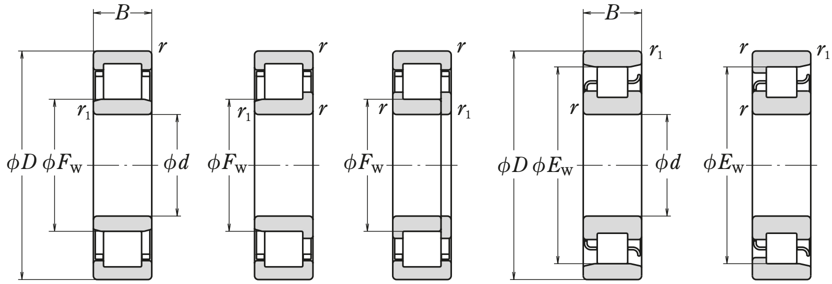


Bearing Designations	Cage (1) Standard	Cage (1) Option	NU	NJ (2)	NUP	N	NF	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1007	(M)	—	NU	NJ	—	N	—	40	39	41	44	—	57	58	56	1	0.5	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 (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 NSKHPS™ cylindrical roller bearings.

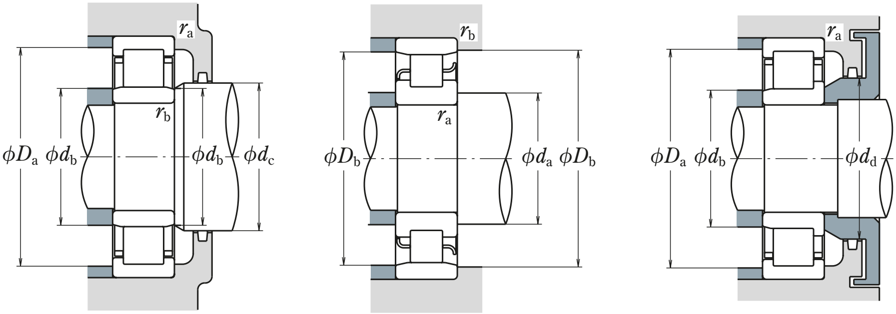
Bore Diameter 45 – 50 mm



NU NJ NUP N NF

Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
									Thermal Reference Speed	Limiting Speeds (5)	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		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
50	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
	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.



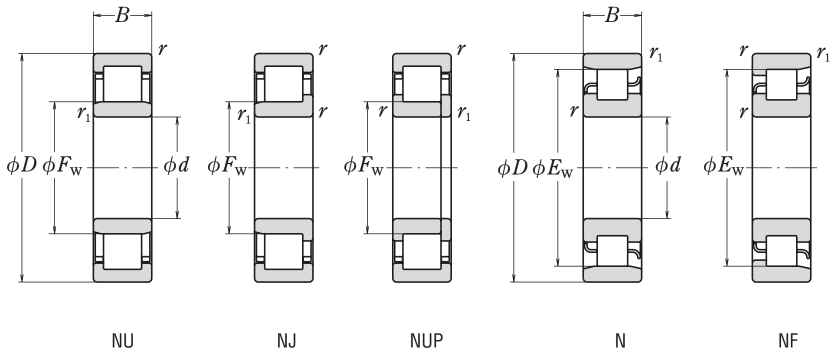
Bearing Designations	Cage([1]) Standard	Cage([1]) Option	NU	NJ([2])	NUP	N	NF	d_a([3]) min.	d_b min.	d_b([4]) max.	d_c min.	d_d min.	D_a([3]) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
NU1009	(M)	—	NU	—	—	N	NF	50	49	51	54	—	70	71	68	1	0.6	0.279
N 209	W	M	—	—	—	N	NF	51.5	—	—	—	—	—	78.5	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	NF	53	—	—	—	—	—	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	NF	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	NF	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	NF	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	NF	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

Abutment and Fillet Dimensions (mm)

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.

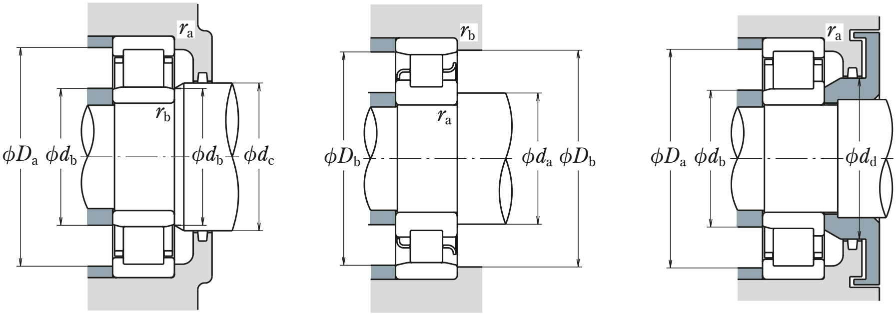
Remark Bearings denoted by an asterisk (∗) are NSKHPS™ cylindrical roller bearings.

Bore Diameter 55 – 60 mm



d	D	B	r min.	r1 min.	Fw	Ew	Cr	C0r	Thermal Reference Speed	Limiting Speeds (5) Mechanical	Limiting Speeds Grease
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Speeds (min⁻¹)		
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
60	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
	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 (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.

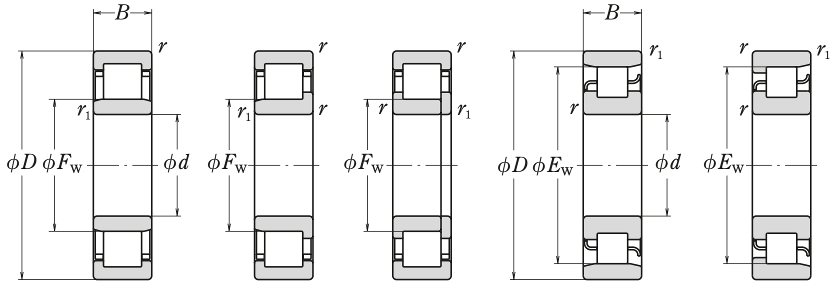


Bearing Designations	Cage (1) Standard	Option	NU (2)	NJ	NUP	N	NF	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1011	(M)	—	NU	NJ	—	N	—	61.5	60	63	66	—	83.5	85	82	1	1	0.445
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 (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 NSKHPS™ cylindrical roller bearings.

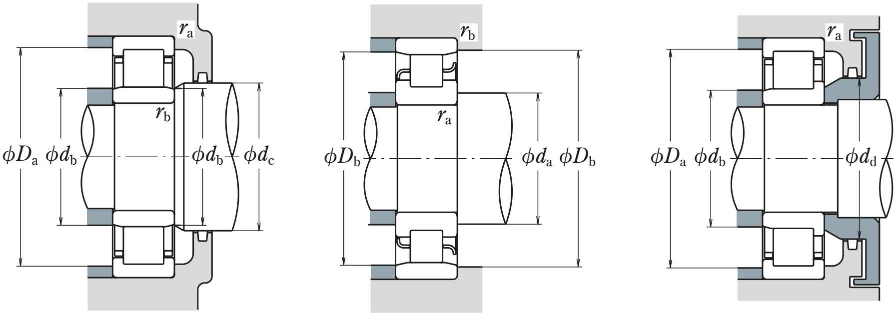
Bore Diameter 65 – 70 mm



NU NJ NUP N NF

d	D	B	r min.	r1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds ([5]) Mechanical	Limiting Speeds Grease
Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
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	—	6 000
	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.

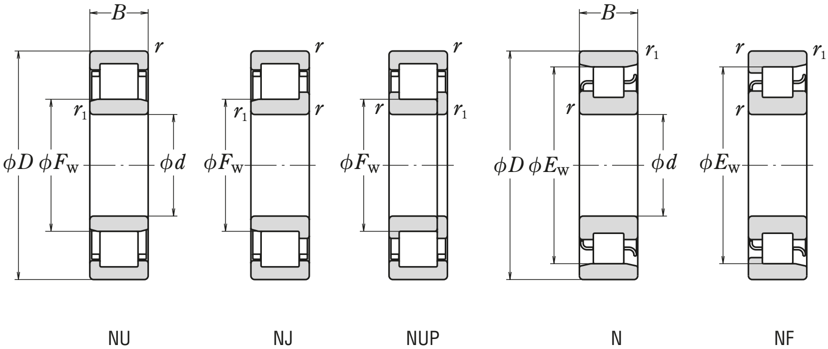


Bearing Designations	Cage (1) Standard	Cage (1) Option	NU	NJ (2)	NUP	N	NF	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1013	(M)	—	NU	NJ	—	N	NF	71.5	70	73	76	—	93.5	95	92	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 (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.

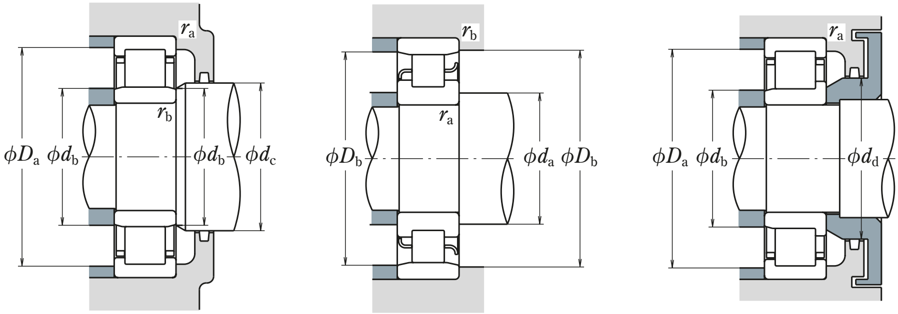
Remark Bearings denoted by an asterisk (*) are NSKHPS™ cylindrical roller bearings.

Bore Diameter 75 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds (5) Mechanical	Grease
75	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 (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.

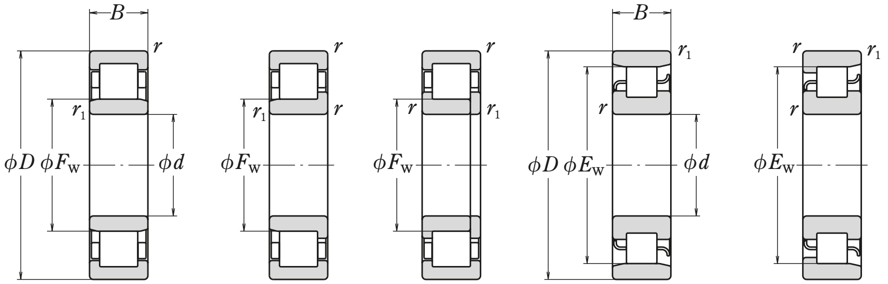


Bearing Designations	Cage [1] Standard	Cage [1] Option	NU	NJ [2]	NUP	N	NF	d_a [3] min.	d_b min.	d_b [4] max.	d_c min.	d_d min.	D_a [3] max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1015	**(M)**	—	**NU**	—	—	**N**	**NF**	81.5	80	83	87	—	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 (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 NSKHPS™ cylindrical roller bearings.

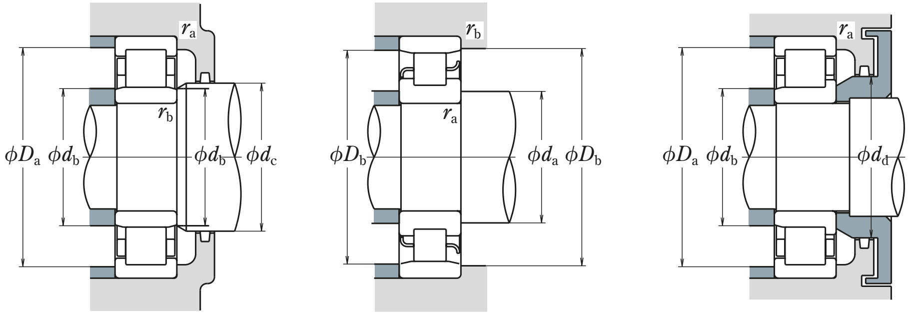
Bore Diameter 80 – 90 mm



NU NJ NUP N NF

Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
									Thermal Reference Speed	Limiting Speeds (5)	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		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	118.5	74 500	95 500	5 600	—	5 000
	150	28	2	2	—	133.8	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	—	156	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	177	335 000	350 000	4 000	—	3 000
90	140	24	1.5	1.1	103	127	88 000	114 000	5 300	—	4 500
	160	30	2	2	—	143	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	—	165	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	191.5	375 000	400 000	3 600	—	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.

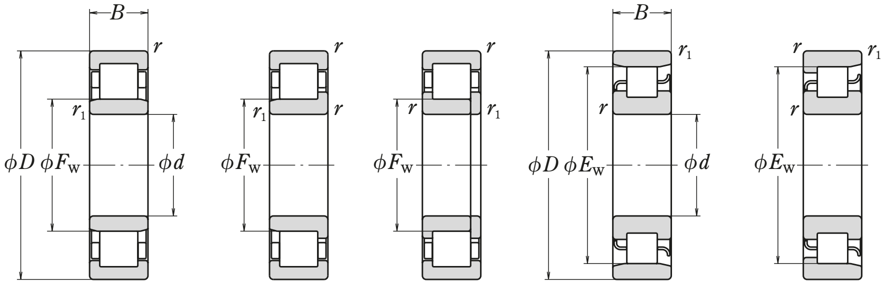


Bearing Designations	Cage[1] Standard	Cage[1] Option	NU	NJ[2]	NUP	N	NF	d_a[3] min.	d_b min.	d_b[4] max.	d_c min.	d_d min.	D_a[3] max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1016	(M)	—	NU	—	NUP	N	—	86.5	85	90	94	—	118.5	120	115	1	1	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 NSKHPS™ cylindrical roller bearings.

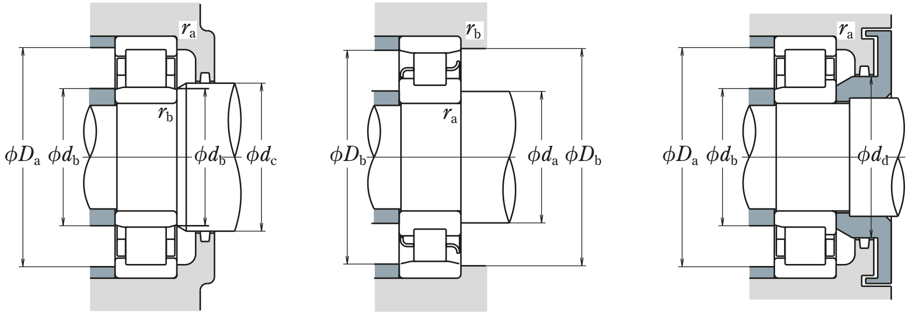
Bore Diameter 95 – 105 mm



NU NJ NUP N NF

d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds ([5]) Mechanical	Limiting Speeds Grease
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Speeds (min⁻¹)		
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
100	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
	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
105	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
	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.



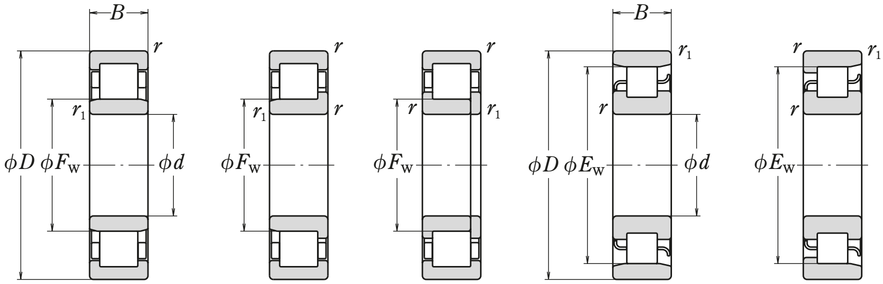
Bearing Designations	Cage (1) Standard	Cage (1) Option	NU (2)	NJ (2)	NUP (2)	N (2)	NF (2)	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1019	(M)	—	NU	NJ	—	N	—	103	101.5	106	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 (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 NSKHPS™ cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

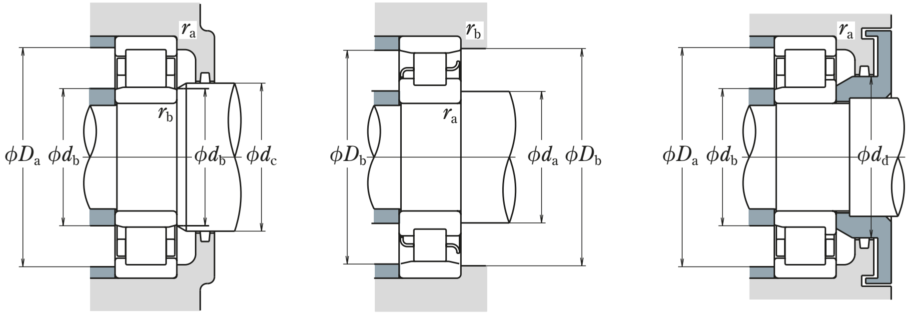
Bore Diameter 110 – 130 mm



NU NJ NUP N NF

Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
									Thermal Reference Speed	Limiting Speeds [5]	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		Mechanical	Grease
110	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
120	180	28	2	1.1	135	165	139 000	191 000	4 000	—	3 400
	215	40	2.1	2.1	—	191.5	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	—	226	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	260	675 000	770 000	2 400	—	2 000
130	200	33	2	1.1	148	182	172 000	238 000	4 000	—	3 200
	230	40	3	3	—	204	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	—	243	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	285	825 000	955 000	2 000	—	1 800

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.

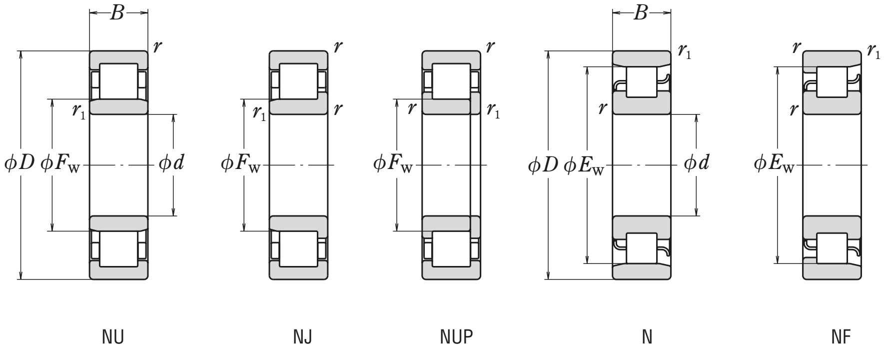


Bearing Designations	Cage(1) Standard	Cage(1) Option	NU	NJ (2)	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1022	**(M)**	—	**NU**	**NJ**	—	**N**	**NF**	119	116.5	123	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 (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.

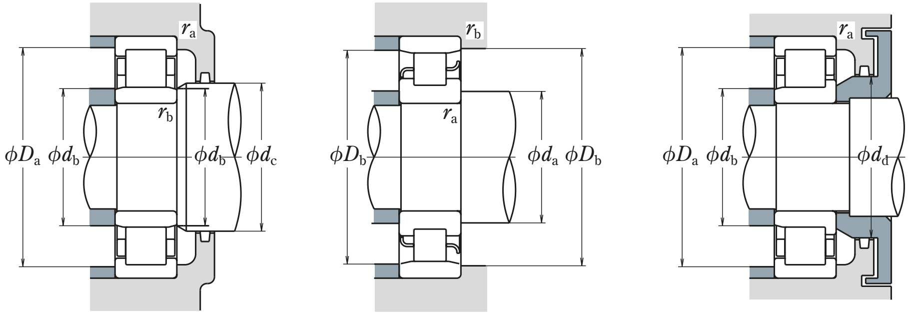
Remark Bearings denoted by an asterisk (*) are NSKHPS™ cylindrical roller bearings.

Bore Diameter 140 – 160 mm



d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds ([5]) Mechanical	Limiting Speeds Grease
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Speeds (min⁻¹)		
140	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
150	225	35	2.1	1.5	169.5	205.5	202 000	294 000	3 600	—	2 800
	270	45	3	3	—	238	360 000	465 000	3 000	—	1 800
	270	45	3	3	182	—	550 000	595 000	2 800	4 300	2 200
	270	45	3	3	182	—	450 000	595 000	2 800	4 300	2 200
	270	73	3	3	182	—	780 000	930 000	2 800	3 800	2 000
	270	73	3	3	182	—	635 000	930 000	2 800	3 800	2 000
	320	65	4	4	—	277	665 000	805 000	2 200	—	1 800
	320	65	4	4	193	—	930 000	920 000	2 200	3 800	1 800
	320	65	4	4	193	—	760 000	920 000	2 200	3 800	1 800
	320	108	4	4	193	—	1 430 000	1 600 000	2 000	2 400	1 600
	320	108	4	4	193	—	1 160 000	1 600 000	2 000	2 400	1 600
	380	85	5	5	213	—	930 000	1 120 000	1 700	—	1 600
160	240	38	2.1	1.5	180	220	238 000	340 000	3 400	—	2 600
	290	48	3	3	—	255	430 000	570 000	2 800	—	2 200
	290	48	3	3	195	—	615 000	665 000	2 600	4 000	2 200
	290	48	3	3	195	—	500 000	665 000	2 600	4 000	2 200
	290	80	3	3	193	—	995 000	1 190 000	2 400	3 600	1 900
	290	80	3	3	193	—	810 000	1 190 000	2 400	3 600	1 900
	340	68	4	4	—	292	700 000	875 000	2 000	—	1 700
	340	68	4	4	204	—	1 060 000	1 050 000	1 900	3 600	1 700
	340	68	4	4	204	—	860 000	1 050 000	1 900	3 600	1 700
	340	114	4	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.



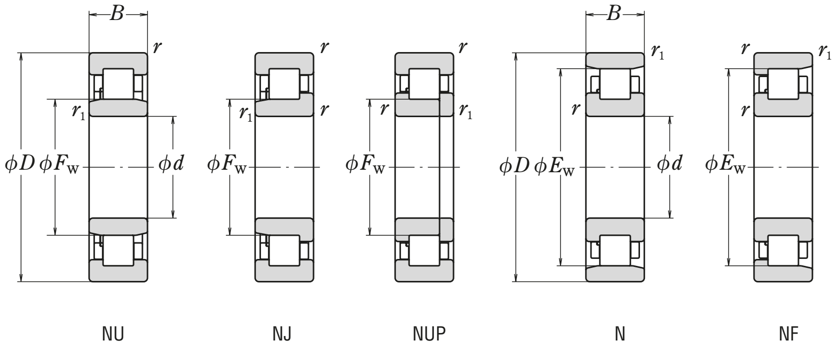
Bearing Designations	Cage[1] Standard	Cage[1] Option	NU[2]	NJ[2]	NUP[2]	N[2]	NF[2]	d_a[3] min.	d_b min.	d_b[4] max.	d_c min.	d_d min.	D_a[3] max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1028	(M)	—	NU	NJ	NUP	N	—	149	146.5	156	161	—	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	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 (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 NSKHPS™ cylindrical roller bearings.

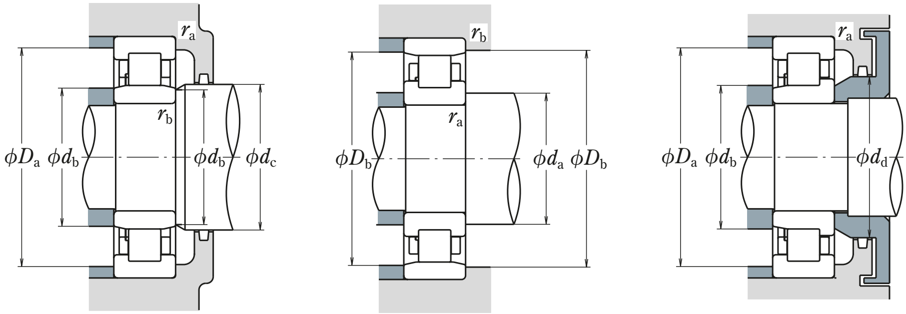
SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 170 – 200 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)		
									Thermal Reference Speed	Limiting Speeds	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		(5) Mechanical	Grease
170	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
180	280	46	2.1	2.1	205	255	355 000	510 000	3 000	—	2 200
	320	52	4	4	—	282	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
	380	75	4	4	—	328	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
190	290	46	2.1	2.1	215	265	365 000	535 000	2 800	—	2 000
	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
200	310	51	2.1	2.1	229	281	390 000	580 000	2 600	—	2 000
	360	58	4	4	—	316	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	—	360	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.



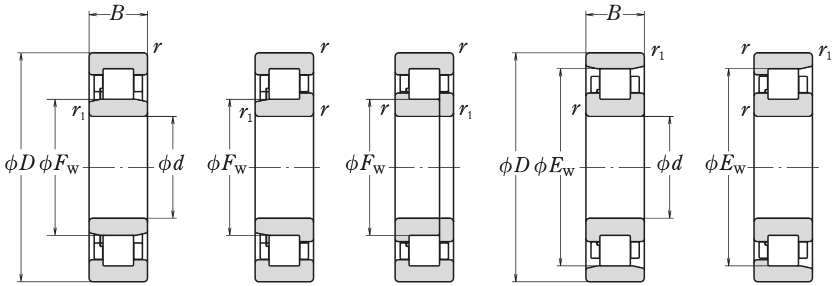
Bearing Designations	Cage (1) Standard	Cage (1) Option	(2) NU	NJ	NUP	N	NF	Abutment and Fillet Dimensions (mm) d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
NU1034	(M)	—	NU	NJ	—	N	—	181	181	190	197	—	249	249	239	2	2	7.91
N 234	M	—	—	—	—	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 (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 NSKHPS™ cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

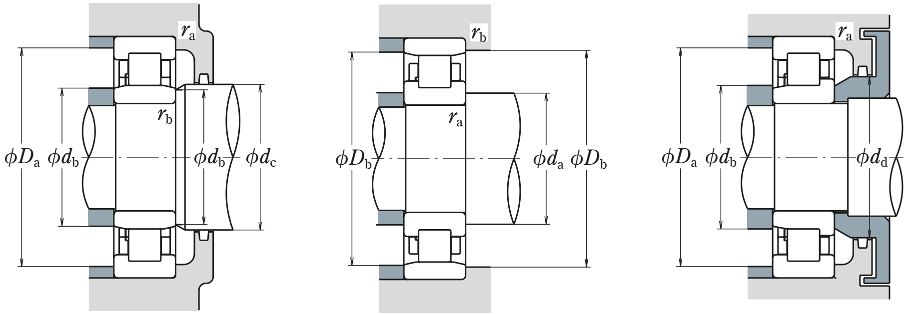
Bore Diameter 220 – 500 mm



NU NJ NUP N NF

			Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})		
									Thermal Reference Speed	Limiting Speeds	
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}		Mechanical	Grease
220	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
240	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
260	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
280	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
300	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
320	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
340	520	82	5	5	385	475	1 080 000	1 740 000	1 400	—	1 100
360	540	82	5	5	405	495	1 110 000	1 830 000	1 300	—	1 000
380	560	82	5	5	425	—	1 140 000	1 910 000	1 200	—	1 000
400	600	90	5	5	450	550	1 360 000	2 280 000	1 100	—	900
420	620	90	5	5	470	570	1 390 000	2 380 000	1 100	—	850
440	650	94	6	6	493	—	1 470 000	2 530 000	1 000	—	800
460	680	100	6	6	516	624	1 580 000	2 740 000	950	—	750
480	700	100	6	6	536	644	1 620 000	2 860 000	900	—	750
500	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.



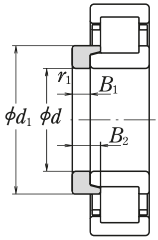
Bearing Designations	Cage(1) Standard	Cage(1) Option	NU	NJ(2)	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1044	(M)	—	NU	NJ	—	N	—	233	233	247	254	—	327	327	313	2.5	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
NU1048	(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 (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.

Remark Bearings denoted by an asterisk (*) are NSKHPS™ cylindrical roller bearings.

L-Shaped Thrust Collars

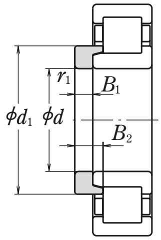
Bore Diameter 20 – 85 mm



L-Shaped Thrust Collar

Boundary Dimensions (mm)					Bearing Designation	Mass (kg)
d	d_1	B_1	B_2	r_1 min.		approx.
20	30	3	6.75	0.6	**HJ 204**	0.012
	29.8	3	5.5	0.6	**HJ 204 E**	0.011
	30	3	7.5	0.6	**HJ 2204**	0.012
	29.8	3	6.5	0.6	**HJ 2204 E**	0.012
	31.7	4	7.5	0.6	**HJ 304**	0.017
	31.4	4	6.5	0.6	**HJ 304 E**	0.017
	31.8	4	8.5	0.6	**HJ 2304**	0.017
	31.4	4	7.5	0.6	HJ 2304 E	0.018
25	34.8	3	6	0.6	**HJ 205 E**	0.014
	34.8	3	6.5	0.6	**HJ 2205 E**	0.014
	38.2	4	7	1.1	**HJ 305 E**	0.025
	38.2	4	8	1.1	HJ 2305 E	0.026
	43.6	6	10.5	1.5	**HJ 405**	0.057
30	41.3	4	7	0.6	**HJ 206 E**	0.025
	41.4	4	7.5	0.6	**HJ 2206 E**	0.025
	45.1	5	8.5	1.1	**HJ 306 E**	0.042
	45.1	5	9.5	1.1	HJ 2306 E	0.043
	50.5	7	11.5	1.5	**HJ 406**	0.080
35	48.2	4	7	0.6	**HJ 207 E**	0.033
	48.2	4	8.5	0.6	**HJ 2207 E**	0.035
	51.1	6	9.5	1.1	**HJ 307 E**	0.060
	51.1	6	11	1.1	HJ 2307 E	0.062
	59	8	13	1.5	**HJ 407**	0.12
40	54.1	5	8.5	1.1	**HJ 208 E**	0.049
	54.1	5	9	1.1	**HJ 2208 E**	0.050
	57.6	7	11	1.5	**HJ 308 E**	0.088
	57.7	7	12.5	1.5	HJ 2308 E	0.091
	64.8	8	13	2	**HJ 408**	0.14
45	59.1	5	8.5	1.1	**HJ 209 E**	0.055
	59.1	5	9	1.1	**HJ 2209 E**	0.055
	64.5	7	11.5	1.5	**HJ 309 E**	0.11
	64.5	7	13	1.5	HJ 2309 E	0.113
	71.7	8	13.5	2	**HJ 409**	0.175
50	64.1	5	9	1.1	**HJ 210 E**	0.061
	64.1	5	9	1.1	**HJ 2210 E**	0.061
	71.4	8	13	2	**HJ 310 E**	0.151
	71.4	8	14.5	2	HJ 2310 E	0.155
	78.8	9	14.5	2.1	**HJ 410**	0.23
55	70.9	6	9.5	1.1	**HJ 211 E**	0.087
	70.9	6	10	1.1	**HJ 2211 E**	0.088
	77.6	9	14	2	**HJ 311 E**	0.195
	77.6	9	15.5	2	HJ 2311 E	0.20
	85.2	10	16.5	2.1	**HJ 411**	0.29
60	77.7	6	10	1.5	**HJ 212 E**	0.108
	77.7	6	10	1.5	**HJ 2212 E**	0.108
	84.5	9	14.5	2.1	**HJ 312 E**	0.231
	84.5	9	16	2.1	HJ 2312 E	0.237
	91.8	10	16.5	2.1	**HJ 412**	0.34
65	84.5	6	10	1.5	HJ 213 E	0.129
	84.5	6	10.5	1.5	HJ 2213 E	0.131
	90.6	10	15.5	2.1	HJ 313 E	0.288
	90.6	10	18	2.1	HJ 2313 E	0.298
	98.5	11	18	2.1	**HJ 413**	0.42
70	89.5	7	11	1.5	HJ 214 E	0.157
	89.5	7	11.5	1.5	HJ 2214 E	0.158
	97.5	10	15.5	2.1	HJ 314 E	0.33
	97.5	10	18.5	2.1	HJ 2314 E	0.345
	110.5	12	20	3	**HJ 414**	0.605
75	94.5	7	11	1.5	HJ 215 E	0.166
	94.5	7	11.5	1.5	HJ 2215 E	0.167
	104.2	11	16.5	2.1	HJ 315 E	0.41
	104.2	11	19.5	2.1	HJ 2315 E	0.43
	116	13	21.5	3	**HJ 415**	0.71
80	101.6	8	12.5	2	HJ 216 E	0.222
	101.6	8	12.5	2	HJ 2216 E	0.222
	110.6	11	17	2.1	HJ 316 E	0.46
	111	11	20	2.1	HJ 2316 E	0.48
	122	13	22	3	**HJ 416**	0.78
85	107.6	8	12.5	2	HJ 217 E	0.25
	107.6	8	13	2	HJ 2217 E	0.252
	117.9	12	18.5	3	HJ 317 E	0.575
	117.9	12	22	3	HJ 2317 E	0.595
	126	14	24	4	**HJ 417**	0.88

Bore Diameter 90 – 320 mm

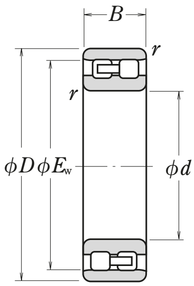


L-Shaped Thrust Collar

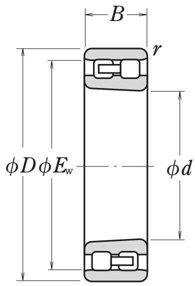
Boundary Dimensions (mm) d	d_1	B_1	B_2	r_1 min.	Bearing Designation	Mass (kg) approx.
90	114.3	9	14	2	HJ 218 E	0.32
	114.3	9	15	2	HJ 2218 E	0.325
	124.2	12	18.5	3	HJ 318 E	0.63
	124.2	12	22	3	HJ 2318 E	0.66
	137	14	24	4	**HJ 418**	1.05
95	120.6	9	14	2.1	HJ 219 E	0.355
	120.6	9	15.5	2.1	HJ 2219 E	0.365
	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	**HJ 419**	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	**HJ 420**	1.5
105	145	13	20.5	3	**HJ 321 E**	0.97
	159.5	16	27	4	**HJ 421**	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	**HJ 422**	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	**HJ 424**	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	**HJ 426**	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	**HJ 428**	3.75

Boundary Dimensions (mm) d	d_1	B_1	B_2	r_1 min.	Bearing Designation	Mass (kg) approx.
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	**HJ 430**	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	**HJ 2334 E**	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	**HJ 2336 E**	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	**HJ 2338 E**	4.45
200	258.2	14	23	4	HJ 240 E	2.65
	258	14	34	4	**HJ 2240**	2.6
	256.9	14	28	4	HJ 2240 E	2.78
	280	18	30	5	**HJ 340 E**	5.0
220	286	15	27.5	4	**HJ 244**	3.55
	286	15	36.5	4	**HJ 2244**	3.55
	307	20	36	5	**HJ 344**	7.05
240	313	16	29.5	4	**HJ 248**	4.65
	313	16	38.5	4	**HJ 2248**	4.65
	334	22	39.5	5	**HJ 348**	8.2
260	340	18	33	5	**HJ 252**	6.2
	340	18	40.5	5	**HJ 2252**	6.2
	362	24	43	6	**HJ 352**	11.4
280	360	18	33	5	**HJ 256**	7.4
300	387	20	34.5	5	**HJ 260**	9.15
320	415	21	37	5	**HJ 264**	11.3

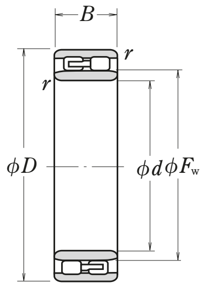
Bore Diameter 25 – 140 mm



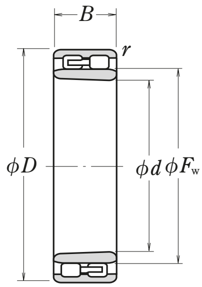
NN
Cylindrical Bore



NN
Tapered Bore



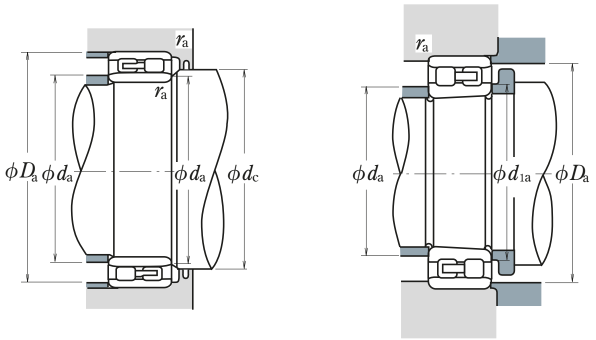
NNU
Cylindrical Bore



NNU
Tapered Bore

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	D	B	r min.	F_W	E_W	C_r	C_{0r}	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).

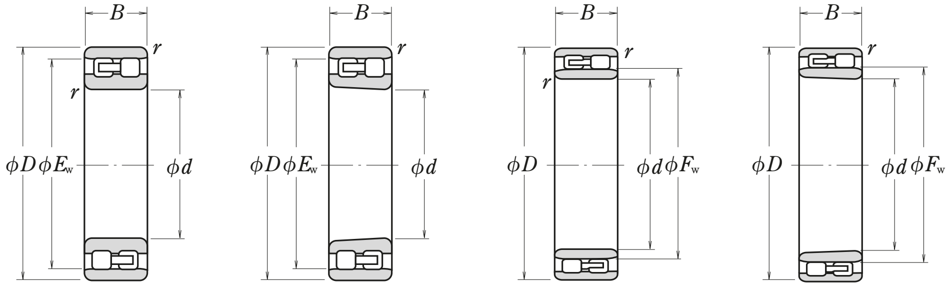


Bearing Designations		Abutment and Fillet Dimensions (mm)							Mass (kg)
Cylindrical Bore	Tapered Bore[1]	d_a[2] min.	d_a[2] max.	d_{1a} min.	d_c min.	D_a max.	D_a min.	r_a max.	approx.
NN 3005	**NN 3005 KR**	29	—	29	—	43	42	0.6	0.127
NN 3006	**NN 3006 KR**	35	—	36	—	50	50	1	0.198
NN 3007	**NN 3007 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
NN 3020	**NN 3020 KR**	108	—	109	—	142	139	1.5	2.28
NNU 4921	**NNU 4921 KR**	111.5	116	113	120	138.5	—	1	1.99
NN 3021	**NN 3021 KR**	114	—	115	—	151	148	2	2.88
NNU 4922	**NNU 4922 KR**	116.5	121	118	125	143.5	—	1	2.07
NN 3022	**NN 3022 KR**	119	—	121	—	161	157	2	3.71
NNU 4924	**NNU 4924 KR**	126.5	133	128	137	158.5	—	1	2.85
NN 3024	**NN 3024 KR**	129	—	131	—	171	167	2	4.04
NNU 4926	**NNU 4926 KR**	138	143	140	148	172	—	1.5	3.85
NN 3026	**NN 3026 KR**	139	—	141	—	191	185	2	5.88
NNU 4928	**NNU 4928 KR**	148	153	150	158	182	—	1.5	4.08
NN 3028	**NN 3028 KR**	149	—	151	—	201	195	2	6.34

Note (2) d_a (max.) refers to values for adjusting rings for NNU bearings.

DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 150 – 360 mm

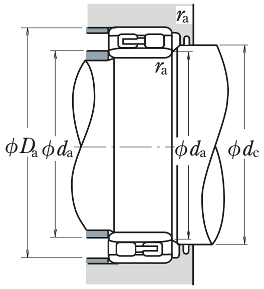


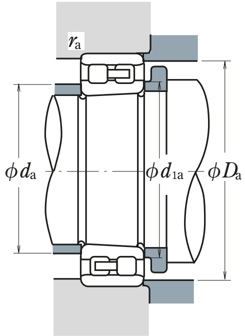
NN Cylindrical Bore | NN Tapered Bore | NNU Cylindrical Bore | NNU Tapered Bore

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B	r min.	F_W	E_W	C_r	C_{0r}	Grease	Oil
150	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
160	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
170	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
180	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
190	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
200	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
220	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
240	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
260	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
280	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
300	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
320	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
340	520	133	5	—	473	1 670 000	3 300 000	1 000	1 200
360	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(1)	d_a(2) min.	d_a(2) max.	d_{1a} min.	d_c min.	D_a max.	D_a min.	r_a max.	approx.
NNU 4930	**NNU 4930 KR**	159	166	162	171	201	—	2	6.39
NN 3030	**NN 3030 KR**	161	—	162	—	214	209	2	7.77
NNU 4932	**NNU 4932 KR**	169	176	172	182	211	—	2	6.76
NN 3032	**NN 3032 KR**	171	—	172	—	229	222	2	9.41
NNU 4934	**NNU 4934 KR**	179	186	182	192	221	—	2	7.12
NN 3034	**NN 3034 KR**	181	—	183	—	249	239	2	12.8
NNU 4936	**NNU 4936 KR**	189	199	193	205	241	—	2	10.4
NN 3036	**NN 3036 KR**	191	—	193	—	269	258	2	16.8
NNU 4938	**NNU 4938 KR**	199	211	203	217	251	—	2	10.9
NN 3038	**NN 3038 KR**	201	—	203	—	279	268	2	17.8
NNU 4940	**NNU 4940 KR**	211	222	214	228	269	—	2	15.3
NN 3040	**NN 3040 KR**	211	—	214	—	299	285	2	22.7
NNU 4944	**NNU 4944 KR**	231	242	234	248	289	—	2	16.6
NN 3044	**NN 3044 KR**	233	—	236	—	327	313	2.5	29.6
NNU 4948	**NNU 4948 KR**	251	262	254	269	309	—	2	18
NN 3048	**NN 3048 KR**	253	—	256	—	347	334	2.5	32.7
NNU 4952	**NNU 4952 KR**	271	288	275	295	349	—	2	31.1
NN 3052	**NN 3052 KR**	276	—	278	—	384	368	3	47.7
NNU 4956	**NNU 4956 KR**	291	308	295	315	369	—	2	33
NN 3056	**NN 3056 KR**	296	—	298	—	404	388	3	51.1
NNU 4960	**NNU 4960 KR**	313	335	318	343	407	—	2.5	51.9
NN 3060	**NN 3060 KR**	316	—	319	—	444	422	3	70.7
NNU 4964	**NNU 4964 KR**	333	355	338	363	427	—	2.5	54.9
NN 3064	**NN 3064 KR**	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 (2) d_a (max.) refers to values for adjusting rings for NNU bearings.

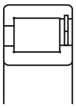
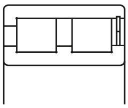
FULL COMPLEMENT SINGLE-ROW (NCF) / DOUBLE-ROW (NNCF) CYLINDRICAL ROLLER BEARINGS

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
Shielded Type	Without Snap Ring With Snap Ring	RS-50 RS-50NR	—

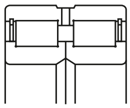
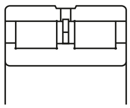
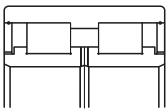
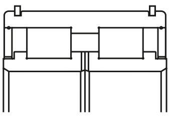
All bearings are inseparable, and the RSF type can be used as a free-end bearing. In this case, please refer to the permissible axial displacement in the bearing tables.

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

TOLERANCES AND RUNNING ACCURACY .... Table 7.2 (Pages A128 to A131)

RECOMMENDED FITS AND INTERNAL CLEARANGES

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

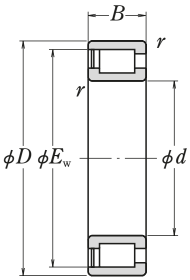
The fits listed in Tables 8.3 (Page A164) and 8.5 (Page A165) apply when used with inner ring rotation in general applications, and internal clearance should conform to Table 4.

Table 4

Units : m

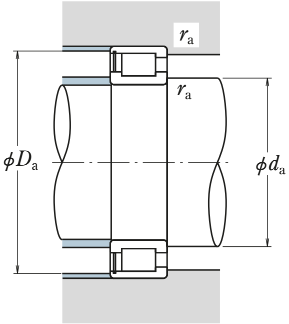
Nominal Bore Dia. *d* (mm)		Clearances			
		CN		C3	
over	incl.	min.	max.	min.	max.
30	**40**	15	50	35	70
40	**50**	20	55	40	75
50	**65**	20	65	45	90
65	**80**	25	75	55	105
80	**100**	30	80	65	115
100	**120**	35	90	80	135
120	**140**	40	105	90	155
140	**160**	50	115	100	165
160	**180**	60	125	110	175
180	**200**	65	135	125	195
200	**225**	75	150	140	215
225	**250**	90	165	155	230
250	**280**	100	180	175	255
280	**315**	110	195	195	280
315	**355**	125	215	215	305
355	**400**	140	235	245	340
400	**450**	155	275	270	390
450	**500**	180	300	300	420

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.

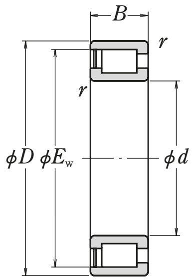


Abutment and Fillet Dimensions (mm)			Mass (kg)
d_a	D_a	r_a max.	approx.
109	131	1	1.0
111	140	1.5	2.1
119	142	1	1.1
122	157	2	3.3
130	155	1	1.7
132	168	2	3.6
141	168	1.5	2.2
142	187	2	5.6
151	180	1.5	2.3
152	198	2	5.9
163	196	2	3.7
165	209	2	7.1
173	208	2	3.8
175	225	2	8.6
182	204	1.5	1.8
183	219	2	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

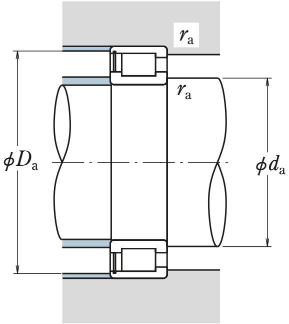
NCF Type, Single-Row

Bore Diameter 300 – 800 mm



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
d	D	B	r min.	E_W	C_r	C_{0r}	
300	380	38	2.5	359	445	870	**NCF1860V**
	420	72	3	389.6	1 120	2 200	**NCF2960V**
	460	118	4	431.7	1 980	3 500	**NCF3060V**
320	400	38	2.1	380	460	925	**NCF1864V**
	440	72	3	410	1 150	2 340	**NCF2964V**
	480	121	4	449.6	2 170	3 900	NCF3064V
340	420	38	2.1	401	475	985	**NCF1868V**
	460	72	3	430.3	1 190	2 470	**NCF2968V**
	520	133	5	485.8	2 480	4 350	NCF3068V
360	440	38	2.5	422	490	1 040	**NCF1872V**
	480	72	3	450.7	1 220	2 610	**NCF2972V**
	540	134	5	503.6	2 550	4 600	NCF3072V
380	480	46	2.5	452.8	575	1 230	**NCF1876V**
	520	82	4	486.7	1 600	3 350	**NCF2976V**
	560	135	5	521.4	2 610	4 800	NCF3076V
400	500	46	2.5	475.7	590	1 300	**NCF1880V**
	540	82	4	511	1 650	3 550	**NCF2980V**
	600	148	5	558.7	3 050	5 750	**NCF3080AV**
420	520	46	2.1	491	600	1 340	**NCF1884V**
	560	82	4	523.2	1 680	3 650	**NCF2984V**
	620	150	5	577.7	3 000	5 650	NCF3084V
440	540	46	2.1	514	615	1 410	**NCF1888V**
	600	95	4	562	2 070	4 300	**NCF2988V**
460	580	56	3	552.7	920	1 950	**NCF1892V**
	620	95	4	576.5	2 100	4 450	NCF2992V
480	600	56	3	573	940	2 040	**NCF1896V**
	650	100	5	615	2 380	5 100	**NCF2996V**
500	620	56	3	593.5	960	2 120	**NCF18/500V**
	670	100	5	630.2	2 420	5 250	NCF29/500V
530	650	56	3	624	990	2 240	**NCF18/530V**
560	680	56	3	654.7	1 020	2 360	**NCF18/560V**
	820	195	6	770	5 600	11 300	**NCF30/560V**
600	730	60	3	695.5	1 140	2 680	NCF18/600V
	800	118	5	752	3 050	7 300	**NCF29/600V**
630	780	69	4	742	1 470	3 400	**NCF18/630V**
670	820	69	4	780	1 520	3 550	NCF18/670V
710	870	74	4	832.5	1 650	3 900	**NCF18/710V**
750	920	78	5	882.3	1 930	4 600	**NCF18/750V**
800	980	82	5	936	2 110	5 100	**NCF18/800V**

Remark Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.

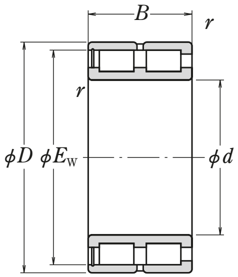


Abutment and Fillet Dimensions (mm)			Mass (kg)
d_a	D_a	r_a max.	approx.
319	360	2	9.7
320	398	2.5	30.7
323	435	3	67.6
338	381	2	10.3
340	418	2.5	33
343	454	3	73
359	402	2	10.7
361	438	2.5	34.1
368	490	4	97
380	423	2	11.5
381	457	2.5	36
388	509	4	102
400	458	2	18.6
404	493	3	52
408	529	4	108
421	478	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

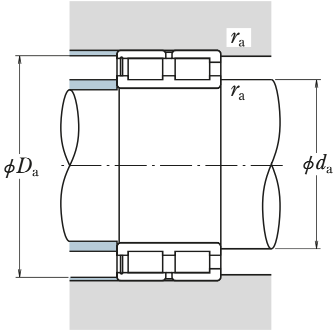
NNCF Type, Double-Row

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	**NNCF5020V**
110	150	40	1.1	138.4	202	430	NNCF4922V
	170	80	2	156.3	490	840	**NNCF5022V**
120	165	45	1.1	153.8	226	480	NNCF4924V
	180	80	2	167.58	500	885	**NNCF5024V**
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	**NNCF5028V**
150	210	60	2	191.6	390	865	NNCF4930V
	225	100	2.1	206.82	785	1 420	**NNCF5030V**
160	220	60	2	204.1	410	930	NNCF4932V
	240	109	2.1	224.8	895	1 620	**NNCF5032V**
170	230	60	2	212.4	415	975	**NNCF4934V**
	260	122	2.1	242.87	1 160	2 140	**NNCF5034V**
180	250	69	2	230.5	550	1 230	**NNCF4936V**
	280	136	2.1	260.3	1 340	2 510	**NNCF5036V**
190	260	69	2	240.7	565	1 290	**NNCF4938V**
	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	**NNCF5044V**
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	**NNCF5048V**
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.

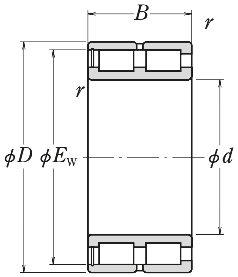


Abutment and Fillet Dimensions (mm)			Mass (kg)
d_a	D_a	r_a max.	approx.
109	130	1	2.0
111	140	1.5	3.8
119	140	1	2.1
122	157	2	6.1
130	155	1	2.9
132	168	2	6.5
141	168	1.5	3.9
142	187	2	10.3
151	178	1.5	4.2
152	198	2	10.8
163	196	2	6.6
165	209	2	13
173	206	2	7.0
175	225	2	15.8
183	216	2	7.3
185	244	2	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

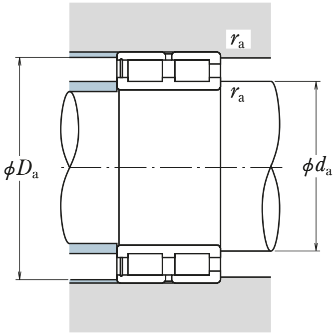
NNCF Type, Double-Row

Bore Diameter 280 – 500 mm



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Designation
d	D	B	r min.	E_W	C_r	C_{0r}	
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	**NNCF5084V**
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

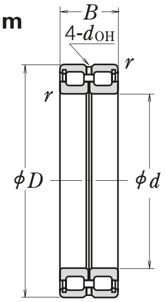
Remark Full complement cylindrical roller bearings are designed for specific applications; when using them, please contact NSK.



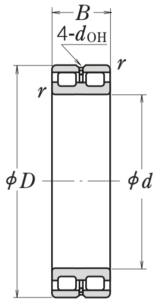
Abutment and Fillet Dimensions (mm)			Mass (kg)
d_a	D_a	r_a max.	approx.
295	334	2	16
297	361	2	34
302	395	3	87.7
318	361	2	23
320	398	2.5	52
323	435	3	125
338	381	2	24.3
340	418	2.5	55
343	454	3	131
359	400	2	25.6
361	438	2.5	58
368	490	4	177
379	421	2	27
381	457	2.5	61
388	509	4	186
399	459	2	45.5
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



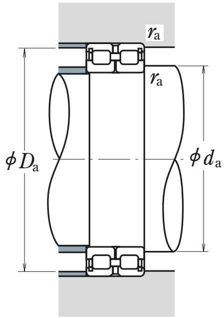
Fixed-End Bearing
RS



Free-End Bearing
RSF

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B	r min.	C_r	C_{0r}	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.

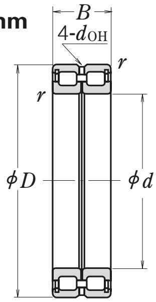


Bearing Designations(1)		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
Fixed-End Bearing	Free-End Bearing	d_{OH}(2)	Axial Disp.(3)	d_a min.	D_a max.	r_a max.	approx.
RS-4910E4	**RSF-4910E4**	2.5	1.5	54	68	0.6	0.30
RS-4912E4	**RSF-4912E4**	2.5	1.5	65	80	1	0.46
RS-4913E4	**RSF-4913E4**	2.5	2	70	85	1	0.50
RS-4914E4	**RSF-4914E4**	3	2	75	95	1	0.79
RS-4916E4	**RSF-4916E4**	3	2	85	105	1	0.89
RS-4918E4	**RSF-4918E4**	3	2	96.5	118.5	1	1.35
RS-4820E4	**RSF-4820E4**	2.5	1.5	105	120	1	0.74
RS-4920E4	**RSF-4920E4**	3	2	106.5	133.5	1	1.97
RS-4821E4	**RSF-4821E4**	2.5	1.5	110	125	1	0.77
RS-4921E4	**RSF-4921E4**	3	2	111.5	138.5	1	2.05
RS-4822E4	**RSF-4822E4**	3	2	115	135	1	1.09
RS-4922E4	**RSF-4922E4**	3	2	116.5	143.5	1	2.15
RS-4824E4	**RSF-4824E4**	3	2	125	145	1	1.28
RS-4924E4	**RSF-4924E4**	4	3	126.5	158.5	1	2.95
RS-4826E4	**RSF-4826E4**	3	2	136.5	158.5	1	1.9
RS-4926E4	**RSF-4926E4**	5	3.5	138	172	1.5	3.95
RS-4828E4	**RSF-4828E4**	3	2	146.5	168.5	1	2.03
RS-4928E4	**RSF-4928E4**	5	3.5	148	182	1.5	4.25
RS-4830E4	**RSF-4830E4**	3	2	156.5	183.5	1	2.85
RS-4930E4	**RSF-4930E4**	5	3.5	159	201	2	6.65
RS-4832E4	**RSF-4832E4**	3	2	166.5	193.5	1	3.05
RS-4932E4	**RSF-4932E4**	5	3.5	169	211	2	7.0
RS-4834E4	**RSF-4834E4**	4	3	176.5	208.5	1	4.1
RS-4934E4	**RSF-4934E4**	4	3.5	179	221	2	7.35
RS-4836E4	**RSF-4836E4**	4	3	186.5	218.5	1	4.3
RS-4936E4	**RSF-4936E4**	6	4.5	189	241	2	10.7
RS-4838E4	**RSF-4838E4**	5	3.5	198	232	1.5	5.65
RS-4938E4	**RSF-4938E4**	6	4.5	199	251	2	11.1
RS-4840E4	**RSF-4840E4**	5	3.5	208	242	1.5	5.95
RS-4940E4	**RSF-4940E4**	7	5	211	269	2	15.7
RS-4844E4	**RSF-4844E4**	5	3.5	228	262	1.5	6.45
RS-4944E4	**RSF-4944E4**	7	5	231	289	2	17

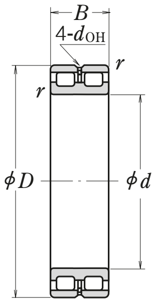
Notes (1) Suffix E4 indicates that the outer ring contains oil holes and an oil groove.
(2) d_{OH} represents the oil hole diameter in the outer ring.
(3) Axial Disp. refers to permissible axial displacement for free-end bearings.

FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

RS-48 · RS-49 Types
RSF-48 · RSF-49 Types
Bore Diameter 240 – 560 mm



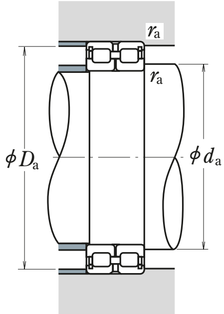
Fixed-End Bearing
RS



Free-End Bearing
RSF

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*B*	*r* min.	C_r	C_{0r}	Grease	Oil
240	300	60	2	495 000	1 340 000	430	850
	320	80	2.1	725 000	1 770 000	400	800
260	320	60	2	515 000	1 450 000	380	750
	360	100	2.1	1 050 000	2 530 000	360	710
280	350	69	2	610 000	1 690 000	340	710
	380	100	2.1	1 090 000	2 720 000	340	670
300	380	80	2.1	805 000	2 160 000	320	630
	420	118	3	1 460 000	3 400 000	300	600
320	400	80	2.1	835 000	2 310 000	300	600
	440	118	3	1 500 000	3 600 000	280	560
340	420	80	2.1	855 000	2 430 000	280	560
	460	118	3	1 560 000	3 900 000	260	530
360	440	80	2.1	885 000	2 580 000	260	530
	480	118	3	1 600 000	4 050 000	260	500
380	480	100	2.1	1 260 000	3 600 000	240	500
	520	140	4	2 040 000	5 200 000	240	450
400	500	100	2.1	1 290 000	3 750 000	240	480
	540	140	4	2 100 000	5 450 000	220	450
420	520	100	2.1	1 320 000	3 950 000	220	450
	560	140	4	2 150 000	5 700 000	200	430
440	540	100	2.1	1 350 000	4 150 000	200	430
	600	160	4	2 840 000	7 350 000	190	380
460	580	118	3	1 730 000	5 150 000	190	380
	620	160	4	2 870 000	7 500 000	190	380
480	600	118	3	1 760 000	5 300 000	190	380
	650	170	5	3 200 000	8 500 000	180	360
500	620	118	3	1 810 000	5 600 000	180	360
	670	170	5	3 300 000	8 900 000	170	340
530	710	180	5	3 400 000	9 200 000	160	320
560	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.



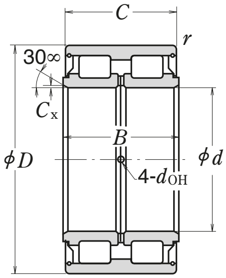
Bearing Designations(1)		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
Fixed-End Bearing	Free-End Bearing	d_{OH}(2)	Axial Disp.(3)	d_a min.	D_a max.	r_a max.	approx.
RS-4848E4	**RSF-4848E4**	5	3.5	249	291	2	10.3
RS-4948E4	**RSF-4948E4**	7	5	251	309	2	18.4
RS-4852E4	**RSF-4852E4**	5	3.5	269	311	2	11
RS-4952E4	**RSF-4952E4**	8	6	271	349	2	32
RS-4856E4	**RSF-4856E4**	6	4.5	289	341	2	16
RS-4956E4	**RSF-4956E4**	8	6	291	369	2	34
RS-4860E4	**RSF-4860E4**	6	5	311	369	2	23
RS-4960E4	**RSF-4960E4**	9	7	313	407	2.5	52
RS-4864E4	**RSF-4864E4**	6	5	331	389	2	24.3
RS-4964E4	**RSF-4964E4**	9	7	333	427	2.5	55
RS-4868E4	**RSF-4868E4**	6	5	351	409	2	25.6
RS-4968E4	**RSF-4968E4**	9	7	353	447	2.5	58
RS-4872E4	**RSF-4872E4**	6	5	371	429	2	27
RS-4972E4	**RSF-4972E4**	9	7	373	467	2.5	61
RS-4876E4	**RSF-4876E4**	8	6	391	469	2	45.5
RS-4976E4	**RSF-4976E4**	11	8	396	504	3	90.5
RS-4880E4	**RSF-4880E4**	8	6	411	489	2	47.5
RS-4980E4	**RSF-4980E4**	11	8	416	524	3	94.5
RS-4884E4	**RSF-4884E4**	8	6	431	509	2	49.5
RS-4984E4	**RSF-4984E4**	11	8	436	544	3	98.5
RS-4888E4	**RSF-4888E4**	8	6	451	529	2	51.5
RS-4988E4	**RSF-4988E4**	11	8	456	584	3	136
RS-4892E4	**RSF-4892E4**	9	7	473	567	2.5	77.5
RS-4992E4	**RSF-4992E4**	11	8	476	604	3	142
RS-4896E4	**RSF-4896E4**	9	7	493	587	2.5	80.5
RS-4996E4	**RSF-4996E4**	12	9	500	630	4	167
RS-48/500E4	**RSF-48/500E4**	9	7	513	607	2.5	83.5
RS-49/500E4	**RSF-49/500E4**	12	9	520	650	4	173
RS-49/530E4	**RSF-49/530E4**	12	11	550	690	4	206
RS-49/560E4	**RSF-49/560E4**	12	11	580	730	4	231

Notes (1) Suffix E4 indicates that the outer ring contains oil holes and an oil groove.
(2) d_{OH} represents the oil hole diameter in the outer ring.
(3) Axial Disp. refers to permissible axial displacement for free-end bearings.

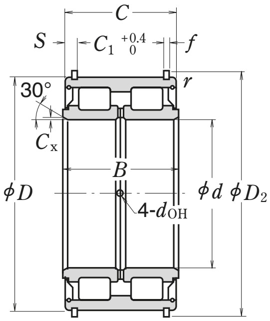
FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

RS-50 Type (Prelubricated)

Bore Diameter 40 – 400 mm



Without Locating Ring



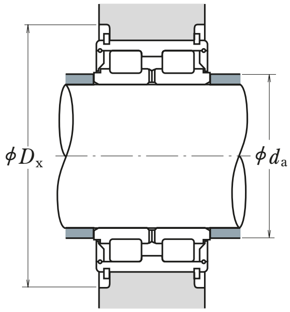
With Locating Ring

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})
d	D	B	C	C_x (1) min.	r min.	C_r	C_{0r}	Grease
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 (1) 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

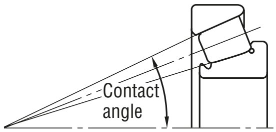
Remarks 3. Cylindrical roller bearings for sheaves are designed for specific applications; when using them, please contact NSK.
4. For shields with outside diameters larger than 180 mm, the above figure is different from the actual shape. For detailed drawings, please contact NSK.


NSK

6. TAPERED ROLLER BEARINGS

Appendix 14 (Page E020) contains the index for inch series tapered roller bearings.

DESIGN, TYPES, AND FEATURES

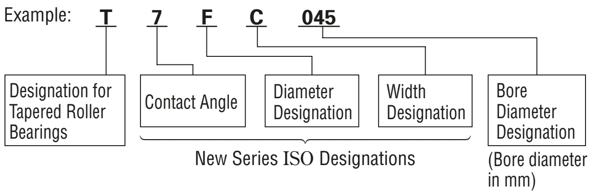


Tapered roller bearings are designed so the apices of the cones formed by the raceways of the inner and outer rings and the inner ring rollers all coincide at one point on the axis of the bearing. When a radial load is imposed, a component axial force occurs; therefore, it is necessary to use two bearings 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):

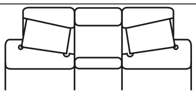
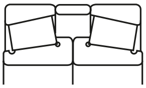
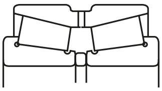
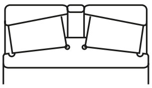
Example: **LM 1 19 49**

- LM: Load Limit Designation
- 1: Contact Angle Designation
- 19: Series No.
- 49: Design No.
- Additional Designation

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 preceeded by ▲ in the bearing tables)

Table 2 Tolerances for Inner Rings (CLASS K)

Units : m

Nominal Bore Diameter d (mm)		Δ_{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 : m

Nominal Outside Diameter D (mm)		Δ_{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 Δ_{T1s}		Deviation of Actual Effective Width of Outer Ring Δ_{T2s}		Deviation of Actual Bearing Width Δ_{Ts}	
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

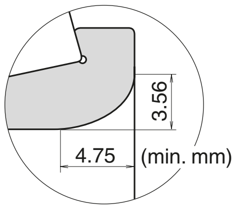
Units : m

Nominal Bore Diameter d				Deviation of a Single Bore Diameter Δ_{ds}		Deviation of Actual Bearing Width Δ_{Ts}	
over		incl.					
(mm)	1/25.4	(mm)	1/25.4	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

METRIC SERIES TAPERED ROLLER BEARINGS .... Table 8.3 (Page A164)
Table 8.5 (Page A165)

INCH SERIES TAPERED ROLLER BEARINGS .... Table 8.7 (Page A166)
Table 8.8 (Page A167)

INTERNAL CLEARANCE

METRIC SERIES TAPERED ROLLER BEARINGS (Matched and Double-Row) .... Table 8.17 (Page A173)

INCH SERIES TAPERED ROLLER BEARINGS (Matched and Double-Row) .... 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 unidirectional axial 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.

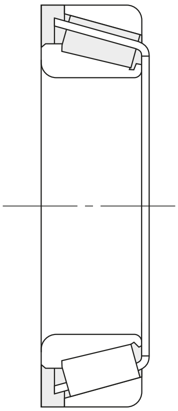


Fig. 1 Free Space in a Tapered Roller Bearing

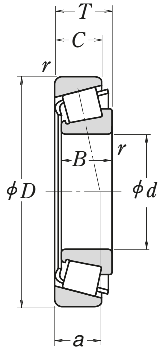
Bearing Bore No.	HR329-J	HR320-XJ
02	—	—
03	—	—
04	—	3.5
/22	—	3.6
05	—	3.7
/28	—	5.3
06	—	6.2
/32	—	6.6
07	4.0	7.5
08	5.8	9.1
09	—	11
10	—	12
11	8.8	19
12	9.0	20
13	—	21
14	17	29
15	—	30
16	—	40
17	—	43
18	28	58
19	29	60
20	37	64

Table 6 Free Space of Tapered Roller Bearings

Units: cm³

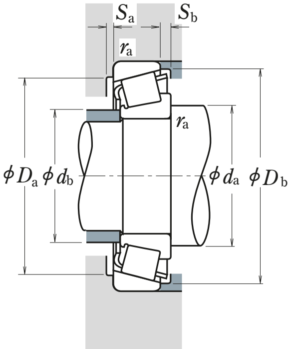
Bearing Free Space							
Bearing Series							
HR330-J	HR331-J	HR302-J	HR322-J	HR332-J	HR303-J	HR303-DJ	HR323-J
—	—	—	—	—	4.5	—	—
—	—	3.3	4.3	—	5.7	—	—
—	—	5.3	6.6	—	7.2	—	9.2
—	—	—	7.3	—	9.1	—	—
4.3	—	6.3	7.4	7.5	11	13	15
—	—	8.8	9.8	10	16	—	—
6.7	—	9.2	11	12	18	21	23
—	—	11	13	14	20	—	—
8.9	—	13	17	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

Bore Diameter 15 – 28 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Outer *r* min.	C_r	C_{0r}	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
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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

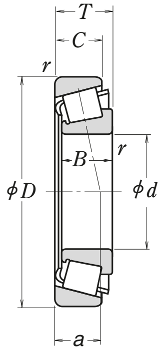
When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

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) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
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

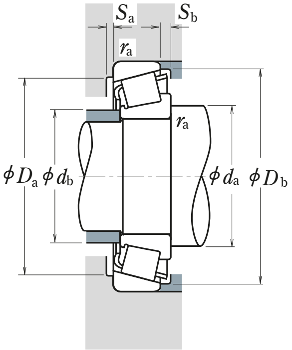
■SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 30 – 35 mm



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	Basic Load Ratings (N) C_r	Basic Load Ratings (N) C_{0r}	Limiting Speeds (min⁻¹) Grease	Limiting Speeds (min⁻¹) 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
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
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

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

$P = XF_r + YF_a$

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

Static Equivalent Load

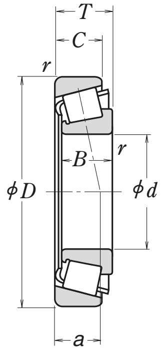
$P_0 = 0.5F_r + Y_0 F_a$

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

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

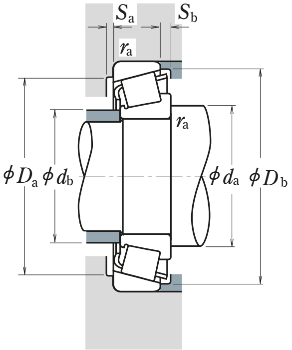
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	r_a max. Ring: Inner	r_a max. Ring: Outer	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
HR 32906 J	2BD	34	34	44	42	44	3	3	0.3	0.3	9.2	0.32	1.9	1.0	0.074
HR 32006 XJ	4CC	39	35	49	47	53	3	4	1	1	13.5	0.43	1.4	0.77	0.172
HR 33006 J	2CE	39	35	49	48	52	3	4	1	1	13.1	0.29	2.1	1.1	0.208
HR 30206 J	3DB	39	37	56	52	58	2	3	1	1	13.9	0.37	1.6	0.88	0.238
HR 30206 C	—	39	36	56	49	59	2	5	1	1	17.8	0.68	0.88	0.49	0.221
HR 32206 J	3DC	39	36	56	51	58.5	2	4	1	1	15.4	0.37	1.6	0.88	0.297
HR 32206 C	—	39	35	56	48	59	2	5	1	1	17.8	0.55	1.1	0.60	0.293
HR 33206 J	2DE	39	35	56	52	59.5	5	5.5	1	1	16.1	0.34	1.8	0.97	0.355
HR 30306 J	2FB	41	40	63	62	66	3	4.5	1.5	1.5	15.1	0.32	1.9	1.1	0.403
HR 30306 C	—	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	(7FB)	44	40	63	55	68	3	6.5	1.5	1.5	23.1	0.83	0.73	0.40	0.393
HR 31306 J	7FB	44	40	63	55	68	3	6.5	1.5	1.5	23.1	0.83	0.73	0.40	0.393
HR 32306 J	2FD	43	38	63	59	66	3	5.5	1.5	1.5	18.0	0.32	1.9	1.1	0.57
HR 32306 CJ	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	4CC	41	37	52	49	55	3	4	1	1	14.2	0.45	1.3	0.73	0.191
330/32	—	41	37	52	50	55	2	4	1	1	13.8	0.31	1.9	1.1	0.225
HR 302/32	—	41	39	59	56	61	3	3	1	1	14.7	0.37	1.6	0.88	0.277
HR 302/32 C	—	41	39	59	54	62	3	4	1	1	16.9	0.55	1.1	0.60	0.273
HR 322/32	—	41	38	59	54	61	3	4	1	1	15.9	0.37	1.6	0.88	0.336
HR 322/32 C	—	41	39	59	51	62	3	5	1	1	20.2	0.59	1.0	0.56	0.335
HR 332/32 J	2DE	41	38	59	55	62	5	5.5	1	1	17.0	0.35	1.7	0.95	0.40
303/32	—	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	2BD	43	40	50	50	52.5	3	2.5	0.6	0.6	10.7	0.29	2.1	1.1	0.123
HR 32007 XJ	4CC	44	40	56	54	60	4	4	1	1	15.0	0.45	1.3	0.73	0.229
HR 33007 J	2CE	44	40	56	55	59	4	4	1	1	14.1	0.31	2.0	1.1	0.267
HR 30207 J	3DB	46	43	63	62	67	3	3	1.5	1.5	15.0	0.37	1.6	0.88	0.34
HR 30207 C	—	46	44	63	59	68	3	5	1.5	1.5	19.6	0.66	0.91	0.50	0.331
HR 32207 J	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	—	46	42	63	58	68.5	3	6	1.5	1.5	20.6	0.55	1.1	0.60	0.442
HR 33207 J	2DE	46	41	63	61	68	5	6	1.5	1.5	18.3	0.35	1.7	0.93	0.54
HR 30307 J	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	—	47	44	71	65	74	3	6.5	2	1.5	20.3	0.55	1.1	0.60	0.518
HR 30307 DJ	7FB	51	44	71	62	77	3	7.5	2	1.5	25.2	0.83	0.73	0.40	0.519
HR 31307 J	7FB	51	44	71	62	77	3	7.5	2	1.5	25.2	0.83	0.73	0.40	0.52
HR 32307 J	2FE	49	43	71	66	74	3	7.5	2	1.5	20.7	0.32	1.9	1.1	0.765

Bore Diameter 40 – 50 mm



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	Basic Load Ratings (N) C_r	Basic Load Ratings (N) C_{0r}	Limiting Speeds (min^{-1}) Grease	Limiting Speeds (min^{-1}) 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
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
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

$P = XF_r + YF_a$

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

Static Equivalent Load

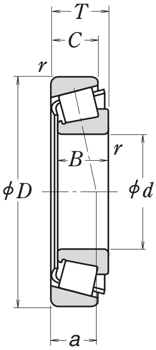
$P_0 = 0.5F_r + Y_0 F_a$

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

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

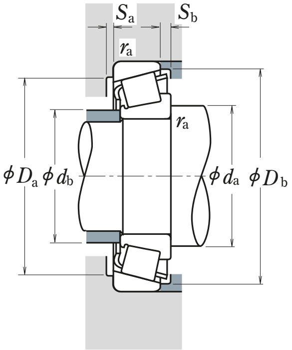
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
HR 32908 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

Bore Diameter 55 – 65 mm



		Boundary Dimensions (mm)			Ring: Inner	Outer	Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	B	C	r min.		C_r	C_{0r}	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
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
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

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

$P = XF_r + YF_a$

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

Static Equivalent Load

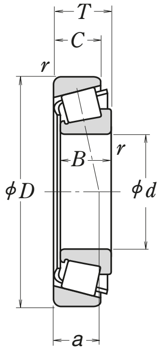
$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

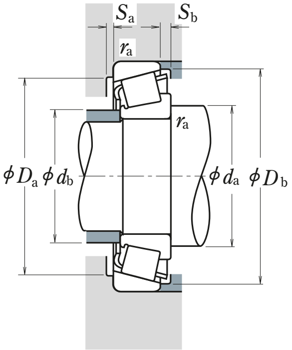
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
HR 32911 J	2BC	64	60	74	73	76	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

Bore Diameter 70 – 80 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	C_r	C_{0r}	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
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
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

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

$P = XF_r + YF_a$

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

Static Equivalent Load

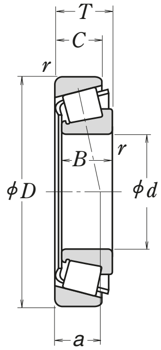
$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

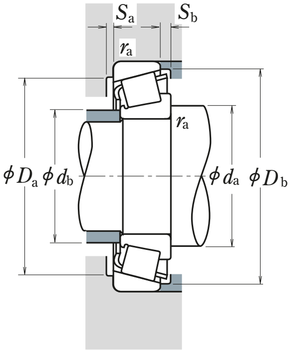
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: r_a max. Inner	Outer	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
HR 32914 J	2BC	79	76	94	93	96	4	4	1	1	17.6	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

Bore Diameter 85 – 100 mm



Boundary Dimensions (mm)					Ring: Inner	Outer	Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	B	C	r min.		C_r	C_{0r}	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

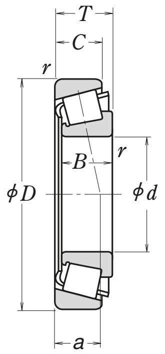
When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

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

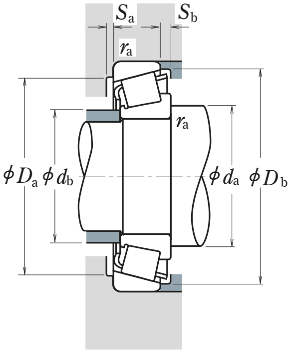
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
HR 32917 J	2BC	96	92	111	111	115	5	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



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	C_r	C_{0r}	Grease	Oil
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

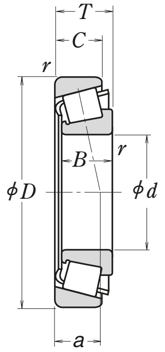
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

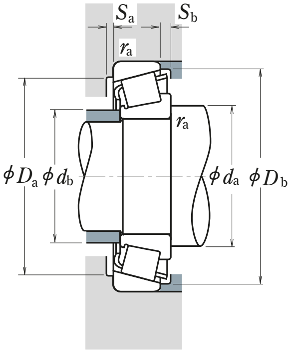
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
HR 32921 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



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	Basic Load Ratings (N) C_r	Basic Load Ratings (N) C_{0r}	Limiting Speeds (min⁻¹) Grease	Limiting Speeds (min⁻¹) Oil
140	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
150	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
	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
160	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
	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
170	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
	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



Dynamic Equivalent Load

$P=XF_r+YF_a$

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

Static Equivalent Load

$P_0=0.5F_r+Y_0F_a$

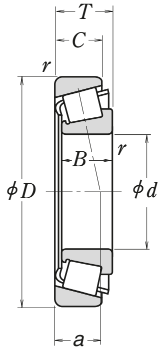
When $F_r > 0.5F_r+Y_0F_a$, use $P_0=F_r$

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

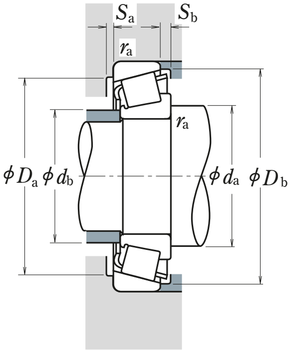
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
HR 32928 J	2CC	152	150	180	178	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



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	C_r	C_{0r}	Grease	Oil
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
180	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
190	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
200	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
	420	146	138	115	6	5	1 820 000	2 870 000	800	1 100
220	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
240	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



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

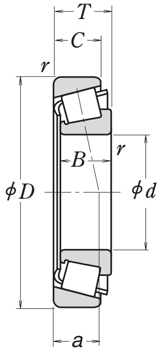
When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

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) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
HR 32936 J	4DC	195	192	240	227	241	8	11	2	2	53.9	0.48	1.3	0.69	6.56
HR 32036 XJ	3FD	198	199	268	248	267	10	16	2.5	2	60.4	0.42	1.4	0.78	14.3
HR 30236 J	4GB	207	210	302	281	297	9	14	4	3	61.8	0.45	1.3	0.73	17.8
HR 32236 J	4GD	207	205	302	270	303	10	20	4	3	78.9	0.45	1.3	0.73	29.8
30336	—	207	233	362	324	345	10	19	4	3	72.5	0.36	1.7	0.92	39.3
30336 D	—	216	229	362	304	352	10	30	4	3	113.1	0.81	0.74	0.41	38.5
32336	—	212	225	362	310	353	10	28	4	3	96.6	0.37	1.6	0.88	66.8
HR 32938 J	4DC	205	201	250	237	251	8	11	2	2	55.3	0.48	1.3	0.69	6.83
HR 32038 XJ	4FD	208	209	278	258	279	10	16	2.5	2	63.4	0.44	1.4	0.75	14.9
HR 30238 J	4GB	217	223	322	302	318	9	14	4	3	65.6	0.44	1.4	0.76	21.4
HR 32238 J	4GD	217	216	322	290	323	10	22	4	3	80.5	0.44	1.4	0.76	35.2
30338	—	223	248	378	346	366	11	21	5	4	76.1	0.36	1.7	0.92	46
32338	—	229	243	378	332	375	11	31	5	4	102.7	0.37	1.6	0.88	78.9
32940	—	218	217	268	256	269	9	10	2.5	2	53.4	0.37	1.6	0.88	9.26
HR 32940 J	3EC	218	216	268	258	271	9	12	2.5	2	54.2	0.39	1.5	0.84	9.65
HR 32040 XJ	4FD	218	221	298	277	297	11	17	2.5	2	67.4	0.43	1.4	0.77	18.9
HR 30240 J	4GB	227	236	342	318	336	10	16	4	3	69.1	0.44	1.4	0.76	25.5
HR 32240 J	3GD	227	230	342	305	340	11	22	4	3	85.1	0.41	1.5	0.81	42.6
30340	—	233	253	398	346	368	11	22	5	4	81.4	0.37	1.6	0.88	52.3
30340 D	—	244	253	398	336	385	11	33	5	4	122.9	0.81	0.74	0.41	49.6
32340	—	239	253	398	346	392	11	31	5	4	106.7	0.37	1.6	0.88	90.9
HR 32944 J	3EC	238	235	288	278	293	9	12	2.5	2	59.2	0.43	1.4	0.78	10.3
HR 32044 XJ	4FD	241	244	326	303	326	12	19	3	2.5	73.6	0.43	1.4	0.77	24.4
30244	—	247	267	382	350	367	11	18	4	3	74.7	0.40	1.5	0.82	33.6
32244	—	247	260	382	340	377	12	24	4	3	93.0	0.40	1.5	0.82	57.4
30344	—	253	283	438	390	414	12	24	5	4	85.4	0.36	1.7	0.92	72.4
32344	—	259	274	438	372	421	12	32	5	4	114.9	0.37	1.6	0.88	114
HR 32948 J	4EC	258	255	308	297	314	9	12	2.5	2	65.1	0.46	1.3	0.72	11.1
HR 32048 XJ	4FD	261	262	346	321	346	12	19	3	2.5	79.1	0.46	1.3	0.72	26.2
30248	—	267	288	422	384	408	11	19	4	3	85.1	0.44	1.4	0.74	45.2
32248	—	267	285	422	374	416	12	27	4	3	102.5	0.40	1.5	0.82	78
30348	—	273	308	478	422	447	12	25	5	4	92.8	0.36	1.7	0.92	92.6
32348	—	279	301	478	410	464	12	33	5	4	123.2	0.37	1.6	0.88	145

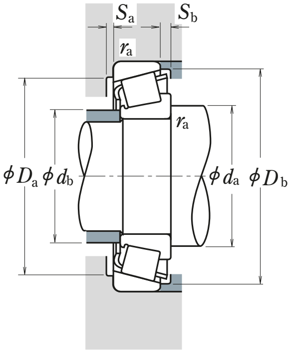
SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 260 – 440 mm



d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Ring: Outer *r* min.	C_r (N)	C_{0r} (N)	Grease (min⁻¹)	Oil (min⁻¹)
260	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
280	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
300	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
320	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
340	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
360	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
380	520	87	82	71	5	4	1 210 000	2 550 000	560	750
400	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
420	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
440	650	130	122	104	6	6	2 230 000	4 600 000	430	600

Column groups: Boundary Dimensions (mm): *d*, *D*, *T*, *B*, *C*, *r*; Basic Load Ratings (N): C_r, C_{0r}; Limiting Speeds (min^{-1}): Grease, Oil.



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

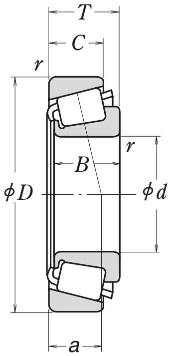
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

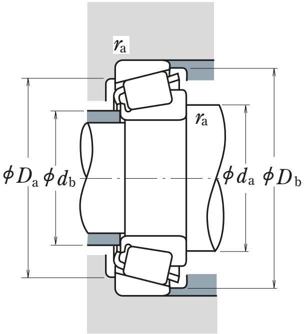
Bearing Designation	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
HR 32952 J	3EC	278	278	348	333	347	11	15.5	2.5	2	69.8	0.41	1.5	0.81	18.6
HR 32052 XJ	4FC	287	287	382	357	383	14	22	4	3	86.3	0.43	1.4	0.76	38.5
30252	—	293	316	458	421	447	12	22	5	4	94.6	0.44	1.4	0.74	60.7
32252	—	293	305	458	394	446	14	31	5	4	116.0	0.45	1.3	0.73	103
30352	—	293	336	512	460	487	16	28	5	5	101.6	0.36	1.7	0.92	114
32352	—	293	328	512	441	495	13	40	5	5	130.5	0.37	1.6	0.88	188
HR 32956 J	4EC	298	297	368	352	368	12	15.5	2.5	2	75.3	0.43	1.4	0.76	20
HR 32056 XJ	4FC	307	305	402	374	402	14	22	4	3	91.6	0.46	1.3	0.72	40.6
30256	—	313	339	478	436	462	12	22	5	4	98.5	0.44	1.4	0.74	66.3
32256	—	313	325	478	412	467	14	31	5	4	123.1	0.47	1.3	0.70	109
32356	—	319	353	552	475	532	14	42	5	5	139.6	0.37	1.6	0.89	224
32960	—	321	326	406	386	405	13	14	3	2.5	79.3	0.37	1.6	0.88	30.5
HR 32960 J	3FD	321	324	406	387	405	13	19	3	2.5	79.9	0.39	1.5	0.84	31.4
HR 32060 XJ	4GD	327	330	442	408	439	15	26	4	3	98.4	0.43	1.4	0.76	56.6
30260	—	333	355	518	470	499	14	25	5	4	105.1	0.44	1.4	0.74	80.6
32260	—	333	352	518	458	514	15	34	5	4	131.7	0.46	1.3	0.72	132
32964	—	341	345	426	404	425	13	13	3	2.5	84.3	0.39	1.5	0.84	32
HR 32964 J	3FD	341	344	426	406	426	13	19	3	2.5	85.0	0.42	1.4	0.79	33.3
HR 32064 XJ	4GD	347	350	462	430	461	15	26	4	3	104.5	0.46	1.3	0.72	60
30264	—	353	381	558	503	533	14	29	5	4	113.7	0.44	1.4	0.74	99.3
32264	—	353	383	558	487	550	15	34	5	4	141.7	0.46	1.3	0.72	175
32364	—	383	412	634	547	616	14	42	6	6	157.5	0.37	1.6	0.88	343
32968	—	361	364	446	426	446	13	13	3	2.5	89.2	0.41	1.5	0.80	33.6
HR 32968 J	4FD	361	362	446	427	446	13	19	3	2.5	91.0	0.44	1.4	0.75	34.3
32068	—	373	386	498	464	496	3.5	22	5	4	104.5	0.37	1.6	0.89	83.7
32972	—	381	386	466	445	465	14	14	3	2.5	91.4	0.40	1.5	0.82	35.8
HR 32972 J	4FD	381	381	466	445	466	13	19	3	2.5	96.8	0.46	1.3	0.72	36.1
32072	—	393	402	518	480	514	5.5	22	5	4	108.6	0.38	1.6	0.86	86.5
32976	—	407	406	502	478	501	16	16	4	3	95.2	0.39	1.6	0.86	49.5
32980	—	427	428	522	499	524	16	16	4	3	100.8	0.40	1.5	0.82	52.7
32080	—	433	443	578	533	565	5	25	5	4	115.3	0.36	1.7	0.92	116
32984	—	447	448	542	521	544	3.5	15	4	3	106.1	0.41	1.5	0.81	54.8
32084	—	453	463	598	552	586	6.5	25	5	4	120.0	0.37	1.6	0.88	121
32088	—	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	D	T	B	C	r min. (Inner)	r min. (Outer)	C_r	C_{0r}	Grease	Oil
	Boundary Dimensions (mm)				Ring:		Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
12.000	31.991	10.008	10.785	7.938	0.8	1.3	10 300	8 900	13 000	18 000
12.700	34.988	10.998	10.988	8.730	1.3	1.3	11 700	10 900	12 000	16 000
15.000	34.988	10.998	10.988	8.730	0.8	1.3	11 700	10 900	12 000	16 000
15.875	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
16.000	47.000	21.000	21.000	16.000	1.0	2.0	35 000	36 500	9 000	12 000
16.993	39.992	12.014	11.153	9.525	0.8	1.3	14 900	15 700	9 500	13 000
17.455	36.525	11.112	11.112	7.938	1.5	1.5	11 600	11 000	10 000	14 000
17.462	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
19.050	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
19.990	47.000	14.381	14.381	11.112	1.5	1.3	23 800	23 900	8 500	11 000
20.000	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000
20.625	49.225	23.020	21.539	17.462	1.5	1.5	37 500	37 000	8 500	11 000
20.638	49.225	19.845	19.845	15.875	1.5	1.5	36 000	37 000	8 000	11 000
21.430	50.005	17.526	18.288	13.970	1.3	1.3	38 500	40 000	8 000	11 000
22.000	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
22.225	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	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

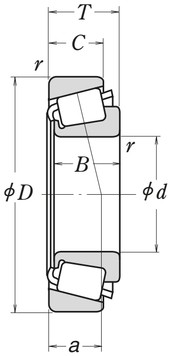
* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

** The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

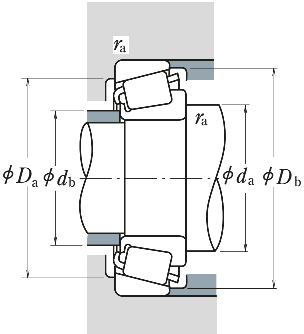
† The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).

*† The tolerance for the bore diameter is 0 to −20 μm, and the tolerance for overall bearing width is +356 to 0 μm.

Bore Diameter 22.606 – 28.575 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	B	C	Ring: Inner r min.	Outer r min.	C_r	C_{0r}	Grease	Oil
22.606	47.000	15.500	15.500	12.000	1.5	1.0	26 300	30 000	8 000	11 000
23.812	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
24.000	55.000	25.000	25.000	21.000	2.0	2.0	49 500	55 000	7 100	9 500
24.981	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
25.000	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
25.400	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
26.988	50.292	14.224	14.732	10.668	3.5	1.3	27 600	32 000	7 100	10 000
	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
28.575	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

$P_0 = 0.5F_r + Y_0F_a$

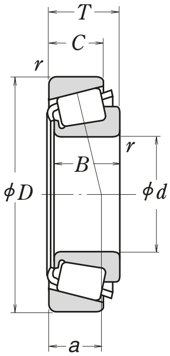
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

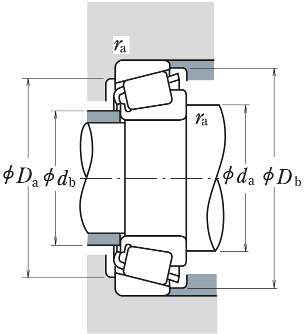
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
LM 72849	**LM 72810**	29	27	40.5	44.5	1.5	1	12.2	0.47	1.3	0.70	0.086	0.046
† L 44640	**† L 44610**	30.5	28.5	44.5	47	1.5	1.3	10.9	0.37	1.6	0.88	0.097	0.039
1779	**1729**	29.5	28.5	49	51	0.8	1.3	12.2	0.31	2.0	1.1	0.143	0.102
▲JHM 33449	**▲JHM 33410**	35	30	47	52	2	2	15.8	0.35	1.7	0.93	0.181	0.107
07098	**07204**	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
07098	**07205**	31	29	44.5	48	1.5	2	12.1	0.40	1.5	0.82	0.085	0.061
17098	**17244**	33	30.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.165	0.091
07097	**07196**	31	29	44.5	47	1.5	1	10.6	0.40	1.5	0.82	0.085	0.035
07097	**07204**	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
07100 SA	**07196**	35	29.5	44.5	47	3.3	1	10.6	0.40	1.5	0.82	0.082	0.035
07100	**07196**	30.5	29.5	44.5	47	1	1	10.6	0.40	1.5	0.82	0.084	0.035
† L 44643	**† L 44610**	31.5	29.5	44.5	47	1.3	1.3	10.9	0.37	1.6	0.88	0.090	0.039
15578	**15520**	32.5	30.5	51	53	1.3	1.5	12.4	0.35	1.7	0.95	0.151	0.070
M 84548	**M 84510**	36	33	48.5	54	1.5	1.5	16.1	0.55	1.1	0.60	0.156	0.089
M 84249	**M 84210**	36	32.5	49.5	56	0.8	1.5	18.3	0.55	1.1	0.60	0.194	0.13
15101	**15245**	32.5	31.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.222	0.081
15100	**15250 X**	38	31.5	55	59	3.5	1.5	14.9	0.35	1.7	0.94	0.22	0.113
M 86643	**M 86610**	38	36.5	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.246	0.128
23100	**23256**	39	34.5	53	61	1.5	1.5	20.0	0.73	0.82	0.45	0.214	0.142
02473	**02420**	34.5	33.5	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.28	0.152
HM 88630	**HM 88610**	39.5	39.5	60	69	0.8	2.3	20.7	0.55	1.1	0.60	0.398	0.188
41100	**41286**	41	36.5	61	68	2.3	1.5	20.7	0.60	1.0	0.55	0.32	0.177
† L 44649	**† L 44610**	37.5	31	44.5	47	3.5	1.3	10.9	0.37	1.6	0.88	0.081	0.039
1997 X	**1922**	37.5	31.5	51	53.5	3.3	1.5	13.9	0.33	1.8	1.0	0.152	0.077
15580	**15523**	38.5	32	51	54	3.5	1.5	14.7	0.35	1.7	0.95	0.141	0.123
15106	**15245**	33.5	33	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.211	0.081
1988	**1922**	39.5	33.5	51	53.5	3.5	1.5	13.9	0.33	1.8	1.0	0.141	0.077
† LM 67043	**† LM 67010**	40	33.5	52	56	3.5	1.3	12.6	0.41	1.5	0.80	0.147	0.062
15112	**15245**	40	34	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.199	0.081
15113	**15245**	34.5	34	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.20	0.081
M 86647	**M 86610**	40	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.223	0.128
02474	**02420**	36.5	36	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.257	0.152
41125	**41286**	48	36.5	61	68	4.8	1.5	20.7	0.60	1.0	0.55	0.292	0.177
41126	**41286**	41.5	36.5	61	68	1.5	1.5	20.7	0.60	1.0	0.55	0.295	0.177
02872	**02820**	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.

Bore Diameter 29.000 – 32.000 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Outer *r* min.	C_r	C_{0r}	Grease	Oil
29.000	50.292	14.224	14.732	10.668	3.5	1.3	26 800	34 000	7 100	9 500
29.367	66.421	23.812	25.433	19.050	3.5	1.3	65 000	73 000	6 000	8 000
30.000	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
30.112	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000
30.162	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
	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
30.213	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
	62.000	19.050	20.638	14.288	1.5	1.3	46 000	53 000	6 000	8 000
30.955	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000
31.750	58.738	14.684	15.080	10.716	1.0	1.0	28 800	33 500	6 000	8 000
	59.131	15.875	16.764	11.811	spec.	1.3	34 500	41 500	6 300	8 500
	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
	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300
32.000	72.233	25.400	25.400	19.842	3.3	2.3	63 500	83 500	5 000	7 100



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

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

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

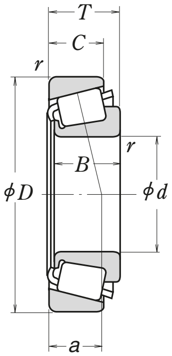
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
† L 45449	† L 45410	39.5	33	44.5	48	3.5	1.3	10.8	0.37	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).

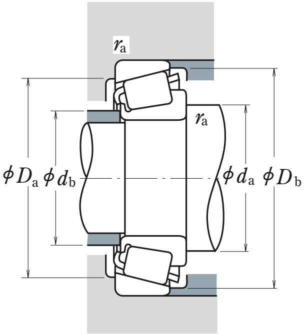
† The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 33.338 – 35.000 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
					Ring: Inner	Outer				
d	D	T	B	C	r min.	r min.	C_r	C_{0r}	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

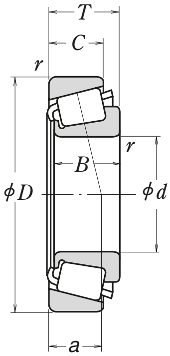
The values of e, Y_1, and Y_0 are given in the table below.

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	Inner Ring	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

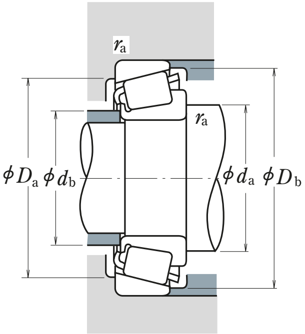
Notes
∗ The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).
∗∗ The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).
† The tolerances for the bore diameter and overall bearing width differ from the standard (see Table 5 on Page C185).
∗† The tolerance for the bore diameter is 0 to −20 μm, and the tolerance for overall bearing width is +356 to 0 μm.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 35.717 – 41.275 mm



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	Basic Load Ratings (N) C_r	Basic Load Ratings (N) C_{0r}	Limiting Speeds (min⁻¹) Grease	Limiting Speeds (min⁻¹) Oil
35.717	72.233	25.400	25.400	19.842	3.5	2.3	63 500	83 500	5 000	7 100
36.487	73.025	23.812	24.608	19.050	1.5	0.8	71 000	86 000	5 300	7 100
36.512	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
38.000	63.000	17.000	17.000	13.500	spec.	1.3	38 500	52 000	5 600	7 500
38.100	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
39.688	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
40.000	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
41.000	68.000	17.500	18.000	13.500	spec.	1.5	43 500	58 000	5 300	7 100
41.275	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	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

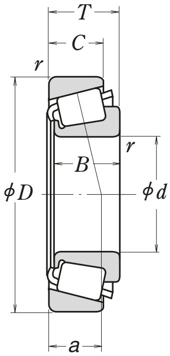
Notes * The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

** The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

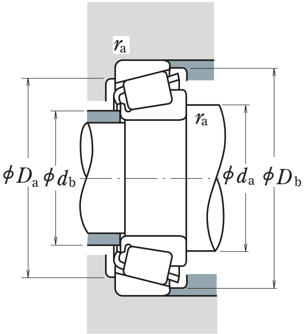
▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

■SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 41.275 – 44.450 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
					Ring: Inner	Outer				
d	*D*	*T*	*B*	*C*	*r* min.		C_r	C_{0r}	Grease	Oil
41.275	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
42.862	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
42.875	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
43.000	74.988	19.368	19.837	14.288	1.5	1.3	52 500	68 000	4 800	6 300
44.450	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

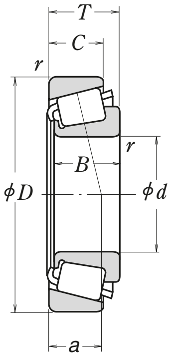
When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

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

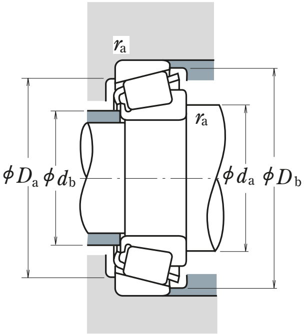
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	approx. Inner Ring	approx. Outer Ring
11162	**11300**	49	46.5	67	71	1.5	1.5	17.4	0.49	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).

Bore Diameter 44.450 – 47.625 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Ring: Outer *r* min.	C_r	C_{0r}	Grease	Oil
44.450	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
44.983	82.931	23.812	25.400	19.050	1.5	0.8	76 500	99 000	4 500	6 000
45.000	93.264	20.638	22.225	15.082	0.8	1.3	77 000	93 000	3 800	5 300
45.230	79.985	19.842	20.638	15.080	2.0	1.3	62 000	78 500	4 500	6 000
45.242	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
45.618	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
46.000	75.000	18.000	18.000	14.000	2.3	1.5	51 000	71 500	4 500	6 300
46.038	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
47.625	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

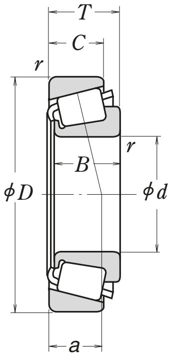
Bearing Designations: INNER RING	Bearing Designations: OUTER RING	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx. Inner Ring	Outer Ring
HM 804843	HM 804810	63	57	81	91	3.5	3.3	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).

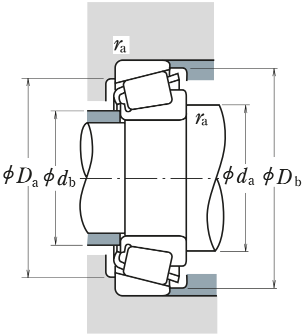
∗∗ The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 48.412 – 52.388 mm



	Boundary Dimensions (mm)				Ring:		Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*T*	*B*	*C*	Inner *r* min.	Outer *r* min.	C_r	C_{0r}	Grease	Oil
48.412	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
49.212	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
50.000	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
50.800	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
	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
52.388	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

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

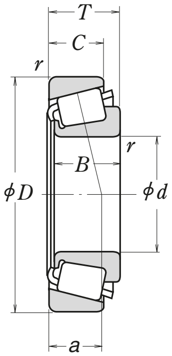
The values of e, Y_1, and Y_0 are given in the table below.

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	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

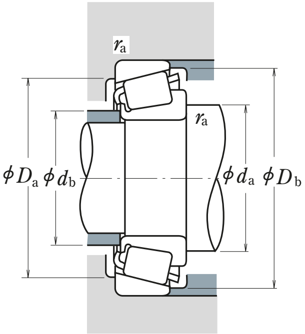
Notes ∗ The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).
▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 53.975 – 58.738 mm



d	D	T	B	C	r min. (Ring: Inner)	r min. (Ring: Outer)	C_r	C_{0r}	Grease	Oil
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
53.975	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
55.000	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
55.562	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
57.150	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
	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
57.531	96.838	21.000	21.946	15.875	3.5	0.8	80 500	100 000	3 600	5 000
58.738	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

$P_0 = 0.5F_r + Y_0F_a$

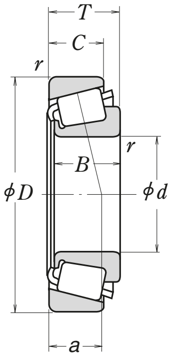
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

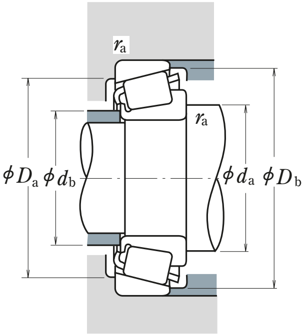
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
4595	**4535**	70	63	90	99	3.5	3.3	27.4	0.34	1.79	0.98	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.

Bore Diameter 60.000 – 64.963 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	C_r	C_{0r}	Grease	Oil
60.000	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
60.325	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
61.912	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
63.500	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
64.963	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

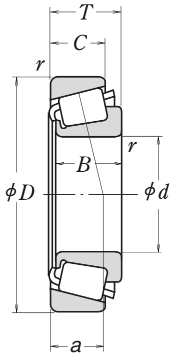
The values of e, Y_1 , and Y_0 are given in the table below.

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	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

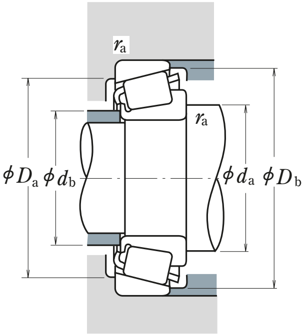
Notes * The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

Bore Diameter 65.000 – 69.850 mm



d	D	T	B	C	Ring: Inner r min.	Ring: Outer r min.	C_r (N)	C_{0r} (N)	Grease (min⁻¹)	Oil (min⁻¹)
65.000	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
65.088	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
66.675	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
68.262	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
	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
69.850	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
	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 $P_0 = F_r$

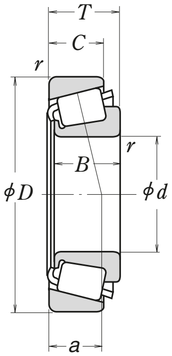
The values of e, Y_1, and Y_0 are given in the table below.

Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	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

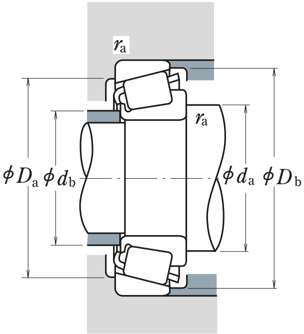
Note ▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 70.000 – 76.200 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Outer *r* min.	C_r	C_{0r}	Grease	Oil
70.000	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
71.438	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
73.025	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
73.817	127.000	36.512	36.170	28.575	0.8	3.3	166 000	234 000	2 800	3 800
74.612	150.000	41.275	41.275	31.750	3.5	3.0	207 000	296 000	2 400	3 200
75.000	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
76.200	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

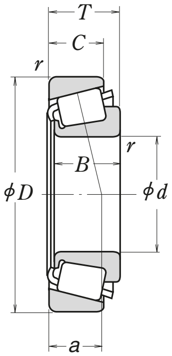
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

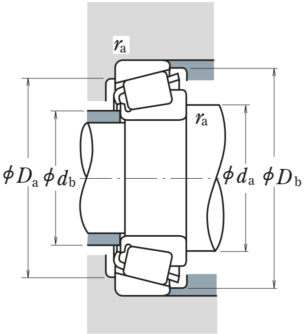
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
▲JLM 813049	▲JLM 813010	78	77	98	105	1	2.5	26.2	0.49	1.2	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.

Bore Diameter 76.200 – 83.345 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*T*	*B*	*C*	Ring: Inner *r* min.	Ring: Outer *r* min.	C_r	C_{0r}	Grease	Oil
76.200	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
77.788	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
79.375	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
80.000	130.000	35.000	34.000	28.500	3.0	2.5	166 000	251 000	2 600	3 600
80.962	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
82.550	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
	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
83.345	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

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

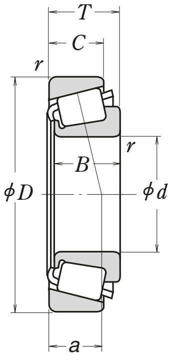
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

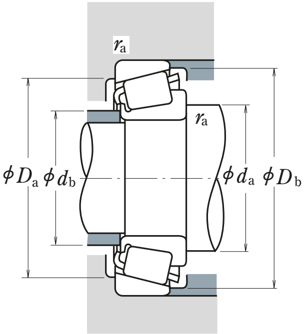
Bearing Designations		Abutment and Fillet Dimensions (mm)				Ring:		Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Inner r_a max.	Outer r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
843	**832**	101	89	149	155	6.4	3.3	35.2	0.30	2.0	1.1	4.11	1.74
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.

Bore Diameter 84.138 – 90.488 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
					Ring: Inner	Outer				
d	*D*	*T*	*B*	*C*	*r* min.	*r* min.	C_r	C_{0r}	Grease	Oil
84.138	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
85.000	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
85.026	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
85.725	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
87.312	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600
88.900	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
90.000	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
90.488	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

Bearing Designations		Abutment and Fillet Dimensions (mm)				Ring:		Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Inner r_a max.	Outer r_a max.	a	e	Y_1	Y_0	approx. Inner Ring	approx. 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

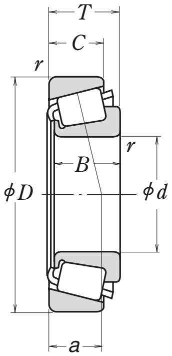
* The maximum bore diameter is listed and its tolerance is negative (see Table 7.4.1 on Page A136).

** The maximum outside diameter is listed and its tolerance is negative (see Table 7.4.2 on Pages A136 and A137).

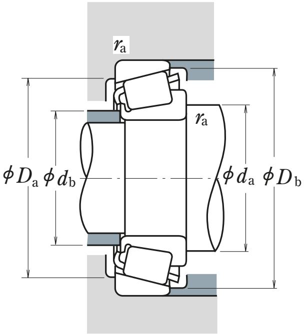
▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 92.075 – 100.012 mm



d	Boundary Dimensions (mm) D	T	B	C	Ring: Inner r min.	Outer r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil
92.075	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
93.662	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
95.000	150.000	35.000	34.000	27.000	3.0	2.5	183 000	285 000	2 200	3 200
95.250	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
96.838	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
98.425	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
99.982	190.500	57.150	57.531	46.038	6.4	3.3	390 000	520 000	1 900	2 600
100.000	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
100.012	157.162	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

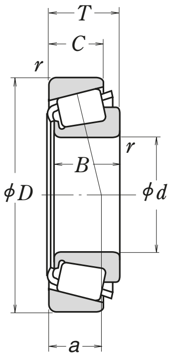
When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

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

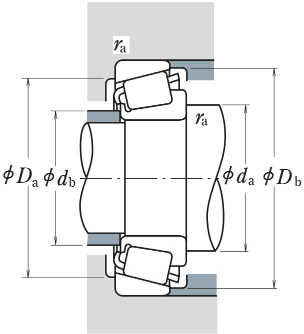
Bearing Designations		Abutment and Fillet Dimensions (mm)				Ring:		Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg)	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Inner r_a max.	Outer r_a max.	a	e	Y_1	Y_0	approx. Inner Ring	approx. Outer Ring
47890	**47820**	107	101	131	140	3.5	3.3	32.3	0.45	1.3	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.

Bore Diameter 101.600 – 117.475 mm



Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
					Ring: Inner	Outer				
d	*D*	*T*	*B*	*C*	*r* min.		C_r	C_{0r}	Grease	Oil
101.600	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
	212.725	66.675	66.675	53.975	7.0	3.3	570 000	810 000	1 700	2 200
104.775	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
106.362	165.100	36.512	36.512	26.988	3.5	3.3	195 000	320 000	2 000	2 600
107.950	158.750	23.020	21.438	15.875	3.5	3.3	102 000	165 000	2 000	2 800
	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
109.987	159.987	34.925	34.925	26.988	3.5	3.3	164 000	315 000	2 000	2 800
	159.987	34.925	34.925	26.988	8.0	3.3	164 000	315 000	2 000	2 800
109.992	177.800	41.275	41.275	30.162	3.5	3.3	232 000	375 000	1 800	2 600
110.000	165.000	35.000	35.000	26.500	3.0	2.5	195 000	320 000	2 000	2 600
	180.000	47.000	46.000	38.000	3.0	2.5	310 000	490 000	1 900	2 600
111.125	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400
114.300	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
115.087	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	3.5	3.3	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

$P_0 = 0.5F_r + Y_0 F_a$

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

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

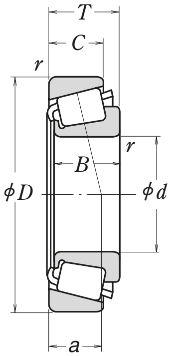
Bearing Designations		Abutment and Fillet Dimensions (mm)						Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	a	e	Y_1	Y_0	Inner Ring	Outer Ring
52400	**52618**	117	111	142	152	3.5	3.3	36.1	0.47	1.3	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).

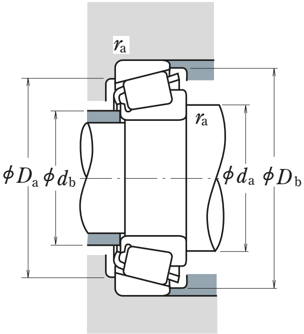
▲ Tolerances are listed in Tables 2, 3, and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH SERIES)

Bore Diameter 120.000 – 165.100 mm



	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
					Ring: Inner	Outer				
d	*D*	*T*	*B*	*C*	*r* min.		C_r	C_{0r}	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

$P_0 = 0.5F_r + Y_0F_a$

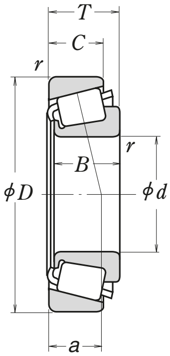
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

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

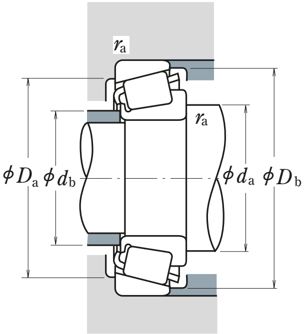
Bearing Designations		Abutment and Fillet Dimensions (mm)				Ring: Inner	Ring: Outer	Eff. Load Center (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
INNER RING	OUTER RING	d_a	d_b	D_a	D_b	r_a max.		a	e	Y_1	Y_0	Inner Ring	Outer Ring
▲ **JL 724348**	▲ **JL 724314**	132	127	156	163	3.3	3.3	32.9	0.46	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.

Bore Diameter 170.000 – 206.375 mm



Boundary Dimensions (mm)					Ring: Inner	Outer	Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	*D*	*T*	*B*	*C*	*r* min.		C_r	C_{0r}	Grease	Oil
170.000	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
174.625	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700
177.800	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
190.000	260.000	46.000	44.000	36.500	3.0	2.5	370 000	730 000	1 100	1 600
190.500	266.700	47.625	46.833	38.100	3.5	3.3	345 000	720 000	1 100	1 500
200.000	300.000	65.000	62.000	51.000	3.5	2.5	615 000	1 130 000	1 000	1 400
203.200	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400
206.375	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400



Dynamic Equivalent Load

$P = XF_r + YF_a$

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

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

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

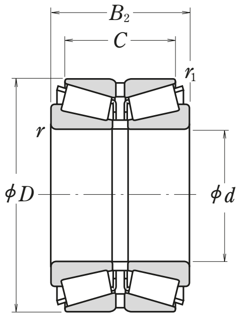
The values of e, Y_1, and Y_0 are given in the table below.

Bearing Designations INNER RING	Bearing Designations OUTER RING	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Ring: Inner r_a max.	Ring: Outer r_a max.	Eff. Load Center (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) 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.

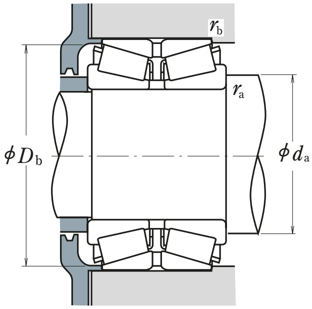
DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 90 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil
40	80	45	37.5	1.5	0.6	109 000	140 000	3 700	5 100
45	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
50	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
55	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
60	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
65	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
70	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
75	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
80	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
85	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
90	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

$P=XF_r+YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

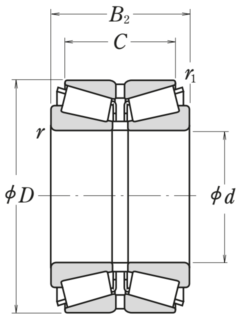
$P_0=F_r+Y_0F_a$

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	Axial Load Factors			Mass (kg)
	d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
HR 40 KBE 42+L	51	75	1.5	0.6	0.37	2.7	1.8	1.8	0.97
HR 45 KBE 42+L	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.08
HR 45 KBE 52X+L	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.31
HR 50 KBE 042+L	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.20
HR 50 KBE 42+L	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.22
HR 50 KBE 52X+L	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.39
HR 50 KBE 043+L	65	104	2	0.6	0.35	2.9	2.0	1.9	2.77
HR 55 KBE 042+L	67	96	2	0.6	0.40	2.5	1.7	1.6	1.59
HR 55 KBE 1003+L	67	96	2	0.6	0.40	2.5	1.7	1.6	1.63
HR 55 KBE 52X+L	67	97	2	0.6	0.40	2.5	1.7	1.6	1.88
HR 55 KBE 43+L	70	113	2	0.6	0.35	2.9	2.0	1.9	3.52
HR 60 KBE 042+L	72	105	2	0.6	0.40	2.5	1.7	1.6	2.03
HR 60 KBE 52X+L	72	106	2	0.6	0.40	2.5	1.7	1.6	2.52
HR 60 KBE 43+L	78	122	2.5	1	0.35	2.9	2.0	1.9	4.40
HR 65 KBE 42+L	77	115	2	0.6	0.40	2.5	1.7	1.6	2.58
HR 65 KBE 1202+L	77	115	2	0.6	0.40	2.5	1.7	1.6	2.61
HR 65 KBE 52X+L	77	117	2	0.6	0.40	2.5	1.7	1.6	3.35
HR 65 KBE 43+L	83	132	2.5	1	0.35	2.9	2.0	1.9	5.42
HR 70 KBE 042+L	82	120	2	0.6	0.42	2.4	1.6	1.6	2.79
HR 70 KBE 42+L	82	120	2	0.6	0.42	2.4	1.6	1.6	2.85
HR 70 KBE 52X+L	82	121	2	0.6	0.42	2.4	1.6	1.6	3.58
HR 70 KBE 43+L	88	142	2.5	1	0.35	2.9	2.0	1.9	6.45
HR 75 KBE 42+L	87	126	2	0.6	0.44	2.3	1.6	1.5	3.15
HR 75 KBE 52X+L	87	127	2	0.6	0.44	2.3	1.6	1.5	3.73
HR 75 KBE 043+L	93	151	2.5	1	0.35	2.9	2.0	1.9	7.66
HR 80 KBE 042+L	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
HR 80 KBE 42+L	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
HR 80 KBE 52X+L	95	136	2	0.6	0.42	2.4	1.6	1.6	4.59
HR 80 KBE 043+L	98	161	2.5	1	0.35	2.9	2.0	1.9	9.02
HR 85 KBE 42+L	100	143	2	0.6	0.42	2.4	1.6	1.6	4.69
HR 85 KBE 52X+L	100	144	2	0.6	0.42	2.4	1.6	1.6	5.70
HR 85 KBE 043+L	106	169	3	1	0.35	2.9	2.0	1.9	10.8
HR 90 KBE 042+L	105	152	2	0.6	0.42	2.4	1.6	1.6	5.53
HR 90 KBE 42+L	105	152	2	0.6	0.42	2.4	1.6	1.6	5.71
HR 90 KBE 52X+L	105	154	2	0.6	0.42	2.4	1.6	1.6	7.26

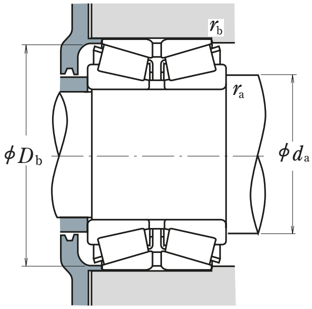
DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 90 – 120 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil
90	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
95	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
100	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
105	190	88	70	3	1	480 000	735 000	1 500	2 000
	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
110	180	56	50	2.5	0.6	264 000	400 000	1 500	2 000
	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
120	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
	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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

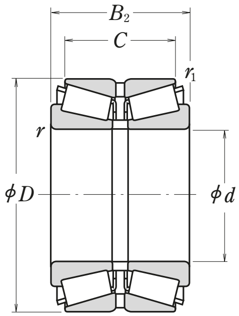
Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

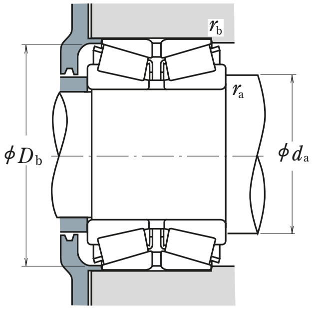
Bearing Designation	Abutment and Fillet Dimensions (mm) d_a min.	D_b min.	r_a max.	r_b max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
HR 90 KBE 043+L	111	178	3	1	0.35	2.9	2.0	1.9	12.7
HR 90 KBE 1901+L	111	179	3	1	0.35	2.9	2.0	1.9	17.9
HR 95 KBE 42+L	113	161	2.5	1	0.42	2.4	1.6	1.6	6.75
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

Bore Diameter 125 – 150 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil
125	210	110	88	4	1	560 000	1 030 000	1 300	1 800
130	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
	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
140	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
	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
	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
	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
150	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
	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
	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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

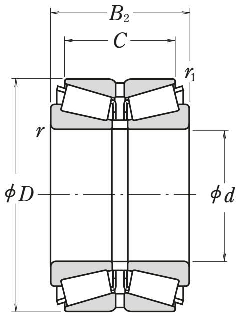
$P_0 = F_r + Y_0 F_a$

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	Axial Load Factors			Mass (kg)
	d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
125 KBE 2101+L	146	201	3	1	0.43	2.3	1.6	1.5	14.5
HR130 KBE 42+L	151	220	3	1	0.44	2.3	1.6	1.5	15.8
HR130 KBE 2301+L	151	220	3	1	0.44	2.3	1.6	1.5	15.9
130 KBE 43+L	157	258	4	1.5	0.36	2.8	1.9	1.8	35
HR130 KBE 2302+L	151	221	3	1	0.44	2.3	1.6	1.5	24.1
HR130 KBE 52+L	151	222	3	1	0.44	2.3	1.6	1.5	23.8
HR130 KBE 2303+L	151	221	3	1	0.44	2.3	1.6	1.5	24.2
140 KBE 30+L	155	202	2	0.6	0.39	2.6	1.7	1.7	6.02
140 KBE 030+L	155	202	2	1	0.40	2.5	1.7	1.6	7.02
140 KBE 2101+L	155	202	2	0.6	0.33	3.0	2.0	2.0	12.3
140 KBE 31+L	158	216	2.5	1	0.39	2.6	1.7	1.7	9.31
140 KBE 031+L	158	215	2.5	1	0.39	2.6	1.7	1.7	11.6
140 KBE 2201+L	158	215	2.5	1	0.39	2.6	1.7	1.7	11.7
140 KBE 2301+L	158	220	2.5	1	0.33	3.0	2.0	2.0	17.6
140 KBE 2302+L	158	221	2.5	1	0.35	2.9	2.0	1.9	20.7
140 KBE 2401+L	161	227	3	1.5	0.44	2.3	1.5	1.5	22.7
HR140 KBE 42+L	161	237	3	1	0.44	2.3	1.6	1.5	18.9
HR140 KBE 52X+L	161	241	3	1	0.44	2.3	1.6	1.5	29.6
140 KBE 43+L	167	275	4	1.5	0.36	2.8	1.9	1.8	42.6
150 KBE 30+L	168	213	2.5	1	0.35	2.9	2.0	1.9	7.41
150 KBE 030+L	168	215	2.5	1	0.35	2.9	2.0	1.9	8.70
150 KBE 31+L	168	240	2.5	1	0.40	2.5	1.7	1.6	14.2
150 KBE 031+L	168	238	2.5	1	0.39	2.6	1.7	1.7	17.8
150 KBE 2502+L	168	238	2.5	1	0.37	2.7	1.8	1.8	20.9
150 KBE 2601+L	171	242	3	1	0.43	2.3	1.6	1.5	30.0
HR150 KBE 42+L	171	253	3	1	0.44	2.3	1.6	1.5	24.3
HR150 KBE 52X+L	171	257	3	1	0.44	2.3	1.6	1.5	37.3
HR150 KBE 2701+L	171	257	3	1	0.44	2.3	1.6	1.5	39.7
HR150 KBE 43+L	177	295	4	1.5	0.35	2.9	2.0	1.9	53.4

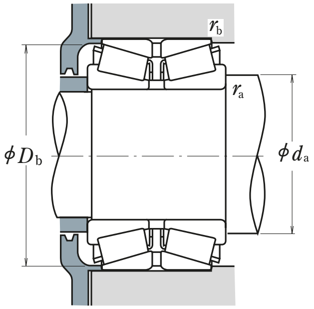
DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 160 – 200 mm



Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil
160	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
165	290	150	125	4	1	1 140 000	2 130 000	900	1 300
170	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
180	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
	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
190	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
	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
200	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
	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

$P=XF_r+YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

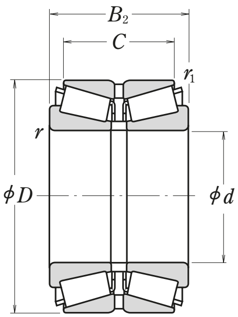
$P_0=F_r+Y_0F_a$

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	Axial Load Factors			Mass (kg)
	d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
160 KBE 30+L	178	231	2.5	1	0.37	2.7	1.8	1.8	8.56
160 KBE 030+L	178	230	2.5	1	0.40	2.5	1.7	1.6	10.5
160 KBE 2401+L	178	232	2.5	1	0.38	2.6	1.8	1.7	16.2
160 KBE 31+L	178	255	2.5	1	0.40	2.5	1.7	1.6	18.6
160 KBE 031+L	178	256	2.5	1	0.39	2.6	1.7	1.7	23.1
160 KBE 2701+L	178	261	2.5	1	0.39	2.6	1.7	1.7	30.6
160 KBE 2801+L	181	266	3	1	0.32	3.2	2.1	2.1	35.9
160 KBE 42+L	181	275	3	1	0.43	2.3	1.6	1.5	28.2
HR160 KBE 52X+L	181	277	3	1	0.44	2.3	1.6	1.5	47.3
160 KBE 43+L	187	314	4	1.5	0.36	2.8	1.9	1.8	60.4
165 KBE 2901+L	186	272	3	1	0.33	3.1	2.1	2.0	39.5
170 KBE 2501+L	188	241	2.5	1	0.44	2.3	1.5	1.5	12.3
170 KBE 30+L	188	248	2.5	1	0.40	2.5	1.7	1.6	11.8
170 KBE 030+L	188	249	2.5	1	0.39	2.6	1.7	1.7	14.4
170 KBE 31+L	188	266	2.5	1	0.39	2.6	1.7	1.7	19.7
170 KBE 031+L	188	268	2.5	1	0.39	2.6	1.7	1.7	24.2
170 KBE 2802+L	188	269	2.5	1	0.39	2.6	1.7	1.7	34.6
HR170 KBE 52X+L	197	297	4	1.5	0.44	2.3	1.6	1.5	57.3
180 KBE 30+L	198	265	2.5	1	0.40	2.5	1.7	1.6	15.4
180 KBE 030+L	198	265	2.5	1	0.35	2.9	2.0	1.9	14.4
180 KBE 31+L	201	284	3	1.5	0.39	2.6	1.7	1.7	24.8
180 KBE 031+L	201	287	3	1.5	0.39	2.6	1.7	1.7	31.1
180 KBE 42+L	207	300	4	1.5	0.44	2.3	1.5	1.5	36.5
HR180 KBE 52X+L	207	308	4	1.5	0.45	2.2	1.5	1.5	59.2
180 KBE 3401+L	207	305	4	1.5	0.43	2.3	1.6	1.5	68.1
190 KBE 30+L	208	279	2.5	1	0.39	2.6	1.7	1.7	16.2
190 KBE 030+L	208	279	2.5	1	0.40	2.5	1.7	1.6	20.1
190 KBE 31+L	211	301	3	1.5	0.40	2.5	1.7	1.6	30.9
190 KBE 031+L	211	302	3	1.5	0.39	2.6	1.7	1.7	39.0
190 KBE 42+L	217	320	4	1.5	0.40	2.5	1.7	1.6	43.9
HR190 KBE 52X+L	217	327	4	1.5	0.44	2.3	1.6	1.5	70.8
HR200 KBE 3101+L	218	301	2.5	1	0.43	2.3	1.6	1.5	40.1
200 KBE 3201+L	227	301	4	1.5	0.52	1.9	1.3	1.3	41.6
200 KBE 3301+L	227	316	4	1.5	0.42	2.4	1.6	1.6	54.4
200 KBE 31+L	221	321	3	1.5	0.40	2.5	1.7	1.6	38.8
200 KBE 031+L	221	324	3	1.5	0.39	2.6	1.7	1.7	47.0
200 KBE 42+L	227	338	4	1.5	0.40	2.5	1.7	1.6	52.6
HR200 KBE 52+L	227	344	4	1.5	0.41	2.5	1.7	1.6	88.3

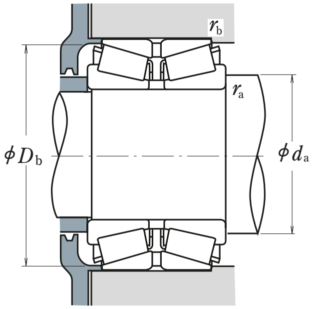
■DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 206 – 260 mm



	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil
206	283	102	83	4	1.5	580 000	1 430 000	900	1 200
210	355	116	103	4	1.5	905 000	1 520 000	700	1 000
220	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
	400	158	122	5	1.5	1 390 000	2 300 000	600	900
240	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
250	380	98	87	4	1	795 000	1 460 000	600	900
260	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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
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	Axial Load Factors			Mass (kg)
	d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
206 KBE 2801+L	227	275	3	1.5	0.51	2.0	1.3	1.3	18.1
210 KBE 31+L	231	338	3	1.5	0.46	2.2	1.5	1.4	41.7
220 KBE 3001+L	238	292	2.5	1	0.37	2.7	1.8	1.8	21.2
220 KBE 30+L	241	324	3	1.5	0.40	2.5	1.7	1.6	27.9
220 KBE 030+L	241	327	3	1.5	0.40	2.5	1.7	1.6	34.7
220 KBE 31+L	247	345	4	1.5	0.39	2.6	1.7	1.7	48.3
220 KBE 031+L	247	349	4	1.5	0.39	2.6	1.7	1.7	60.2
220 KBE 42+L	247	371	4	1.5	0.40	2.5	1.7	1.6	74.2
240 KBE 30+L	261	344	3	1.5	0.39	2.6	1.7	1.7	30.1
240 KBE 030+L	261	344	3	1.5	0.35	2.9	2.0	1.9	37.3
240 KBE 31+L	267	380	4	1.5	0.43	2.3	1.6	1.5	60.0
240 KBE 031+L	267	378	4	1.5	0.39	2.6	1.7	1.7	73.6
240 KBE 4003+L	267	384	4	1.5	0.33	3.0	2.0	2.0	96.4
250 KBE 3801+L	271	365	3	1	0.40	2.5	1.7	1.6	35.5
260 KBE 30+L	287	379	4	1.5	0.40	2.5	1.7	1.6	43.4
260 KBE 030+L	287	382	4	1.5	0.40	2.5	1.7	1.6	54.1
260 KBE 31+L	287	416	4	1.5	0.39	2.6	1.7	1.7	82.5
260 KBE 4401+L	287	414	4	1.5	0.38	2.6	1.8	1.7	98.1
260 KBE 031+L	287	416	4	1.5	0.39	2.6	1.7	1.7	104.0

7. SPHERICAL ROLLER BEARINGS

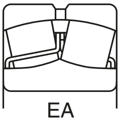
DESIGN, TYPES, AND FEATURES

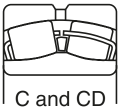
Various types of high load capacity spherical roller bearings are available. Types EA, C and CD have pressed-steel cages, and type CA has machined-brass cages. EA-type bearings listed here are classified as NSKHPS™ bearings, which offer particularly high load-carrying capacity, high limiting speeds, and superior performance under high-temperature operating conditions up to 200 °C.

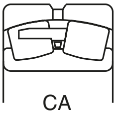
An oil groove and holes are located in the outer ring to supply lubricant, and the bearing numbers are suffixed with E4.

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.


EA

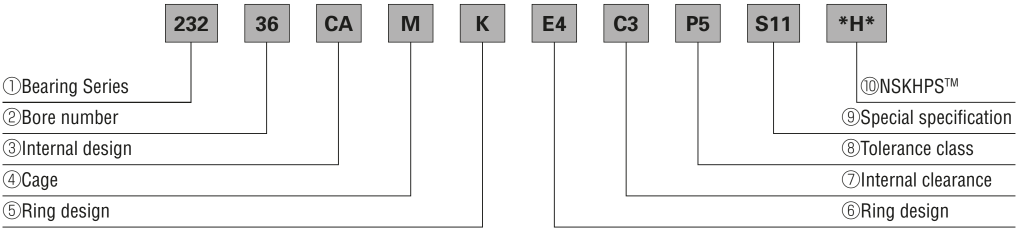

C and CD


CA

Formulation of Bearing Designations

Spherical Roller Bearings

Example:



①Bearing Series	239, 230, 240, 231, 241, 222, 232, 213, 223 : Spherical roller bearings
②Bore number	Bore number indicates bore diameter. Bore number X 5 (mm)
③Internal design	EA, CA : High load capacity
④Cage	M : Machined-brass cage (for CA Design)
	Omitted: Pressed-steel cage (for EA Design)
⑤⑥Ring 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
⑦Internal clearance	Omitted : CN clearance, C3 : Clearance greater than CN,
	C4 : Clearance greater than C3, C5 : Clearance greater than C4
⑧Tolerance class	Omitted : ISO Normal, P6 : ISO Class 6, P5 : ISO Class 5, P4 : ISO Class 4
⑨Special specification	S11 ; Dimensional stabilizing treatment: working temperature under 200 °C
	(omitted for EA design)
⑩NSKHPS™	*H* : NSKHPS™ designation
	Tolerance Class : ISO Normal

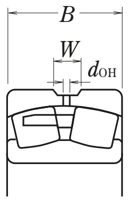


Table 1 Dimensions of Oil Grooves and Holes

Units : mm

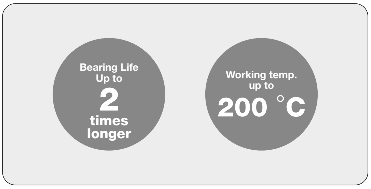
Nominal Width B over	Nominal Width B incl.	Oil Groove Width W	Hole Diameter d_{OH}
18	30	5	2.5
30	40	6	3
40	50	7	4
50	65	8	5
65	80	10	6
80	100	12	8
100	120	15	10
120	160	20	12
160	200	25	15
200	250	30	20
250	315	35	20
315	400	40	25
400	—	40	25

Table 2 Number of Oil Holes

Nominal Outer Ring Dia D (mm) over	Nominal Outer Ring Dia D (mm) incl.	Number of Holes
—	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:



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.

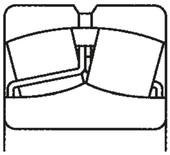
TECHNICAL DATA

Free Space of Spherical Roller Bearings

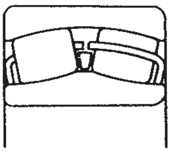
Spherical roller bearings have self-aligning capabilities and the capacity to carry substantially large radial and bi-axial loads. For these reasons, this bearing is used widely in many applications, such as plumber blocks. Application problems include a long span, which causes substantial deflection 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.

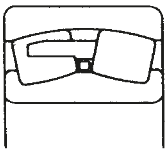
The amount of bearing free space for various spherical roller bearings is shown in Table 1. Under general operating conditions, a user may pack up to 1/3 to 2/3 of the free space of the bearing with grease.



EA type



C, CD type



CA type

Table 1 Free Space of Spherical Roller Bearings (EA, C, CD, and CA)

Units: cm^3

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 Δ_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 Δ_{rT1} and Δ_{rT2}, and determine the internal clearance at the top of the bearing Δ_{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 Δ_{rL1} and Δ_{rL2}, and determine the internal clearance on the left side of the bearing Δ_{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 Δ_{rR1} and Δ_{rR2}, and determine the internal clearance on the right side of the bearing Δ_{rR} by the following equation:

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

Finally, determine the internal bearing clearance Δ_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.

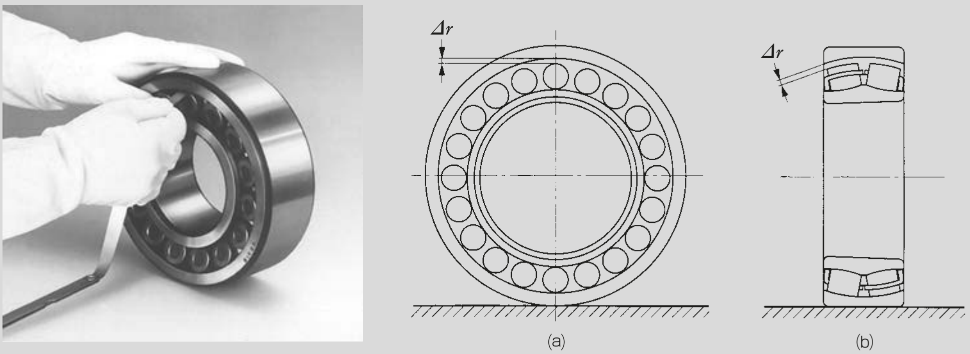


Fig. 1 Clearance Measurement Point (Bearing Outside Diameter: Less Than 200 mm)

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 Δ_{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 Δ_r (Fig. 3). Because the bearing has two rows, two measurements of bearing internal clearance should be taken as Δ_{rS1} and Δ_{rS2}, and the internal clearance at the very bottom of the bearing Δ_{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 Δ_{rL1} and Δ_{rL2}, and determine the internal clearance on the left side of bearing Δ_{rL} by the following equation:

$$\Delta_{rL} = 1/2\ (\Delta_{rL1} + \Delta_{rL2})$$

Next, take the individual values on the right side as Δ_{rR1} and Δ_{rR2}, and determine the internal clearance on the right side of bearing Δ_{rR} by the following equation:

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

Finally, determine internal bearing clearance (Δ_r) by the following equation:

$$\Delta_r = 1/2\ (\Delta_{rS} + \Delta_{rL} + \Delta_{rR})$$

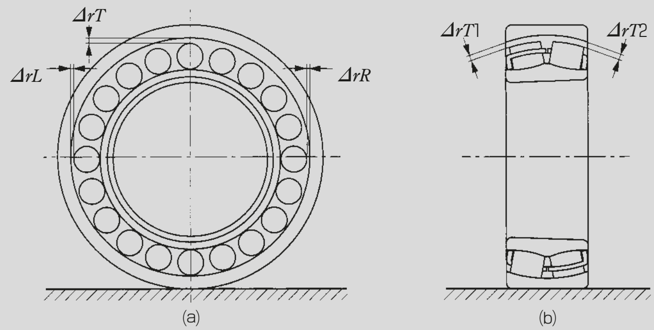


Fig. 2 Clearance Measurement Points (Bearing Outside Diameter: Larger Than 200 mm)

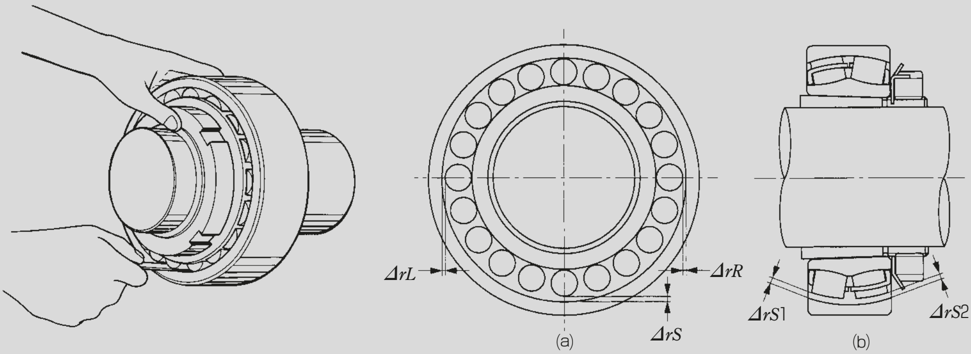


Fig. 3 Clearance Measurement Points

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 speified 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 onehalf 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

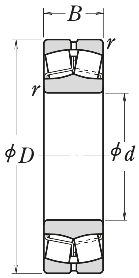
Units : mm

Bore Diameter d (mm)		Reduction in Radial Clearance		Axial Movement				Minimum Permissible Residual Clearance		
				Taper 1 : 12		Taper 1 : 30				
over	incl.	min.	max.	min.	max.	min.	max.	CN	C3	C4
30	**40**	0.025	0.030	0.40	0.45	—	—	0.010	0.025	0.035
40	**50**	0.030	0.035	0.45	0.55	—	—	0.015	0.030	0.045
50	**65**	0.030	0.035	0.45	0.55	—	—	0.025	0.035	0.060
65	**80**	0.040	0.045	0.60	0.70	—	—	0.030	0.040	0.075
80	**100**	0.045	0.055	0.70	0.85	1.75	2.15	0.035	0.050	0.085
100	**120**	0.050	0.060	0.75	0.90	1.9	2.25	0.045	0.065	0.110
120	**140**	0.060	0.070	0.90	1.1	2.25	2.75	0.055	0.080	0.130
140	**160**	0.065	0.080	1.0	1.3	2.5	3.25	0.060	0.100	0.150
160	**180**	0.070	0.090	1.1	1.4	2.75	3.5	0.070	0.110	0.170
180	**200**	0.080	0.100	1.3	1.6	3.25	4.0	0.070	0.110	0.190
200	**225**	0.090	0.110	1.4	1.7	3.5	4.25	0.080	0.130	0.210
225	**250**	0.100	0.120	1.6	1.9	4.0	4.75	0.090	0.140	0.230
250	**280**	0.110	0.140	1.7	2.2	4.25	5.5	0.100	0.150	0.250
280	**315**	0.120	0.150	1.9	2.4	4.75	6.0	0.110	0.160	0.280
315	**355**	0.140	0.170	2.2	2.7	5.5	6.75	0.120	0.180	0.300
355	**400**	0.150	0.190	2.4	3.0	6.0	7.5	0.130	0.200	0.330
400	**450**	0.170	0.210	2.7	3.3	6.75	8.25	0.140	0.220	0.360
450	**500**	0.190	0.240	3.0	3.7	7.5	9.25	0.160	0.240	0.390
500	**560**	0.210	0.270	3.4	4.3	8.5	11.0	0.170	0.270	0.410
560	**630**	0.230	0.300	3.7	4.8	9.25	12.0	0.200	0.310	0.460
630	**710**	0.260	0.330	4.2	5.3	10.5	13.0	0.220	0.330	0.520
710	**800**	0.280	0.370	4.5	5.9	11.5	15.0	0.240	0.390	0.590
800	**900**	0.310	0.410	5.0	6.6	12.5	16.5	0.280	0.430	0.660
900	**1000**	0.340	0.460	5.5	7.4	14.0	18.5	0.310	0.470	0.730
1000	**1120**	0.370	0.500	5.9	8.0	15.0	20.0	0.360	0.530	0.800

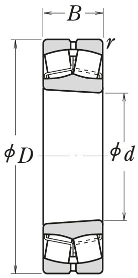
Remarks The values for reduction in radial internal clearance are for bearings with CN clearance. For bearings with C3 or C4 Clearance, the maximum values listed should be used.

SPHERICAL ROLLER BEARINGS

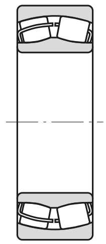
Bore Diameter 20 – 55 mm



Cylindrical Bore



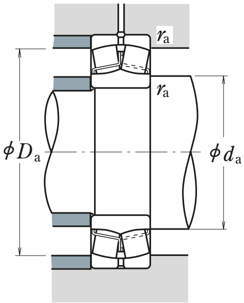
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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 (1) Suffix K represents bearings with tapered bores (taper 1:12).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

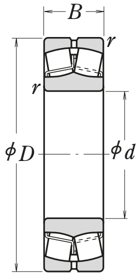
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Desginations Tapered Bore([1])	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
21304CDKE4	27	28	45	42	1	0.31	3.2	2.1	2.1	0.17
22205CKE4	31	31	46	45	1	0.35	2.9	1.9	1.9	0.17
21305CDKE4	32	34	55	51	1	0.29	3.4	2.3	2.3	0.26
22206CKE4	36	37	56	54	1	0.33	3.1	2.1	2.0	0.27
21306CDKE4	37	40	65	59	1	0.28	3.6	2.4	2.3	0.39
22207CKE4	42	43	65	63	1	0.32	3.1	2.1	2.0	0.42
21307CDKE4	44	47	71	67	1.5	0.28	3.6	2.4	2.4	0.53
∗22208EAKE4	47	49	73	70	1	0.28	3.6	2.4	2.4	0.50
∗21308EAKE4	49	55	81	75	1.5	0.25	3.9	2.7	2.6	0.73
∗22308EAKE4	49	52	81	77	1.5	0.35	2.8	1.9	1.9	0.98
∗22209EAKE4	52	55	78	75	1	0.25	3.9	2.7	2.6	0.55
∗21309EAKE4	54	65	91	89	1.5	0.23	4.3	2.9	2.8	0.96
∗22309EAKE4	54	60	91	86	1.5	0.34	2.9	2.0	1.9	1.34
∗22210EAKE4	57	60	83	81	1	0.24	4.3	2.9	2.8	0.61
∗21310EAKE4	60	72	100	98	2	0.23	4.4	3.0	2.9	1.21
∗22310EAKE4	60	64	100	93	2	0.35	2.8	1.9	1.9	1.78
∗22211EAKE4	64	65	91	89	1.5	0.23	4.3	2.9	2.8	0.81
∗21311EAKE4	65	72	110	98	2	0.23	4.4	3.0	2.9	1.58
∗22311EAKE4	65	73	110	103	2	0.34	2.9	2.0	1.9	2.3

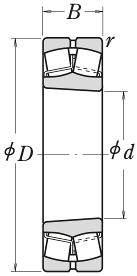
Remarks
1. Bearings denoted by an asterisk (∗) are NSKHPS bearings; they come standard with an oil groove and holes.
2. The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings. In this case, light loads are defined as ≦0.05C_r normal loads as 0.05 to 0.10C_r, 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

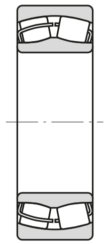
Bore Diameter 60 – 90 mm



Cylindrical Bore



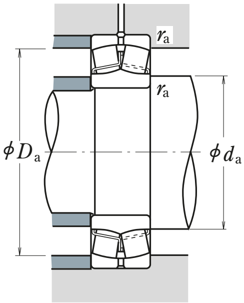
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

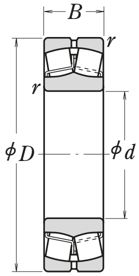
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

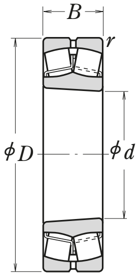
Desgινations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
23012CKE4	67	68	88	85	1	0.26	3.9	2.6	2.5	0.68
***22212EAKE4**	69	72	101	98	1.5	0.23	4.4	3.0	2.9	1.1
***21312EAKE4**	72	87	118	117	2	0.22	4.5	3.0	3.0	1.98
***22312EAKE4**	72	79	118	111	2	0.34	3.0	2.0	1.9	2.89
***22213EAKE4**	74	80	111	107	1.5	0.24	4.2	2.8	2.7	1.51
***21313EAKE4**	77	94	128	126	2	0.22	4.6	3.1	3.0	2.45
***22313EAKE4**	77	84	128	119	2	0.34	3.0	2.0	2.0	3.52
***22214EAKE4**	79	84	116	111	1.5	0.23	4.3	2.9	2.8	1.58
***21314EAKE4**	82	101	138	135	2	0.22	4.6	3.1	3.0	3.0
***22314EAKE4**	82	91	138	129	2	0.33	3.0	2.0	2.0	4.28
***22215EAKE4**	84	87	121	117	1.5	0.22	4.5	3.0	3.0	1.64
***21315EAKE4**	87	101	148	134	2	0.22	4.6	3.1	3.0	3.64
***22315EAKE4**	87	97	148	137	2	0.33	3.0	2.0	2.0	5.26
***22216EAKE4**	90	94	130	126	2	0.22	4.6	3.1	3.0	2.01
***21316EAKE4**	92	109	158	146	2	0.23	4.4	3.0	2.9	4.32
***22316EAKE4**	92	103	158	145	2	0.33	3.0	2.0	2.0	6.23
***22217EAKE4**	95	101	140	135	2	0.22	4.6	3.1	3.0	2.54
***21317EAKE4**	99	108	166	142	2.5	0.24	4.3	2.9	2.8	5.2
***22317EAKE4**	99	110	166	155	2.5	0.33	3.1	2.1	2.0	7.23
***22218EAKE4**	100	108	150	142	2	0.24	4.3	2.9	2.8	3.3
23218CKE4	100	105	150	138	2	0.32	3.2	2.1	2.1	4.51
***21318EAKE4**	104	115	176	152	2.5	0.24	4.3	2.9	2.8	6.1
***22318EAKE4**	104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.56

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 $\leqq 0.05C_r$ 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 C349 – C350 and C356.

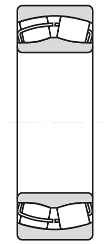
Bore Diameter 95 – 110 mm



Cylindrical Bore



Tapered Bore

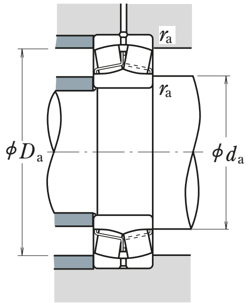


Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
95	170	43	2.1	415 000	450 000	3 800	4 500	3 000	**∗22219EAE4**
	170	55.6	2.1	370 000	525 000	2 600	—	1 700	**23219CAME4**
	200	45	3	430 000	435 000	3 600	4 800	1 500	**∗21319CAME4**
	200	45	3	345 000	435 000	3 400	—	1 500	**21319CE4**
	200	67	3	735 000	780 000	2 600	3 000	2 200	**∗22319EAE4**
100	150	37	1.5	212 000	335 000	3 200	—	2 200	**23020CDE4**
	150	50	1.5	276 000	470 000	2 800	—	1 800	**24020CE4**
	165	52	2	345 000	530 000	2 800	—	1 700	**23120CE4**
	165	65	2	345 000	535 000	2 400	—	1 700	**24120CAME4**
	180	46	2.1	455 000	490 000	3 600	4 300	2 800	**∗22220EAE4**
	180	60.3	2.1	525 000	605 000	2 800	3 800	1 600	**∗23220CAME4**
	180	60.3	2.1	420 000	605 000	2 600	—	1 600	**23220CE4**
	215	47	3	495 000	485 000	3 400	4 500	1 400	**∗21320CAME4**
	215	47	3	395 000	485 000	3 200	—	1 400	**21320CE4**
	215	73	3	750 000	785 000	2 600	3 400	1 700	**∗22320CAME4(²)**
110	170	45	2	293 000	465 000	3 200	—	2 000	**23022CDE4**
	170	60	2	380 000	645 000	2 600	—	1 600	**24022CE4**
	180	56	2	480 000	630 000	3 200	4 000	1 600	**∗23122CAME4**
	180	56	2	385 000	630 000	2 600	—	1 600	**23122CE4**
	180	69	2	575 000	750 000	2 200	3 400	1 600	**∗24122CAME4**
	180	69	2	460 000	750 000	2 000	—	1 600	**24122CE4**
	200	53	2.1	605 000	645 000	3 400	3 400	2 600	**∗22222EAE4**
	200	69.8	2.1	645 000	760 000	2 600	3 400	1 500	**∗23222CAME4**
	200	69.8	2.1	515 000	760 000	2 200	—	1 500	**23222CE4**
	240	50	3	565 000	545 000	3 000	4 300	1 300	**∗21322CAME4**
	240	80	3	925 000	980 000	2 200	3 000	1 500	**∗22322CAME4(²)**

Notes (¹) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).

(²) 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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

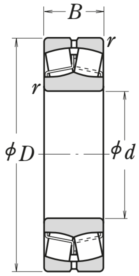
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Desginations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
∗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(2)	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(2)	124	—	226	206	2.5	0.35	2.9	1.9	1.9	17.6

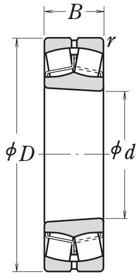
Remarks
1. Bearings denoted by an asterisk (∗) are NSKHPS bearings; they come standard with an oil groove and holes.
2. The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings. In this case, light loads are defined as ≦0.05C_r normal loads as 0.05 to 0.10C_r, and heavy loads as > 0.10C_r.
3. For the dimensions of adapters and withdrawal sleeves, refer to Pages C351 and C357.

SPHERICAL ROLLER BEARINGS

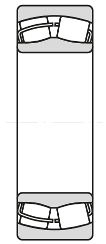
Bore Diameter 120 – 130 mm



Cylindrical Bore



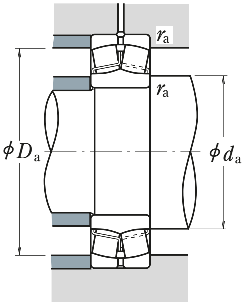
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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(2)**
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 (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).
(2) 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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

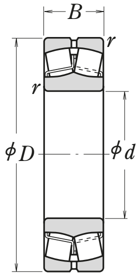
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

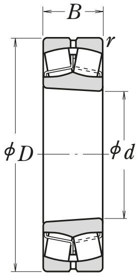
Desginations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
∗23024CAMKE4	130	—	170	163	2	0.22	4.5	3.0	2.9	4.11
23024CDKE4	130	134	170	163	2	0.22	4.5	3.0	2.9	4.11
∗24024CAMK30E4	130	—	170	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(2)	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
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 $\leqq 0.05C_r$ 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 C351 and C357.

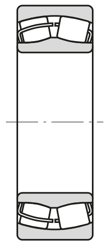
Bore Diameter 140 – 150 mm



Cylindrical Bore



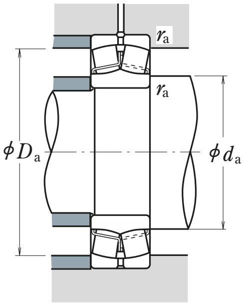
Tapered Bore



Without an Oil Groove or Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
140	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**
150	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**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

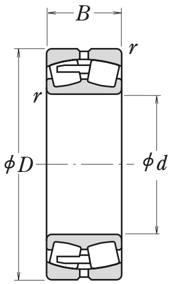
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

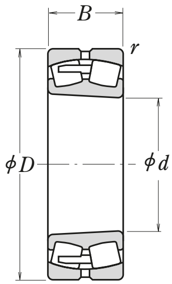
Desginations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
∗23028CAMKE4	150	—	200	190	2	0.22	4.5	3.0	2.9	6.49
23028CDKE4	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
∗24028CAMK30E4	150	—	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
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 $\leqq 0.05C_r$ 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 C352 and C357 – C358.

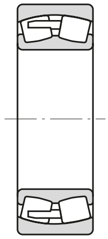
Bore Diameter 160 – 170 mm



Cylindrical Bore



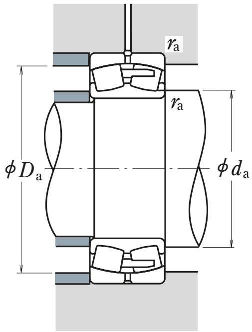
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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	***23934CAME4**
	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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

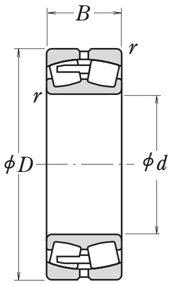
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Desginations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
∗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

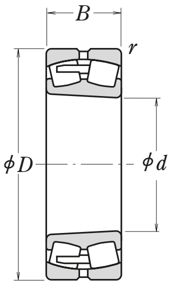
Remarks
1. Bearings denoted by an asterisk (∗) are NSKHPS bearings; they come standard with an oil groove and holes.
2. The recommended fits (shaft tolerances) on Page A164 are different when selecting NSKHPS bearings.
   In this case, light loads are defined as $\leqq 0.05C_r$ normal loads as 0.05 to $0.10C_r$, and heavy loads as $> 0.10C_r$.
3. For the dimensions of adapters and withdrawal sleeves, refer to Pages C352 and C358.

SPHERICAL ROLLER BEARINGS

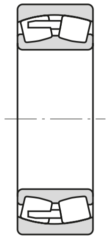
Bore Diameter 180 – 190 mm



Cylindrical Bore



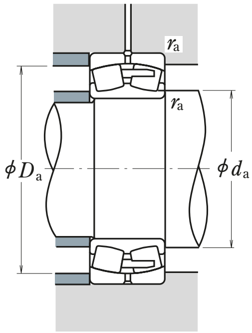
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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	**∗23938CAME4**
	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 (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

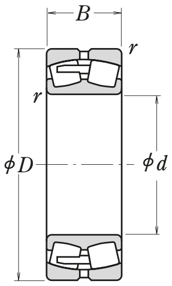
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

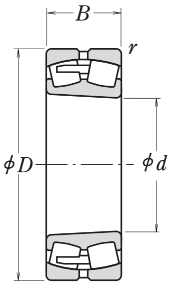
Desgignations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
∗23936CAMKE4	190	—	240	230	2	0.18	5.5	3.7	3.6	7.64
∗23036CAMKE4	192	—	268	249	2	0.24	4.2	2.8	2.8	17.1
23036CDKE4	192	202	268	249	2	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
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 ≦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 C352 and C358.

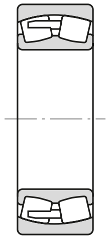
Bore Diameter 200 – 220 mm



Cylindrical Bore



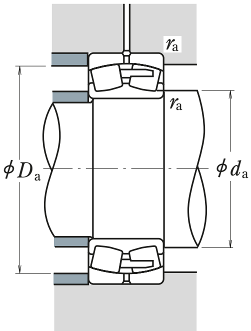
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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**
220	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**
	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 (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

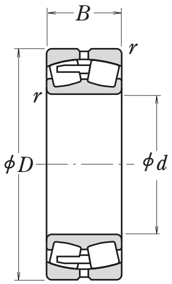
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

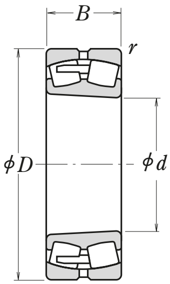
Desgintions Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
∗23940CAMKE4	212	—	268	258	2	0.20	5.1	3.4	3.3	11
∗23040CAMKE4	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
∗24040CAMK30E4	212	—	298	271	2	0.33	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
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 $\leqq 0.05C_r$ 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 C353 and C359.

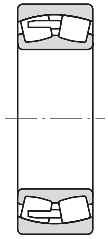
Bore Diameter 240 – 280 mm



Cylindrical Bore



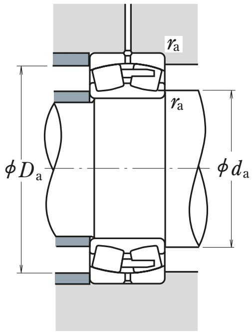
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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	**∗23952CAME4**
	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**
280	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**
	460	146	5	2 790 000	4 000 000	1 000	1 500	560	**∗23156CAME4**
	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**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

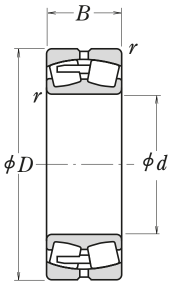
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

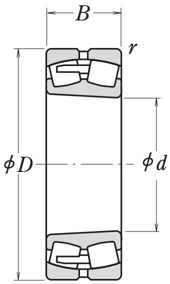
Desgionations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
∗23948CAMKE4	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
∗23048CAMKE4	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
∗24048CAMK30E4	254	—	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
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 $\leqq 0.05C_r$ 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 C353 and C359.

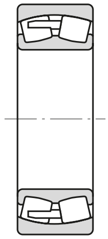
Bore Diameter 300 – 380 mm



Cylindrical Bore



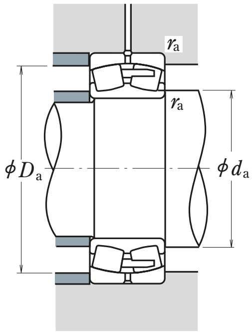
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
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	∗**23964CAME4**
	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 (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

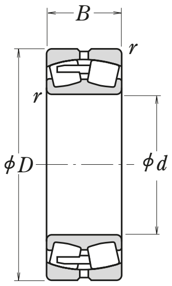
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

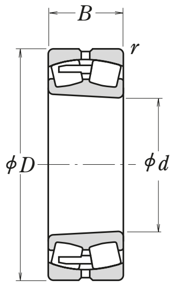
Desginations Tapered Bore([1])	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
∗23960CAMKE4	314	—	406	386	2.5	0.19	5.2	3.5	3.4	38.2
∗23060CAMKE4	318	—	442	413	3	0.24	4.2	2.8	2.7	70.5
∗24060CAMK30E4	318	—	442	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
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 $\leqq 0.05C_r$ 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 C354 and C360.

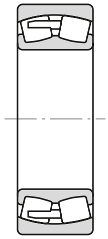
Bore Diameter 400 – 460 mm



Cylindrical Bore



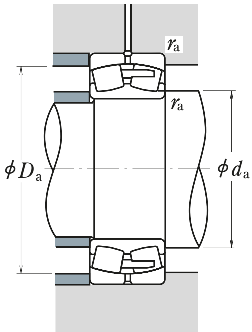
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
400	540	106	4	2 370 000	4 250 000	1 000	1 400	530	**∗23980CAME4**
	600	148	5	3 700 000	5 900 000	800	1 300	480	**∗23080CAME4**
	600	200	5	4 500 000	7 600 000	560	1 100	400	**∗24080CAME4**
	650	200	6	4 150 000	7 900 000	500	—	380	**23180CAME4**
	650	250	6	4 950 000	10 100 000	320	—	380	**24180CAME4**
	720	256	6	5 800 000	10 400 000	380	—	340	**23280CAME4**
420	560	106	4	2 340 000	4 250 000	1 000	1 400	500	**∗23984CAME4**
	620	150	5	2 910 000	5 850 000	670	—	450	**23084CAME4**
	620	200	5	3 750 000	8 100 000	480	—	380	**24084CAME4**
	700	224	6	5 000 000	9 400 000	480	—	340	**23184CAME4**
	700	280	6	6 000 000	12 000 000	280	—	340	**24184CAME4**
	760	272	7.5	6 450 000	11 700 000	360	—	320	**23284CAME4**
440	600	118	4	2 190 000	4 800 000	630	—	450	**23988CAME4**
	650	157	6	3 150 000	6 350 000	630	—	430	**23088CAME4**
	650	212	6	4 150 000	9 100 000	450	—	360	**24088CAME4**
	720	226	6	5 300 000	10 300 000	430	—	320	**23188CAME4**
	720	280	6	6 000 000	12 100 000	280	—	320	**24188CAME4**
	790	280	7.5	6 900 000	12 800 000	340	—	300	**23288CAME4**
460	620	118	4	2 220 000	4 950 000	600	—	430	**23992CAME4**
	680	163	6	3 450 000	7 100 000	600	—	400	**23092CAME4**
	680	218	6	4 500 000	9 950 000	430	—	340	**24092CAME4**
	760	240	7.5	5 700 000	10 900 000	430	—	300	**23192CAME4**
	760	300	7.5	6 300 000	12 400 000	280	—	300	**24192CAME4**
	830	296	7.5	7 350 000	13 700 000	320	—	280	**23292CAME4**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

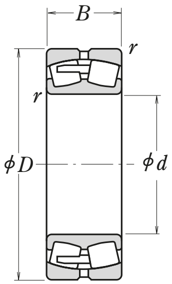
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

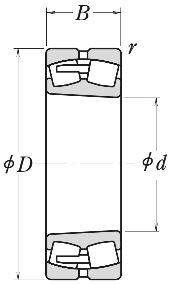
Desgniations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
∗23980CAMKE4	418	—	522	501	3	0.18	5.7	3.9	3.8	69.1
∗23080CAMKE4	422	—	578	540	4	0.23	4.4	3.0	2.9	146
∗24080CAMK30E4	422	—	578	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
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 $\leqq 0.05C_r$ 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 C354 – C355 and C360 – C361.

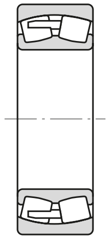
Bore Diameter 480 – 560 mm



Cylindrical Bore



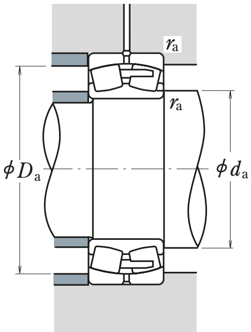
Tapered Bore



Without an Oil Groove and Holes

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	*D*	*B*	*r* min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
480	650	128	5	2 580 000	5 850 000	560	—	400	**23996CAME4**
	700	165	6	3 800 000	7 950 000	560	—	400	**23096CAME4**
	700	218	6	4 600 000	10 200 000	400	—	320	**24096CAME4**
	790	248	7.5	6 050 000	11 700 000	400	—	300	**23196CAME4**
	790	308	7.5	7 150 000	14 600 000	240	—	300	**24196CAME4**
	870	310	7.5	7 850 000	14 400 000	300	—	260	**23296CAME4**
500	670	128	5	2 460 000	5 550 000	560	—	400	**239/500CAME4**
	720	167	6	3 750 000	8 100 000	530	—	380	**230/500CAME4**
	720	218	6	4 450 000	9 900 000	400	—	300	**240/500CAME4**
	830	264	7.5	6 850 000	13 400 000	360	—	280	**231/500CAME4**
	830	325	7.5	8 000 000	16 000 000	220	—	280	**241/500CAME4**
	920	336	7.5	9 000 000	16 600 000	280	—	260	**232/500CAME4**
530	710	136	5	2 930 000	6 800 000	500	—	360	**239/530CAME4**
	780	185	6	4 400 000	9 200 000	500	—	340	**230/530CAME4**
	780	250	6	5 400 000	11 800 000	360	—	280	**240/530CAME4**
	870	272	7.5	7 150 000	14 100 000	340	—	260	**231/530CAME4**
	870	335	7.5	8 500 000	17 500 000	200	—	260	**241/530CAME4**
	980	355	9.5	10 100 000	18 800 000	260	—	240	**232/530CAME4**
560	750	140	5	3 100 000	7 250 000	480	—	340	**239/560CAME4**
	820	195	6	5 000 000	10 700 000	450	—	320	**230/560CAME4**
	820	258	6	5 950 000	13 300 000	340	—	260	**240/560CAME4**
	920	280	7.5	7 850 000	15 500 000	320	—	240	**231/560CAME4**
	920	355	7.5	9 400 000	19 600 000	190	—	240	**241/560CAME4**
	1 030	365	9.5	10 900 000	20 500 000	240	—	220	**232/560CAME4**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

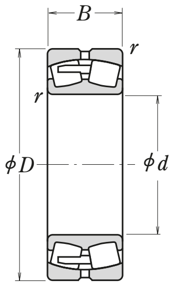
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

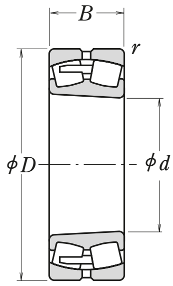
Desgination Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
23996CAMKE4	502	—	628	602	4	0.18	5.7	3.8	3.7	121
23096CAMKE4	508	—	672	633	5	0.22	4.6	3.1	3.0	211
24096CAMK30E4	508	—	672	625	5	0.30	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.

Bore Diameter 600 – 750 mm



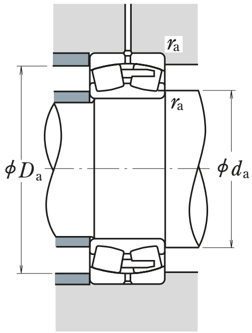
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing
d	*D*	*B*	*r* min.	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds Mechanical	Limiting Speeds Grease	Cylindrical Bore
600	800	150	5	3 450 000	8 100 000	450	—	320	**239/600CAME4**
	870	200	6	5 450 000	12 200 000	400	—	300	**230/600CAME4**
	870	272	6	6 600 000	15 100 000	300	—	240	**240/600CAME4**
	980	300	7.5	8 750 000	17 500 000	280	—	220	231/600CAME4
	980	375	7.5	10 400 000	21 900 000	170	—	220	**241/600CAME4**
	1 090	388	9.5	12 700 000	24 900 000	200	—	200	**232/600CAME4**
630	850	165	6	4 000 000	9 350 000	400	—	300	**239/630CAME4**
	920	212	7.5	5 900 000	12 700 000	400	—	280	**230/630CAME4**
	920	290	7.5	7 550 000	17 700 000	280	—	220	**240/630CAME4**
	1 030	315	7.5	9 600 000	19 400 000	260	—	200	231/630CAME4
	1 030	400	7.5	11 300 000	23 900 000	160	—	200	**241/630CAME4**
	1 150	412	12	13 400 000	25 600 000	200	—	180	**232/630CAME4**
670	900	170	6	4 350 000	10 300 000	380	—	260	**239/670CAME4**
	980	230	7.5	6 850 000	15 000 000	360	—	240	**230/670CAME4**
	980	308	7.5	8 450 000	19 500 000	260	—	200	**240/670CAME4**
	1 090	336	7.5	10 600 000	21 600 000	240	—	190	**231/670CAME4**
	1 090	412	7.5	12 400 000	26 500 000	150	—	190	**241/670CAME4**
	1 220	438	12	14 900 000	28 700 000	180	—	170	**232/670CAME4**
710	950	180	6	4 800 000	11 700 000	360	—	240	**239/710CAME4**
	1 030	236	7.5	7 100 000	15 800 000	340	—	240	**230/710CAME4**
	1 030	315	7.5	8 850 000	20 700 000	240	—	190	**240/710CAME4**
	1 150	438	9.5	13 900 000	30 500 000	130	—	170	**241/710CAME4**
	1 280	450	12	15 700 000	30 500 000	170	—	160	**232/710CAME4**
750	1 000	185	6	5 250 000	12 800 000	320	—	220	**239/750CAME4**
	1 090	250	7.5	7 750 000	17 200 000	320	—	220	**230/750CAME4**
	1 090	335	7.5	10 100 000	24 000 000	220	—	180	**240/750CAME4**
	1 360	475	15	17 700 000	35 500 000	150	—	140	**232/750CAME4**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

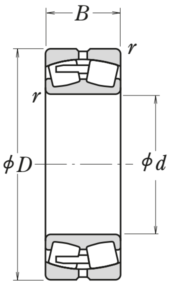
Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

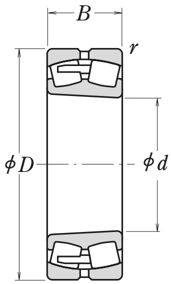
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Desginations	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore[1]	d_a		D_a		r_a	e	Y_2	Y_3	Y_0	approx.
	min.	max.	max.	min.	max.					
239/600CAMKE4	622	—	778	745	4	0.17	5.9	3.9	3.9	205
230/600CAMKE4	628	—	842	794	5	0.21	4.8	3.3	3.2	389
240/600CAMK30E4	628	—	842	772	5	0.30	3.3	2.2	2.2	529
231/600CAMKE4	636	—	944	856	6	0.30	3.4	2.3	2.2	898
241/600CAMK30E4	636	—	944	836	6	0.39	2.6	1.8	1.7	1 050
232/600CAMKE4	644	—	1 046	923	8	0.36	2.8	1.9	1.8	1 590
239/630CAMKE4	658	—	822	786	5	0.18	5.6	3.8	3.7	259
230/630CAMKE4	666	—	884	835	6	0.22	4.7	3.1	3.1	468
240/630CAMK30E4	666	—	884	815	6	0.30	3.3	2.2	2.2	637
231/630CAMKE4	666	—	994	900	6	0.30	3.4	2.3	2.2	1 040
241/630CAMK30E4	666	—	994	876	6	0.38	2.7	1.8	1.7	1 250
232/630CAMKE4	684	—	1 096	970	10	0.37	2.8	1.9	1.8	1 850
239/670CAMKE4	698	—	872	836	5	0.17	5.8	3.9	3.8	300
230/670CAMKE4	706	—	944	891	6	0.22	4.7	3.1	3.1	571
240/670CAMK30E4	706	—	944	868	6	0.30	3.3	2.2	2.2	773
231/670CAMKE4	706	—	1 054	952	6	0.30	3.3	2.2	2.2	1 230
241/670CAMK30E4	706	—	1 054	934	6	0.37	2.7	1.8	1.8	1 440
232/670CAMKE4	724	—	1 166	1 024	10	0.37	2.7	1.8	1.8	2 210
239/710CAMKE4	738	—	922	883	5	0.17	5.8	3.9	3.8	352
230/710CAMKE4	746	—	994	936	6	0.22	4.6	3.1	3.0	647
240/710CAMK30E4	746	—	994	916	6	0.29	3.4	2.3	2.2	861
241/710CAMK30E4	754	—	1 106	981	8	0.38	2.6	1.8	1.7	1 730
232/710CAMKE4	764	—	1 226	1 080	10	0.36	2.8	1.9	1.8	2 470
239/750CAMKE4	778	—	972	931	5	0.17	6.0	4.1	4.0	398
230/750CAMKE4	786	—	1 054	990	6	0.22	4.6	3.1	3.0	768
240/750CAMK30E4	786	—	1 054	969	6	0.29	3.4	2.3	2.2	1 030
232/750CAMKE4	814	—	1 296	1 148	12	0.36	2.8	1.9	1.8	2 980

Bore Diameter 800 – 1400 mm



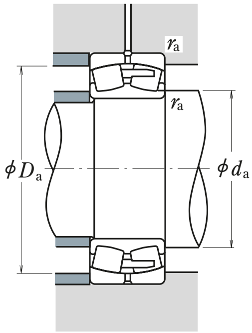
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min^{-1})			Bearing
						Thermal Reference Speed	Limiting Speeds		
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore
800	1 060	195	6	5 600 000	13 700 000	300	—	220	**239/800CAME4**
	1 150	258	7.5	8 350 000	19 100 000	300	—	200	**230/800CAME4**
	1 150	345	7.5	10 900 000	26 300 000	200	—	160	**240/800CAME4**
	1 280	375	9.5	13 800 000	29 200 000	190	—	150	231/800CAME4
	1 420	488	15	20 300 000	41 000 000	130	—	130	**232/800CAME4**
850	1 120	200	6	6 100 000	15 200 000	280	—	190	**239/850CAME4**
	1 220	272	7.5	9 300 000	21 400 000	280	—	180	**230/850CAME4**
	1 220	365	7.5	11 600 000	28 300 000	190	—	150	**240/850CAME4**
	1 500	515	15	22 300 000	45 500 000	120	—	120	**232/850CAME4**
900	1 180	206	6	6 600 000	16 700 000	260	—	180	**239/900CAME4**
	1 280	280	7.5	9 850 000	22 800 000	260	—	160	230/900CAME4
	1 280	375	7.5	12 800 000	31 500 000	170	—	140	**240/900CAME4**
	1 580	515	15	23 400 000	47 500 000	120	—	110	**232/900CAME4**
950	1 250	224	7.5	7 600 000	19 900 000	240	—	160	**239/950CAME4**
	1 360	300	7.5	11 300 000	26 500 000	240	—	150	**230/950CAME4**
	1 360	412	7.5	14 500 000	36 500 000	160	—	120	**240/950CAME4**
	1 660	530	15	24 700 000	50 500 000	110	—	100	**232/950CAME4**
1 000	1 320	236	7.5	8 200 000	21 700 000	220	—	150	239/1000CAME4
	1 420	308	7.5	11 900 000	28 100 000	220	—	140	230/1000CAME4
	1 420	412	7.5	15 300 000	38 500 000	150	—	110	**240/1000CAME4**
1 060	1 400	250	7.5	9 300 000	24 400 000	200	—	130	**239/1060CAME4**
	1 500	325	9.5	13 000 000	31 500 000	200	—	120	**230/1060CAME4**
	1 500	438	9.5	16 800 000	43 000 000	140	—	100	240/1060CAME4
1 120	1 580	345	9.5	15 400 000	38 000 000	180	—	110	230/1120CAME4
	1 580	462	9.5	18 700 000	49 500 000	120	—	95	**240/1120CAME4**
1 180	1 660	475	9.5	20 200 000	52 500 000	120	—	85	240/1180CAME4
1 250	1 750	500	9.5	21 000 000	59 500 000	110	—	75	**240/1250CAME4**
1 320	1 850	530	12	22 600 000	63 500 000	100	—	67	**240/1320CAME4**
1 400	1 950	545	12	24 500 000	65 000 000	95	—	60	**240/1400CAME4**

Note (1) Suffixes K and K30 represent bearings with tapered bores (taper 1:12 or 1:30).



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
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.

Desgination	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
239/800CAMKE4	828	—	1 032	987	5	0.17	6.0	4.0	3.9	462
230/800CAMKE4	836	—	1 114	1 045	6	0.21	4.7	3.2	3.1	870
240/800CAMK30E4	836	—	1 114	1 029	6	0.27	3.7	2.5	2.5	1 130
231/800CAMKE4	844	—	1 236	1 127	8	0.28	3.6	2.4	2.3	1 870
232/800CAMKE4	864	—	1 356	1 208	12	0.35	2.8	1.9	1.9	3 250
239/850CAMKE4	878	—	1 092	1 046	5	0.16	6.2	4.2	4.1	523
230/850CAMKE4	886	—	1 184	1 109	6	0.21	4.8	3.2	3.1	1 020
240/850CAMK30E4	886	—	1 184	1 093	6	0.28	3.6	2.4	2.4	1 350
232/850CAMKE4	914	—	1 436	1 274	12	0.35	2.8	1.9	1.9	3 890
239/900CAMKE4	928	—	1 152	1 103	5	0.16	6.4	4.3	4.2	591
230/900CAMKE4	936	—	1 244	1 169	6	0.20	4.9	3.3	3.2	1 160
240/900CAMK30E4	936	—	1 244	1 147	6	0.28	3.6	2.4	2.4	1 520
232/900CAMKE4	964	—	1 516	1 354	12	0.33	3.0	2.0	2.0	4 300
239/950CAMKE4	986	—	1 214	1 169	6	0.16	6.3	4.2	4.1	732
230/950CAMKE4	986	—	1 324	1 241	6	0.21	4.8	3.2	3.2	1 400
240/950CAMK30E4	986	—	1 324	1 219	6	0.28	3.6	2.4	2.3	1 880
232/950CAMKE4	1 014	—	1 596	1 428	12	0.32	3.1	2.1	2.1	4 800
239/1000CAMKE4	1 036	—	1 284	1 229	6	0.16	6.4	4.3	4.2	881
230/1000CAMKE4	1 036	—	1 384	1 298	6	0.20	4.9	3.3	3.2	1 560
240/1000CAMK30E4	1 036	—	1 384	1 275	6	0.27	3.7	2.5	2.4	2 010
239/1060CAMKE4	1 096	—	1 364	1 302	6	0.16	6.1	4.1	4.0	1 030
230/1060CAMKE4	1 104	—	1 456	1 368	8	0.21	4.9	3.3	3.2	1 790
240/1060CAMK30E4	1 104	—	1 456	1 346	8	0.28	3.6	2.4	2.4	2 410
230/1120CAMKE4	1 164	—	1 536	1 444	8	0.20	5.0	3.4	3.3	2 120
240/1120CAMK30E4	1 164	—	1 536	1 421	8	0.27	3.7	2.5	2.5	2 790
240/1180CAMK30E4	1 224	—	1 616	1 494	8	0.27	3.7	2.5	2.4	3 180
240/1250CAMK30E4	1 294	—	1 706	1 579	8	0.25	4.0	2.7	2.6	3 700
240/1320CAMK30E4	1 374	—	1 796	1 656	10	0.26	3.9	2.6	2.6	4 400
240/1400CAMK30E4	1 454	—	1 896	1 767	10	0.25	4.0	2.7	2.6	4 900


NSK

8. THRUST BALL BEARINGS

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.

Table1 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	51156X – 51172X
51200 – 51236X	51238X – 51272X
51305 – 51336X	51338X – 51340X
51405 – 51418X	51420X – 51436X
53200 – 53236X	53238X – 53272X
53305 – 53336X	53338X – 53340X
53405 – 53418X	53420X – 53436X

TOLERANCES AND RUNNING ACCURACY

THRUST BALL BEARINGS .... Table 7.6 (Pages A140 to A142)

RECOMMENDED FITS

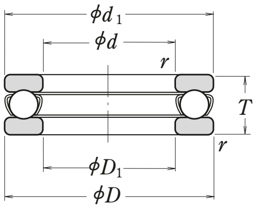
THRUST BALL BEARINGS ....Table 8.4 (Pages A164)
Table 8.6 (Pages A165)

MINIMUM AXIAL LOAD

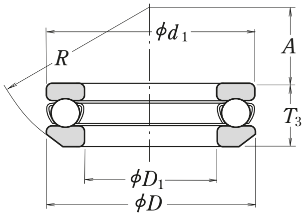
Be sure to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.

SINGLE-DIRECTION THRUST BALL BEARINGS

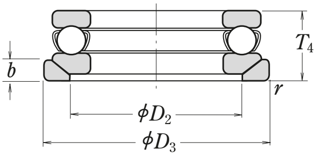
Bore Diameter 10 – 50 mm



With Flat Seat

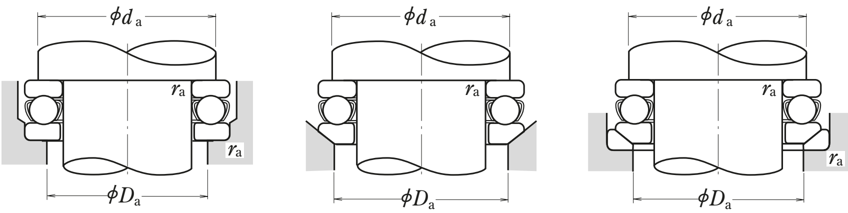


With Aligning Seat



With Aligning Seat Washer

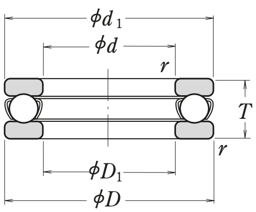
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat
10	24	9	—	—	0.3	10 100	14 000	6 700	10 000	**51100**
	26	11	11.6	13	0.6	12 800	17 100	6 000	9 000	**51200**
12	26	9	—	—	0.3	10 400	15 400	6 700	10 000	**51101**
	28	11	11.4	13	0.6	13 300	19 000	5 600	8 500	**51201**
15	28	9	—	—	0.3	10 600	16 800	6 300	9 500	**51102**
	32	12	13.3	15	0.6	16 700	24 800	5 000	7 500	**51202**
17	30	9	—	—	0.3	11 400	19 500	6 000	9 000	**51103**
	35	12	13.2	15	0.6	17 300	27 300	4 800	7 500	**51203**
20	35	10	—	—	0.3	15 100	26 600	5 300	8 000	**51104**
	40	14	14.7	17	0.6	22 500	37 500	4 300	6 300	**51204**
25	42	11	—	—	0.6	19 700	37 000	4 800	7 100	**51105**
	47	15	16.7	19	0.6	28 000	50 500	3 800	5 600	**51205**
	52	18	19.8	22	1	36 000	61 500	3 200	5 000	**51305**
	60	24	26.4	29	1	56 000	89 500	2 600	4 000	**51405**
30	47	11	—	—	0.6	20 600	42 000	4 300	6 700	**51106**
	52	16	17.8	20	0.6	29 500	58 000	3 400	5 300	**51206**
	60	21	22.6	25	1	43 000	78 500	2 800	4 300	**51306**
	70	28	30.1	33	1	73 000	126 000	2 200	3 400	**51406**
35	52	12	—	—	0.6	22 100	49 500	4 000	6 000	**51107**
	62	18	19.9	22	1	39 500	78 000	3 000	4 500	**51207**
	68	24	25.6	28	1	56 000	105 000	2 400	3 800	**51307**
	80	32	34	37	1.1	87 500	155 000	2 000	3 000	**51407**
40	60	13	—	—	0.6	27 100	63 000	3 600	5 300	**51108**
	68	19	20.3	23	1	47 500	98 500	2 800	4 300	**51208**
	78	26	28.5	31	1	70 000	135 000	2 200	3 400	**51308**
	90	36	38.2	42	1.1	103 000	188 000	1 700	2 600	**51408**
45	65	14	—	—	0.6	28 100	69 000	3 400	5 000	**51109**
	73	20	21.3	24	1	48 000	105 000	2 600	4 000	**51209**
	85	28	30.1	33	1	80 500	163 000	2 000	3 000	**51309**
	100	39	42.4	46	1.1	128 000	246 000	1 600	2 400	**51409**
50	70	14	—	—	0.6	29 000	75 500	3 200	4 800	**51110**
	78	22	23.5	26	1	49 000	111 000	2 400	3 600	**51210**
	95	31	34.3	37	1.1	97 500	202 000	1 800	2 800	**51310**
	110	43	45.6	50	1.5	147 000	288 000	1 400	2 200	**51410**



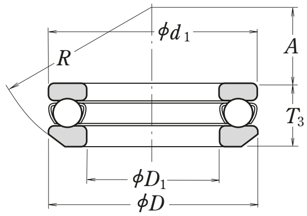
Designations		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	24	11	—	—	—	—	—	18	16	0.3	0.019	—	—
53200	**53200 U**	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	—	—
53201	**53201 U**	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	—	—
53202	**53202 U**	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	—	—
53203	**53203 U**	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	—	—
53204	**53204 U**	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	—	—
53205	**53205 U**	47	27	36	50	5.5	19	40	38	34	0.6	0.111	0.123	0.151
53305	**53305 U**	52	27	38	55	6	21	45	41	36	1	0.169	0.182	0.224
53405	**53405 U**	60	27	42	62	8	19	50	46	39	1	0.334	0.353	0.426
—	—	47	32	—	—	—	—	—	40	37	0.6	0.064	—	—
53206	**53206 U**	52	32	42	55	5.5	22	45	43	39	0.6	0.137	0.154	0.183
53306	**53306 U**	60	32	45	62	7	22	50	48	42	1	0.267	0.28	0.336
53406	**53406 U**	70	32	50	75	9	20	56	54	46	1	0.519	0.535	0.666
—	—	52	37	—	—	—	—	—	45	42	0.6	0.081	—	—
53207	**53207 U**	62	37	48	65	7	24	50	51	46	1	0.21	0.231	0.292
53307	**53307 U**	68	37	52	72	7.5	24	56	55	48	1	0.386	0.403	0.488
53407	**53407 U**	80	37	58	85	10	23	64	62	53	1	0.769	0.785	0.967
—	—	60	42	—	—	—	—	—	52	48	0.6	0.12	—	—
53208	**53208 U**	68	42	55	72	7	28.5	56	57	51	1	0.27	0.289	0.355
53308	**53308 U**	78	42	60	82	8.5	28	64	63	55	1	0.536	0.581	0.704
53408	**53408 U**	90	42	65	95	12	26	72	70	60	1	1.1	1.12	1.38
—	—	65	47	—	—	—	—	—	57	53	0.6	0.143	—	—
53209	**53209 U**	73	47	60	78	7.5	26	56	62	56	1	0.31	0.333	0.419
53309	**53309 U**	85	47	65	90	10	25	64	69	61	1	0.672	0.702	0.888
53409	**53409 U**	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	—	—
53210	**53210 U**	78	52	62	82	7.5	32.5	64	67	61	1	0.378	0.404	0.504
53310	**53310 U**	95	52	72	100	11	28	72	77	68	1	0.931	1.01	1.27
53410	**53410 U**	110	52	80	115	14	35	90	86	74	1.5	1.94	1.98	2.41

SINGLE-DIRECTION THRUST BALL BEARINGS

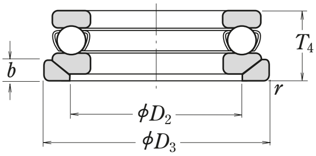
Bore Diameter 55 – 100 mm



With Flat Seat



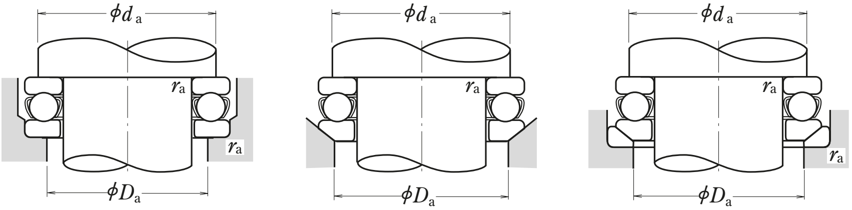
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	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**

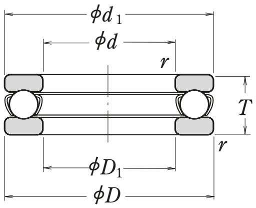
Note ([1]) The outside diameter d_1 of shaft washers for bearing designations with an X is smaller than the outside diameter D of the housing washers.



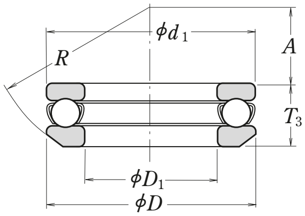
Designations(1)		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	78	57	—	—	—	—	—	69	64	0.6	0.227	—	—
53211	**53211 U**	90	57	72	95	9	35	72	76	69	1	0.599	0.656	0.819
53311	**53311 U**	105	57	80	110	11.5	30	80	85	75	1	1.31	1.45	1.78
53411	**53411 U**	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	—	—
53212	**53212 U**	95	62	78	100	9	32.5	72	81	74	1	0.673	0.731	0.897
53312	**53312 U**	110	62	85	115	11.5	41	90	90	80	1	1.4	1.51	1.83
53412	**53412 U**	130	62	95	135	16	34	100	102	88	1.5	3.16	3.2	3.91
—	—	90	67	—	—	—	—	—	80	75	1	0.324	—	—
53213	**53213 U**	100	67	82	105	9	40	80	86	79	1	0.756	0.812	0.989
53313	**53313 U**	115	67	90	120	12.5	38.5	90	95	85	1	1.54	1.67	2.04
53413	**53413 U**	140	68	100	145	17.5	40	112	110	95	2	4.1	4.22	5.13
—	—	95	72	—	—	—	—	—	85	80	1	0.346	—	—
53214	**53214 U**	105	72	88	110	9	38	80	91	84	1	0.793	0.866	1.05
53314	**53314 U**	125	72	98	130	13	43	100	103	92	1	2.0	2.2	2.64
53414	**53414 U**	150	73	110	155	19.5	34	112	118	102	2	5.05	5.12	6.21
—	—	100	77	—	—	—	—	—	90	85	1	0.389	—	—
53215	**53215 U**	110	77	92	115	9.5	49	90	96	89	1	0.845	1.27	1.11
53315	**53315 U**	135	77	105	140	15	37	100	111	99	1.5	2.6	2.8	3.42
53415	**53415 U**	160	78	115	165	21	42	125	125	110	2	6.15	6.23	7.58
—	—	105	82	—	—	—	—	—	95	90	1	0.417	—	—
53216	**53216 U**	115	82	98	120	10	46	90	101	94	1	0.931	1.01	1.23
53316	**53316 U**	140	82	110	145	15	50	112	116	104	1.5	2.74	2.94	3.55
53416	**53416 U**	170	83	125	175	22	36	125	133	117	2	7.21	7.33	8.9
—	—	110	87	—	—	—	—	—	100	95	1	0.44	—	—
53217	**53217 U**	125	88	105	130	11	52	100	109	101	1	1.22	1.35	1.63
53317	**53317 U**	150	88	115	155	17.5	43	112	124	111	1.5	3.57	3.78	4.67
53417 X	**53417 XU**	177	88	130	185	23	47	140	141	124	2	8.51	8.72	10.4
—	—	120	92	—	—	—	—	—	108	102	1	0.646	—	—
53218	**53218 U**	135	93	110	140	13.5	45	100	117	108	1	1.69	1.89	2.38
53318	**53318 U**	155	93	120	160	18	40	112	129	116	1.5	3.83	4.11	5.09
53418 X	**53418 XU**	187	93	140	195	25.5	40	140	149	131	2	10.2	10.3	12.4
—	—	135	102	—	—	—	—	—	121	114	1	0.96	—	—
53220	**53220 U**	150	103	125	155	14	52	112	130	120	1	2.25	2.49	3.03
53320	**53320 U**	170	103	135	175	18	46	125	142	128	1.5	4.98	5.31	6.37
53420 X	**53420 XU**	205	103	155	220	27	50	160	165	145	2.5	14.8	15	18.1

SINGLE-DIRECTION THRUST BALL BEARINGS

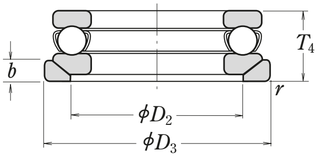
Bore Diameter 110 – 190 mm



With Flat Seat



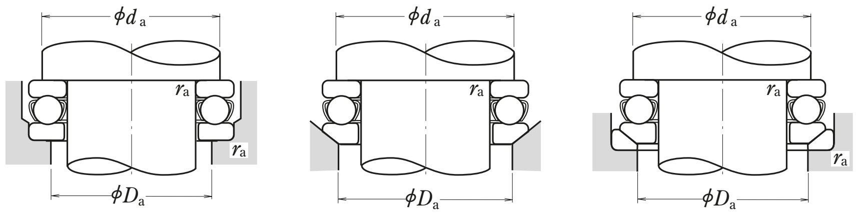
With Aligning Seat



With Aligning Seat Washer

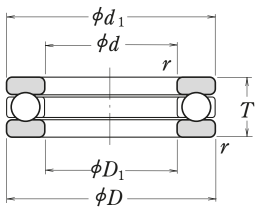
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat
110	145	25	—	—	1	88 000	288 000	1 700	2 400	**51122**
	160	38	40.2	45	1.1	136 000	395 000	1 300	1 900	**51222**
	190	63	67.2	72	2	282 000	755 000	900	1 300	**51322 X**
	230	95	99.7	109	3	415 000	1 150 000	630	950	**51422 X**
120	155	25	—	—	1	90 000	310 000	1 600	2 400	**51124**
	170	39	40.8	46	1.1	141 000	430 000	1 200	1 800	**51224**
	210	70	74.1	80	2.1	330 000	930 000	800	1 200	**51324 X**
	250	102	107.3	118	4	480 000	1 400 000	600	900	**51424 X**
130	170	30	—	—	1	105 000	350 000	1 400	2 000	**51126**
	190	45	47.9	53	1.5	183 000	550 000	1 100	1 600	**51226 X**
	225	75	80.3	86	2.1	350 000	1 030 000	750	1 100	**51326 X**
	270	110	115.2	128	4	525 000	1 590 000	530	800	**51426 X**
140	180	31	—	—	1	107 000	375 000	1 300	2 000	**51128 X**
	200	46	48.6	55	1.5	186 000	575 000	1 000	1 500	**51228 X**
	240	80	84.9	92	2.1	370 000	1 130 000	670	1 000	**51328 X**
	280	112	117	131	4	550 000	1 750 000	530	800	**51428 X**
150	190	31	—	—	1	110 000	400 000	1 300	1 900	**51130 X**
	215	50	53.3	60	1.5	238 000	735 000	950	1 400	**51230 X**
	250	80	83.7	92	2.1	380 000	1 200 000	670	1 000	**51330 X**
	300	120	125.9	140	4	620 000	2 010 000	480	710	**51430 X**
160	200	31	—	—	1	113 000	425 000	1 200	1 900	**51132 X**
	225	51	54.7	61	1.5	249 000	805 000	900	1 400	**51232 X**
	270	87	91.7	100	3	475 000	1 570 000	600	900	**51332 X**
	320	130	135.3	150	5	650 000	2 210 000	450	670	**51432 X**
170	215	34	—	—	1.1	135 000	510 000	1 100	1 700	**51134 X**
	240	55	58.7	65	1.5	280 000	915 000	850	1 300	**51234 X**
	280	87	91.3	100	3	465 000	1 570 000	600	900	**51334 X**
	340	135	141	156	5	715 000	2 480 000	430	630	**51434 X**
180	225	34	—	—	1.1	136 000	530 000	1 100	1 700	**51136 X**
	250	56	58.2	66	1.5	284 000	955 000	800	1 200	**51236 X**
	300	95	99.3	109	3	480 000	1 680 000	560	850	**51336 X**
	360	140	148.3	164	5	750 000	2 730 000	400	600	**51436 X**
190	240	37	—	—	1.1	172 000	655 000	1 000	1 600	**51138 X**
	270	62	65.7	73	2	320 000	1 110 000	750	1 100	**51238 X**
	320	105	111	121	4	550 000	1 960 000	500	750	**51338 X**

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.

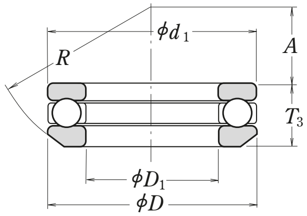


Designations[1]		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	145	112	—	—	—	—	—	131	124	1	1.04	—	—
53222	**53222 U**	160	113	135	165	14	65	125	140	130	1	2.42	2.65	3.2
53322 X	**53322 XU**	187	113	150	195	20.5	51	140	158	142	2	7.19	7.55	9.1
53422 X	**53422 XU**	225	113	170	240	29	59	180	181	159	2.5	20	20.5	24.3
—	—	155	122	—	—	—	—	—	141	134	1	1.12	—	—
53224	**53224 U**	170	123	145	175	15	61	125	150	140	1	2.7	2.94	3.58
53324 X	**53324 XU**	205	123	165	220	22	63	160	173	157	2	9.7	10.1	12.4
53424 X	**53424 XU**	245	123	185	260	32	70	200	196	174	3	26.2	26.5	31.3
—	—	170	132	—	—	—	—	—	154	146	1	1.68	—	—
53226 X	**53226 XU**	187	133	160	195	17	67	140	166	154	1.5	3.95	4.35	5.33
53326 X	**53326 XU**	220	134	177	235	26	53	160	186	169	2	12.1	12.7	15.8
53426 X	**53426 XU**	265	134	200	280	38	58	200	212	188	3	32.3	32.4	38.8
—	—	178	142	—	—	—	—	—	164	156	1	1.83	—	—
53228 X	**53228 XU**	197	143	170	210	17	87	160	176	164	1.5	4.3	4.74	5.89
53328 X	**53328 XU**	235	144	190	250	26	68	180	199	181	2	14.2	16.3	19.5
53428 X	**53428 XU**	275	144	206	290	38	83	225	222	198	3	34.7	34.8	41.4
—	—	188	152	—	—	—	—	—	174	166	1	1.95	—	—
53230 X	**53230 XU**	212	153	180	225	20.5	79	160	189	176	1.5	5.52	6.09	7.82
53330 X	**53330 XU**	245	154	200	260	26	89.5	200	209	191	2	15	17.3	20.5
53430 X	**53430 XU**	295	154	225	310	41	69	225	238	212	3	43.5	43.8	51.9
—	—	198	162	—	—	—	—	—	184	176	1	2.07	—	—
53232 X	**53232 XU**	222	163	190	235	21	74	160	199	186	1.5	6.04	6.78	8.7
53332 X	**53332 XU**	265	164	215	280	29	77	200	225	205	2.5	19.6	22.3	26.7
53432 X	**53432 XU**	315	164	240	330	41.5	84	250	254	226	4	52.7	52.9	62
—	—	213	172	—	—	—	—	—	197	188	1	2.72	—	—
53234 X	**53234 XU**	237	173	200	250	21.5	91	180	212	198	1.5	7.41	8.21	10.5
53334 X	**53334 XU**	275	174	220	290	29	105	225	235	215	2.5	20.3	23.2	28
53434 X	**53434 XU**	335	174	255	350	46	74	250	269	241	4	61.2	61.3	73
—	—	222	183	—	—	—	—	—	207	198	1	2.79	—	—
53236 X	**53236 XU**	247	183	210	260	21.5	112	200	222	208	1.5	7.94	8.57	10.8
53336 X	**53336 XU**	295	184	240	310	32	91	225	251	229	2.5	25.9	29.2	34.9
53436 X	**53436 XU**	355	184	270	370	46.5	97	280	285	255	4	70.5	72.1	84.9
—	—	237	193	—	—	—	—	—	220	210	1	3.6	—	—
53238 X	**53238 XU**	267	194	230	280	23	98	200	238	222	2	11.8	12.9	15.7
53338 X	**53338 XU**	315	195	255	330	33	104	250	266	244	3	36.5	38.1	44.7

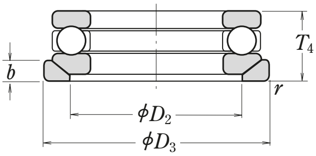
Bore Diameter 200 – 360 mm



With Flat Seat



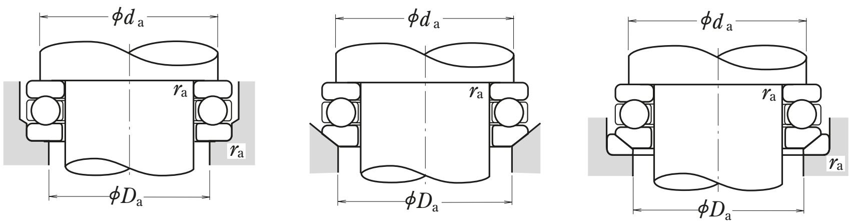
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat
200	250	37	—	—	1.1	173 000	675 000	1 000	1 500	**51140X**
	280	62	65.3	74	2	315 000	1 110 000	710	1 100	**51240X**
	340	110	118.4	130	4	600 000	2 220 000	480	710	**51340X**
220	270	37	—	—	1.1	179 000	740 000	950	1 500	**51144X**
	300	63	65.6	75	2	325 000	1 210 000	670	1 000	**51244X**
240	300	45	—	—	1.5	229 000	935 000	850	1 200	**51148X**
	340	78	81.6	92	2.1	420 000	1 650 000	560	850	**51248X**
260	320	45	—	—	1.5	233 000	990 000	800	1 200	**51152X**
	360	79	82.8	93	2.1	435 000	1 800 000	560	850	**51252X**
280	350	53	—	—	1.5	315 000	1 310 000	710	1 000	**51156X**
	380	80	85	94	2.1	450 000	1 950 000	530	800	**51256X**
300	380	62	—	—	2	360 000	1 560 000	600	900	**51160X**
	420	95	100.5	112	3	540 000	2 410 000	450	670	**51260X**
320	400	63	—	—	2	365 000	1 660 000	600	900	**51164X**
	440	95	100.5	112	3	585 000	2 680 000	450	670	**51264X**
340	420	64	—	—	2	375 000	1 760 000	560	850	**51168X**
	460	96	100.3	113	3	595 000	2 800 000	430	630	**51268X**
360	440	65	—	—	2	385 000	1 860 000	560	800	**51172X**
	500	110	116.7	130	4	705 000	3 500 000	380	560	**51272X**

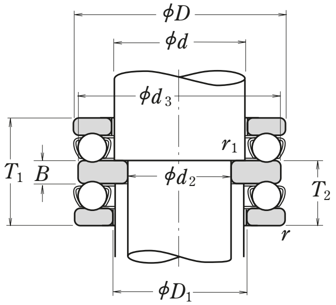
Note (1) The outside diameter d_1 of shaft washers for bearing designations with an X is smaller than the outside diameter D of the housing washers.



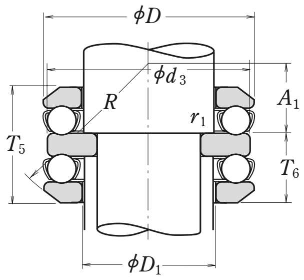
Designations[1]		Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	—	247	203	—	—	—	—	—	230	220	1	3.75	—	—
53240 X	**53240 XU**	277	204	240	290	23	125	225	248	232	2	12.3	13.4	16.1
53340 X	**53340 XU**	335	205	270	350	38	92	250	282	258	3	43.6	46.2	54.8
—	—	267	223	—	—	—	—	—	250	240	1	4.09	—	—
53244 X	**53244 XU**	297	224	260	310	25	118	225	268	252	2	13.6	14.9	18
—	—	297	243	—	—	—	—	—	276	264	1.5	6.55	—	—
53248 X	**53248 XU**	335	244	290	350	30	122	250	299	281	2	23.7	25.6	30.7
—	—	317	263	—	—	—	—	—	296	284	1.5	7.01	—	—
53252 X	**53252 XU**	355	264	305	370	30	152	280	319	301	2	25.1	27.3	33.2
—	—	347	283	—	—	—	—	—	322	308	1.5	12	—	—
53256 X	**53256 XU**	375	284	325	390	31	143	280	339	321	2	27.1	30.3	37
—	—	376	304	—	—	—	—	—	348	332	2	17.2	—	—
53260 X	**53260 XU**	415	304	360	430	34	164	320	371	349	2.5	43.5	47.7	56.1
—	—	396	324	—	—	—	—	—	368	352	2	18.6	—	—
53264 X	**53264 XU**	435	325	380	450	36	157	320	391	369	2.5	45	49.9	59.4
—	—	416	344	—	—	—	—	—	388	372	2	19.9	—	—
53268 X	**53268 XU**	455	345	400	470	36	199	360	411	389	2.5	47.9	52.7	62
—	—	436	364	—	—	—	—	—	408	392	2	21.5	—	—
53272 X	**53272 XU**	495	365	430	510	43	172	360	442	418	3	68.8	76.3	90.9

DOUBLE-DIRECTION THRUST BALL BEARINGS

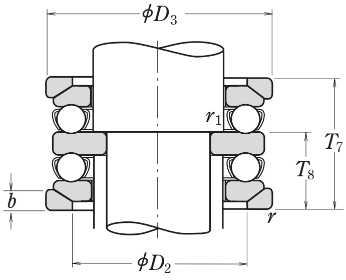
Bore Diameter 10 – 55 mm



With Flat Seat

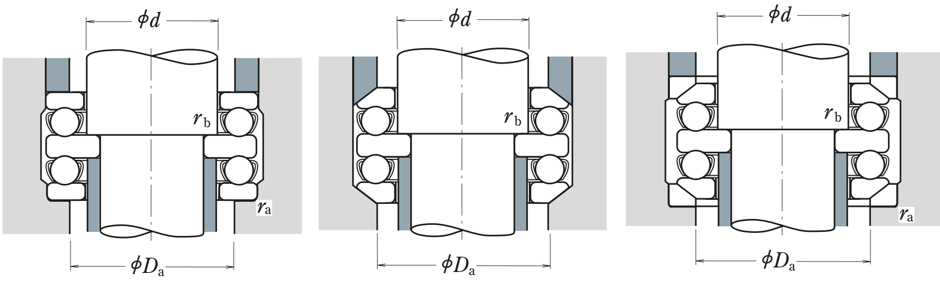


With Aligning Seat



With Aligning Seat Washer

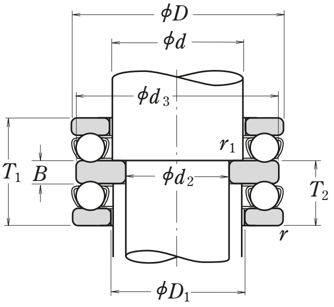
Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing	
d_2	d	D	T_1	T_5	T_7	r min.	r_1 min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat
10	15	32	22	24.6	28	0.6	0.3	16 700	24 800	4 800	7 100	**52202**	**54202**
15	20	40	26	27.4	32	0.6	0.3	22 500	37 500	4 000	6 000	**52204**	**54204**
	25	60	45	49.8	55	1	0.6	56 000	89 500	2 400	3 600	**52405**	**54405**
20	25	47	28	31.4	36	0.6	0.3	28 000	50 500	3 400	5 300	**52205**	**54205**
	25	52	34	37.6	42	1	0.3	36 000	61 500	3 000	4 500	**52305**	**54305**
	30	70	52	56.2	62	1	0.6	73 000	126 000	2 200	3 200	**52406**	**54406**
25	30	52	29	32.6	37	0.6	0.3	29 500	58 000	3 200	5 000	**52206**	**54206**
	30	60	38	41.2	46	1	0.3	43 000	78 500	2 600	4 000	**52306**	**54306**
	35	80	59	63	69	1.1	0.6	87 500	155 000	1 800	2 800	**52407**	**54407**
30	35	62	34	37.8	42	1	0.3	39 500	78 000	2 800	4 300	**52207**	**54207**
	35	68	44	47.2	52	1	0.3	56 000	105 000	2 400	3 600	**52307**	**54307**
	40	68	36	38.6	44	1	0.6	47 500	98 500	2 600	3 800	**52208**	**54208**
	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**
35	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**
	45	100	72	78.8	86	1.1	0.6	128 000	246 000	1 500	2 200	**52409**	**54409**
40	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**



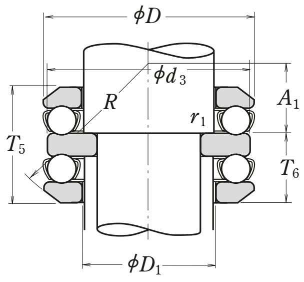
Designations	Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
With Aligning Seat Washer	d_3	D_1	D_2	D_3	T_2	T_6	T_8	B	b	A_1	R	D_a max.	r_a max.	r_b max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
54202 U	32	17	24	35	13.5	14.8	16.5	5	4	10.5	28	24	0.6	0.3	0.081	0.090	0.113
54204 U	40	22	30	42	16	16.7	19	6	5	16	36	30	0.6	0.3	0.148	0.151	0.185
54405 U	60	27	42	62	28	30.4	33	11	8	15	50	42	1	0.6	0.641	0.68	0.825
54205 U	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
54305 U	52	27	38	55	21	22.8	25	8	6	18	45	38	1	0.3	0.324	0.35	0.434
54406 U	70	32	50	75	32	34.1	37	12	9	16	56	50	1	0.6	0.978	1.01	1.27
54206 U	52	32	42	55	18	19.8	22	7	5.5	20	45	42	0.6	0.3	0.254	0.288	0.345
54306 U	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
54407 U	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
54207 U	62	37	48	65	21	22.9	25	8	7	21	50	48	1	0.3	0.406	0.447	0.57
54307 U	68	37	52	72	27	28.6	31	10	7.5	21	56	52	1	0.3	0.71	0.744	0.915
54208 U	68	42	55	72	22.5	23.8	26.5	9	7	25	56	55	1	0.6	0.543	0.581	0.713
54308 U	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
54408 U	90	42	65	95	40	42.2	46	15	12	22	72	65	1	0.6	1.98	2.02	2.54
54209 U	73	47	60	78	23	24.3	27	9	7.5	23	56	60	1	0.6	0.606	0.652	0.823
54309 U	85	47	65	90	32	34.1	37	12	10	21	64	65	1	0.6	1.28	1.34	1.71
54409 U	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
54210 U	78	52	62	82	24	25.5	28	9	7.5	30.5	64	62	1	0.6	0.697	0.75	0.949
54310 U	95	52	72	100	36	39.3	42	14	11	23	72	72	1	0.6	1.78	1.94	2.46
54410 U	110	52	80	115	48	50.6	55	18	14	30	90	80	1.5	0.6	3.51	3.59	4.45
54211 U	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
54311 U	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
54411 U	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
54212 U	95	62	78	100	28	30	33	10	9	30.5	72	78	1	0.6	1.22	1.33	1.66
54312 U	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
54412 U	130	62	95	135	57	60	64	21	16	28	100	95	1.5	0.6	5.74	5.82	7.24
54413 U	140	68	100	145	62	66.2	71	23	17.5	34	112	100	2	1	7.41	7.66	9.47
54213 U	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
54313 U	115	67	90	120	40	43.4	47	15	12.5	34.5	90	90	1	0.6	2.8	3.06	3.8
54214 U	105	72	88	110	28.5	30.3	33.5	10	9	36.5	80	88	1	1	1.44	1.59	1.95
54314 U	125	72	98	130	44	48.2	52	16	13	39	100	98	1	1	3.67	4.07	4.95
54414 U	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

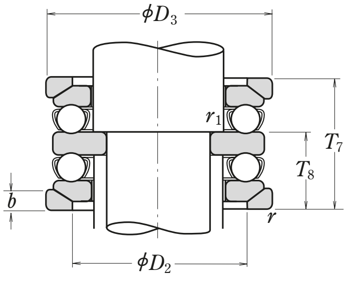
Bore Diameter 60 – 130 mm



With Flat Seat



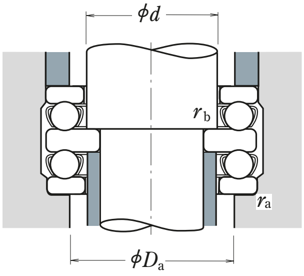
With Aligning Seat

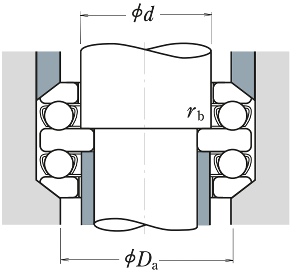


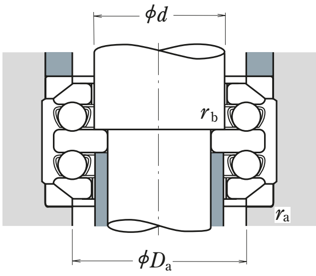
With Aligning Seat Washer

Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Designations[1]	
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
60	75	110	47	49.6	57	1	1	78 000	209 000	1 800	2 600	**52215**	**54215**
	75	135	79	87.2	95	1.5	1	159 000	365 000	1 200	1 800	**52315**	**54315**
	75	160	115	123	135	2	1	254 000	560 000	900	1 400	**52415**	**54415**
65	80	115	48	51	58	1	1	79 000	218 000	1 700	2 600	**52216**	**54216**
	80	140	79	86.2	95	1.5	1	164 000	395 000	1 200	1 800	**52316**	**54316**
	80	170	120	128.4	140	2.1	1	272 000	620 000	850	1 300	**52416**	**54416**
	85	180	128	138	150	2.1	1.1	310 000	755 000	800	1 200	**52417 X**	**54417 X**
70	85	125	55	59.2	67	1	1	96 000	264 000	1 500	2 200	**52217**	**54217**
	85	150	87	95.2	105	1.5	1	207 000	490 000	1 100	1 600	**52317**	**54317**
	90	190	135	143.4	157	2.1	1.1	330 000	825 000	750	1 100	**52418 X**	**54418 X**
75	90	135	62	69	76	1.1	1	114 000	310 000	1 400	2 000	**52218**	**54218**
	90	155	88	97.2	106	1.5	1	214 000	525 000	1 100	1 600	**52318**	**54318**
80	100	210	150	160	176	3	1.1	370 000	985 000	670	1 000	**52420 X**	**54420 X**
85	100	150	67	72.8	81	1.1	1	135 000	375 000	1 300	1 900	**52220**	**54220**
	100	170	97	105.4	115	1.5	1	239 000	595 000	950	1 500	**52320**	**54320**
90	110	230	166	—	—	3	1.1	415 000	1 150 000	600	900	**52422 X**	—
95	110	160	67	71.4	81	1.1	1	136 000	395 000	1 200	1 800	**52222**	**54222**
	110	190	110	118.4	128	2	1	282 000	755 000	850	1 300	**52322 X**	**54322 X**
	120	250	177	—	—	4	1.5	515 000	1 540 000	560	850	**52424 X**	—
100	120	170	68	71.6	82	1.1	1.1	141 000	430 000	1 200	1 800	**52224**	**54224**
	120	210	123	131.2	143	2.1	1.1	330 000	930 000	750	1 100	**52324 X**	**54324 X**
	130	270	192	—	—	4	1.5	525 000	1 590 000	530	800	**52426 X**	—
110	130	190	80	85.8	96	1.5	1.1	183 000	550 000	1 000	1 500	**52226 X**	**54226 X**
	130	225	130	—	—	2.1	1.1	350 000	1 030 000	710	1 100	**52326 X**	—
	140	280	196	—	—	4	1.5	550 000	1 750 000	500	750	**52428 X**	—
120	140	200	81	86.2	99	1.5	1.1	186 000	575 000	1 000	1 500	**52228 X**	**54228 X**
	140	240	140	—	—	2.1	1.1	370 000	1 130 000	670	1 000	**52328 X**	—
	150	300	209	—	—	4	2	620 000	2 010 000	480	710	**52430 X**	—
130	150	215	89	95.6	109	1.5	1.1	238 000	735 000	900	1 300	**52230 X**	**54230 X**
	150	250	140	—	—	2.1	1.1	380 000	1 200 000	630	950	**52330 X**	—
	160	320	226	—	—	5	2	650 000	2 210 000	430	630	**52432 X**	—

Note (1) 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.



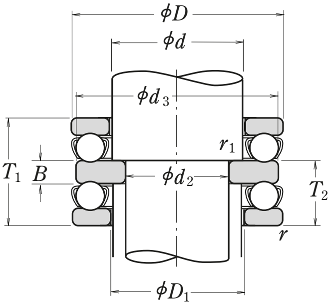




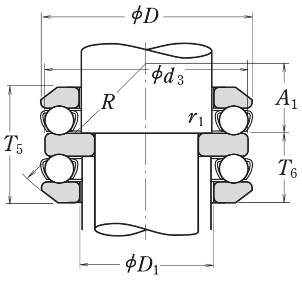
With Aligning Seat Washer	Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
	d_3	D_1	D_2	D_3	T_2	T_6	T_8	B	b	A_1	R	D_a max.	r_a max.	r_b max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
54215 U	110	77	92	115	28.5	29.8	33.5	10	9.5	47.5	90	92	1	1	1.54	1.66	2.06
54315 U	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
54415 U	160	78	115	165	70.5	74.5	80.5	26	21	36.5	125	115	2	1	10.8	11	13.7
54216 U	115	82	98	120	29	30.5	34	10	10	45	90	98	1	1	1.66	1.78	2.21
54316 U	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
54416 U	170	83	125	175	73.5	77.7	83.5	27	22	30.5	125	125	2	1	12.6	12.8	16
54417 XU	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
54217 U	125	88	105	130	33.5	35.6	39.5	12	11	49.5	100	105	1	1	2.26	2.45	3.02
54317 U	150	88	115	155	53	57.1	62	19	17.5	39	112	115	1.5	1	6.38	6.8	10.5
54418 XU	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
54218 U	135	93	110	140	38	41.5	45	14	13.5	42	100	110	1	1	3.09	3.42	4.39
54318 U	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
54420 XU	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
54220 U	150	103	125	155	41	43.9	48	15	14	49	112	125	1	1	4.08	4.54	5.64
54320 U	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	—	—
54222 U	160	113	135	165	41	43.2	48	15	14	62	125	135	1	1	4.39	4.83	5.94
54322 XU	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	—	—
54224 U	170	123	145	175	41.5	43.3	48.5	15	15	58.5	125	145	1	1	4.92	5.4	6.68
54324 XU	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	—	—
54226 XU	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	—	—
54228 XU	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	—	—
54230 XU	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

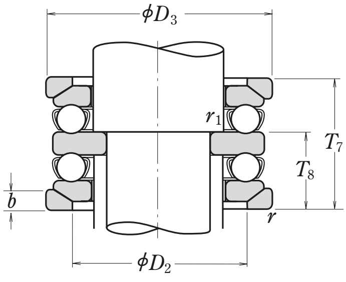
Bore Diameter 135 – 190 mm



With Flat Seat



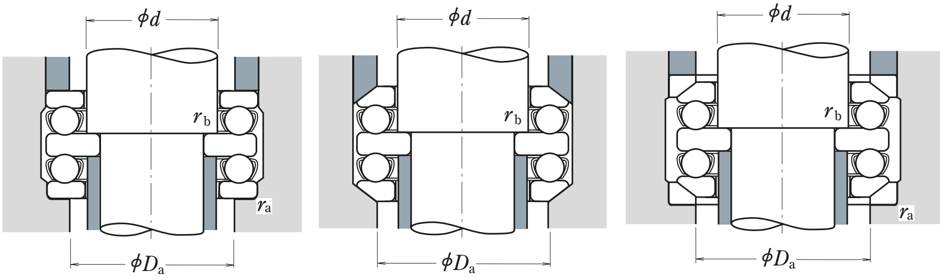
With Aligning Seat



With Aligning Seat Washer

Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Designations[1]	
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
135	170	340	236	—	—	5	2.1	715 000	2 480 000	400	600	**52434 X**	—
140	160	225	90	97.4	110	1.5	1.1	249 000	805 000	850	1 300	**52232 X**	**54232 X**
	160	270	153	—	—	3	1.1	475 000	1 570 000	600	900	**52332 X**	—
	180	360	245	—	—	5	3	750 000	2 730 000	380	560	**52436 X**	—
150	170	240	97	104.4	117	1.5	1.1	280 000	915 000	800	1 200	**52234 X**	**54234 X**
	170	280	153	—	—	3	1.1	465 000	1 570 000	560	850	**52334 X**	—
	180	250	98	102.4	118	1.5	2	284 000	955 000	800	1 200	**52236 X**	**54236 X**
	180	300	165	—	—	3	2	480 000	1 680 000	530	800	**52336 X**	—
160	190	270	109	116.4	131	2	2	320 000	1 110 000	710	1 100	**52238 X**	**54238 X**
	190	320	183	—	—	4	2	550 000	1 960 000	480	710	**52338 X**	—
170	200	280	109	115.6	133	2	2	315 000	1 110 000	710	1 000	**52240 X**	**54240 X**
	200	340	192	—	—	4	2	600 000	2 220 000	450	670	**52340 X**	—
190	220	300	110	115.2	134	2	2	325 000	1 210 000	670	1 000	**52244 X**	**54244 X**

Note [1] 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) d_3	D_1	D_2	D_3	T_2	T_6	T_8	B	b	A_1	R	Abutment and Fillet Dimensions (mm) D_a max.	r_a max.	r_b max.	Mass(kg) approx. With Flat Seat	With Aligning Seat	With Aligning Seat Washer
—	339	174	—	—	143	—	—	50	—	—	—	240	4	2	110	—	—
54232 XU	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	—	—
54234 XU	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	—	—
54236 XU	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	—	—
54238 XU	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	—	—
54240 XU	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	—	—
54244 XU	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

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)

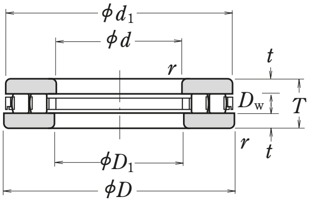
RECOMMENDED FITS

THRUST CYLINDRICAL ROLLER BEARINGS……………………Table 8.4 (Pages A164)
Table 8.6 (Pages A165)

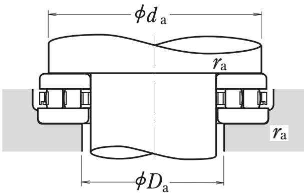
MINIMUM AXIAL LOAD

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.

Bore Diameter 35 – 130 mm



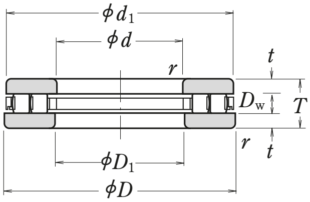
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	r min.	C_a	C_{0a}	Grease	Oil
35	80	32	1.1	95 500	247 000	1 000	3 000
40	78	22	1	63 000	194 000	1 200	3 600
45	65	14	0.6	33 000	100 000	1 700	5 000
	85	24	1	71 000	233 000	1 100	3 400
50	110	27	1.1	139 000	470 000	900	2 800
	95	27	1.1	113 000	350 000	1 000	3 000
55	105	30	1.1	134 000	450 000	900	2 600
60	95	26	1	99 000	325 000	1 000	3 000
	110	30	1.1	139 000	480 000	850	2 600
65	100	27	1	110 000	325 000	950	2 800
	115	30	1.1	145 000	515 000	850	2 600
70	150	36	2	259 000	935 000	670	2 000
	125	34	1.1	191 000	635 000	750	2 200
75	100	19	1	63 500	221 000	1 100	3 400
	135	36	1.5	209 000	735 000	710	2 200
80	115	28	1	120 000	420 000	900	2 600
	140	36	1.5	208 000	740 000	710	2 000
85	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
90	120	22	1	96 000	370 000	950	3 000
	155	39	1.5	250 000	885 000	630	1 900
100	170	42	1.5	292 000	1 110 000	560	1 700
110	160	38	1.1	228 000	855 000	630	1 900
	190	48	2	390 000	1 490 000	500	1 500
120	170	39	1.1	233 000	895 000	600	1 800
	210	54	2.1	505 000	1 930 000	450	1 400
130	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



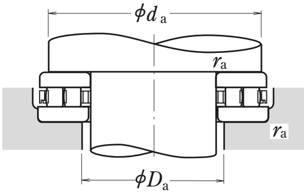
Bearing Designation	Dimensions (mm)				Abutment and Fillet Dimensions (mm)			Mass (kg)
	d_1	D_1	D_w	t	d_a min.	D_a max.	r_a max.	approx.
35 TMP 14	80	37	12	10	71	46	1	0.97
40 TMP 93	78	42	8	7	71	48	1	0.525
45 TMP 11	65	47	6	4	60	49	0.6	0.144
45 TMP 93	85	47	8	8	78	53	1	0.665
50 TMP 74	109	52	11	8	100	61	1	1.52
50 TMP 93	93	52	11	8	89	57	1	0.94
55 TMP 93	105	55.2	11	9.5	98	63	1	1.28
60 TMP 12	95	62	10	8	88	67	1	0.735
60 TMP 93	110	62	11	9.5	103	68	1	1.36
65 TMP 12	100	67	12.5	7.25	93	71	1	0.805
65 TMP 93	115	65.2	11	9.5	108	73	1	1.44
70 TMP 74	149	72	15	10.5	137	84	2	3.8
70 TMP 93	125	72	14	10	117	78	1	1.95
75 TMP 11	100	77	8	5.5	96	79	1	0.41
75 TMP 93	135	77	14	11	125	84	1.5	2.42
80 TMP 12	115	82	11	8.5	109	86	1	1.02
80 TMP 93	138	82	14	11	130	91	1.5	2.54
85 TMP 11	110	87	7.5	5.75	105	89	1	0.46
85 TMP 12	125	88	14	8.5	118	92	1	1.36
85 TMP 93	148	87	14	12.5	140	95	1.5	3.2
90 TMP 11	119	91.5	9	6.5	114	95	1	0.725
90 TMP 93	155	90.2	16	11.5	144	101	1.5	3.3
100 TMP 93	170	103	16	13	159	110	1.5	4.25
110 TMP 12	160	113	15	11.5	150	119	1	2.66
110 TMP 93	190	113	19	14.5	179	120	2	6.15
120 TMP 12	170	123	15	12	160	129	1	2.93
120 TMP 93	210	123	22	16	199	129	2	8.55
130 TMP 12	187	133	19	13	177	142	1.5	4.5
130 TMP 93	225	133	22	18	214	140	2	10.4
130 TMP 94	270	133	32	26.5	254	150	3	26.2

Remark For cylindrical roller thrust bearings not listed adove, please contact NSK.

Bore Diameter 140 – 320 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	
d	D	T	r min.	C_a	C_{0a}	Grease	Oil
140	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
150	215	50	2	375 000	1 500 000	480	1 400
	250	60	2.1	635 000	2 510 000	400	1 200
160	200	31	1	173 000	815 000	630	1 900
	270	67	3	745 000	3 150 000	360	1 100
170	240	55	1.5	485 000	1 960 000	430	1 300
	280	67	3	800 000	3 500 000	340	1 000
180	300	73	3	1 000 000	4 000 000	320	950
	360	109	5	1 640 000	6 200 000	240	710
190	270	62	3	705 000	2 630 000	360	1 100
	320	78	4	1 080 000	4 500 000	300	900
200	250	37	1.1	365 000	1 690 000	500	1 500
	340	85	4	1 180 000	5 150 000	280	800
220	270	37	1.1	385 000	1 860 000	480	1 500
	300	63	2	770 000	3 100 000	340	1 000
240	300	45	1.5	435 000	2 160 000	400	1 200
	340	78	2.1	965 000	4 100 000	280	850
260	320	45	1.5	460 000	2 350 000	400	1 200
	360	79	2.1	995 000	4 350 000	280	850
280	350	53	1.5	545 000	2 800 000	340	1 000
	380	80	2.1	1 050 000	4 750 000	260	800
300	380	62	2	795 000	4 000 000	300	900
	420	95	3	1 390 000	6 250 000	220	670
320	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) d_1	D_1	D_w	t	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.
140 TMP 12	197	143	17	14.5	188	153	2	4.85
140 TMP 93	240	143	25	17.5	226	154	2	12.2
140 TMP 94	280	143	32	26.5	262	158	3	27.5
150 TMP 12	215	153	19	15.5	202	163	2	6.15
150 TMP 93	250	153	25	17.5	236	165	2	12.8
160 TMP 11	200	162	11	10	191	168	1	2.21
160 TMP 93	265	164	25	21	255	173	2.5	16.9
170 TMP 12	237	173	22	16.5	227	182	1.5	8.2
170 TMP 93	280	173	25	21	265	183	2.5	17.7
180 TMP 93	300	185	32	20.5	284	194	2.5	22.5
180 TMP 94	354	189	45	32	335	205	4	58.2
190 TMP 12	266	195	30	16	255	200	2.5	11.8
190 TMP 93	320	195	32	23	303	205	3	27.6
200 TMP 11	247	203	17	10	242	207	1	4.1
200 TMP 93	340	205	32	26.5	322	218	3	34.5
220 TMP 11	267	223	17	10	262	227	1	4.5
220 TMP 12	297	224	30	16.5	287	232	2	13.5
240 TMP 11	297	243	18	13.5	288	251	1.5	7.2
240 TMP 12	335	244	32	23	322	258	2	23.3
260 TMP 11	317	263	18	13.5	308	272	1.5	7.75
260 TMP 12	355	264	32	23.5	342	276	2	25.2
280 TMP 11	347	283	20	16.5	335	294	1.5	11.6
280 TMP 12	375	284	32	24	362	296	2	27.2
300 TMP 11	376	304	25	18.5	365	315	2	16.7
300 TMP 12	415	304	38	28.5	398	322	2.5	42
320 TMP 11	396	324	25	19	385	335	2	18
320 TMP 12	435	325	38	28.5	418	340	2.5	44.5

Remark For cylindrical roller thrust bearings not listed adove, please contact NSK.

10. THRUST TAPERED ROLLER BEARINGS

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.

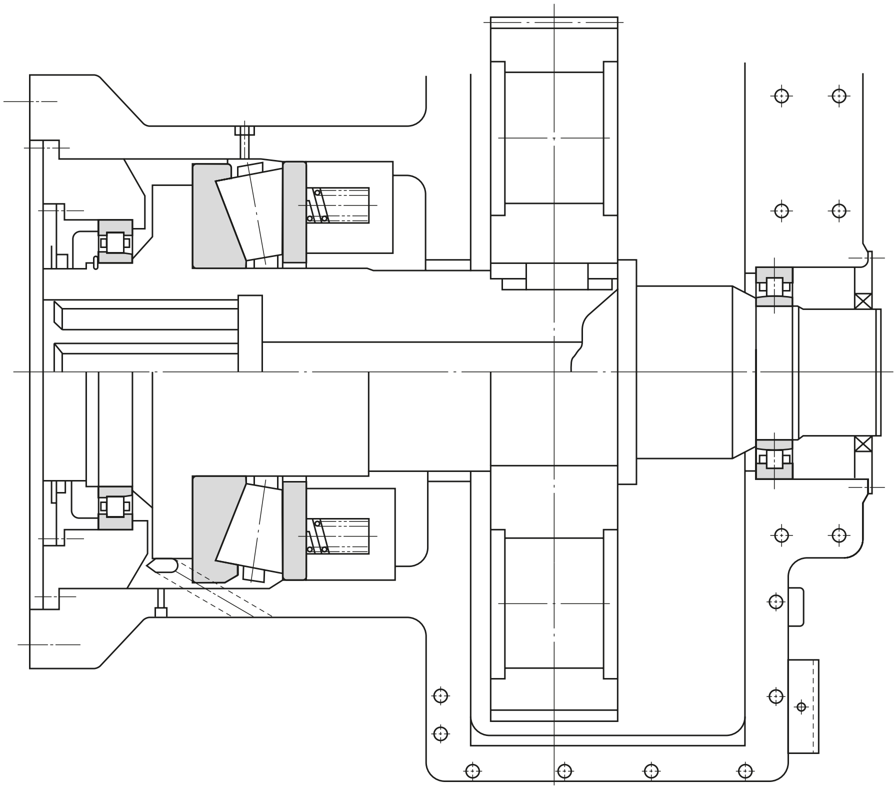
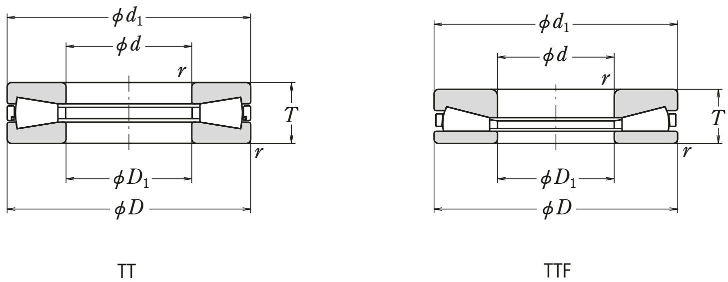


Fig. 2 Thrust Tapered Roller Bearings in a Heavy-Duty Extruder

THRUST TAPERED ROLLER BEARINGS

TT, TTF Types

Bore Diameter 101.600 – 168.275 mm



Boundary Dimensions (mm/inch)				Basic Load Ratings (kN)	
d	D	T	r min.	C_a	C_{0a}
101.600 4.0000	215.900 8.5000	46.038 1.8125	3.3	710	2 900
111.760 4.4000	223.520 8.8000	55.880 2.2000	3.3	790	2 920
114.300 4.5000	250.825 9.8750	53.975 2.1250	4.0	970	4 100
127.000 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
128.575 5.0620	265.100 10.4370	63.500 2.5000	6.4	1 040	4 350
130	250	70	2.1	1 100	4 100
135	245	65	2.1	855	3 100
150	300	90	5	1 470	6 300
152.400 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
165.100 6.5000	311.150 12.2500	88.900 3.5000	6.4	1 560	5 250
168.275 6.6250	304.800 12.0000	69.850 2.7500	6.4	1 230	5 000

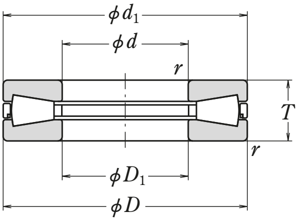
Bearing Designation	Dimensions (mm) D_1	d_1	Corner Radius of Shaft or Housing r_a max.	Mass (kg) approx.
∗101TT2151	103.200	214.300	3.3	8.9
∗111TT2251	113.300	221.900	3.3	11.2
∗114TT2551	114.500	250.825	4.0	14.4
∗127TT2551	128.600	265.100	4.8	17.3
∗127TTF2651	128.600	265.100	4.8	17.3
∗128TT2651	128.900	265.100	6.4	18.2
130TTF2501	130.3	250	2	17
135TT2401	135.3	245	2	14.5
150TTF3001	152	306	4	34.2
∗152TTF3151	152.700	315.900	6.4	28.9
∗152TT3152	152.400	317.500	6.4	28.9
∗165TT3151	165.400	311.150	6.4	33
∗168TTF3051	169.000	302.500	6.4	24.1

Note ∗ Bearings marked with ∗ are Inch Series bearings.

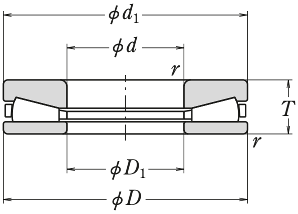
THRUST TAPERED ROLLER BEARINGS

TT, TTF Types

Bore Diameter 170 – 241.300 mm



TT



TTF

Boundary Dimensions (mm/inch)				Basic Load Ratings (kN)	
d	D	T	r min.	C_a	C_{0a}
170	320	100	5	1 650	5 550
174.625 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
177.800 7.0000	368.300 14.5000	82.550 3.2500	8.0	1 900	8 250
203.200 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
206.375 8.1250	419.100 16.5000	120.370 4.7390	C10	2 590	11 700
228.600 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
234.950 9.2500	546.100 21.5000	127.000 5.0000	15.9	4 600	21 400
241	404	110	4	2 200	8 650
241.300 9.5000	496.888 19.5625	129.000 5.0787	C8	3 450	16 700

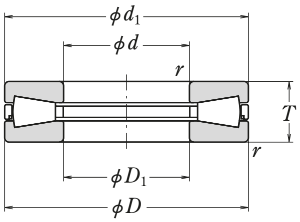
Bearing Designation	Dimensions (mm) D_1	d_1	Corner Radius of Shaft or Housing r_a max.	Mass (kg) approx.
170TT3201	170.5	320	4	39.3
*174TT3551	174.625	358.775	6.4	43.3
*174TTF3551	174.625	358.775	6.4	43.3
*177TT3651	180.400	365.800	8.0	45.9
*203TT4151	205.600	416.700	9.7	66.1
*203TTF4153A	203.200	419.100	9.7	66.1
*203TT4152	205.600	416.700	9.7	86.6
*203TTF4152	205.600	416.700	9.7	86.6
*206TT4151	206.375	419.100	6	85.5
*228TT4851	228.900	482.600	11.2	101
*228TTF4851	230.600	480.600	11.2	101
*234TT5451	237.000	544.000	15.9	165
241TTF4002	241	404	3	61.8
*241TT4952	241.300	496.888	5	130

Note * Bearings marked with * are Inch Series bearings.

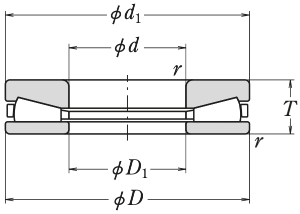
THRUST TAPERED ROLLER BEARINGS

TT, TTF Types

Bore Diameter 254.000 – 600 mm

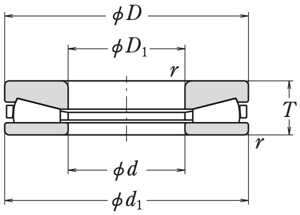


TT



TTF

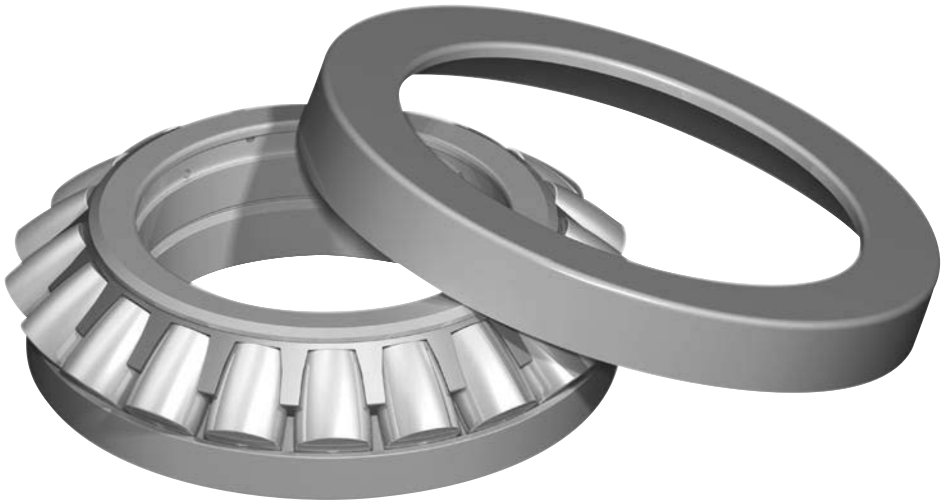
	Boundary Dimensions (mm/inch)			Basic Load Ratings (kN)	
d	D	T	r min.	C_a	C_{0a}
254.000	539.750	117.475	11.2	3 950	18 600
10.0000	21.2500	4.6250			
260	360	75	2.1	1 110	4 650
273.050	552.450	133.350	C8	4 400	20 700
10.7500	21.7500	5.2500			
279.400	603.250	136.525	11.2	5 400	25 200
11.0000	23.7500	5.3750			
330	440	85	3	1 300	6 300
340	460	96	3	1 690	7 750
350	460	85	2	1 370	6 600
360	470	85	4	1 440	6 950
	600	120	4	3 700	20 100
380	550	110	4	2 760	12 100
406.400	711.200	146.050	9.7	5 900	28 600
16.0000	28.0000	5.7500			
	838.200	177.800	12.7	8 950	46 500
	33.0000	7.0000			
431.800	863.600	228.600	10.4	15 100	69 500
17.0000	34.0000	9.0000			
440	600	105	4	2 720	13 900
450	570	100	3	2 170	10 500
460	580	90	3	1 890	9 550
500	630	82	3	2 020	11 600
508	730.25	120.65	6	4 900	26 100
508.000	990.600	196.850	12.7	12 000	65 000
20.0000	39.0000	7.7500			
558	780	120	9.5	4 800	25 500
558.800	1 066.800	285.750	10.4	21 100	94 500
22.0000	42.0000	11.2500			
560	670	85	3	1 950	10 700
600	710	86	3	1 900	10 700



TTF-1

Bearing Designation	Dimensions (mm) D_1	d_1	Corner Radius of Shaft or Housing r_a max.	Mass (kg) approx.
∗254TTF5351	254.000	539.750	11.2	142
260TTF3601	260.3	360	2	24.8
∗273TT5551	273.050	552.450	5	164
∗279TT6051	279.700	603.250	11.2	208
330TTF4401	331	440	2.5	38.5
340TTF4603	340	460	2.5	49.2
350TTF4602A(1)	351	450	2	40.4
360TTF4701	360.4	470	3	41.4
360TTF6201	366	620	3	148
380TTF5501	381	550	3	92.9
∗406TT7151	406.800	711.200	9.7	266
∗406TT8351	406.800	837.800	12.7	510
∗431TTF8651	435.000	862.000	10.4	683
440TTF6001	440	600	3	93.3
450TTF5701	455	569	2.5	65.4
460TTF5801	465	579	2.5	60
500TTF6301	505	628	2.5	64.3
508TT7301	509	730.25	5	177
∗508TT9951	508.000	990.600	12.7	760
558TT7801	558	780	8	190
∗558TTF1051	561.980	1 065.219	10.4	1 260
560TTF6701	565	668	2.5	61.4
600TTF7101	604	710	2.5	66.2

Note ∗ Bearings marked with ∗ are Inch Series bearings.
(1) For this bearing, dimensional designations are defined by Figure TTF-1.



11. THRUST SPHERICAL ROLLER BEARINGS

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.

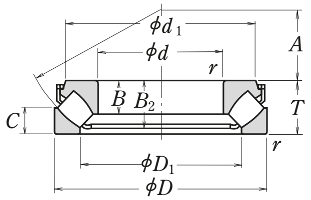
PERMISSIBLE MISALIGNMENT

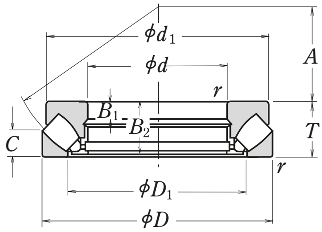
The permissible misalignment of thrust spherical roller bearings varies depending on size, but it is approximately 0.018 to 0.036 radian (1° to 2°) with average loads.

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.

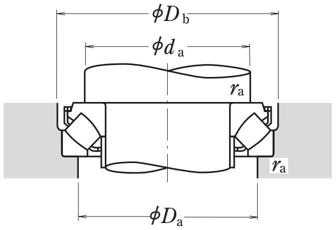
Bore Diameter 60 – 200 mm

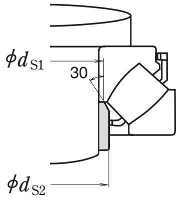




Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	Bearing Designation
d	D	T	r min.	C_a	C_{0a}	Oil	
60	130	42	1.5	330 000	885 000	2 600	**29412 E**
65	140	45	2	405 000	1 100 000	2 400	**29413 E**
70	150	48	2	450 000	1 240 000	2 400	**29414 E**
75	160	51	2	515 000	1 430 000	2 200	**29415 E**
80	170	54	2.1	575 000	1 600 000	2 000	**29416 E**
85	150	39	1.5	330 000	1 040 000	2 400	**29317 E**
	180	58	2.1	630 000	1 760 000	1 900	**29417 E**
90	155	39	1.5	350 000	1 080 000	2 200	**29318 E**
	190	60	2.1	695 000	1 950 000	1 800	**29418 E**
100	170	42	1.5	410 000	1 280 000	2 000	**29320 E**
	210	67	3	840 000	2 400 000	1 600	**29420 E**
110	190	48	2	530 000	1 710 000	1 800	**29322 E**
	230	73	3	1 010 000	2 930 000	1 500	**29422 E**
120	210	54	2.1	645 000	2 100 000	1 600	**29324 E**
	250	78	4	1 160 000	3 400 000	1 400	**29424 E**
130	225	58	2.1	740 000	2 450 000	1 500	**29326 E**
	270	85	4	1 330 000	3 900 000	1 200	**29426 E**
140	240	60	2.1	840 000	2 810 000	1 400	**29328 E**
	280	85	4	1 370 000	4 200 000	1 200	**29428 E**
150	250	60	2.1	870 000	2 900 000	1 400	**29330 E**
	300	90	4	1 580 000	4 900 000	1 100	**29430 E**
160	270	67	3	1 010 000	3 400 000	1 300	**29332 E**
	320	95	5	1 740 000	5 400 000	1 100	**29432 E**
170	280	67	3	1 050 000	3 500 000	1 200	**29334 E**
	340	103	5	1 680 000	5 800 000	1 000	**29434**
180	300	73	3	1 230 000	4 200 000	1 100	**29336 E**
	360	109	5	1 870 000	6 500 000	900	**29436**
190	320	78	4	1 370 000	4 700 000	1 100	**29338 E**
	380	115	5	2 100 000	7 450 000	850	**29438**
200	280	48	2	540 000	2 310 000	1 500	**29240**
	340	85	4	1 570 000	5 450 000	1 000	**29340 E**
	400	122	5	2 290 000	8 150 000	800	**29440**

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

$P=1.2F_r+F_a$

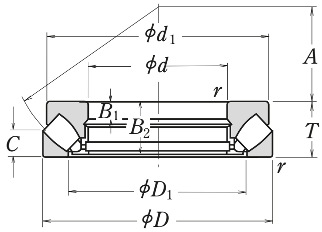
Static Equivalent Load

$P_0=2.8F_r+F_a$

However, $F_r/F_a \leqq 0.55$ must be satisfied.

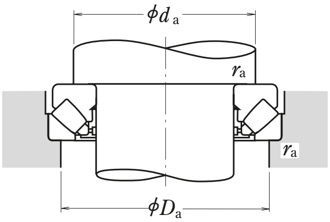
Dimensions (mm)						Spacer Sleeve Dimensions (mm)		Abutment and Fillet Dimensions (mm)				Mass (kg)
d_1	D_1	B,B_1	B_2	C	A	d_{S1} max.	d_{S2} max.	d_a(1) min.	D_a max.	D_b min.	r_a max.	approx.
114.5	89	27	38	20	38	67	67	90	108	133	1.5	2.55
121.5	93	29.5	40.5	22	42	72	72	100	115	143	2	3.2
131.5	102	31	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

Bore Diameter 220 – 420 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min^{-1})	Bearing Designation
d	D	T	r min.	C_a	C_{0a}	Oil	
220	300	48	2	560 000	2 500 000	1 400	**29244**
	360	85	4	1 340 000	5 200 000	950	**29344**
	420	122	6	2 350 000	8 650 000	800	**29444**
240	340	60	2.1	800 000	3 450 000	1 200	**29248**
	380	85	4	1 360 000	5 400 000	950	**29348**
	440	122	6	2 420 000	9 100 000	750	**29448**
260	360	60	2.1	855 000	3 850 000	1 200	**29252**
	420	95	5	1 700 000	6 800 000	800	**29352**
	480	132	6	2 820 000	10 700 000	710	**29452**
280	380	60	2.1	885 000	4 100 000	1 100	**29256**
	440	95	5	1 830 000	7 650 000	800	**29356**
	520	145	6	3 400 000	13 100 000	630	**29456**
	520	145	6	3 950 000	14 900 000	630	**29456 EM**
300	420	73	3	1 160 000	5 150 000	950	**29260**
	480	109	5	2 190 000	9 100 000	710	**29360**
	540	145	6	3 500 000	13 700 000	630	**29460**
320	440	73	3	1 190 000	5 450 000	950	**29264**
	500	109	5	2 230 000	9 400 000	670	**29364**
	580	155	7.5	3 650 000	14 600 000	560	**29464**
340	460	73	3	1 230 000	5 750 000	900	**29268**
	540	122	5	2 640 000	11 200 000	630	**29368**
	620	170	7.5	4 400 000	17 400 000	530	**29468**
360	500	85	4	1 550 000	7 300 000	800	**29272**
	560	122	5	2 670 000	11 500 000	600	**29372**
	640	170	7.5	4 200 000	17 200 000	500	**29472**
	640	170	7.5	5 450 000	20 400 000	500	**29472 EM**
380	520	85	4	1 620 000	7 800 000	800	**29276**
	600	132	6	3 300 000	14 500 000	560	**29376**
	670	175	7.5	4 800 000	19 500 000	480	**29476**
400	540	85	4	1 640 000	8 000 000	750	**29280**
	620	132	6	3 250 000	14 500 000	530	**29380**
	710	185	7.5	5 400 000	22 100 000	450	**29480**
420	580	95	5	2 010 000	9 800 000	670	**29284**
	650	140	6	3 500 000	15 700 000	500	**29384**
	730	185	7.5	5 650 000	23 500 000	450	**29484**

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

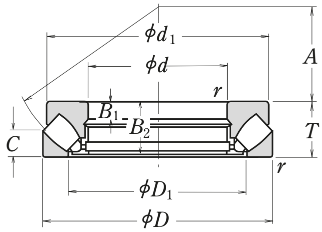
$P_0 = 2.8F_r + F_a$

However, $F_r/F_a \leqq 0.55$ 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

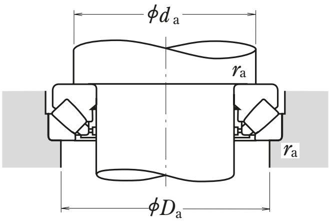
THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 440 – 500 mm



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	Bearing Designation
d	D	T	r min.	C_a	C_{0a}	Oil	
440	600	95	5	2 030 000	10 100 000	670	**29288**
	680	145	6	3 750 000	16 700 000	480	**29388**
	780	206	9.5	6 550 000	27 200 000	400	**29488**
	780	206	9.5	8 000 000	31 500 000	400	**29488 EM**
460	620	95	5	2 060 000	10 300 000	670	**29292**
	710	150	6	4 100 000	18 400 000	450	**29392**
	800	206	9.5	6 750 000	28 600 000	380	**29492**
480	650	103	5	2 370 000	12 100 000	600	**29296**
	730	150	6	4 150 000	19 000 000	450	**29396**
	850	224	9.5	7 200 000	31 000 000	360	**29496**
500	670	103	5	2 390 000	12 400 000	600	**292/500**
	750	150	6	4 350 000	20 400 000	450	**293/500**
	870	224	9.5	7 850 000	33 000 000	340	**294/500**

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, $F_r/F_a \leqq 0.55$ 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


NSK
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12. NEEDLE ROLLER BEARINGS

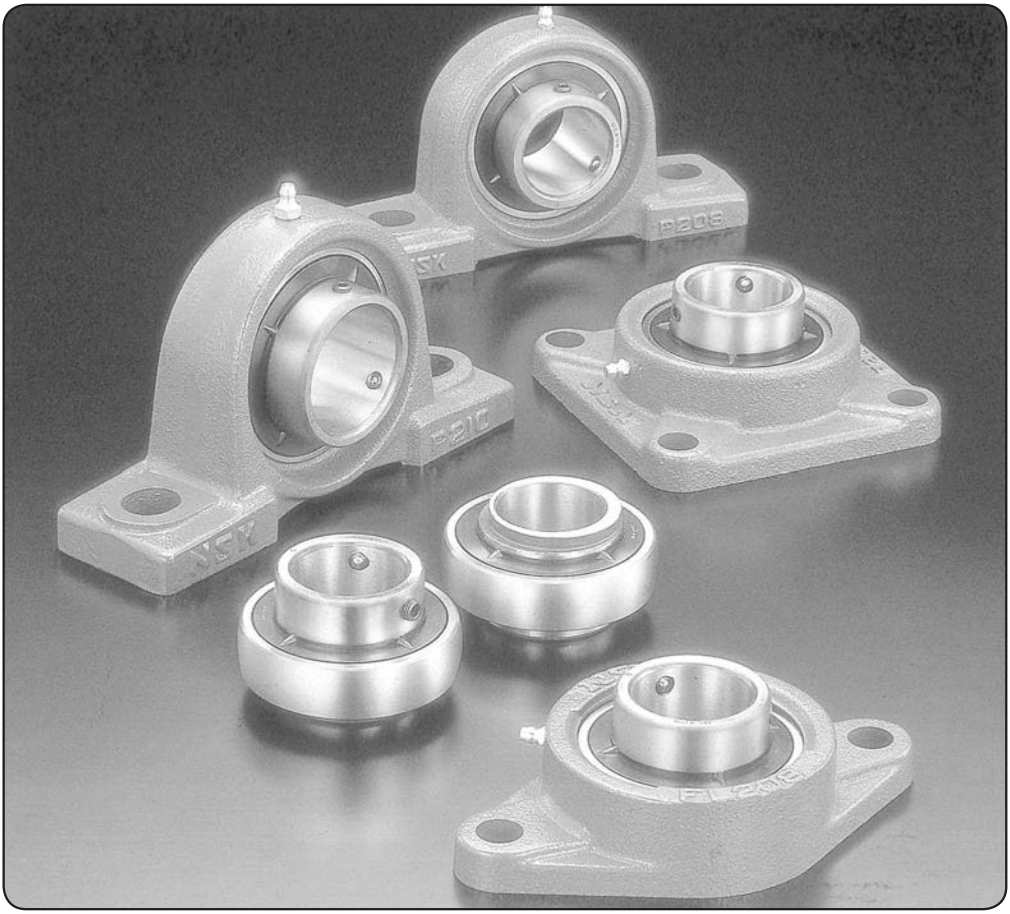
DESIGN AND TYPES

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; FBN, FBNP, WJC, FWJC
Drawn Cup Needle Roller Bearings	FJ, FJH, FJL, J, JH; MFJ, MFJH, MFJL, MJ, MJH; F, FH, B, BH; MF, MFH, M, MH; Y, YH; FJT, FJTT, MFJT, FJLT, FJLTT, MFJLT; FJP, JP; FIR, IR
Solid Needle Roller Bearings	RNA 48, RNA 49, RNA 59, RNA 69, HJ; RLM; RNAF; 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 (Pleas refer to B350 page); F Type; P Type; T 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.

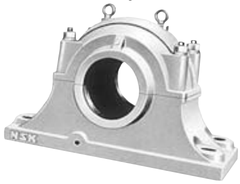
Types SN2C and SN3C have different bore diameters on both sides.

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.

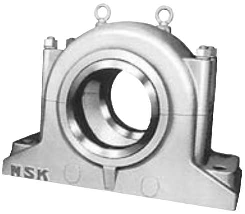
SG 5

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.



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.



SD31TS
SD32TS

These types feature labyrinth seals, making them suitable for high-speed applications.

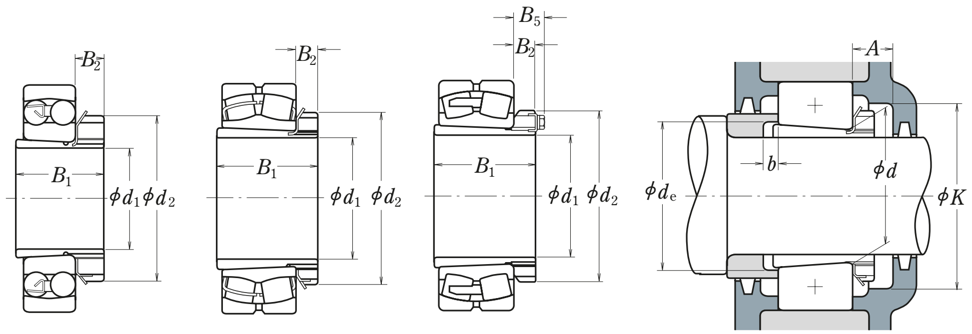
V · C

Single-piece plummer blocks (integrated roller bearing units) have higher rigidity and precision than split plummer blocks.

15. ACCESSORIES FOR ROLLING BEARINGS

ADAPTERS FOR ROLLING BEARINGS

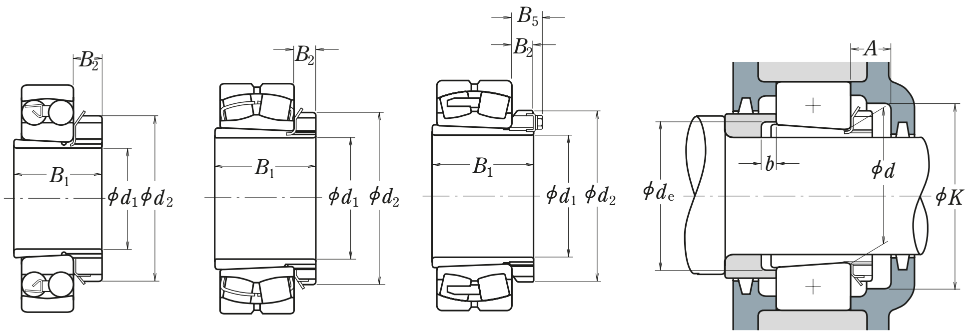
Shaft Diameter 17 – 40 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Designation (Adapter)	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
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	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	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	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

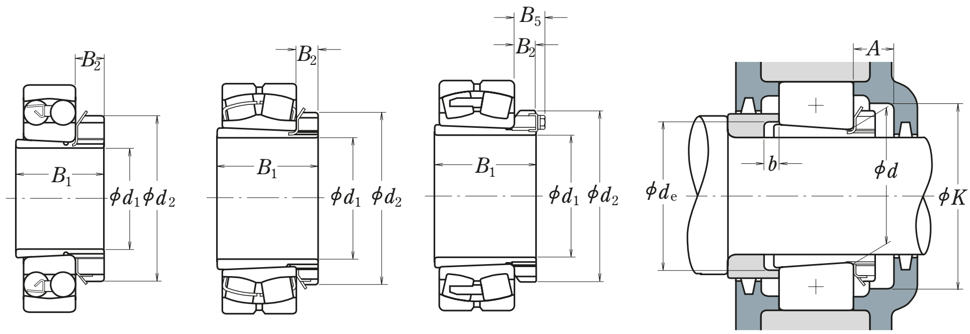


Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
45	50	1210K + **H 210X**	35	70	12	—	A 210X	19	76	53	5	0.275
	50	2210K + **H 310X**	42	70	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
50	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
	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
55	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
	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
60	65	1213K + **H 213X**	40	85	14	—	A 213X	21	96	70	5	0.40
	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

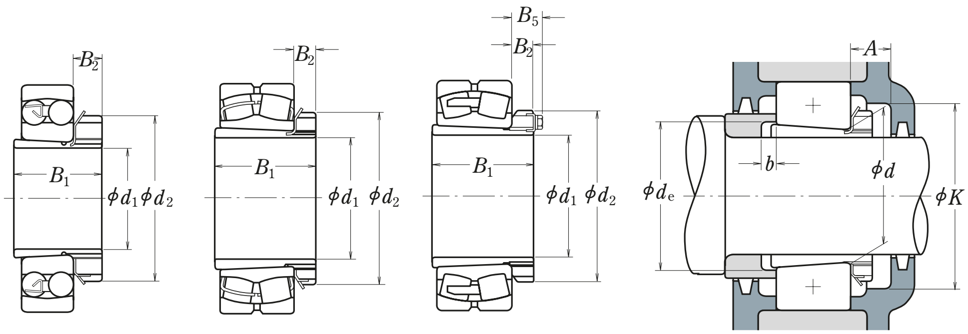
Shaft Diameter 65 – 80 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
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	22315E AKE4 + **H2315X**	73	98	15	—	A2315X	23	110	82	5	1.05
70	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
	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	22316E AKE4 + **H2316X**	78	105	17	—	A2316X	25	120	87	5	1.3
75	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
	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	22317E AKE4 + **H2317X**	82	110	18	—	A2317X	27	128	94	6	1.45
80	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
	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.

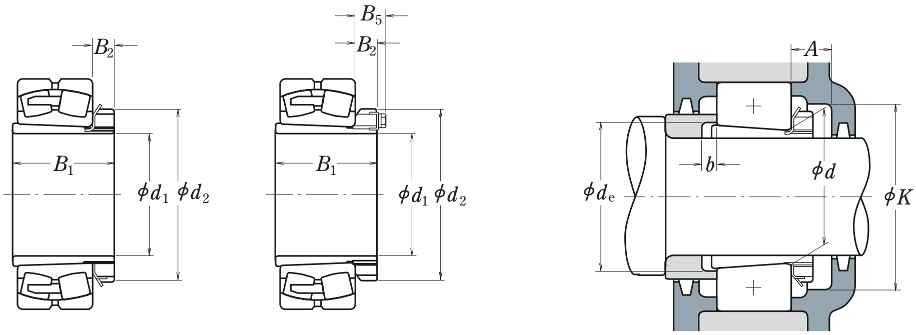
Shaft Diameter 85 – 115 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation / Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
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
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
	120	22324E AKE4 + **H2324**	112	155	22	—	A 2324	33	180	131	7	3.2
115	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

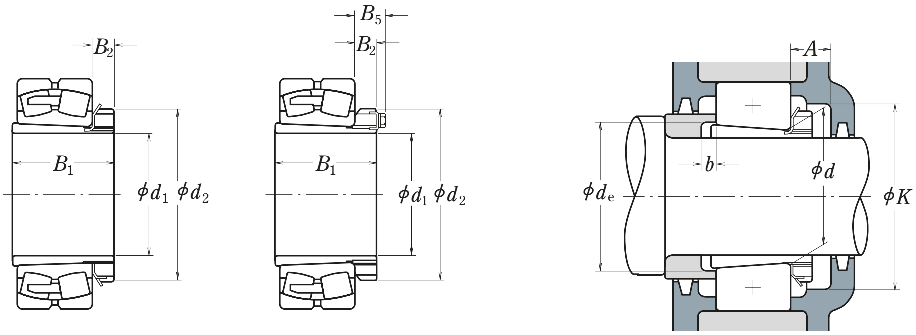
Remark Suffix X represents adapter sleeves with narrow slits for which washers with straight tabs should be used.

Shaft Diameter 125 – 170 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings		Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
125	140	23028C DKE4	+ **H3028**	82	165	24	—	A 3028	36	205	147	8	3.15
	140	23128C KE4	+ **H3128**	97	180	24	—	A 3128	36	205	149	8	4.35
	140	22228C DKE4	+ **H3128**	97	180	24	—	A 3128	36	205	149	8	4.35
	140	23228C KE4	+ **H2328**	131	180	24	—	A 2328	36	205	152	22	5.55
	140	22328C KE4	+ **H2328**	131	180	24	—	A 2328	36	205	152	8	5.55
135	150	23030C DKE4	+ **H3030**	87	180	26	—	A 3030	37	220	158	8	3.9
	150	23130C KE4	+ **H3130**	111	195	26	—	A 3130	37	220	160	8	5.5
	150	22230C DKE4	+ **H3130**	111	195	26	—	A 3130	37	220	160	15	5.5
	150	23230C KE4	+ **H2330**	139	195	26	—	A 2330	37	220	163	20	6.6
	150	22330C AKE4	+ **H2330**	139	195	26	—	A 2330	37	220	163	8	6.6
140	160	23932C AKE4	+ **H3932**	78	190	28	—	A 3932	39	205	168	8	4.64
	160	23032C DKE4	+ **H3032**	93	190	28	—	A 3032	39	230	168	8	5.2
	160	23132C KE4	+ **H3132**	119	210	28	—	A 3132	39	230	170	8	7.65
	160	22232C DKE4	+ **H3132**	119	210	28	—	A 3132	39	230	170	14	7.65
	160	23232C KE4	+ **H2332**	147	210	28	—	A 2332	39	230	174	18	9.15
	160	22332C AKE4	+ **H2332**	147	210	28	—	A 2332	39	230	174	8	9.15
150	170	23934B CAKE4	+ **H3934**	79	200	29	—	A 3934	40	215	179	8	5.07
	170	23034C DKE4	+ **H3034**	101	200	29	—	A 3034	40	250	179	8	6.0
	170	23134C KE4	+ **H3134**	122	220	29	—	A 3134	40	250	180	8	8.4
	170	22234C DKE4	+ **H3134**	122	220	29	—	A 3134	40	250	180	10	8.4
	170	23234C KE4	+ **H2334**	154	220	29	—	A 2334	40	250	185	18	10
	170	22334C AKE4	+ **H2334**	154	220	29	—	A 2334	40	250	185	8	10
160	180	23936C AKE4	+ **H3936**	87	210	30	—	A 3936	41	230	189	8	5.87
	180	23036C DKE4	+ **H3036**	109	210	30	—	A 3036	41	260	189	8	6.85
	180	23136C KE4	+ **H3136**	131	230	30	—	A 3136	41	260	191	8	9.5
	180	22236C DKE4	+ **H3136**	131	230	30	—	A 3136	41	260	191	18	9.5
	180	23236C KE4	+ **H2336**	161	230	30	—	A 2336	41	260	195	22	11.5
	180	22336C AKE4	+ **H2336**	161	230	30	—	A 2336	41	260	195	8	11.5
170	190	23938C AKE4	+ **H3938**	89	220	31	—	A 3938	43	240	199	9	6.35
	190	23038C AKE4	+ **H3038**	112	220	31	—	A 3038	43	270	199	9	7.45
	190	23138C KE4	+ **H3138**	141	240	31	—	A 3138	43	270	202	9	11
	190	22238C AKE4	+ **H3138**	141	240	31	—	A 3138	43	270	202	21	11
	190	23238C KE4	+ **H2338**	169	240	31	—	A 2338	43	270	206	21	12.5
	190	22338C AKE4	+ **H2338**	169	240	31	—	A 2338	43	270	206	9	12.5

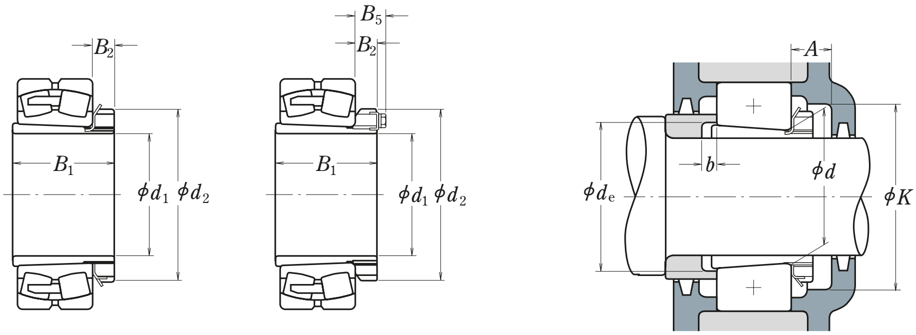
Shaft Diameter 180 – 260 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation / Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
180	200	23940C AKE4 + **H3940**	98	240	32	—	A3940	46	260	210	10	8.0
	200	23040C AKE4 + **H3040**	120	240	32	—	A3040	46	280	210	10	9.2
	200	23140C KE4 + **H3140**	150	250	32	—	A3140	46	280	212	10	12
	200	22240C AKE4 + **H3140**	150	250	32	—	A3140	46	280	212	24	12
	200	23240C KE4 + **H2340**	176	250	32	—	A2340	46	280	216	20	14
	200	22340C AKE4 + **H2340**	176	250	32	—	A2340	46	280	216	10	14
200	220	23944C AKE4 + **H3944**	96	260	30	41	A3944	55	280	231	10	8.32
	220	23044C AKE4 + **H3044**	128	260	30	41	A3044	55	320	231	12	10.5
	220	23144C KE4 + **H3144**	158	280	32	44	A3144	55	320	233	10	14.5
	220	22244C AKE4 + **H3144**	158	280	32	44	A3144	55	320	233	22	14.5
	220	23244C KE4 + **H2344**	183	280	32	44	A2344	55	320	236	11	16.5
	220	22344C AKE4 + **H2344**	183	280	32	44	A2344	55	320	236	10	16.5
220	240	23948C AKE4 + **H3948**	101	290	34	46	A3948	60	300	251	11	11.2
	240	23048C AKE4 + **H3048**	133	290	34	46	A3048	60	340	251	11	13
	240	23148C KE4 + **H3148**	169	300	34	46	A3148	60	340	254	11	17.5
	240	22248C AKE4 + **H3148**	169	300	34	46	A3148	60	340	254	19	17.5
	240	23248C AKE4 + **H2348**	196	300	34	46	A2348	60	340	257	6	19.5
	240	22348C AKE4 + **H2348**	196	300	34	46	A2348	60	340	257	11	19.5
240	260	23952C AKE4 + **H3952**	116	310	34	46	A3952	60	330	272	11	13.4
	260	23052C AKE4 + **H3052**	147	310	34	46	A3052	60	370	272	13	15.5
	260	23152C AKE4 + **H3152**	187	330	36	49	A3152	60	370	276	11	22
	260	22252C AKE4 + **H3152**	187	330	36	49	A3152	60	370	276	25	22
	260	23252C AKE4 + **H2352**	208	330	36	49	A2352	60	370	278	2	24
	260	22352C AKE4 + **H2352**	208	330	36	49	A2352	60	370	278	11	24
260	280	23956C AKE4 + **H3956**	121	330	38	50	A3956	65	350	292	12	15.5
	280	23056C AKE4 + **H3056**	152	330	38	50	A3056	65	390	292	12	17.5
	280	23156C AKE4 + **H3156**	192	350	38	51	A3156	65	390	296	12	24.5
	280	22256C AKE4 + **H3156**	192	350	38	51	A3156	65	390	296	28	24.5
	280	23256C AKE4 + **H2356**	221	350	38	51	A2356	65	390	299	11	28
	280	22356C AKE4 + **H2356**	221	350	38	51	A2356	65	390	299	12	28

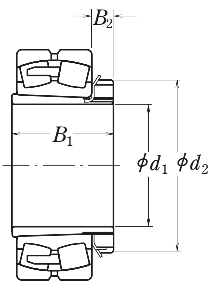
ADAPTERS FOR ROLLING BEARINGS

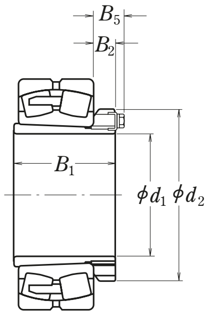
Shaft Diameter 280 – 410 mm

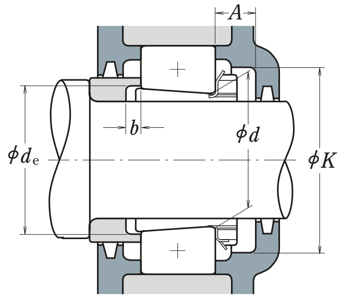


Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
280	300	23960C AKE4 + **H3960**	140	360	42	54	A3960	69	380	313	12	20.7
	300	23060C AKE4 + **H3060**	168	360	42	54	A3060	69	430	313	12	23
	300	23160C AKE4 + **H3160**	208	380	40	53	A3160	69	430	317	12	30
	300	22260C AKE4 + **H3160**	208	380	40	53	A3160	69	430	317	32	30
	300	23260C AKE4 + **H3260**	240	380	40	53	A3260	69	430	321	12	34
300	320	23964C AKE4 + **H3964**	140	380	42	55	A3964	72	400	334	13	21.8
	320	23064C AKE4 + **H3064**	171	380	42	55	A3064	72	450	334	13	24.5
	320	23164C AKE4 + **H3164**	226	400	42	56	A3164	72	450	339	13	35
	320	22264C AKE4 + **H3164**	226	400	42	56	A3164	72	450	339	39	35
	320	23264C AKE4 + **H3264**	258	400	42	56	A3264	72	450	343	13	39.5
320	340	23968C AKE4 + **H3968**	144	400	45	58	A3968	75	430	354	14	24.6
	340	23068C AKE4 + **H3068**	187	400	45	58	A3068	75	490	355	14	28.5
	340	23168C AKE4 + **H3168**	254	440	55	72	A3168	75	490	360	14	49.5
	340	23268C AKE4 + **H3268**	288	440	55	72	A3268	75	490	364	14	54.5
340	360	23972C AKE4 + **H3972**	144	420	45	58	A3972	75	450	374	14	25.7
	360	23072C AKE4 + **H3072**	188	420	45	58	A3072	75	510	375	14	30.5
	360	23172C AKE4 + **H3172**	259	460	58	75	A3172	75	510	380	14	54
	360	23272C AKE4 + **H3272**	299	460	58	75	A3272	75	510	385	14	60.5
360	380	23976C AKE4 + **H3976**	164	450	48	62	A3976	82	480	396	15	31.9
	380	23076C AKE4 + **H3076**	193	450	48	62	A3076	82	540	396	15	36
	380	23176C AKE4 + **H3176**	264	490	60	77	A3176	82	540	401	15	61.5
	380	23276C AKE4 + **H3276**	310	490	60	77	A3276	82	540	405	15	69.5
380	400	23980C AKE4 + **H3980**	168	470	52	66	A3980	86	500	417	15	35.2
	400	23080C AKE4 + **H3080**	210	470	52	66	A3080	86	580	417	15	41.5
	400	23180C AKE4 + **H3180**	272	520	62	82	A3180	86	580	421	15	70.5
	400	23280C AKE4 + **H3280**	328	520	62	82	A3280	86	580	427	15	81
400	420	23984C AKE4 + **H3984**	168	490	52	66	A3984	86	520	437	16	36.6
	420	23084C AKE4 + **H3084**	212	490	52	66	A3084	86	600	437	16	43.5
	420	23184C AKE4 + **H3184**	304	540	70	90	A3184	86	600	443	16	84
	420	23284C AKE4 + **H3284**	352	540	70	90	A3284	86	600	448	16	94
410	440	23988C AKE4 + **H3988**	189	520	60	77	A3988	99	550	458	17	58.6
	440	23088C AKE4 + **H3088**	228	520	60	77	A3088	99	620	458	17	65
	440	23188C AKE4 + **H3188**	307	560	70	90	A3188	99	620	464	17	104
	440	23288C AKE4 + **H3288**	361	560	70	90	A3288	99	620	469	17	118

Shaft Diameter 430 – 470 mm

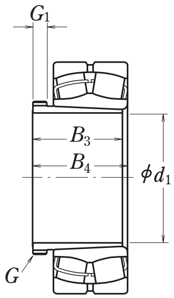






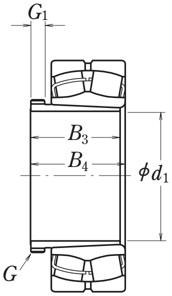
Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Designation	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
430	460	23992C AKE4 + **H3992**	189	540	60	77	A3992	99	570	478	17	62
	460	23092C AKE4 + **H3092**	234	540	60	77	A3092	99	650	478	17	69.5
	460	23192C AKE4 + **H3192**	326	580	75	95	A3192	99	650	485	17	116
	460	23292C AKE4 + **H3292**	382	580	75	95	A3292	99	650	491	17	132
450	480	23996C AKE4 + **H3996**	200	560	60	77	A3996	99	600	499	18	67.5
	480	23096C AKE4 + **H3096**	237	560	60	77	A3096	99	690	499	18	73.5
	480	23196C AKE4 + **H3196**	335	620	75	95	A3196	99	690	505	18	133
	480	23296C AKE4 + **H3296**	397	620	75	95	A3296	99	690	512	18	152
470	500	239/500C AKE4 + **H39/500**	208	580	68	85	A39/500	109	620	519	18	74.6
	500	230/500C AKE4 + **H30/500**	247	580	68	85	A30/500	109	700	519	18	82
	500	231/500C AKE4 + **H31/500**	356	630	80	100	A31/500	109	700	527	18	143
	500	232/500C AKE4 + **H32/500**	428	630	80	100	A32/500	109	700	534	18	166

Shaft Diameter 35 – 85 mm



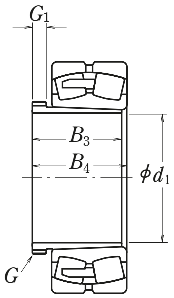
Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation: Applicable Bearings	Designation	Screw Threads G	Dimensions (mm) B_3	Dimensions (mm) G_1	Dimensions (mm) B_4	Mass (kg) approx.
35	40	21308EAKE4	+ **AH 308**	M 45 × 1.5	29	6	32	0.09
	40	22308EAKE4	+ **AH 2308**	M 45 × 1.5	40	7	43	0.13
40	45	21309EAKE4	+ **AH 309**	M 50 × 1.5	31	6	34	0.11
	45	22309EAKE4	+ **AH 2309**	M 50 × 1.5	44	7	47	0.165
45	50	21310EAKE4	+ **AHX 310**	M 55 × 2	35	7	38	0.16
	50	22310EAKE4	+ **AHX 2310**	M 55 × 2	50	9	53	0.235
50	55	22211EAKE4	+ **AHX 311**	M 60 × 2	37	7	40	0.19
	55	21311EAKE4	+ **AHX 311**	M 60 × 2	37	7	40	0.19
	55	22311EAKE4	+ **AHX 2311**	M 60 × 2	54	10	57	0.285
55	60	22212EAKE4	+ **AHX 312**	M 65 × 2	40	8	43	0.215
	60	21312EAKE4	+ **AHX 312**	M 65 × 2	40	8	43	0.215
	60	22312EAKE4	+ **AHX 2312**	M 65 × 2	58	11	61	0.34
60	65	22213EAKE4	+ **AH 313**	M 75 × 2	42	8	45	0.255
	65	21313EAKE4	+ **AH 313**	M 75 × 2	42	8	45	0.255
	65	22313EAKE4	+ **AH 2313**	M 75 × 2	61	12	64	0.395
65	70	22214EAKE4	+ **AH 314**	M 80 × 2	43	8	47	0.28
	70	21314EAKE4	+ **AH 314**	M 80 × 2	43	8	47	0.28
	70	22314EAKE4	+ **AHX 2314**	M 80 × 2	64	12	68	0.53
70	75	22215EAKE4	+ **AH 315**	M 85 × 2	45	8	49	0.315
	75	21315EAKE4	+ **AH 315**	M 85 × 2	45	8	49	0.315
	75	22315EAKE4	+ **AHX 2315**	M 85 × 2	68	12	72	0.605
75	80	22216EAKE4	+ **AH 316**	M 90 × 2	48	8	52	0.365
	80	21316EAKE4	+ **AH 316**	M 90 × 2	48	8	52	0.365
	80	22316EAKE4	+ **AHX 2316**	M 90 × 2	71	12	75	0.665
80	85	22217EAKE4	+ **AHX 317**	M 95 × 2	52	9	56	0.48
	85	21317EAKE4	+ **AHX 317**	M 95 × 2	52	9	56	0.48
	85	22317EAKE4	+ **AHX 2317**	M 95 × 2	74	13	78	0.745
85	90	22218EAKE4	+ **AHX 318**	M 100 × 2	53	9	57	0.52
	90	21318EAKE4	+ **AHX 318**	M 100 × 2	53	9	57	0.52
	90	23218CKE4	+ **AHX 3218**	M 100 × 2	63	10	67	0.58
	90	22318EAKE4	+ **AHX 2318**	M 100 × 2	79	14	83	0.845

Shaft Diameter 90 – 135 mm



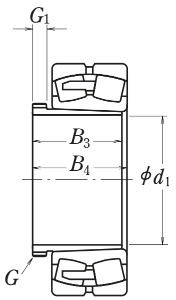
Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Screw Threads G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
90	95	22219EAKE4 + **AHX 319**	M 105 × 2	57	10	61	0.595
	95	21319CKE4 + **AHX 319**	M 105 × 2	57	10	61	0.595
	95	22319EAKE4 + **AHX 2319**	M 105 × 2	85	16	89	0.89
95	100	21320CKE4 + **AHX 3120**	M 110 × 2	64	11	68	0.70
	100	22220EAKE4 + **AHX 320**	M 110 × 2	59	10	63	0.66
	100	21320CKE4 + **AHX 320**	M 110 × 2	59	10	63	0.66
	100	23220CKE4 + **AHX 3220**	M 110 × 2	73	11	77	0.77
	100	22320EAKE4 + **AHX 2320**	M 110 × 2	90	16	94	1.0
105	110	23122CKE4 + **AHX 3122**	M 120 × 2	68	11	72	0.76
	110	22222EAKE4 + **AHX 3122**	M 120 × 2	68	11	72	0.76
	110	24122CK30E4 + **AH 24122**	M 115 × 2	82	13	91	0.73
	110	23222CKE4 + **AHX 3222**	M 125 × 2	82	11	86	1.04
	110	22322EAKE4 + **AHX 2322**	M 125 × 2	98	16	102	1.35
115	120	23024CDKE4 + **AHX 3024**	M 130 × 2	60	13	64	0.75
	120	24024CK30E4 + **AH 24024**	M 125 × 2	73	13	82	0.70
	120	23124CKE4 + **AHX 3124**	M 130 × 2	75	12	79	0.95
	120	22224EAKE4 + **AHX 3124**	M 130 × 2	75	12	79	0.95
	120	24124CK30E4 + **AH 24124**	M 130 × 2	93	13	102	1.02
	120	23224CKE4 + **AHX 3224**	M 135 × 2	90	13	94	1.3
	120	22324EAKE4 + **AHX 2324**	M 135 × 2	105	17	109	1.6
125	130	23026CDKE4 + **AHX 3026**	M 140 × 2	67	14	71	0.95
	130	24026CK30E4 + **AH 24026**	M 135 × 2	83	14	93	0.89
	130	23126CKE4 + **AHX 3126**	M 140 × 2	78	12	82	1.08
	130	22226EAKE4 + **AHX 3126**	M 140 × 2	78	12	82	1.08
	130	24126CK30E4 + **AH 24126**	M 140 × 2	94	14	104	1.14
	130	23226CKE4 + **AHX 3226**	M 145 × 2	98	15	102	1.58
	130	22326CKE4 + **AHX 2326**	M 145 × 2	115	19	119	1.97
135	140	23028CDKE4 + **AHX 3028**	M 150 × 2	68	14	73	1.01
	140	24028CK30E4 + **AH 24028**	M 145 × 2	83	14	93	0.96
	140	23128CKE4 + **AHX 3128**	M 150 × 2	83	14	88	1.28
	140	22228CDKE4 + **AHX 3128**	M 150 × 2	83	14	88	1.28
	140	24128CK30E4 + **AH 24128**	M 150 × 2	99	14	109	1.3
	140	23228CKE4 + **AHX 3228**	M 155 × 3	104	15	109	1.84
	140	22328CKE4 + **AHX 2328**	M 155 × 3	125	20	130	2.33

Shaft Diameter 145 – 180 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings		Screw Threads G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
145	150	23030CDKE4	+ **AHX 3030**	M 160 × 3	72	15	77	1.15
	150	24030CK30E4	+ **AH 24030**	M 155 × 3	90	15	101	1.11
	150	23130CKE4	+ **AHX 3130**	M 165 × 3	96	15	101	1.79
	150	22230CDKE4	+ **AHX 3130**	M 165 × 3	96	15	101	1.79
	150	24130CK30E4	+ **AH 24130**	M 160 × 3	115	15	126	1.63
	150	23230CKE4	+ **AHX 3230**	M 165 × 3	114	17	119	2.22
	150	22330CAKE4	+ **AHX 2330**	M 165 × 3	135	24	140	2.82
150	160	23032CDKE4	+ **AH 3032**	M 170 × 3	77	16	82	2.05
	160	24032CK30E4	+ **AH 24032**	M 170 × 3	95	15	106	2.28
	160	23132CKE4	+ **AH 3132**	M 180 × 3	103	16	108	3.2
	160	22232CDKE4	+ **AH 3132**	M 180 × 3	103	16	108	3.2
	160	24132CK30E4	+ **AH 24132**	M 170 × 3	124	15	135	3.03
	160	23232CKE4	+ **AH 3232**	M 180 × 3	124	20	130	4.1
	160	22332CAKE4	+ **AH 2332**	M 180 × 3	140	24	146	4.7
160	170	23034CDKE4	+ **AH 3034**	M 180 × 3	85	17	90	2.45
	170	24034CK30E4	+ **AH 24034**	M 180 × 3	106	16	117	2.74
	170	23134CKE4	+ **AH 3134**	M 190 × 3	104	16	109	3.4
	170	22234CDKE4	+ **AH 3134**	M 190 × 3	104	16	109	3.4
	170	24134CK30E4	+ **AH 24134**	M 180 × 3	125	16	136	3.26
	170	23234CKE4	+ **AH 3234**	M 190 × 3	134	24	140	4.8
	170	22334CAKE4	+ **AH 2334**	M 190 × 3	146	24	152	5.25
170	180	23036CDKE4	+ **AH 3036**	M 190 × 3	92	17	98	2.8
	180	24036CK30E4	+ **AH 24036**	M 190 × 3	116	16	127	3.19
	180	23136CKE4	+ **AH 3136**	M 200 × 3	116	19	122	4.2
	180	24136CK30E4	+ **AH 24136**	M 190 × 3	134	16	145	3.74
	180	22236CDKE4	+ **AH 2236**	M 200 × 3	105	17	110	3.75
	180	23236CKE4	+ **AH 3236**	M 200 × 3	140	24	146	5.3
	180	22336CAKE4	+ **AH 2336**	M 200 × 3	154	26	160	5.85
180	190	23038CAKE4	+ **AH 3038**	Tr 205 × 4	96	18	102	3.35
	190	24038CK30E4	+ **AH 24038**	M 200 × 3	118	18	131	3.47
	190	23138CKE4	+ **AH 3138**	Tr 210 × 4	125	20	131	4.9
	190	24138CK30E4	+ **AH 24138**	M 200 × 3	146	18	159	4.38
	190	22238CAKE4	+ **AH 2238**	Tr 210 × 4	112	18	117	4.25
	190	23238CKE4	+ **AH 3238**	Tr 210 × 4	145	25	152	5.9
	190	22338CAKE4	+ **AH 2338**	Tr 210 × 4	160	26	167	6.65

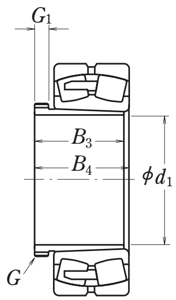
Shaft Diameter 190 – 260 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings		Screw Threads G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
190	200	23040CAKE4	+ **AH 3040**	Tr 215 × 4	102	19	108	3.8
	200	24040CK30E4	+ **AH 24040**	Tr 210 × 4	127	18	140	3.92
	200	23140CKE4	+ **AH 3140**	Tr 220 × 4	134	21	140	5.5
	200	24140CK30E4	+ **AH 24140**	Tr 210 × 4	158	18	171	5.0
	200	22240CAKE4	+ **AH 2240**	Tr 220 × 4	118	19	123	4.7
	200	23240CKE4	+ **AH 3240**	Tr 220 × 4	153	25	160	6.7
	200	22340CAKE4	+ **AH 2340**	Tr 220 × 4	170	30	177	7.55
200	220	23044CAKE4	+ **AH 3044**	Tr 235 × 4	111	20	117	7.4
	220	24044CK30E4	+ **AH 24044**	Tr 230 × 4	138	20	152	8.23
	220	23144CKE4	+ **AH 3144**	Tr 240 × 4	145	23	151	10.5
	220	24144CK30E4	+ **AH 24144**	Tr 230 × 4	170	20	184	10.3
	220	22244CAKE4	+ **AH 2244**	Tr 240 × 4	130	20	136	9.1
	220	23244CKE4	+ **AH 2344**	Tr 240 × 4	181	30	189	13.5
	220	22344CAKE4	+ **AH 2344**	Tr 240 × 4	181	30	189	13.5
220	240	23048CAKE4	+ **AH 3048**	Tr 260 × 4	116	21	123	8.75
	240	24048CK30E4	+ **AH 24048**	Tr 250 × 4	138	20	153	9.0
	240	23148CKE4	+ **AH 3148**	Tr 260 × 4	154	25	161	12
	240	24148CK30E4	+ **AH 24148**	Tr 260 × 4	180	20	195	12.6
	240	22248CAKE4	+ **AH 2248**	Tr 260 × 4	144	21	150	11
	240	23248CAKE4	+ **AH 2348**	Tr 260 × 4	189	30	197	15.5
	240	22348CAKE4	+ **AH 2348**	Tr 260 × 4	189	30	197	15.5
240	260	23052CAKE4	+ **AH 3052**	Tr 280 × 4	128	23	135	10.5
	260	24052CAK30E4	+ **AH 24052**	Tr 270 × 4	162	22	178	11.7
	260	23152CAKE4	+ **AH 3152**	Tr 290 × 4	172	26	179	16
	260	24152CAK30E4	+ **AH 24152**	Tr 280 × 4	202	22	218	15.5
	260	22252CAKE4	+ **AH 2252**	Tr 290 × 4	155	23	161	14
	260	23252CAKE4	+ **AH 2352**	Tr 290 × 4	205	30	213	19.5
	260	22352CAKE4	+ **AH 2352**	Tr 290 × 4	205	30	213	19.5
260	280	23056CAKE4	+ **AH 3056**	Tr 300 × 4	131	24	139	12
	280	24056CAK30E4	+ **AH 24056**	Tr 290 × 4	162	22	179	12.6
	280	23156CAKE4	+ **AH 3156**	Tr 310 × 5	175	28	183	17.5
	280	24156CAK30E4	+ **AH 24156**	Tr 300 × 4	202	22	219	16.8
	280	22256CAKE4	+ **AH 2256**	Tr 310 × 5	155	24	163	15
	280	23256CAKE4	+ **AH 2356**	Tr 310 × 5	212	30	220	21.5
	280	22356CAKE4	+ **AH 2356**	Tr 310 × 5	212	30	220	21.5

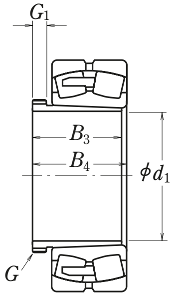
■WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 280 – 380 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings	Screw Threads G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
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
300	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
	320	24164CAK30E4 + **AH 24164**	Tr 340 × 5	242	24	260	23.5
	320	23264CAKE4 + **AH 3264**	Tr 350 × 5	246	36	254	25
320	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
340	360	23072CAKE4 + **AH 3072**	Tr 385 × 5	167	30	176	21
	360	24072CAK30E4 + **AH 24072**	Tr 380 × 5	206	26	226	22.5
	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
360	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
380	400	23080CAKE4 + **AH 3080**	Tr 430 × 5	183	33	193	27.5
	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

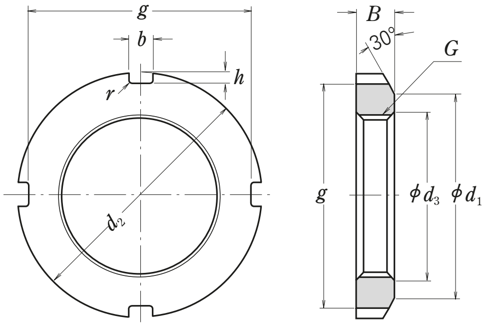
Shaft Diameter 400 – 480 mm



Shaft Diameter (mm) d_1	Nominal Bore Dia. (mm) d	Designation Applicable Bearings		Screw Threads G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
400	420	23084CAKE4	+ **AH 3084**	Tr 450 × 5	186	34	196	29
	420	24084CAK30E4	+ **AH 24084**	Tr 440 × 5	230	30	252	29.8
	420	23184CAKE4	+ **AH 3184**	Tr 460 × 5	266	40	276	46.5
	420	24184CAK30E4	+ **AH 24184**	Tr 440 × 5	310	30	332	41.4
	420	23284CAKE4	+ **AH 3284**	Tr 460 × 5	321	46	331	59
420	440	23088CAKE4	+ **AHX 3088**	Tr 470 × 5	194	35	205	42
	440	24088CAK30E4	+ **AH 24088**	Tr 460 × 5	242	30	264	33
	440	23188CAKE4	+ **AHX 3188**	Tr 480 × 5	270	42	281	50
	440	24188CAK30E4	+ **AH 24188**	Tr 460 × 5	310	30	332	43.5
	440	23288CAKE4	+ **AHX 3288**	Tr 480 × 5	330	48	341	64
440	460	23092CAKE4	+ **AHX 3092**	Tr 490 × 5	202	37	213	46
	460	24092CAK30E4	+ **AH 24092**	Tr 480 × 5	250	32	273	35.9
	460	23192CAKE4	+ **AHX 3192**	Tr 510 × 6	285	43	296	58
	460	24192CAK30E4	+ **AH 24192**	Tr 480 × 5	332	32	355	49.7
	460	23292CAKE4	+ **AHX 3292**	Tr 510 × 6	349	50	360	74.5
460	480	23096CAKE4	+ **AHX 3096**	Tr 520 × 6	205	38	217	51
	480	24096CAK30E4	+ **AH 24096**	Tr 500 × 5	250	32	273	37.5
	480	23196CAKE4	+ **AHX 3196**	Tr 530 × 6	295	45	307	63
	480	24196CAK30E4	+ **AH 24196**	Tr 500 × 5	340	32	363	53
	480	23296CAKE4	+ **AHX 3296**	Tr 530 × 6	364	52	376	82
480	500	230/500CAKE4	+ **AHX 30/500**	Tr 540 × 6	209	40	221	54.5
	500	240/500CAK30E4	+ **AH 240/500**	Tr 530 × 6	253	35	276	41.9
	500	231/500CAKE4	+ **AHX 31/500**	Tr 550 × 6	313	47	325	71
	500	241/500CAK30E4	+ **AH 241/500**	Tr 530 × 6	360	35	383	61.2
	500	232/500CAKE4	+ **AHX 32/500**	Tr 550 × 6	393	54	405	94.5

■NUTS FOR ROLLING BEARINGS

(For Adapters and Shafts)

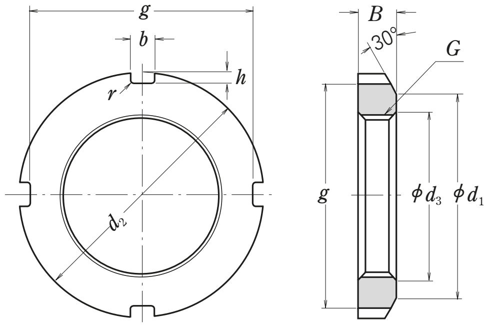


Nut with Washer

Units : mm

Designation	Nut Series AN										Reference		
	Screw Threads G	Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Mass (kg) approx.	Adapter ([1]) Sleeve Bore Dia. Numbers	Washer Designation	Shaft Dia.
AN 02	M 15×1	25	21	21	4	2	15.5	5	0.4	0.010	—	**AW 02 X**	15
AN 03	M 17×1	28	24	24	4	2	17.5	5	0.4	0.013	—	**AW 03 X**	17
AN 04	M 20×1	32	26	28	4	2	20.5	6	0.4	0.019	04	**AW 04 X**	20
AN 05	M 25×1.5	38	32	34	5	2	25.8	7	0.4	0.025	05	**AW 05 X**	25
AN 06	M 30×1.5	45	38	41	5	2	30.8	7	0.4	0.043	06	**AW 06 X**	30
AN 07	M 35×1.5	52	44	48	5	2	35.8	8	0.4	0.053	07	**AW 07 X**	35
AN 08	M 40×1.5	58	50	53	6	2.5	40.8	9	0.5	0.085	08	**AW 08 X**	40
AN 09	M 45×1.5	65	56	60	6	2.5	45.8	10	0.5	0.119	09	**AW 09 X**	45
AN 10	M 50×1.5	70	61	65	6	2.5	50.8	11	0.5	0.148	10	**AW 10 X**	50
AN 11	M 55×2	75	67	69	7	3	56	11	0.5	0.158	11	**AW 11 X**	55
AN 12	M 60×2	80	73	74	7	3	61	11	0.5	0.174	12	**AW 12 X**	60
AN 13	M 65×2	85	79	79	7	3	66	12	0.5	0.203	13	**AW 13 X**	65
AN 14	M 70×2	92	85	85	8	3.5	71	12	0.5	0.242	14	**AW 14 X**	70
AN 15	M 75×2	98	90	91	8	3.5	76	13	0.5	0.287	15	**AW 15 X**	75
AN 16	M 80×2	105	95	98	8	3.5	81	15	0.6	0.395	16	**AW 16 X**	80
AN 17	M 85×2	110	102	103	8	3.5	86	16	0.6	0.45	17	**AW 17 X**	85
AN 18	M 90×2	120	108	112	10	4	91	16	0.6	0.555	18	**AW 18 X**	90
AN 19	M 95×2	125	113	117	10	4	96	17	0.6	0.66	19	**AW 19 X**	95
AN 20	M 100×2	130	120	122	10	4	101	18	0.6	0.70	20	**AW 20 X**	100
AN 21	M 105×2	140	126	130	12	5	106	18	0.7	0.845	21	**AW 21 X**	105
AN 22	M 110×2	145	133	135	12	5	111	19	0.7	0.965	22	**AW 22 X**	110
AN 23	M 115×2	150	137	140	12	5	116	19	0.7	1.01	—	**AW 23**	115
AN 24	M 120×2	155	138	145	12	5	121	20	0.7	1.08	24	**AW 24**	120
AN 25	M 125×2	160	148	150	12	5	126	21	0.7	1.19	—	**AW 25**	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

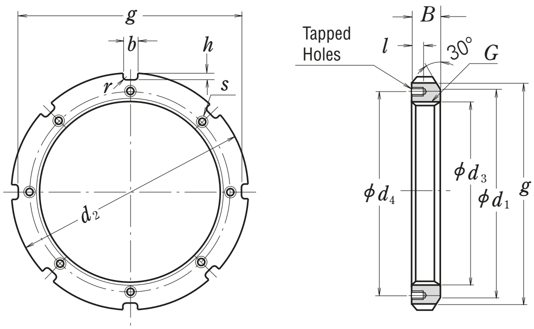
Designation	Screw Threads G	d_2	d_1	g	b	h	d_3	B	r max.	Mass (kg) approx.	Adapter (1) Sleeve Bore Dia. Numbers	Washer Designation	Shaft Dia.
Nut Series AN											**Reference**		
AN 26	M 130×2	165	149	155	12	5	131	21	0.7	1.25	26	**AW 26**	130
AN 27	M 135×2	175	160	163	14	6	136	22	0.7	1.55	—	**AW 27**	135
AN 28	M 140×2	180	160	168	14	6	141	22	0.7	1.56	28	**AW 28**	140
AN 29	M 145×2	190	172	178	14	6	146	24	0.7	2.0	—	**AW 29**	145
AN 30	M 150×2	195	171	183	14	6	151	24	0.7	2.03	30	**AW 30**	150
AN 31	M 155×3	200	182	186	16	7	156.5	25	0.7	2.21	—	—	—
AN 32	M 160×3	210	182	196	16	7	161.5	25	0.7	2.59	32	**AW 32**	160
AN 33	M 165×3	210	193	196	16	7	166.5	26	0.7	2.43	—	—	—
AN 34	M 170×3	220	193	206	16	7	171.5	26	0.7	2.8	34	**AW 34**	170
AN 36	M 180×3	230	203	214	18	8	181.5	27	0.7	3.05	36	**AW 36**	180
AN 38	M 190×3	240	214	224	18	8	191.5	28	0.7	3.4	38	**AW 38**	190
AN 40	M 200×3	250	226	234	18	8	201.5	29	0.7	3.7	40	**AW 40**	200
Nut Series ANL													
ANL 24	M 120×2	145	133	135	12	5	121	20	0.7	0.78	24	**AWL 24**	120
ANL 26	M 130×2	155	143	145	12	5	131	21	0.7	0.88	26	**AWL 26**	130
ANL 28	M 140×2	165	151	153	14	6	141	22	0.7	0.99	28	**AWL 28**	140
ANL 30	M 150×2	180	164	168	14	6	151	24	0.7	1.38	30	**AWL 30**	150
ANL 32	M 160×3	190	174	176	16	7	161.5	25	0.7	1.56	32	**AWL 32**	160
ANL 34	M 170×3	200	184	186	16	7	171.5	26	0.7	1.72	34	**AWL 34**	170
ANL 36	M 180×3	210	192	194	18	8	181.5	27	0.7	1.95	36	**AWL 36**	180
ANL 38	M 190×3	220	202	204	18	8	191.5	28	0.7	2.08	38	**AWL 38**	190
ANL 40	M 200×3	240	218	224	18	8	201.5	29	0.7	2.98	40	**AWL 40**	200

Note (1) 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

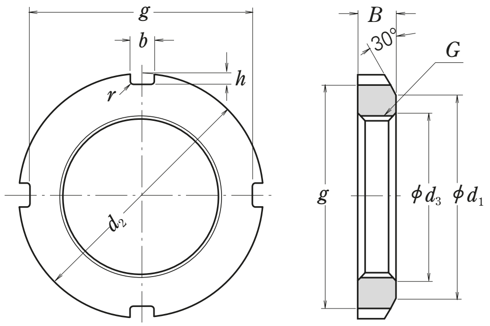
Designation	Nut Series AN													Reference		
	Screw Threads G	Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Tapped Holes l	Screw Threads (S)	d_4	Mass (kg) approx.	Adapter (1) Sleeve Bore Dia. Numbers	Stopper Designation	Shaft Dia.
AN 44	Tr 220×4	280	250	260	20	10	222	32	0.8	15	M 8×1.25	238	5.2	44	**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 (1) 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)	Withdrawal Sleeve Designations			
		d_2	d_1	g	b	h	d_3	B	r max.	approx.	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**			

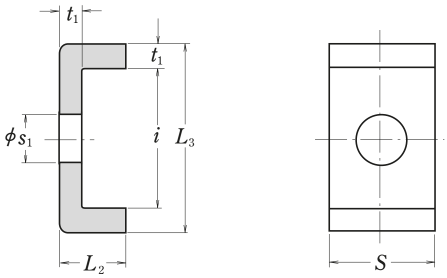
Remarks 1. The basic design and dimensions of screw threads are in accordance with JIS B 0216.
2. There may be more notches in the nut than shown in the above figure.

NUTS FOR ROLLING BEARINGS

(Combination of Withdrawal Sleeves and Nuts)

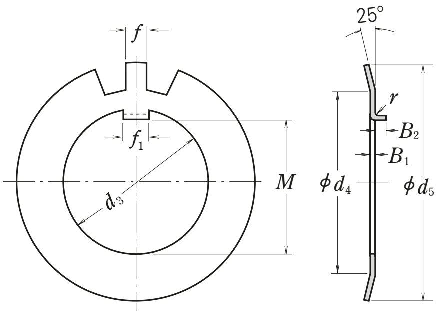
Designation	Reference						
	Withdrawal Sleeve Designations						
	AH 30	AH 31	AH 2	AH 22	AH 32	AH 3	AH 23
AN 09	—	—	**AH 208**	—	—	**AH 308**	**AH 2308**
AN 10	—	—	**AH 209**	—	—	**AH 309**	**AH 2309**
AN 11	—	—	**AH 210**	—	—	**AHX 310**	**AHX 2310**
AN 12	—	—	**AH 211**	—	—	**AHX 311**	**AHX 2311**
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**

STOPPERS FOR ROLLING BEARINGS

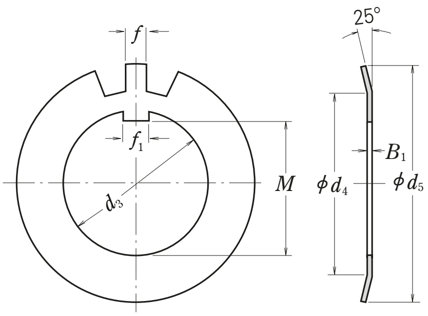


Units : mm

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**
AL 52	4	24	12	12	25.5	33.5	3.4	**AN 52, AN 56**
AL 60	4	24	12	12	30.5	38.5	3.8	**AN 60**
AL 64	5	24	15	12	31	41	5.35	**AN 64**
AL 68	5	28	15	14	38	48	6.65	**AN 68, AN 72**
AL 76	5	32	15	14	40	50	7.95	**AN 76**
AL 80	5	32	15	18	45	55	8.2	**AN 80, AN 84**
AL 88	5	36	15	18	43	53	9.0	**AN 88, AN 92**
AL 96	5	36	15	18	53	63	10.4	**AN 96**
AL 100	5	40	15	18	45	55	10.5	**AN 100**
	Stopper Series ALL							
ALL 44	4	20	12	7	13.5	21.5	2.12	**ANL 44**
ALL 48	4	20	12	9	17.5	25.5	2.29	**ANL 48, ANL 52**
ALL 56	4	24	12	9	17.5	25.5	2.92	**ANL 56**
ALL 60	4	24	12	9	20.5	28.5	3.15	**ANL 60**
ALL 64	5	24	15	9	21	31	4.55	**ANL 64, ANL 68**
ALL 72	5	28	15	9	20	30	5.05	**ANL 72**
ALL 76	5	28	15	12	24	34	5.3	**ANL 76, ANL 80**
ALL 84	5	32	15	12	24	34	6.1	**ANL 84**
ALL 88	5	32	15	14	28	38	6.45	**ANL 88, ANL 92**
ALL 96	5	36	15	14	28	38	7.3	**ANL 96, ANL 100**



Bent-Tab



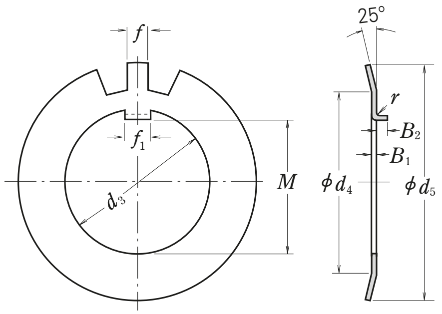
Straight-Tab

Units : mm

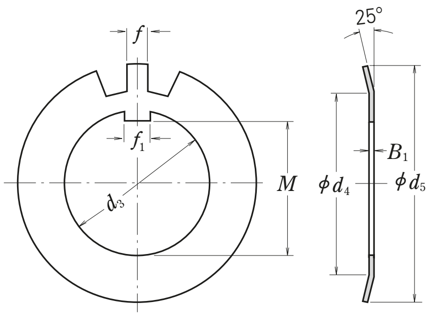
Designation		Lock-Washer Series AW											Reference		
		Basic Dimensions									No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter [1] Sleeve Bore Dia. Numbers	Nut Designation	Shaft Dia.
Bent-Tab	Straight-Tab	d_3	M	f_1	B_1	f	d_4	d_5	Bent-Tab r	Bent-Tab B_2					
AW 02	**AW 02 X**	15	13.5	4	1	4	21	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 [1] 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

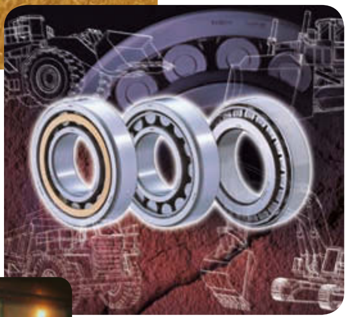
Units : mm

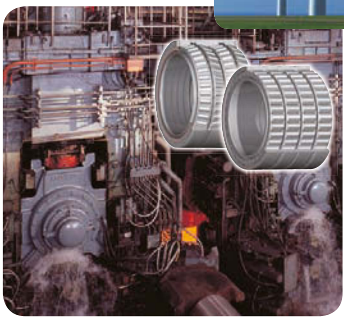
Designation		Lock-Washer Series AW											Reference		
		Basic Dimensions									No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter (1) Sleeve Bore Dia. Numbers	Nut Designation	Shaft Dia.
Bent-Tab	Straight-Tab	d_3	M	f_1	B_1	f	d_4	d_5	Bent-Tab r	Bent-Tab B_2					
AW 26	**AW 26 X**	130	125	14	2	12	149	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															
AWL 24	**AWL 24 X**	120	115	14	2	12	133	155	1.5	6	19	7.7	24	**ANL 24**	120
AWL 26	**AWL 26 X**	130	125	14	2	12	143	165	1.5	6	19	8.7	26	**ANL 26**	130
AWL 28	**AWL 28 X**	140	135	16	2	14	151	175	1.5	8	19	10.9	28	**ANL 28**	140
AWL 30	**AWL 30 X**	150	145	16	2	14	164	190	1.5	8	19	11.3	30	**ANL 30**	150
AWL 32	**AWL 32 X**	160	154	18	2.5	16	174	200	1.5	8	19	16.2	32	**ANL 32**	160
AWL 34	**AWL 34 X**	170	164	18	2.5	16	184	210	1.5	8	19	19	34	**ANL 34**	170
AWL 36	**AWL 36 X**	180	174	20	2.5	18	192	220	1.5	8	19	18	36	**ANL 36**	180
AWL 38	**AWL 38 X**	190	184	20	2.5	18	202	230	1.5	8	19	20.5	38	**ANL 38**	190
AWL 40	**AWL 40 X**	200	194	20	2.5	18	218	250	1.5	8	19	21.4	40	**ANL 40**	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

Note (*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

Air Turbine Bearings for Dental Handpieces

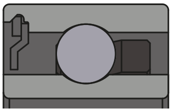
Greatly improved corrosion resistance lengthens bearing replacement cycles.

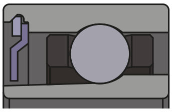
Dental Handpiece Bearings

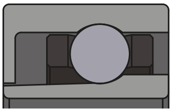
Features of NSK Dental Handpiece Bearings

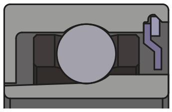
This bearing Series has been developed to cover the wide range of handpiece sizes and shapes used in the market (43 types in total).

· Bearing Type

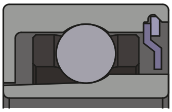

Deep groove

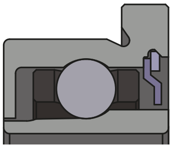

Angular

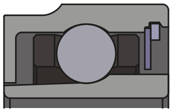

Integral angular

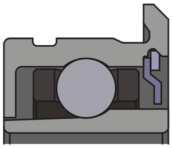

Integral shielded angular

· 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.

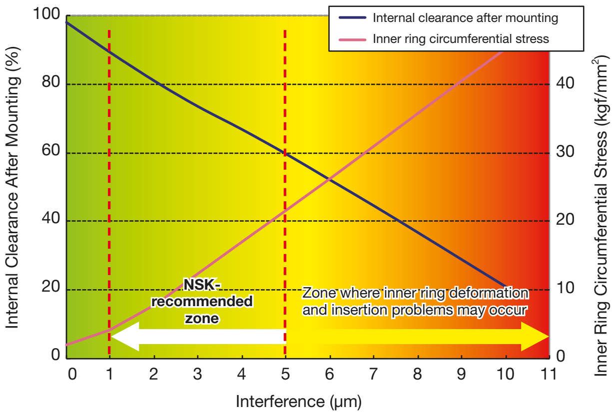
B3Z100X -H-20SN34 T52C ZS CG9 7A U438 CF1X
(1) (2) (3) (4) (5) (6) (7) (8)

(1) B3Z100X: Model name indicating basic designation for air turbines
(2) -H-20SN34: Ceramic ballsl (**-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

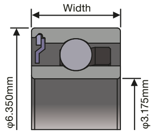
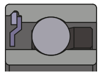
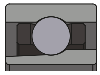
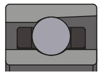
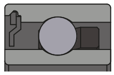
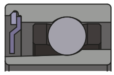
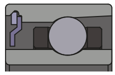
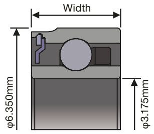
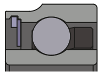
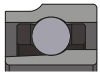
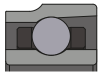
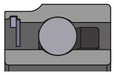
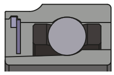
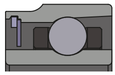
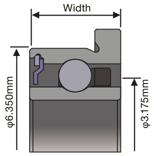
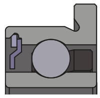
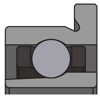
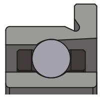
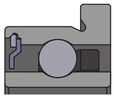
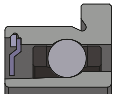
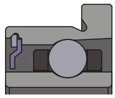
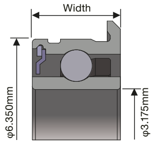
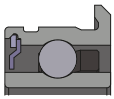
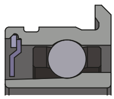
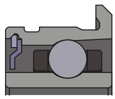
For optimal performance, bearings must be correctly fitted on the shaft and in the housing. To provide this performance, Class ABEC9 tolerance (from -0.0025 mm to 0 mm) is used for the inner ring bore of NSK bearings. NSK can supply bearings with two classifications of ring bore diameter tolerance (from -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

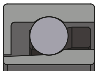
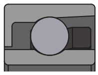
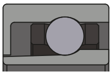
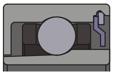
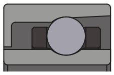
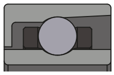
Bearing Series	Width	Deep Groove Bearing	Angular Contact Bearing: Inner Ring Counterbore	Angular Contact Bearing: Outer Ring Counterbore
100 Series (Straight type) 	**2.380mm** (0.0937")	 B3Z-100X	 BH3Z-101X	 BH3Z-102X
	2.779mm (0.1094")	 B3Z-100	 BH3Z-101A	 BH3Z-102A
150 Series (Grooved type) 	**2.380mm** (0.0937")	 B3Z-150X	 BH3Z-151X	 BH3Z-152X
	2.779mm (0.1094")	 B3Z-150	 BH3Z-151A	 BH3Z-152A
200 Series (Flanged type) 	**2.380mm** (0.0937")	 FBC3Z-200X	 FBH3Z-201X	 FBH3Z-202X
	2.779mm (0.1094")	 FBC3Z-200	 FBH3Z-201A	 FBH3Z-202A
250 Series 	**2.779mm** (0.1094")	 FBC3Z-250	 FBH3Z-251A	 FBH3Z-252A

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	
				
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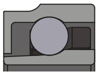
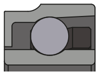
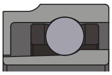
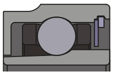
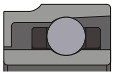
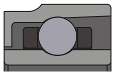
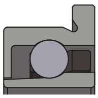
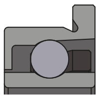
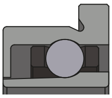
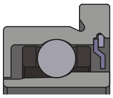
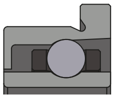
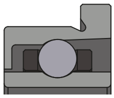
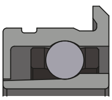
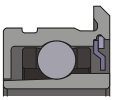
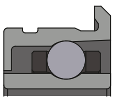
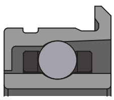
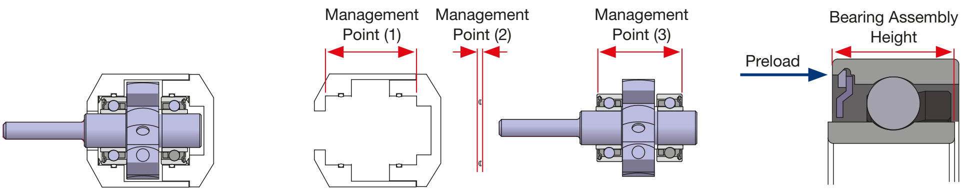
				
	BH3Z-153X		BH3Z-154X	
				
	BH3Z-153A	BH3Z-153B	BH3Z-154A	BH3Z-154
				
	FBH3Z-203X		FBH3Z-204X	
				
	FBH3Z-203A	FBH3Z-203B	FBH3Z-204A	FBH3Z-204
				
	FBH3Z-253A	FBH3Z-253B	FBH3Z-254A	FBH3Z-254

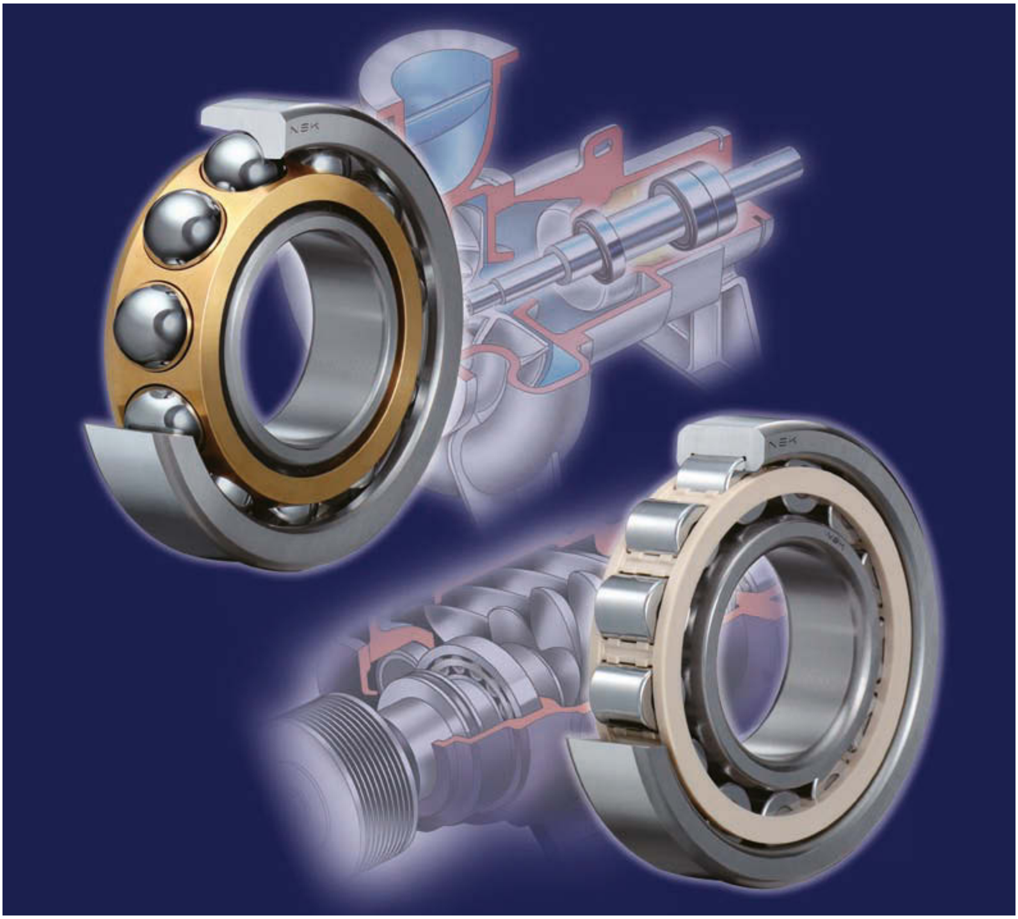
Preload Stabilization

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

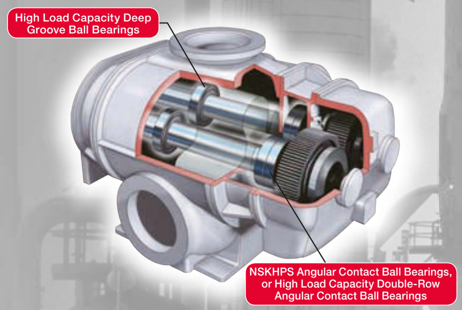
Bearings for Compressors

Bearing Tables

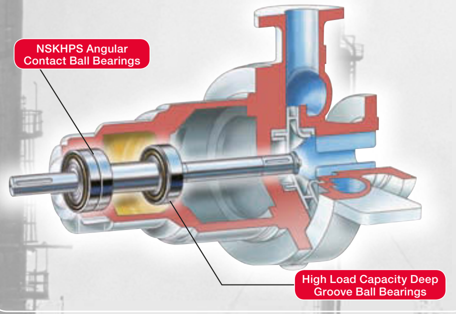
Bearings for Pumps

Advanced machined-brass cages provide strength and endurance.
Optimized internal geometries allow efficient lubricant flow through the bearing.

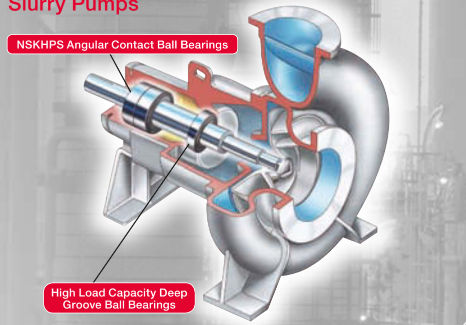
Vacuum Pumps



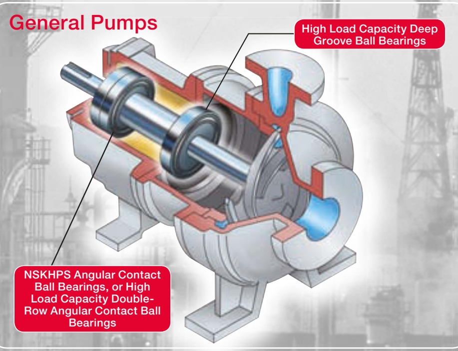
Pumps for Petroleum and Chemicals



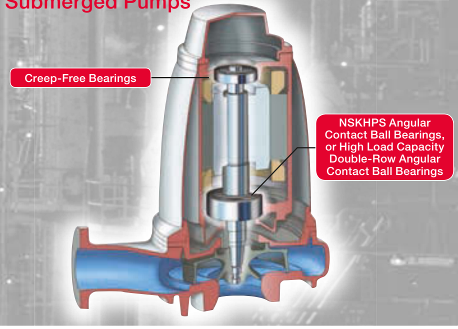
Slurry Pumps



General Pumps



Submerged Pumps



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*1, etc.)
- Pulp and paper industry (ANSI standards*2, etc.)

*1 Standards related to petroleum specified by the American Petroleum Institute

*2 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.

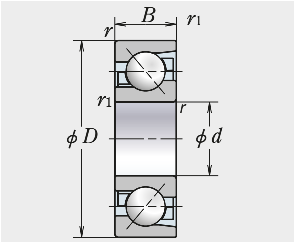
Compared to conventional bearings:

- Bearing life: 90% longer
- Maximum rotational speed: 20% faster
- Universal arrangement standard
- 40° contact angle

Axial Internal Clearance in Combined ACBBs (Measured Clearance)

Unit: μm

Nominal Bore Diameter *d* (mm)		CNB		GA	
Over	Incl.	Min.	Max.	Min.	Max.
12	18	17	25		
18	30	20	28	−2	6
30	50	24	32		
50	80	29	41	−3	9



Bearing Designation

Example: 7310 B EA MR SU GA

- 7310 — Basic designation
- B — Contact angle: 40°
- EA — Internal designation: High load capacity
- MR — Cage: Machined cage
- SU — Arrangement: Universal arrangement (single unit)
- GA — Internal clearance

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
	d	D	B	r (min.)	r_1 (min.)	C_r	C_{0r}	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 NSKHPS 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.

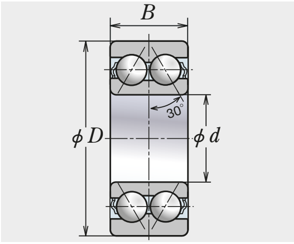
Features of Bearings for Pumps

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**

- 3309: Basic Designation
- F: Contact angle: 30°
- CGXX: Radial internal clearance

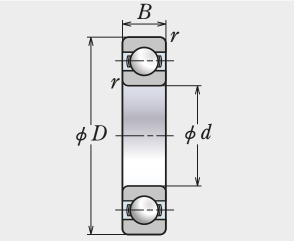
Bearing Designation	Boundary Dimensions (mm)			Basic Load Ratings (N)	
	d	D	B	C_r (dynamic)	C_{0r} (static)
3305F	25	62	25.4	30 500	20 500
3306F	30	72	30.2	39 500	27 300
3307F	35	80	34.9	49 500	35 000
3308F	40	90	36.5	60 500	44 000
3309F	45	100	39.7	66 500	49 500
3310F	50	110	44.4	85 500	64 500
3311F	55	120	49.2	106 000	82 000
3312F	60	130	54	122 000	95 500
3313F	65	140	58.7	138 000	109 000

High Load Capacity Deep Groove Ball Bearings (Open Type)

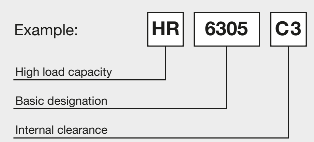
Applications
- Petroleum and chemical industries (API standards, etc.)
- Pulp and paper industry (ANSI standards, etc.)
- Semiconductor and liquid crystal panels (vacuum pumps)

High load capacity enables reduced pump size and extended maintenance intervals.

Compared to conventional bearings:
- Bearing life: 70% longer



Bearing Designation



Bearing Designation	Boundary Dimensions (mm)				Basic Load Ratings (N)	
	d	D	B	r (min.)	C_r (dynamic)	C_{0r} (static)
HR 6202	15	35	11	0.6	8 550	3 950
HR 6302	15	42	13	1.0	13 300	5 900
HR 6203	17	40	12	0.6	11 300	5 350
HR 6303	17	47	14	1.0	15 600	7 100
HR 6304	20	52	15	1.1	18 200	9 050
HR 6205	25	52	15	1.0	15 300	8 100
HR 6305	25	62	17	1.1	23 700	12 200
HR 6206	30	62	16	1.0	23 300	12 800
HR 6306	30	72	19	1.1	29 800	15 800
HR 6207	35	72	17	1.1	28 300	16 000
HR 6307	35	80	21	1.5	39 500	21 500
HR 6208	40	80	18	1.1	32 500	19 900
HR 6308	40	90	23	1.5	47 000	26 200
HR 6209	45	85	19	1.1	36 500	22 600
HR 6309	45	100	25	1.5	57 000	34 500
HR 6210	50	90	20	1.1	39 000	25 800
HR 6310	50	110	27	2.0	66 500	40 500
HR 6211	55	100	21	1.5	48 000	32 000
HR 6311	55	120	29	2.0	78 000	46 000
HR 6212	60	110	22	1.5	58 000	38 000

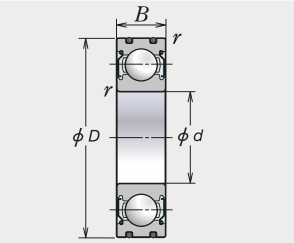
Features of Bearings for Pumps

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)



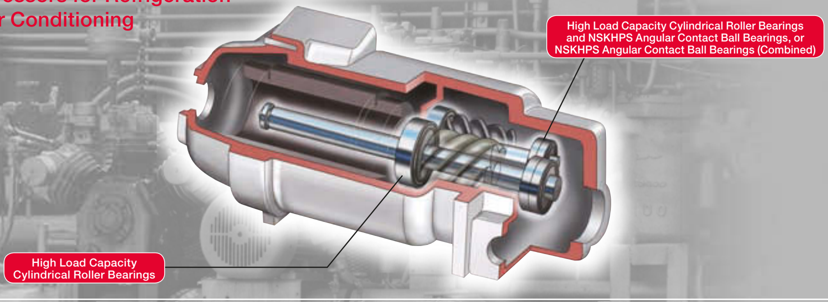
Bearing Designation	Boundary Dimensions (mm)				Basic Load Ratings (N)	
	d	D	B	r (min.)	C_r (dynamic)	C_{0r} (static)
6000	10	26	8	0.3	4 550	1 970
6200	10	30	9	0.6	5 100	2 390
6300	10	35	11	0.6	8 100	3 450
6001	12	28	8	0.3	5 100	2 370
6201	12	32	10	0.6	6 800	3 050
6301	12	37	12	1.0	9 700	4 200
6002	15	32	9	0.3	5 600	2 830
6202	15	35	11	0.6	7 650	3 750
6302	15	42	13	1.0	11 400	5 450
6003	17	35	10	0.3	6 000	3 250
6203	17	40	12	0.6	9 550	4 800
6303	17	47	14	1.0	13 600	6 650
6004	20	42	12	0.6	9 400	5 000
6204	20	47	14	1.0	12 800	6 600
6304	20	52	15	1.1	15 900	7 900
6005	25	47	12	0.6	10 100	5 850
6205	25	52	15	1.0	14 000	7 850
6305	25	62	17	1.1	20 600	11 200
6006	30	55	13	1.0	13 200	8 300
6206	30	62	16	1.0	19 500	11 300
6306	30	72	19	1.1	26 700	15 000
6007	35	62	14	1.0	16 000	10 300
6207	35	72	17	1.1	25 700	15 300
6307	35	80	21	1.5	33 500	19 200
6008	40	68	15	1.0	16 800	11 500
6208	40	80	18	1.1	29 100	17 900
6308	40	90	23	1.5	40 500	24 000
6009	45	75	16	1.0	20 900	15 200
6209	45	85	19	1.1	31 500	20 400
6309	45	100	25	1.5	53 000	32 000

Bearings for Compressors

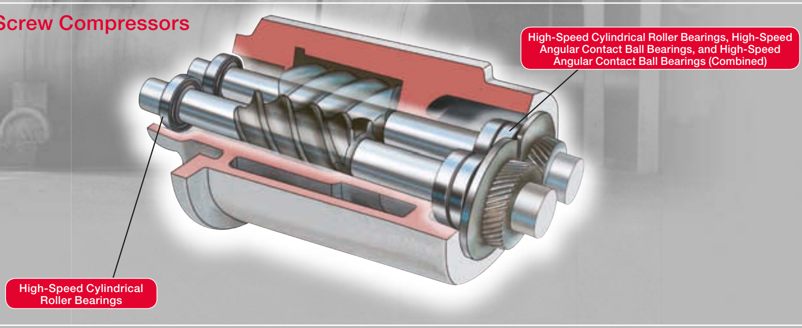
Bearings for Compressors

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.

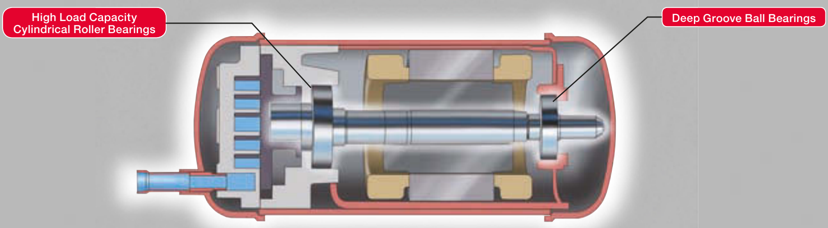
Compressors for Refrigeration and Air Conditioning



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)

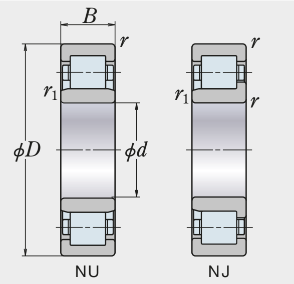
Applications
- Refrigeration and air conditioning screw compressors
- Air and gas screw compressors

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: μm

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 Designaiton

Example: NU 310 E T7 [ ]

- NU: Type
- 310: Basic Designation
- E: Internal deisgnation: High load capacity
- T7: 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)

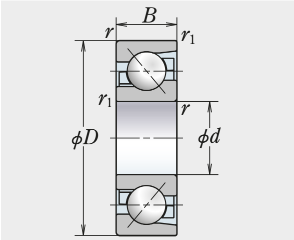
Applications
- Refrigeration and air conditioning screw compressors
- Air and gas screw compressors

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: μm

Nominal Bore Diameter *d* (mm)		CNB		GA	
Over	Incl.	Min.	Max.	Min.	Max.
12	18	17	25		
18	30	20	28	−2	6
30	50	24	32		
50	80	29	41	−3	9



Bearing Designation

Example: 7310 | B | EA | T7 | SU | CNB

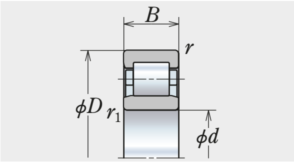
- 7310: Basic Designation
- B: Contact angle: 40°
- EA: Internal designation: High load capacity
- T7: Cage: L-PPS cage
- SU: Arrangement: Universal arrangement (single unit)
- CNB: Internal clearance

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)		Maximum Rotational Speed (min^{-1})
	d	D	B	r (min.)	r_1 (min.)	C_r (dynamic)	C_{0r} (static)	Oil
7201BEA	12	32	10	0.6	0.3	8 150	3 750	30 000
7301BEA	12	37	12	1	0.6	11 100	4 950	26 000
7202BEA	15	35	11	0.6	0.3	9 800	4 800	26 000
7302BEA	15	42	13	1	0.6	14 300	6 900	22 000
7203BEA	17	40	12	0.6	0.3	11 600	6 100	22 000
7303BEA	17	47	14	1	0.6	16 800	8 300	20 000
7204BEA	20	47	14	1	0.6	15 600	8 150	19 000
7304BEA	20	52	15	1.1	0.6	19 800	10 500	18 000
7205BEA	25	52	15	1	0.6	17 600	10 200	17 000
7305BEA	25	62	17	1.1	0.6	27 200	14 900	15 000
7206BEA	30	62	16	1	0.6	23 700	14 300	14 000
7306BEA	30	72	19	1.1	0.6	36 500	20 600	13 000
7207BEA	35	72	17	1.1	0.6	32 500	19 600	12 000
7307BEA	35	80	21	1.5	1	40 500	24 400	11 000
7208BEA	40	80	18	1.1	0.6	38 500	24 500	11 000
7308BEA	40	90	23	1.5	1	53 000	33 000	10 000
7209BEA	45	85	19	1.1	0.6	40 500	27 100	10 000
7309BEA	45	100	25	1.5	1	62 500	39 500	9 000
7210BEA	50	90	20	1.1	0.6	42 000	29 700	9 500
7310BEA	50	110	27	2	1	78 000	50 500	8 000
7211BEA	55	100	21	1.5	1	51 500	37 000	8 500
7311BEA	55	120	29	2	1	89 000	58 500	7 500
7212BEA	60	110	22	1.5	1	61 500	45 000	7 500
7312BEA	60	130	31	2.1	1.1	102 000	68 500	6 700
7213BEA	65	120	23	1.5	1	70 000	53 500	7 100
7313BEA	65	140	33	2.1	1.1	114 000	77 000	6 300
7214BEA	70	125	24	1.5	1	75 500	58 500	6 700
7314BEA	70	150	35	2.1	1.1	124 000	87 500	6 000
7215BEA	75	130	25	1.5	1	78 500	63 500	6 300
7216BEA	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. $d_m n$: 1 300 000 (see Remarks 1 & 2) and bearing accuracy greater than Class P5 as standard.



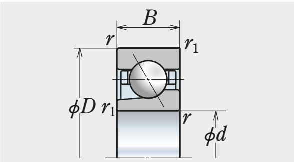
Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (N)	
	d	D	B	r (min.)	r_1 (min.)	C_r (dynamic)	C_{0r} (static)
NU205EMM	25	52	15	1	0.6	29 300	27 700
NU206EMM	30	62	16	1	0.6	39 000	37 500
NU207EMM	35	72	17	1.1	0.6	50 500	50 000
NU208EMM	40	80	18	1.1	1.1	55 500	55 500
NU209EMM	45	85	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. $d_m n$: 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

Bearings for Agricultural Machinery

Lineup

Powertrain

Engine/Electrical Accessories

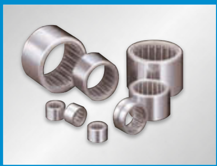
Plastic Pulley for Accessory & Timing Belts

Deep Groove Ball Bearings

HR Series Tapered Roller Bearings

Drivetrain

Transmission/Differential Gear/Propeller Shaft



Needle Roller Bearings

Creep-Free Bearings™

Double-Row Angular Contact Ball Bearings

Thrust Ball Bearings

Long-Life Pinion Shaft With Cage and Rollers

Water Pump Bearings

Other

Ball Bearing Units

Implements

Agril Disc Hub

UR Bearings
(Special Carbonitriding Heat-Treatment Technology)

Chassis

Wheel/Steering

NSKHPS™ Spherical Roller Bearings

NSKHPS™ Deep Groove Ball Bearings

Hub Unit Bearings (HUB I)

Hi-TF Bearings

TM Series
Sealed Deep Groove Ball Bearings

Bearings for Agricultural Machinery

High-Performance Standard NSKHPS™ 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 NSKHPS™ 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 grove 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.

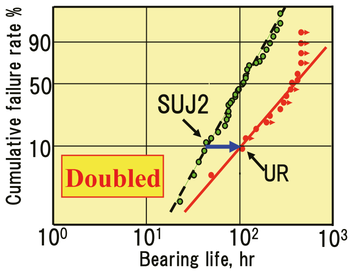
UR Bearings

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

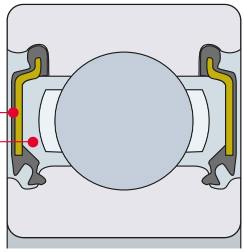


TM Series Sealed Deep Groove Ball Bearings

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.

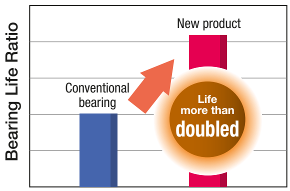


Bearing Series	TM302-TM314 / TM203-TM214	Major dimensions are the same as the Series 62 and Series 63 deep groove ball bearings.

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.

Comparison of life test results for conventional and newly developed bearing

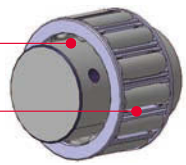


Features

- 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.



Corresponding size:
Inscribed circle diameter up to 32 mm

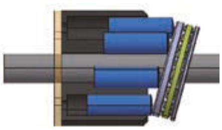
HST Long-Life, High-Reliability Cage-Equipped Thrust Ball Bearings for Agricultural Machinery

These bearings contribute to the long life and reliability of agricultural machinery.

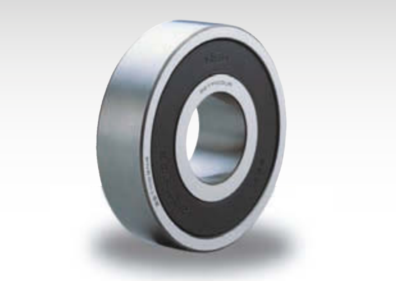
Features

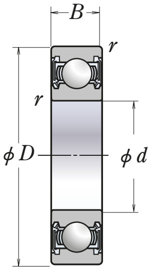
Over twice the life of conventional bearings through the use of special technology.

- 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

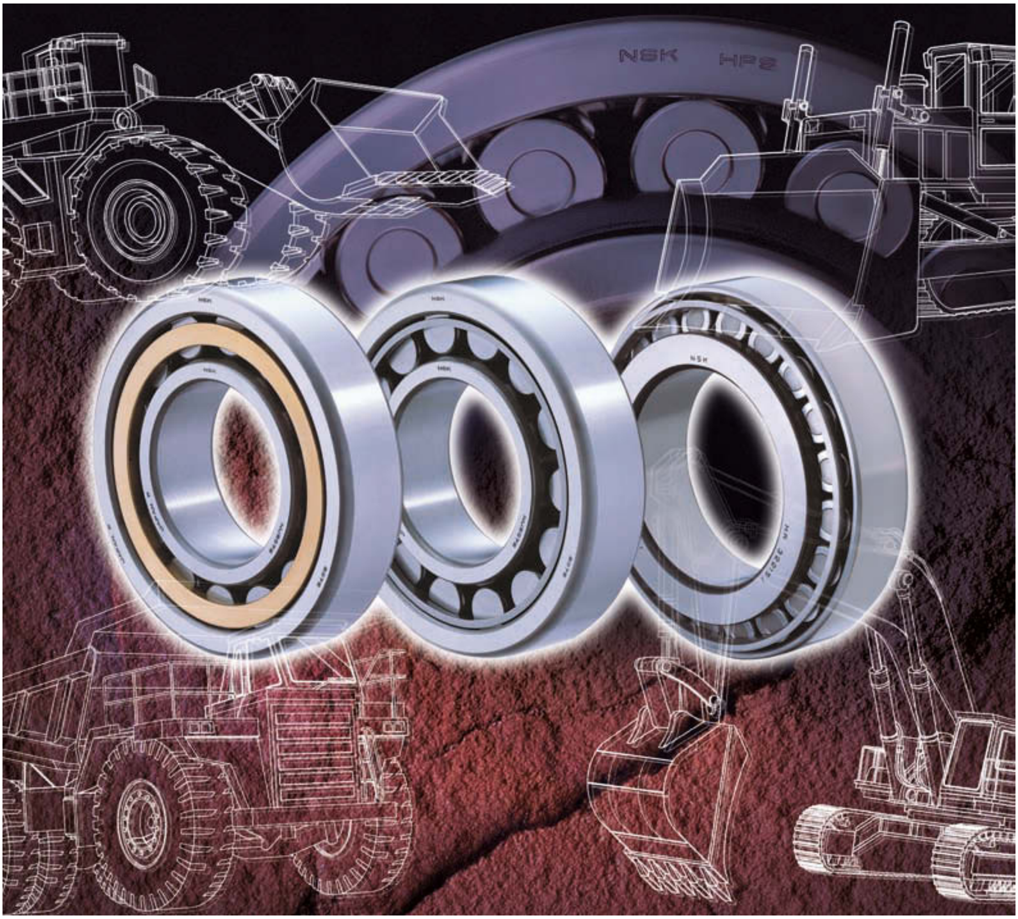
- TM — TM Series
- 205 — Basic designation
- C3 — Internal clearance designation

Bearing Designation	Boundary Dimensions (mm)			Basic Load Ratings (N)	
	d	D	B	C_r	C_{0r}
TM203	17	40	12	9 550	4 800
TM303	17	47	14	13 600	6 650
TM204	20	47	14	12 800	6 600
TM304	20	52	15	15 900	7 900
TM2/22	22	50	14	12 900	6 800
TM3/22	22	56	16	18 400	9 250
TM205	25	52	15	14 000	7 850
TM305	25	62	17	20 600	11 200
TM2/28	28	58	16	16 600	9 500
TM3/28	28	68	18	26 700	14 000
TM206	30	62	16	19 500	11 300
TM306	30	72	19	26 700	15 000
TM2/32	32	65	17	20 700	11 600
TM3/32	32	75	20	29 400	17 000
TM207	35	72	17	25 700	15 300
TM307	35	80	21	33 500	19 200
TM208	40	80	18	29 100	17 800
TM308	40	90	23	40 500	24 000
TM209	45	85	19	31 500	20 400
TM309	45	100	25	53 000	32 000
TM210	50	90	20	35 000	23 200
TM310	50	110	27	62 000	38 500
TM211	55	100	21	43 500	29 300
TM311	55	120	29	71 500	44 500
TM212	60	110	22	52 500	36 000
TM312	60	130	31	82 000	52 000
TM213	65	120	23	57 500	40 000
TM313	65	140	33	92 500	60 000
TM214	70	125	24	62 000	44 000
TM314	70	150	35	104 000	68 000

Note The maximum continuous operating temperature for standard nitrile rubber seals is 110 °C.

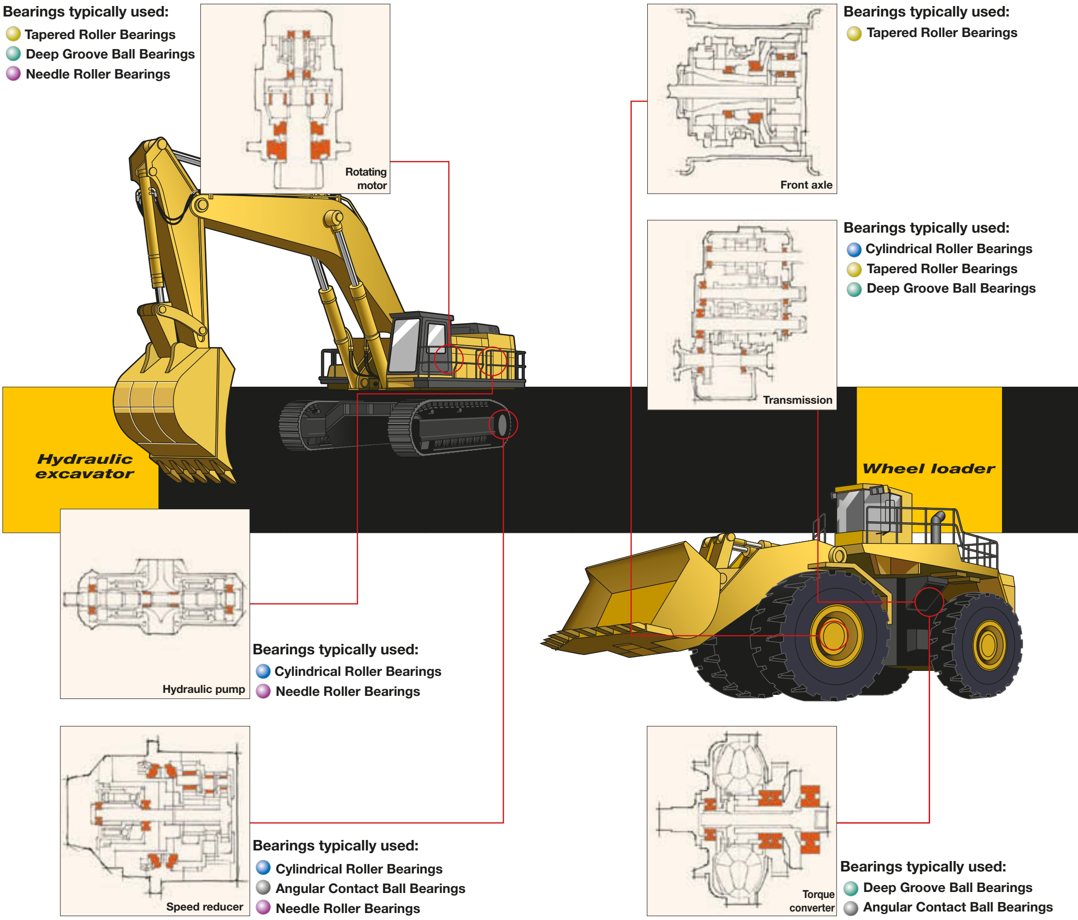
Bearings for Construction Machinery

Tough bearings that provide long service life under harsh conditions reflect NSK's accumulated technological prowess.



Bearings for Construction Machinery

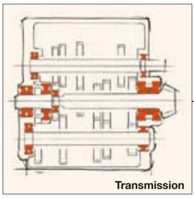
Lineup



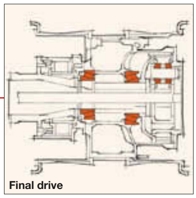
NSKHPS™ Spherical Roller Bearings

NSKHPS™ Cylindrical Roller Bearings

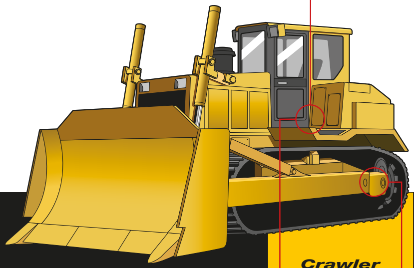
HR Series Tapered Roller Bearings

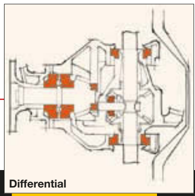

Transmission

Bearings typically used:
- Cylindrical Roller Bearings
- Tapered Roller Bearings
- Spherical Roller Bearings


Final drive

Bearings typically used:
- Tapered Roller Bearings

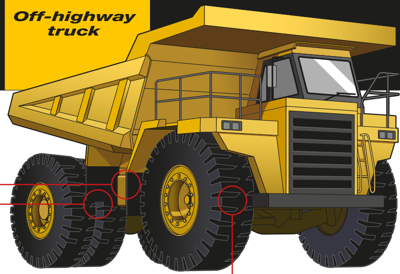


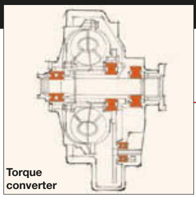

Differential

Bearings typically used:
- Cylindrical Roller Bearings
- Tapered Roller Bearings

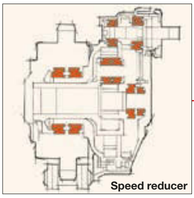
Crawler dozer

Off-highway truck

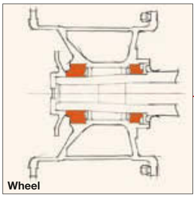



Torque converter

Bearings typically used:
- Cylindrical Roller Bearings
- Deep Groove Ball Bearings
- Angular Contact Ball Bearings


Speed reducer

Bearings typically used:
- Tapered Roller Bearings


Wheel

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.

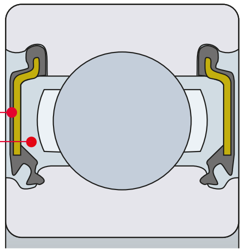
2. Wide product lineup
NSK offers a wide lineup of NSKHPS bearings with four types of cages and a range of sizes for a high degree of versatility across general-purpose applications.
- Pressed-steel cage with high cost performance
- Highly reliable machined-brass cage
- Polyamide-resin cage with excellent 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.

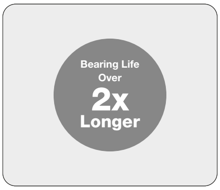
Features

- Optimzed 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

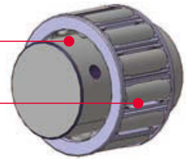
These bearings have improved durability and reliability to achieve long service life under harsh operating conditions, such as extended continuous operation, by utilizing a pinion shaft with a cage and rollers as a single assembly.

Features



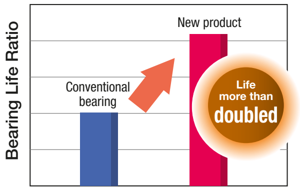
Pinion shaft
- The raceway is polished to a mirror-smooth finish to ensure a sufficiently thick oil film.
- A special heat treatment is applied to the pinion shaft as a measure against contaminated-lubricant conditions.

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



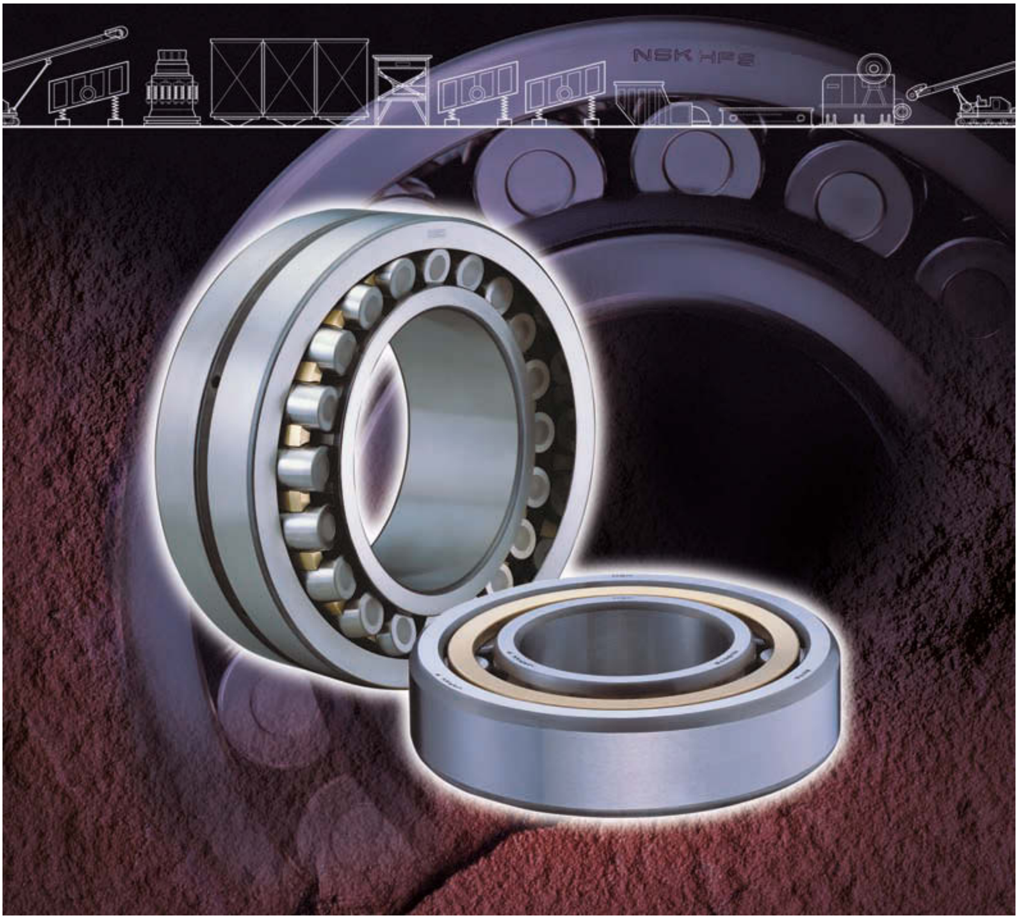
Hi-TF Bearings

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

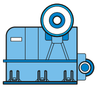
Bearings for Mining Machinery

Tough bearings that offer longer service life under demanding mining conditions thanks to NSK's wealth of outstanding technologies.



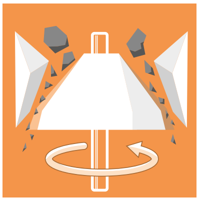
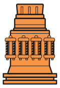
Bearing Tables

Bearings for Mining Machinery

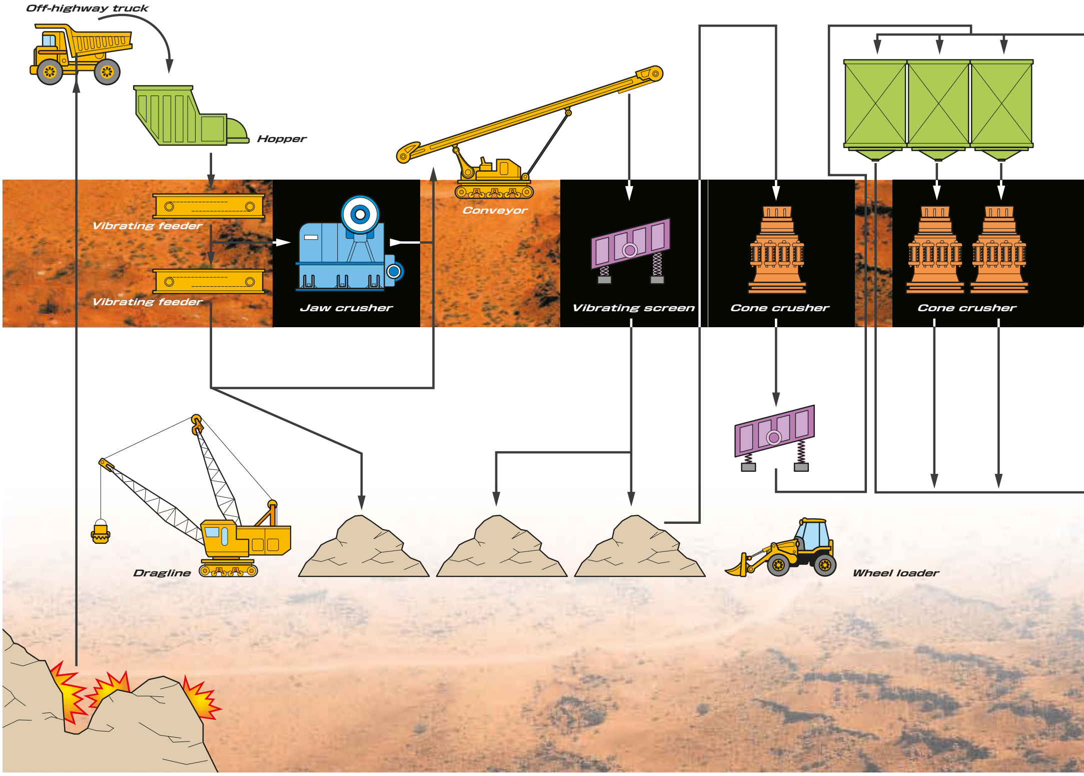
Jaw Crusher

Work material is crushed between two opposing jaw plates. One plate opens and shuts, crushing raw material against the stationary jaw plate.

Cone Crusher

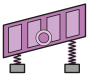
Material is fed into the crusher cavity and processed by the eccentric rotating action of the inner cone against the outer cone. Work can be reduced to a diameter ranging from 50 mm to 100 mm.



NSKHPS™ Spherical Roller Bearings

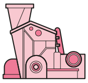
NSKHPS™ Cylindrical Roller Bearings

CA-VS3 and CA-VS4 Series Super-Long-Life Spherical Roller Bearings for Vibrating Equipment



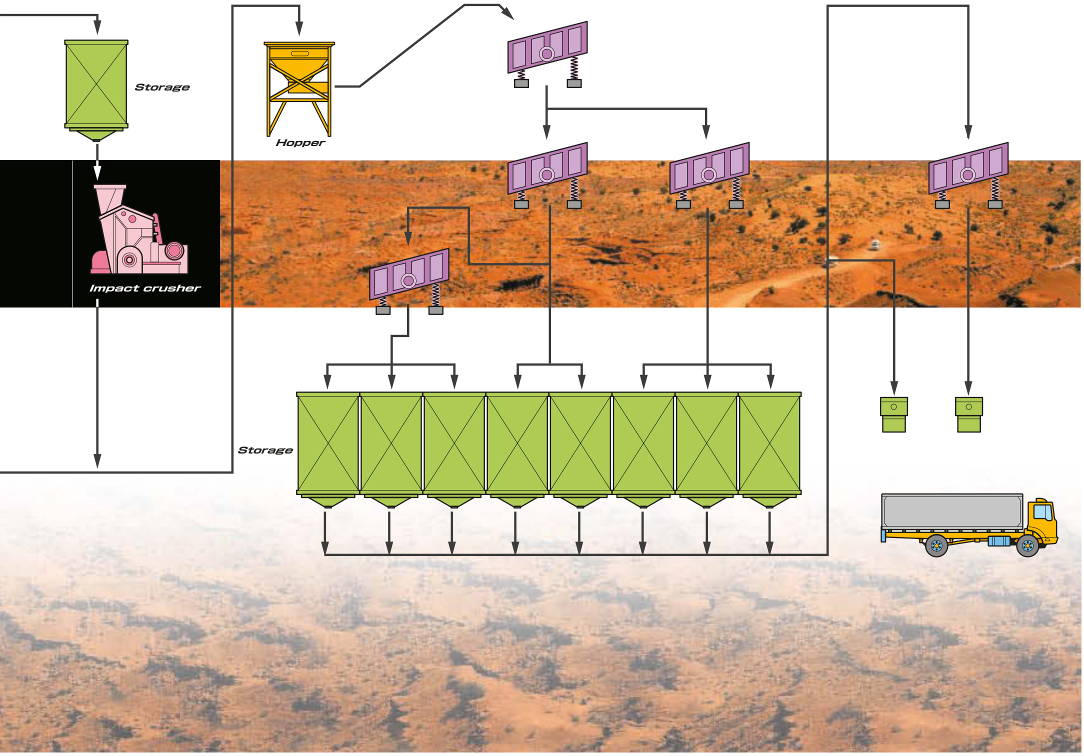
Vibrating Screen

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 dimentional 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.

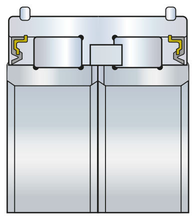
2. Wide product lineup
NSK offers NSKHPS bearings with four types of cages featuring a range of sizes for a high degree of versatility across general-purpose applications:
- Pressed-steel cage with high cost-performance
- Highly reliable machined-brass cage
- Polyamide-resin cage with excellent heat 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

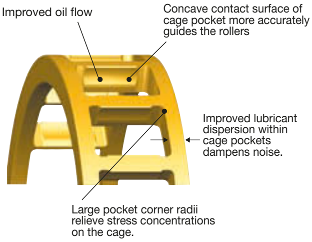
- Highly resistant to heavy or shock loads.
- Long service life for vibrating applications.

- Excellent self-aligning ability.
- Preventive measures against shaft deflection.

Easy installation

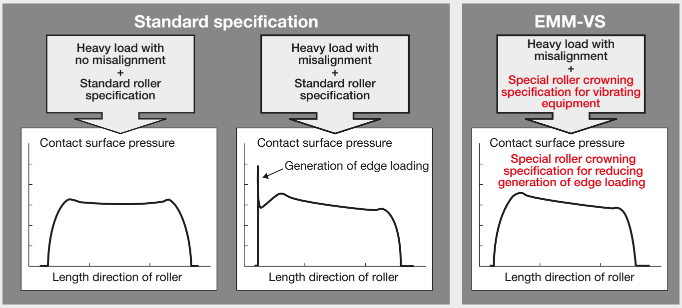
EMM-VS Series Cylindrical Roller Bearings for Vibrating Equipment

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

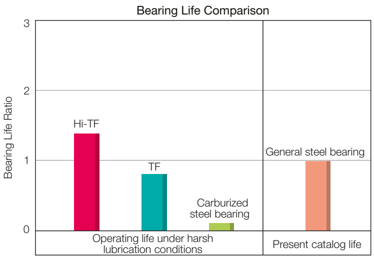


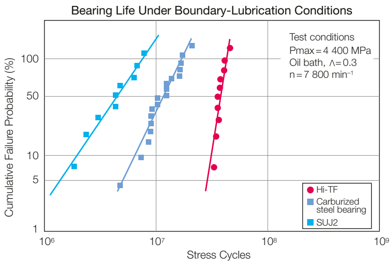
Hi-TF Bearings

Bearings manufactured from NSK's Hi-TF material have been specifi cally 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**

- 223 — Bearing Series (Bearing type+width series+diameter series)
- 20 — Bearing bore (Bore number)
- CAM — Cage type; CAM: High load capacity machined-brass cage
- E4 — Outer ring with oil groove and oil hole (external features designation)
- -VS3 — •Bearings for vibrating equipment •Special accuracy for vibrating equipment •Special internal clearance for vibrating equipment

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.

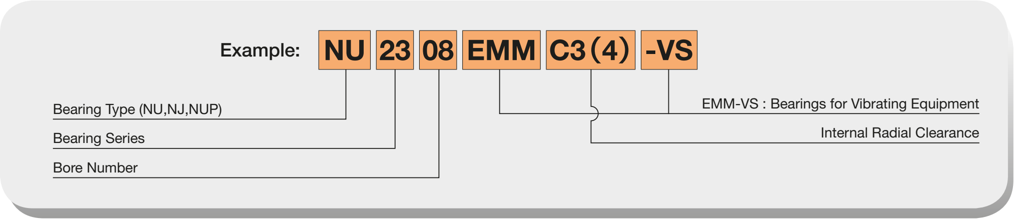
■ The numbers in VS3 and VS4 (3 and 4) refer to bearing internal clearance "C3U15" and "C4U15."

- 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.

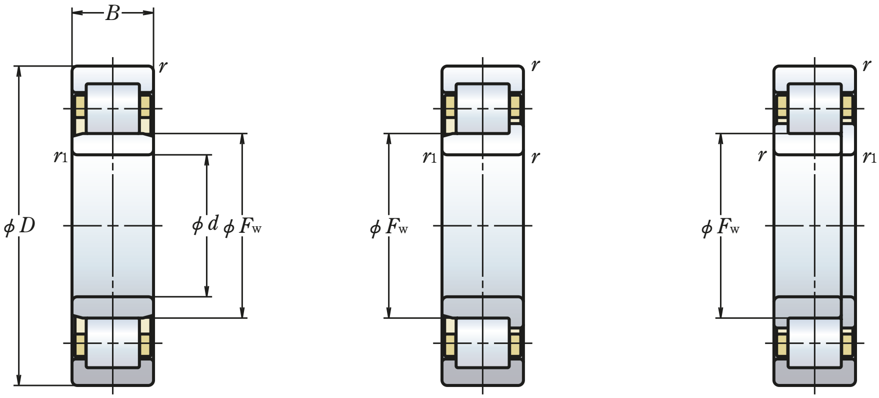
Bearing Designation	Basic Load Ratings (kN) C_r	Basic Load Ratings (kN) C_{0r}	Boundary Dimensions (mm) d (mm)	Diameter Tolerance (μm)	D (mm)	Diameter Tolerance (μm)	B (mm)	Radial Clearance (Cylindrical Bore) VS3(μm)	Radial Clearance (Cylindrical Bore) VS4(μm)
22308CAME4-VS( )	152 000	129 000	40	0 / -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		110		40		
22311CAME4-VS( )	261 000	241 000	55	0 / -9	120		43	75 to 90	100 to 120
22312CAME4-VS( )	305 000	288 000	60		130		46		
22313CAME4-VS( )	330 000	315 000	65		140		48		
22314CAME4-VS( )	380 000	370 000	70		150		51	90 to 110	120 to 145
22315CAME4-VS( )	425 000	415 000	75		160	-5 / -18	55		
22316CAME4-VS( )	485 000	480 000	80		170		58		
22317CAME4-VS( )	520 000	510 000	85	0 / -12	180		60	110 to 135	150 to 180
22318CAME4-VS( )	605 000	595 000	90		190	-10 / -23	64		
22319CAME4-VS( )	655 000	675 000	95		200		67		
22320CAME4-VS( )	750 000	785 000	100		215		73		
22322CAME4-VS( )	925 000	980 000	110		240		80	135 to 160	180 to 210
22324CAME4-VS( )	1 060 000	1 120 000	120		260		86		
22326CAME4-VS( )	1 240 000	1 350 000	130	0 / -15	280		93	160 to 190	205 to 240
22328CAME4-VS( )	1 450 000	1 590 000	140		300	-13 / -28	102		
22330CAME4-VS( )	1 530 000	1 690 000	150		320		108	190 to 220	240 to 280
22332CAME4-VS( )	1 700 000	1 900 000	160		340		114		
22334CAME4-VS( )	1 970 000	2 110 000	170		360		120	200 to 240	260 to 310
22336CAME4-VS( )	2 170 000	2 340 000	180		380		126		
22338CAME4-VS( )	2 370 000	2 590 000	190	0 / -18	400		132	220 to 260	285 to 340

Remark VS( ): Replace the parentheses with the appropriate number (3 or 4) when ordering.

EMM-VS Series Cylindrical Roller Bearings for Vibrating Equipment



NU NJ NUP



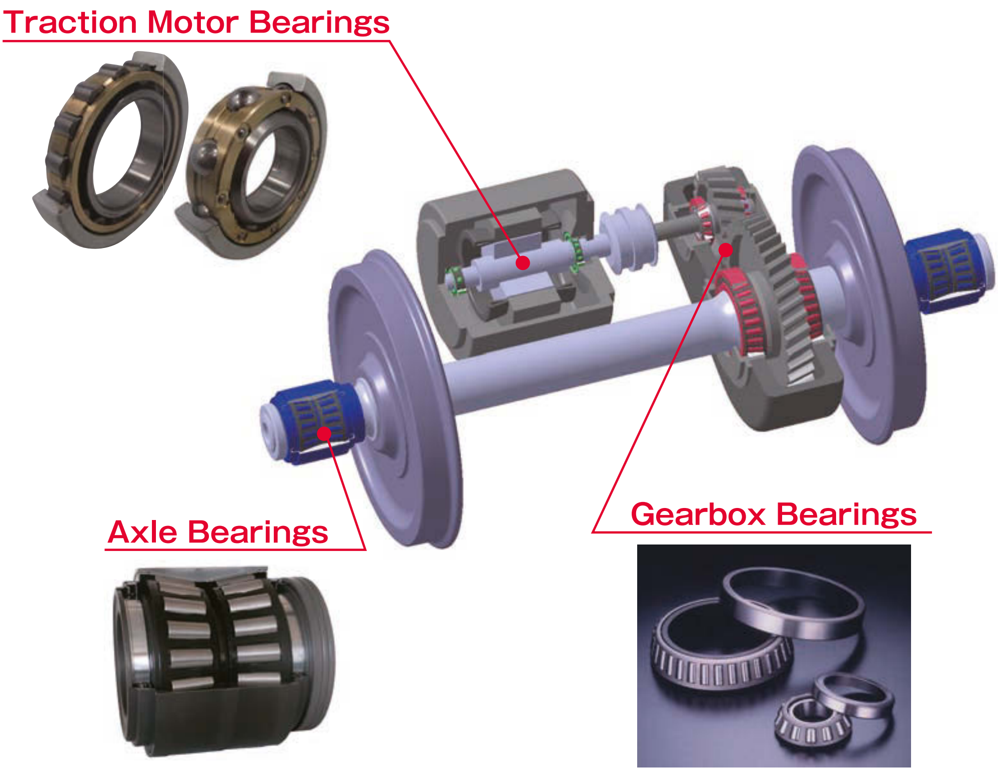
Bearing Designations		Boundary Dimensions (mm)						Basic Load Ratings (N)	
		d	D	B	r min.	r_1 min.	F_w	C_r	C_{0r}
NU2308EMMC3-VS	**NU2308EMMC4-VS**	40	90	33	1.5	1.5	52	114 000	122 000
NU2309EMMC3-VS	**NU2309EMMC4-VS**	45	100	36	1.5	1.5	58.5	137 000	153 000
NU2310EMMC3-VS	**NU2310EMMC4-VS**	50	110	40	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

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.



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

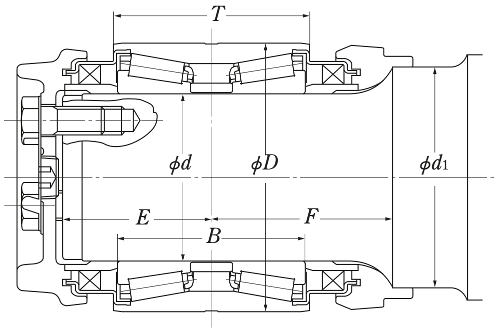
- NSK bearings have higher seizure resistance under high-speed rotation due to special designs.
- A high-toughness cage may be used in necessary applications.

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



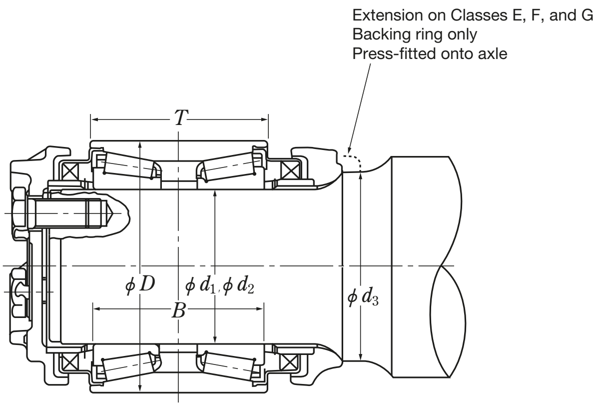
Bearing Designation	Dimensions (mm)				
	d	*D*	*T*	*B*	d_1
J-908	90	154	90	80	110
J-318	110	175	130	125	155
J-910	110	188	150	145	150
J-901	110	190	150	145	150
J-905	110	195	150	145	150
J-909	110	205	140	130	150
J-902	110	220	145	144	155
J-900	115	210	150	145	144
J-319	120	195	142	136	155
J-904	120	220	145	145	155
J-355	120	220	155	155	150
J-907A	120	220	155	150	149
J-320	130	208	152	146	165
J-913	130	220	155	155	160
J-920	130	220	155	155	171
J-934	130	230	160	150	149
J-937	130	230	160	150	160
J-936B	130	240	165	160	160
J-943	130	240	160	160	160
J-921C	150	250	185	179.5	185
J-942	185	280	160	155	225

E	*F*	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



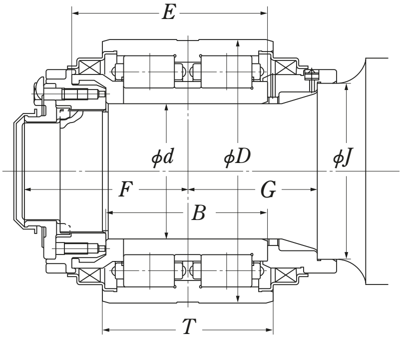
Class	Journal Size	Unit Number	Bearing Designations		d_1(bearing) max.-min.	d_2(axle) max.-min.
B	4 1/4 X 8	J-371	**HM120848R**	**HM120817XDR**	101.625-101.600 4.001-4.000	101.702-101.676 4.0040-4.0030
C	5 X 9	J-372	**HM124646R**	**HM124618XDR**	119.087-119.062 4.6885-4.6875	119.164-119.139 4.6915-4.6905
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)

D	*T*	*B*	d_3	Basic Dynamic Load Rating N (lbf)	Basic Static Load Rating N (lbf)
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

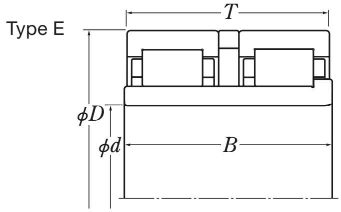
Sealed-Clean Rotating End Cap Cylindrical Roller Bearings



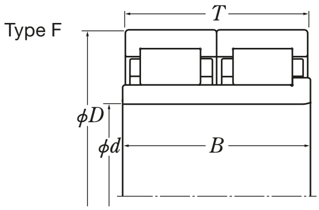
Bearing Designation	Dimensions (mm) d	D	T	B	J	E	F	G	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
J-580A	100	195	150	175	130	—	120	105	670 000	1 040 000
J-447B	110	220	160	154	170	—	135	140	875 000	1 370 000
J-577	110	220	170	182	140	210	128	112	875 000	1 370 000
J-504	120	195	140	134	155	176	135	132	545 000	915 000
120JRF11	120	215	146	146	—	—	—	—	830 000	1 350 000
J-809	120	220	145	145	155	171	145	117	700 000	1 120 000
J-805	120	220	155	157	150	190	113	100	765 000	1 250 000
J-806	120	220	160	172	160	200	128	112	765 000	1 250 000
J-810A	120	220	160	185.5	145	—	128	104	765 000	1 250 000
J-811	120	220	160	204	150	242	128	112	815 000	1 320 000
J-817	120	220	175	175	144	197	118	113	850 000	1 430 000
J-605	120	220	175	182	140	210	128	112	850 000	1 430 000
J-803	120	220	175	182	150	210	128	112	850 000	1 430 000
J-594	120	230	150	142	155	171	145	113	830 000	1 290 000
J-574	120	240	160	162	168	193	158	113	935 000	1 420 000
J-574A	120	240	160	162	168	196	120	125	935 000	1 420 000
J-480B	120	240	160	164	150	197	128	112	935 000	1 450 000
J-556B	120	240	170	180	168	218	130	125	1 020 000	1 580 000
J-802	120	240	170	182	150	205	128	112	1 020 000	1 580 000
J130-20DR	130	220	124	124	—	—	—	—	805 000	1 320 000
J-814	130	230	160	185.5	155	—	128	104	800 000	1 340 000
J-816	130	240	160	160	160	188	100	112	825 000	1 310 000
J-807	130	240	160	160	160	188	118	112	825 000	1 310 000
J-801	130	240	160	160	165	188	116	105	825 000	1 310 000
J-589	130	240	160	160	170	188	131	116	825 000	1 310 000
J-567	130	250	170	170	165	208	95	135	1 030 000	1 610 000
J-578	130	260	175	182	160	212.5	128	112	1 030 000	1 610 000
J-555	130	260	180	182	160	215	128	112	1 030 000	1 610 000
160JRT02	160	280	159	180	—	—	—	—	1 060 000	1 730 000

Axle Bearings

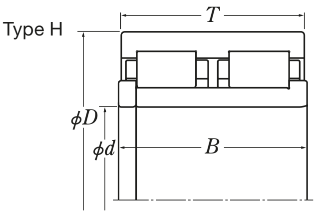
Open Cylindrical Roller Bearings



Bearing Designation	Dimensions (mm) d	D	T	B	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
85JRJ02	85	150	120.0	125	365 000	585 000
90JRJ01	90	160	118.5	130	355 000	530 000
110JRJ01	110	200	150.0	160	625 000	995 000
2J110-2	110	220	180.0 (80x2)	190	875 000	1 370 000
120JRJ01	120	220	180.0	183	850 000	1 430 000
2J120-1	120	240	180.0 (80x2)	190	935 000	1 450 000
2J120-3M	120	240	180.0 (80x2)	180	935 000	1 450 000

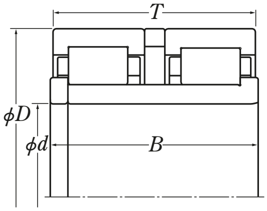


Bearing Designation	Dimensions (mm) d	D	T	B	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
2J110-1	110	225	70×2	150	935 000	1 430 000
120JRJ02A	120	240	160	180	935 000	1 450 000



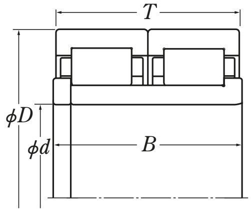
Bearing Designation	Dimensions (mm) d	D	T	B	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
JC14	130	260	160	160	1 140 000	1 840 000

Type I



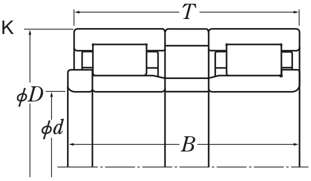
Bearing Designation	Dimensions (mm) *d*	*D*	*T*	*B*	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
95JRT02	95	170	115	125	440 000	685 000
95JRT01	95	190	125	130	800 000	1 340 000
20100-1	100	200	170	170	650 000	1 030 000
20110-1	110	220	180	185	875 000	1 370 000
120JRT04	120	220	160	165	810 000	1 340 000
20120-11	120	220	180	183	850 000	1 430 000
JC34	120	230	165	170	945 000	1 460 000
120JRT01	120	240	180	185	935 000	1 450 000
20120-4	120	240	180	185	935 000	1 450 000
JC38A	125	235	165	170	945 000	1 470 000
JC39A	125	236	165	175.5	960 000	1 500 000
130JRT08	130	235	165	170	895 000	1 520 000
20130-7	130	240	180	185	915 000	1 490 000
130JRT01	130	260	180	185	1 030 000	1 610 000
20130-6	130	260	180	185	1 030 000	1 610 000
JC37A	130	265	166	166	1 140 000	1 700 000
20140-1	140	250	155	160	865 000	1 480 000
170JRT01	170	340	230	230	1 660 000	2 760 000

Type J



Bearing Designation	Dimensions (mm) *d*	*D*	*T*	*B*	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
JC27X	120	230	150	177	935 000	1 440 000
JC400K	120	230	150	177	885 000	1 340 000

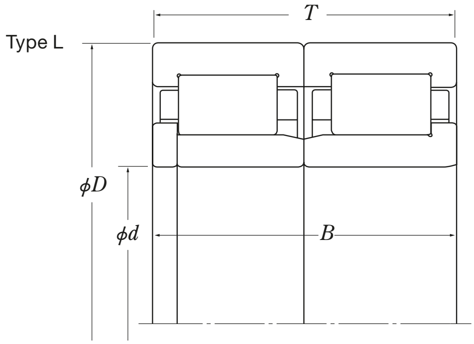
Type K



Bearing Designation	Dimensions (mm) *d*	*D*	*T*	*B*	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
J130-5/U130-5DB+KL38	130	240	198 (80×2)	204	880 000	1 450 000

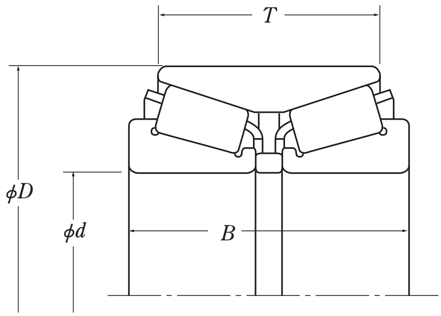
Axle Bearings

Open Cylindrical Roller Bearings



Bearing Designation	Dimensions (mm) d	D	T	B	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
J110-2/U110-4DB	110	215	73 × 2	73 × 2	800 000	1 240 000
42724T/152724T	120	240	80 × 2	80 × 2	910 000	1 400 000
J120-1C/U120-2C	120	240	80 × 2	80 × 2	960 000	1 500 000
J120-1D/U120-2D	120	240	80 × 2	80 × 2	960 000	1 500 000
42726TT/152726TT	130	250	80 × 2	80 × 2	1 030 000	1 610 000
J130-3/U130-4	130	250	80 × 2	80 × 2	1 030 000	1 610 000
JC130M	130	250	160	160	1 030 000	1 610 000
J130-18/U130-16	130	220	62 × 2	62 × 2	785 000	1 340 000
J130-16/U130-14	130	220	73 × 2	73 × 2	860 000	1 510 000
J150-5/U150-2	150	270	160 (80 × 2)	160 (80 × 2)	1 020 000	1 700 000

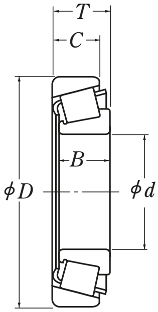
Open Tapered Roller Bearings



Bearing Designation	Dimensions (mm) d	D	T	B	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
110KBE2201+L	110	220	115	145	820 000	1 350 000
120KBE2001+L	120	200	84	100	515 000	865 000
120KBE52X+L	120	215	109	132	720 000	1 170 000
JT21	120	220	130	155	860 000	1 480 000
JT21A	120	220	130	155	860 000	1 480 000
JT21B	120	220	130	155	860 000	1 480 000
130KBE2302+L	130	230	115	145	850 000	1 480 000
140KBE2302+L	140	230	110	140	820 000	1 550 000
140KBE2701+L	140	270	95	120	870 000	1 440 000
150KBE2502+L	150	250	95	115	745 000	1 320 000
160KBE2701A+L	160	270	120	140	860 000	1 510 000
170KBE2802A+L	170	280	130	150	1 110 000	2 160 000
180KBE3401+L	180	340	140	180	1 410 000	2 510 000

Gearbox Bearings

Tapered Roller Bearings

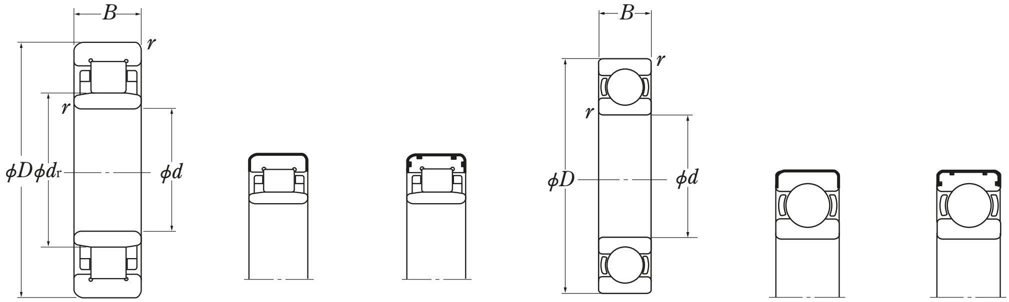


Bearing Designation	Dimensions (mm) d	D	T	B	C	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Application([1])
QT30	60	130	33.5	31	22	127 000	139 000	Gear (P)
30312DQWAP6	60	130	33.5	31	22	127 000	139 000	Gear (P)
30313DQWAP6U1	65	140	36	33	23	147 000	163 000	Gear (P)
QT9	70	150	38	35	25	165 000	185 000	Gear (P)
QT9A	70	150	38	35	25	165 000	185 000	Gear (P)
QT9B-2	70	150	38	35	25	165 000	185 000	Gear (P)
QT9F	70	150	38	35	25	165 000	185 000	Gear (P)
QT9J	70	150	38	35	25	165 000	185 000	Gear (P)
R70-25	70	150	38	35	25	165 000	185 000	Gear (P)
30314DAQWAP6A	70	150	38	35	25	165 000	185 000	Gear (P)
30314QWAP6	70	150	38	35	30	194 000	218 000	Gear (P)
QT31	70	150	40	37	27	172 000	198 000	Gear (P)
QT7A	75	160	40	37	27	189 000	224 000	Gear (P)
30315DXQWAP6	75	160	40	37	26	189 000	224 000	Gear (P)
30315QWAP6	75	160	40	37	31	209 000	233 000	Gear (P)
R80-1	80	170	42.5	39	28	196 000	222 000	Gear (P)
QT4A	80	170	42.5	39	28	208 000	241 000	Gear (P)
30316QWAP6	80	170	42.5	39	33	235 000	265 000	Gear (P)
30317DQWAP6A	85	180	44.5	41	29	233 000	269 000	Gear (P)
30317QWAP6A	85	180	44.5	41	34	262 000	300 000	Gear (P)
QT18	85	180	45.5	42	29	244 000	285 000	Gear (P)
30328QWAP6	140	300	67.75	62	53	600 000	740 000	Gear (G)
QT1([2])	190	280	49	46	36.5	605 000	1 240 000	Gear (G)
QT29([3])	193.675	282.575	50.800	47.625	36.512	360 000	600 000	Gear (G)
QT26	195	280	58	60	41	410 000	780 000	Gear (G)
QT25	200	280	51	48	41	410 000	780 000	Gear (G)
32940QSA	200	280	51	48	41	410 000	780 000	Gear (G)
QT13([2])	200	290	49	46	36.5	625 000	1 330 000	Gear (G)
QT27	200	290	55	60	41	410 000	790 000	Gear (G)
QT34A	202	290	58	60	41	435 000	855 000	Gear (G)
QT33	205	283	51	48	41	415 000	795 000	Gear (G)
QT38	205	310	60	60	47	545 000	1 020 000	Gear (G)
R205-1	205	310	60	60	47	545 000	1 020 000	Gear (G)
R205-4	205	310	60	60	47	545 000	1 020 000	Gear (G)
QT5	210	320	70	66	56	665 000	1 180 000	Gear (G)
QT35	215	315	65	70	49	595 000	1 130 000	Gear (G)
R215-3	215	315	65	70	49	595 000	1 130 000	Gear (G)
QT32	218	315	65	70	49	595 000	1 130 000	Gear (G)
32944QWASA	220	300	51	48	41	425 000	855 000	Gear (G)
32052Q	260	400	87	82	71	1 130 000	2 020 000	Gear (G)

Notes ([1]) Gear (P): Pinion-side bearing of gear unit, Gear (G): Gear-side bearing of gear unit
([2]) Double-row configuration
([3]) Sizes have been converted to millimeters from inches.

Traction Motor Bearings

Bearings for Electric Car Traction Motors



Non-Insulated | Ceramic-Insulated | PPS-Insulated

Cylindrical Roller Bearings

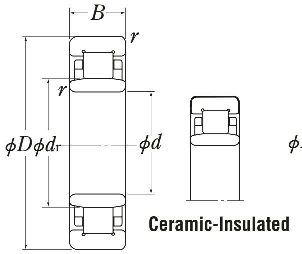
Non-Insulated | Ceramic-Insulated | PPS-Insulated

Ball Bearings

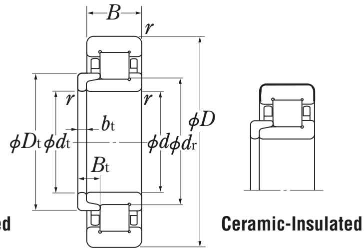
Loaded Side, Cylindrical Roller Bearing	Dimensions (mm)					Non-Loaded Side, Ball Bearing	Dimensions (mm)		
	d	*D*	*B*	d_r	*r* (min.)		*d*	*D*	*B*
NU210E(1)	50	90	20	59.5	1.1	**6016**	80	125	22
NU212	60	110	22	73.5	1.5	**6310**	50	110	27
NU312	60	130	31	77.0	2.1	**6310**	50	110	27
NU213	65	120	23	79.6	1.5	**6310**	50	110	27
NU313	65	140	33	83.5	2.1	**6311**	55	120	29
NU214	70	125	24	84.5	1.5	**6310**	50	110	27
						6311	55	120	29
NU314	70	150	35	90.0	2.1	**6311**	55	120	29
NU215	75	130	25	88.5	1.5	**6311**	55	120	29
						6312	60	130	31
NU315	75	160	37	95.5	2.1	**6311**	55	120	29
						6312	60	130	31
						6314	70	150	35
NU415	75	190	45	104.5	3.0	**6313**	65	140	33
NU216	80	140	26	95.3	2.0	**6312**	60	130	31
NU316	80	170	39	103.0	2.1	**6312**	60	130	31
NU416	80	200	48	110.0	3.0	**6313**	65	140	33
NU217	85	150	28	101.8	2.0	**6217**	85	150	28
NU218	90	160	30	107.0	2.0	**6218**	90	160	30
NU219	95	170	32	113.5	2.1	**6219**	95	170	32

Note (1) E: High-Capacity

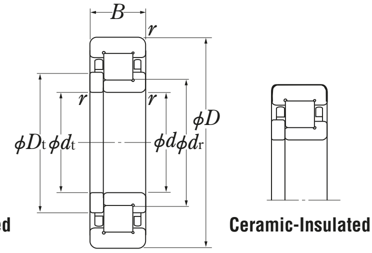
Bearings for Electric Locomotive Traction Motors



Non-Insulated
Cylindrical Roller Bearings (NU Type)



Non-Insulated
Cylindrical Roller Bearings (NH Type)



Non-Insulated
Cylindrical Roller Bearings (NUP Type)

2xx Series (Free End-Bearings)

Boundary Dimensions (mm) d	D	B	d_r	r (min.)	Basic Designation	Internal Design(1)	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
120	215	40	143.5	2.1	**NU224**	E	320 000	395 000
130	230	40	153.5	3.0	**NU226**	E	345 000	425 000

Note (1) E: High-capacity type

3xx Series (Free End-Bearings)

Boundary Dimensions (mm) d	D	B	d_r	r (min.)	Basic Designation	Internal Design(1)	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
90	190	43	113.5	3	**NU318**	E	315 000	355 000
100	215	47	127.5	3	**NU320**	E	380 000	425 000
110	240	50	143.0	3	**NU322**	E	425 000	485 000
120	260	55	154.0	3	**NU324**	E	530 000	610 000
130	280	58	165.0	4	**NU326**	B	655 000	795 000
			167.0			E	615 000	735 000
140	300	62	180.0	4	**NU328**	E	665 000	795 000
			178.0			F	705 000	860 000
150	320	65	193.0	4	**NU330**	E	760 000	920 000
			193.0			EA	715 000	855 000
			190.5			J	800 000	985 000
			190.0			L	790 000	970 000
160	340	68	204.0	4	**NU332**	E	860 000	1 050 000
180	380	75	231.0	4	**NU336**	E	985 000	1 230 000

Note (1) E, EA: High-capacity type B, F, J, L: Special specification

3xx Series (NH Type, NUP Type)

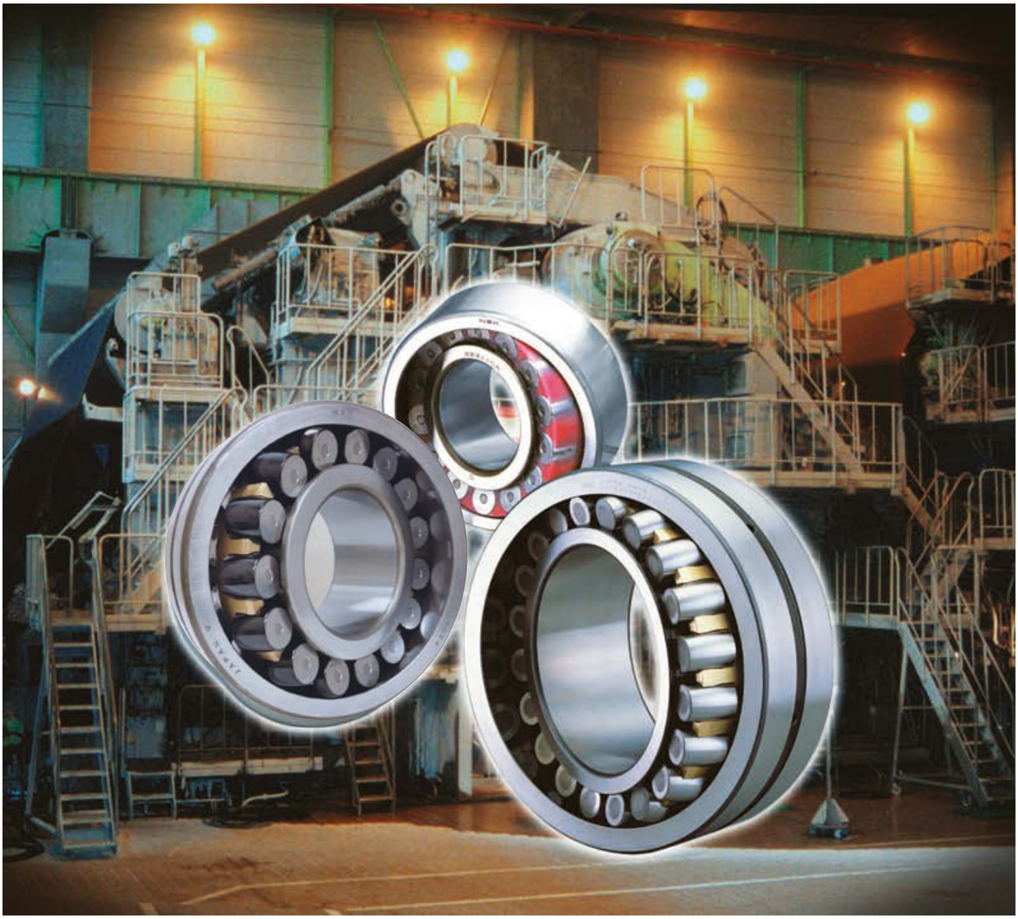
Dimensions (mm) d, d_t	D	B	d_r	D_t	B_t	b_t	r (min.)	Basic Designation	Internal Design(1)	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
80	170	39	101.0	111.8	17.0	11.0	2.1	**NH316**	E	256 000	282 000
90	190	43	115.0	125.0	21.0	12.0	3.0	**NH318**	—	240 000	265 000
			113.5	124.2	18.5				E	315 000	355 000
90	190	43	115.0	125.0	—	—	3.0	**NUP318**	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	**NH320**	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
110	240	50	143.0	155.0	22.0	14.0	3.0	**NH322**	E	425 000	485 000
120	260	55	154.0	168.5	23.5	14.0	3.0	**NH324**	—	475 000	550 000
130	280	58	167.0	182.0	24.0	14.0	4.0	**NH326**	—	560 000	665 000
				181.0					E	615 000	735 000
140	300	62	180.0	196.0	26.0	15.0	4.0	**NH328**	—	615 000	745 000

Note (1) E:High-capacity type A,B:Special specification

Air Turbine Dental Handpieces
Pumps & Compressors
Agricultural Machinery
Construction Machinery
Mining Machinery
Railway Rolling Stock
Papermaking Machines
Wind Power Industry
Steel Industry
INDUSTRY SOLUTIONS

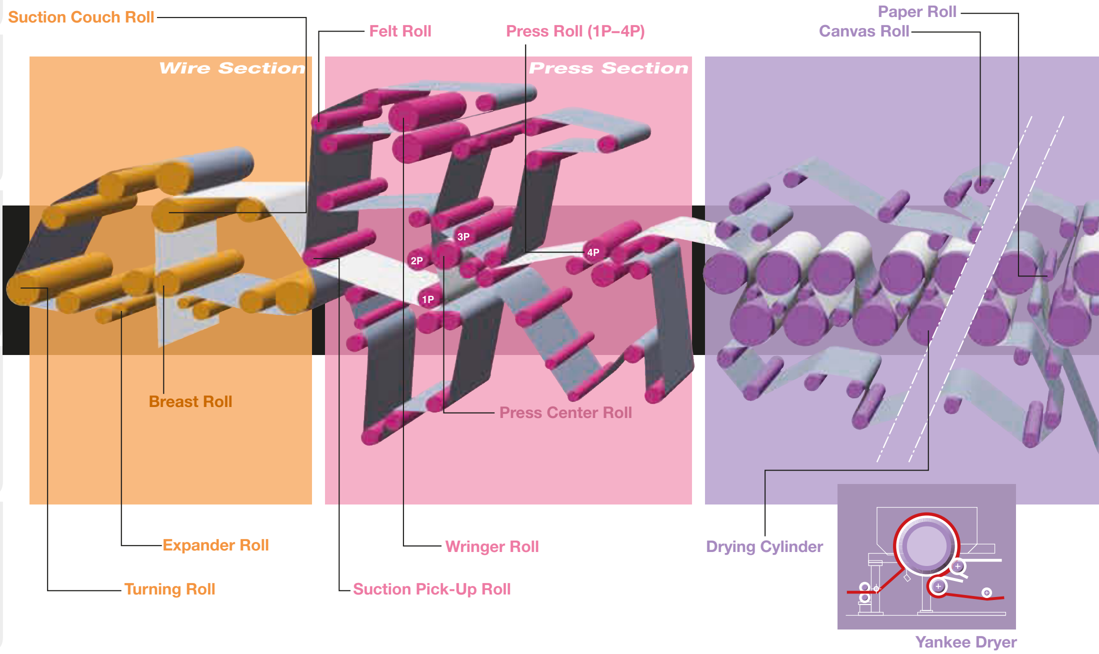
Bearings for Papermaking Machines

Bearings featuring excellent durability under wet, dusty, and high-temperature environments resulting in longer life, higher limiting speed, and dramatically enhanced productivity.



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.

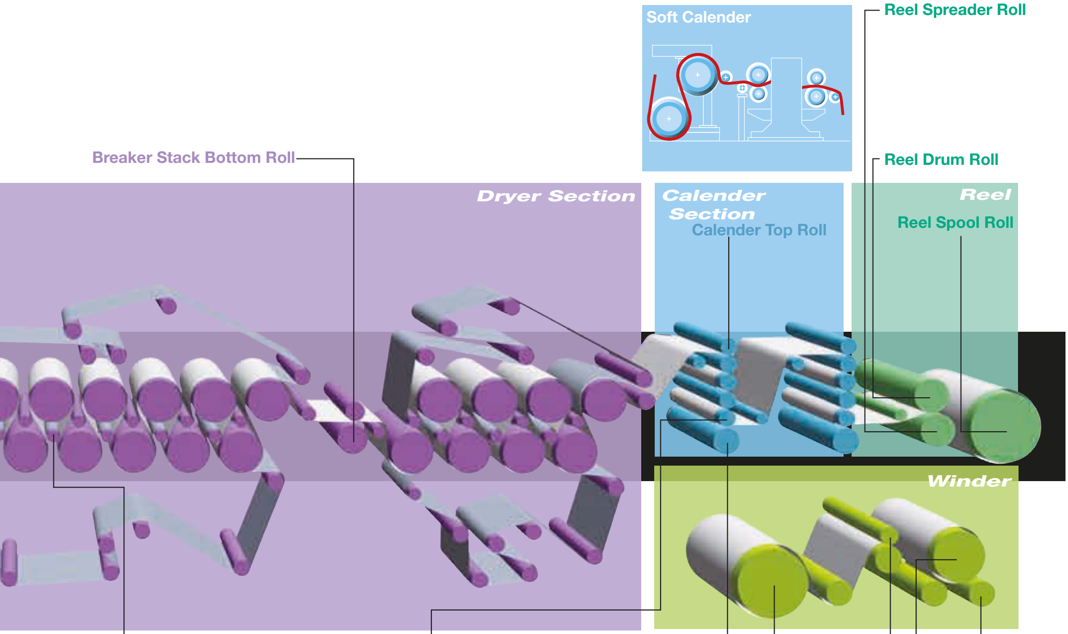
Major applications: raw material conveyors, carrier rope sheaves, suction rolls

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,Calernder 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.

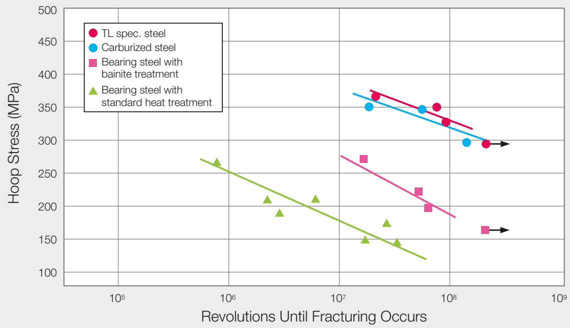
<Applications>
Used in all applications excluding drying/calender rolls and large-size bearings for press rolls.

Designations | Pages D076 to D081

Features

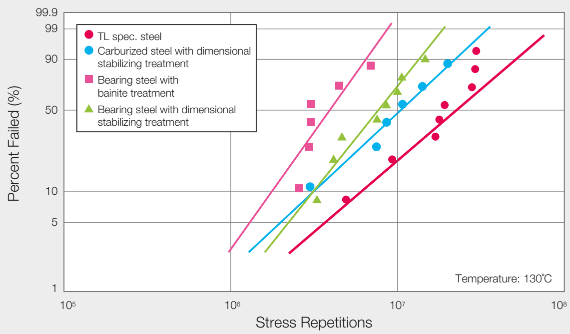
Enhanced inner ring strength

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.



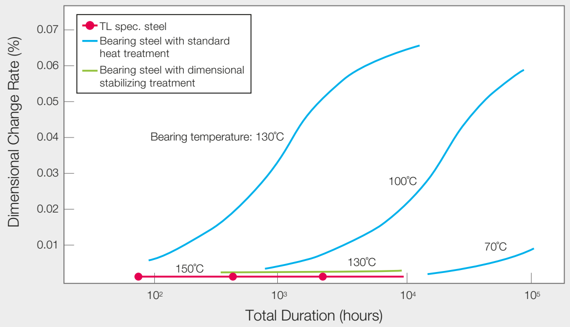
Longer life

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 polyolefi n 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.

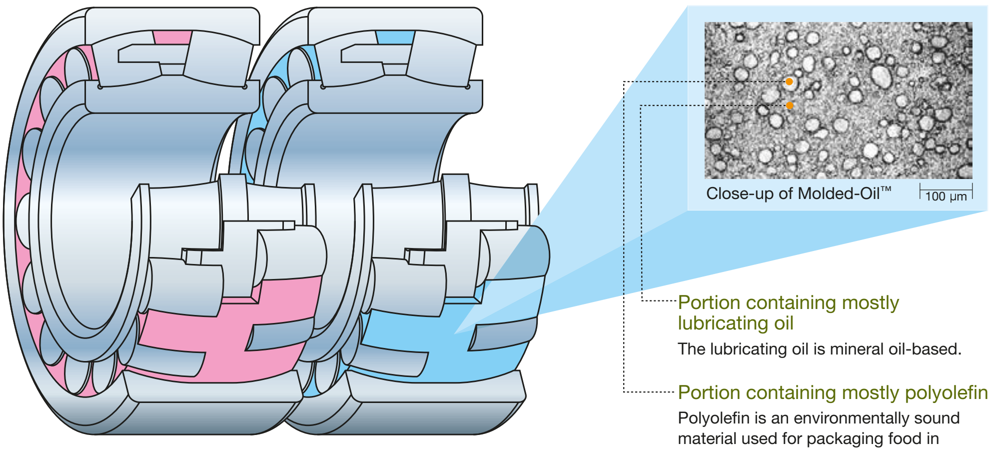
Low torque

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

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**

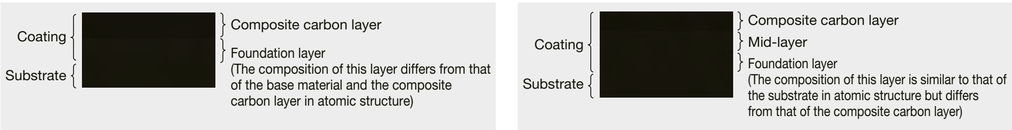


Fig. 1

Twin-disc test

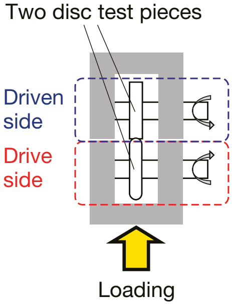
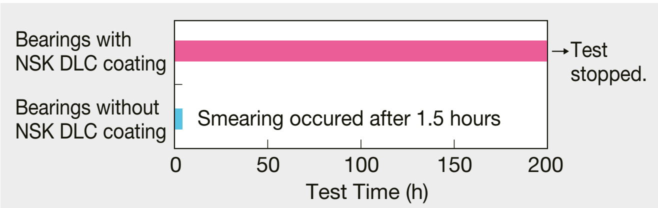


Fig. 2

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

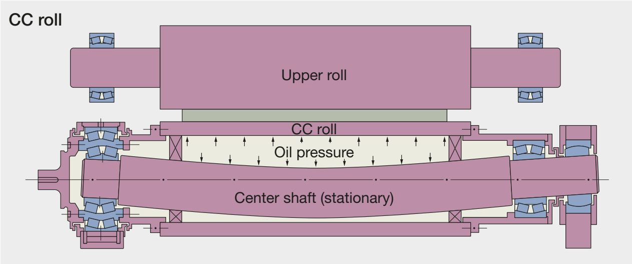
Triple Ring Bearings

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.

Desgnations | Page D084

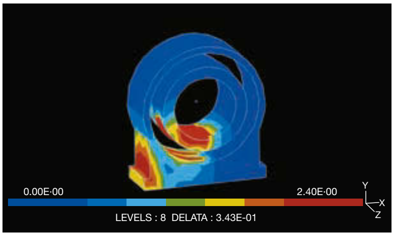
Features

- **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-ofthe-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

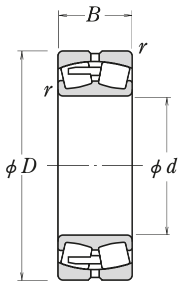
Bearing Designation

Example : 2SL 180-2 UPA

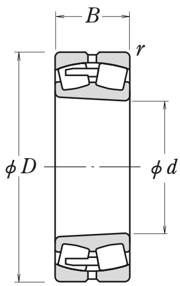
- Triple ring bearings (Spherical roller bearings)
- Bearing bore 180 mm
- Special accuracy (Tolerance class)

■TL Series Spherical Roller Bearings

Bore Diameter 40 – 160 mm



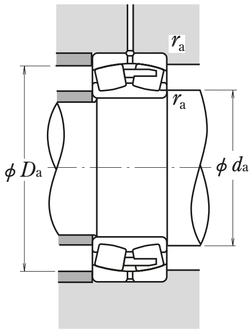
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}	Cylindrical Bore
40	90	33	1.5	122	129	12 400	13 200	**TL22308CAME4**
55	120	43	2	209	241	21 300	24 600	**TL22311CAME4**
60	130	46	2.1	246	288	25 100	29 400	**TL22312CAME4**
65	140	48	2.1	375	380	38 000	38 500	**TL22313EAE4**
70	150	51	2.1	425	435	43 500	44 000	**TL22314EAE4**
75	130	31	2.1	340	415	34 500	42 000	**TL22315CAME4**
80	170	58	2.1	390	480	39 500	48 500	**TL22316CAME4**
90	190	64	3	665	705	68 000	72 000	**TL22318EAE4**
95	200	67	3	525	675	53 500	68 500	**TL22319CAME4**
100	215	73	3	860	930	88 000	94 500	**TL22320EAE4**
110	170	45	2	293	465	29 900	47 500	**TL23022CDE4**
	200	69.8	2.1	515	760	52 500	77 500	**TL23222CE4**
	240	80	3	1 030	1 120	105 000	115 000	**TL22322EAE4**
120	260	86	3	1 190	1 320	122 000	134 000	**TL22324EAE4**
130	280	93	4	995	1 350	101 000	137 000	**TL22326CAME4**
140	210	53	2	420	715	43 000	73 000	**TL23028CDE4**
	250	68	3	645	930	65 500	95 000	**TL22228CDE4**
	250	88	3	835	1 300	85 000	133 000	**TL23228CE4**
150	225	56	2.1	470	815	48 000	83 000	**TL23030CDE4**
	225	56	2.1	470	815	48 000	83 000	**TL23030CAME4**
	250	80	2.1	725	1 180	74 000	121 000	**TL23130CAME4**
	270	73	3	765	1 120	78 000	114 000	**TL22230CDE4**
	320	108	4	1 220	1 690	125 000	172 000	**TL22330CAME4**
160	240	60	2.1	540	955	55 000	97 500	**TL23032CDE4**
	290	80	3	910	1 320	93 000	135 000	**TL22232CDE4**
	290	104	3	1 100	1 770	112 000	180 000	**TL23232CE4**

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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

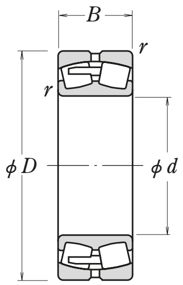
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

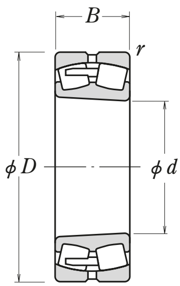
Designations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
TL22308CAMKE4	49	—	81	77	1.5	0.38	2.6	1.8	1.7	1.0
TL22311CAMKE4	65	—	110	103	2	0.36	2.8	1.9	1.8	2.3
TL22312CAMKE4	72	—	118	111	2	0.36	2.8	1.9	1.9	2.9
TL22313EAKE4	77	84	128	119	2	0.33	3.0	2.0	2.0	3.5
TL22314EAKE4	82	91	138	129	2	0.33	3.0	2.0	2.0	4.3
TL22215CAMKE4	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	104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.6
TL22319CAMKE4	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	120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
TL23222CKE4	122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
TL22322EAKE4	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	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
TL22228CDKE4	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
TL23228CKE4	154	163	236	213	2.5	0.25	2.9	1.9	1.9	18.8
TL2303CDKE4	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
TL23030CAMKE4	162	—	213	203	2	0.22	4.6	3.1	3.0	7.9
TL23130CAMKE4	162	—	238	218	2	0.3	3.4	2.3	2.2	15.8
TL22230CDKE4	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
TL22330CAMKE4	168	—	302	270	3	0.35	2.9	1.9	1.9	41.5
TL23032CDKE4	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
TL22232CDKE4	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
TL23232CKE4	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



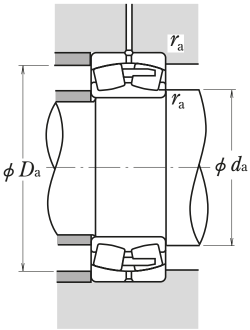
Cylindrical Bore



Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (kN)		Basic Load Ratings {kgf}		Bearing
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}	Cylindrical Bore
170	230	45	2	350	660	35 500	67 500	**TL23934BCAME4**
	260	67	2.1	640	1 090	65 000	112 000	**TL23034CDE4**
	280	88	2.1	940	1 570	96 000	160 000	**TL23134CAME4**
	360	120	4	1 580	2 110	161 000	215 000	**TL22334CAME4**
180	280	74	2.1	750	1 270	76 000	129 000	**TL23036CDE4**
	320	112	4	1 300	2 110	133 000	215 000	**TL23236CAME4**
190	290	75	2.1	775	1 350	79 000	138 000	**TL23038CAME4**
	320	104	3	1 190	2 020	121 000	206 000	**TL23138CAME4**
	340	92	4	1 140	1 730	116 000	176 000	**TL22238CAME4**
	340	120	4	1 440	2 350	147 000	240 000	**TL23238CAME4**
	400	132	5	1 890	2 590	193 000	264 000	**TL22338CAME4**
200	310	82	2.1	940	1 700	96 000	174 000	**TL23040CAME4**
	340	112	3	1 360	2 330	139 000	238 000	**TL23140CAME4**
	360	98	4	1 300	2 010	133 000	204 000	**TL22240CAME4**
	360	128	4	1 660	2 750	169 000	281 000	**TL23240CAME4**
220	340	90	3	1 090	1 980	111 000	202 000	**TL23044CAME4**
	370	120	4	1 570	2 710	160 000	276 000	**TL23144CAME4**
	400	108	4	1 570	2 430	160 000	247 000	**TL22244CAME4**
	400	144	4	2 520	3 400	257 000	350 000	**TL23244CAME4**
	460	145	5	2 350	3 400	240 000	345 000	**TL22344CAME4**
240	320	60	2.1	635	1 300	65 000	133 000	**TL23948CAME4**
	350	92	3	1 160	2 140	118 000	218 000	**TL23048CAME4**
	400	128	4	1 790	3 100	182 000	320 000	**TL23148CAME4**
	500	155	5	2 600	3 800	265 000	385 000	**TL22348CAME4**
250	350	75	2.1	930	1 870	95 000	191 000	**TL23952CAME4**
	400	104	4	1 430	2 580	145 000	263 000	**TL23052CAME4**
260	440	144	4	2 160	3 750	221 000	385 000	**TL23152CAME4**

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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

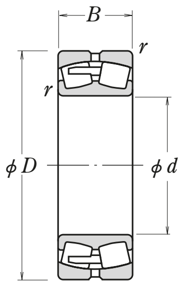
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

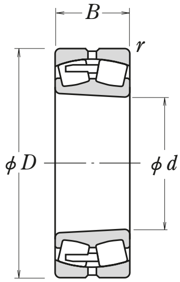
Designations Tapered Bore[1]	Abutment and Fillet Dimensions (mm) d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
TL23934BCAMKE4	180	—	220	213	2	0.17	5.8	3.9	3.8	5.38
TL23034CDKE4	182	191	248	233	2	0.23	4.3	2.9	2.9	13
TL23134CAMKE4	182	—	268	245	2	0.29	3.5	2.3	2.3	21
TL22334CAMKE4	188	—	342	304	3	0.35	2.9	1.9	1.9	57.9
TL23036CDKE4	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
TL23236CAMKE4	198	—	302	274	3	0.35	2.9	1.9	1.9	38.5
TL23038CAMKE4	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
TL23138CAMKE4	204	—	306	276	3.5	0.31	3.2	2.2	2.1	34
TL22238CAMKE4	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
TL23238CAMKE4	208	—	322	288	3	0.35	2.9	1.9	1.9	46.5
TL22338CAMKE4	212	—	378	338	4	0.34	2.9	2.0	1.9	77.6
TL23040CAMKE4	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
TL23140CAMKE4	214	—	326	293	2.5	0.32	3.2	2.1	2.1	41.5
TL22240CAMKE4	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
TL23240CAMKE4	218	—	342	307	3	0.35	2.9	1.9	1.9	57
TL23044CAMKE4	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
TL23144CAMKE4	238	—	352	320	3	0.31	3.2	2.2	2.1	52
TL22244CAMKE4	238	—	382	348	3	0.27	3.7	2.5	2.4	59
TL23244CAMKE4	238	—	382	337	3	0.36	2.8	1.9	1.8	79.5
TL22344CAMKE4	242	—	438	391	4	0.33	3.0	2.0	2.0	116
TL23948CAMKE4	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
TL23048CAMKE4	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
TL23148CAMKE4	258	—	382	347	3	0.31	3.3	2.2	2.2	64.5
TL22348CAMKE4	262	—	478	423	4	0.32	3.2	2.1	2.1	147
TL23952CAMKE4	272	—	348	333	2	0.19	5.4	3.6	3.5	23
TL23052CAMKE4	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

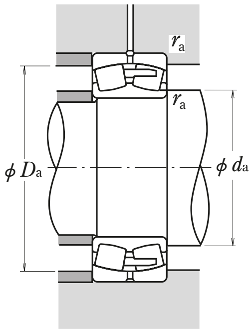


Tapered Bore

Boundary Dimensions (mm)				Basic Load Ratings (kN)		Basic Load Ratings {kgf}		Bearing
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}	Cylindrical Bore
280	380	75	2.1	925	1 950	94 500	199 000	**TL23956CAME4**
	420	106	4	1 540	2 950	157 000	300 000	**TL23056CAME4**
	460	146	5	2 230	4 000	228 000	410 000	**TL23156CAME4**
	500	176	5	2 880	4 900	294 000	500 000	**TL23256CAME4**
300	420	90	3	1 230	2 490	125 000	254 000	**TL23960CAME4**
	460	118	4	1 920	3 700	196 000	375 000	**TL23060CAME4**
	500	160	5	2 670	4 800	273 000	490 000	**TL23160CAME4**
	540	192	5	3 400	5 900	350 000	600 000	**TL23260CAME4**
320	540	176	5	3 050	5 500	315 000	560 000	**TL23164CAME4**
340	520	133	5	2 280	4 400	232 000	445 000	**TL23068CAME4**
	580	190	5	3 600	6 600	370 000	670 000	**TL23168CAME4**
360	540	134	4	2 390	4 700	244 000	480 000	**TL23072CAME4**
380	520	106	4	1 870	4 100	190 000	420 000	**TL23976CAME4**
400	600	148	5	2 970	5 900	305 000	605 000	**TL23080CAME4**
420	560	106	4	1 870	4 250	191 000	430 000	**TL23984CAME4**
440	650	157	6	3 150	6 350	320 000	645 000	**TL23088CAME4**
460	620	118	4	2 220	4 950	227 000	505 000	**TL23992CAME4**
500	670	128	5	2 460	5 550	250 000	565 000	**TL239/500CAME4**

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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

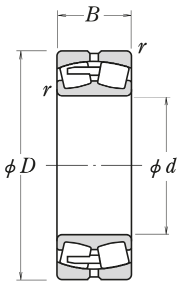
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

Designations Tapered Bore(1)	Abutment and Fillet Dimensions (mm) d_a min.	 d_a max.	 D_a max.	 D_a min.	 r_a max.	Constant e	Axial Load Factors Y_2	 Y_3	 Y_0	Mass (kg) approx.
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

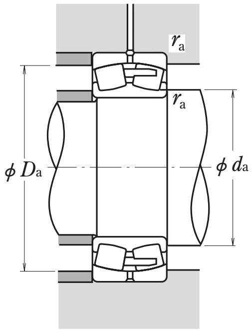
Bore Diameter　35 – 160 mm



Cylindrical Bore

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Designation	Abutment and	
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}	Cylindrical Bore	d_a min.	d_a max.
35	80	21	1.5	71	76	7 250	7 750	**21307L12CAM**	44	—
40	90	23	1.5	82	93	8 350	9 500	**21308L11ACAM**	49	—
	90	33	1.5	122	129	12 400	13 200	**22308L11CAM**	49	—
45	85	23	1.1	778	88	7 950	9 000	**22209L11CAM**	52	—
	100	36	1.5	148	167	15 100	17 100	**22309L12CAM**	54	—
50	90	23	1.1	82	93	8 350	9 500	**22210L11CAM**	57	—
55	120	43	2	209	241	21 300	24 600	**22311L12CAM**	65	—
60	110	28	1.5	127	154	12 900	15 700	**22212L12CAM**	69	—
65	120	31	1.5	152	190	15 500	19 300	**22213L11CAM**	74	—
	140	48	2.1	265	315	27 000	32 500	**22313L11CAM**	77	—
	140	48	2.1	265	315	27 000	32 500	**22313L12CAM**	77	—
70	125	31	1.5	163	205	16 600	20 900	**22214L11CAM**	79	—
75	160	55	2.1	340	415	34 500	42 000	**22315L12CAM**	87	—
80	140	33	2	181	232	18 500	23 700	**22216L11CAM**	90	—
85	150	36	2	215	276	21 900	28 200	**22217L12CAM**	95	—
90	160	40	2	256	340	26 200	34 500	**22218L12CAM**	100	—
95	170	43	2.1	296	395	30 000	40 000	**22219L12CAM**	107	—
100	165	52	2	345	530	35 500	54 000	**23120L11CAM**	110	—
	215	73	3	600	785	61 500	80 000	**22320L11CAM**	114	—
110	200	53	2.1	425	585	43 500	59 500	**22222L12CAM**	122	—
120	180	46	2	315	525	32 000	53 500	**23024L11CAM**	130	—
	200	62	2	465	720	47 500	73 500	**23124L12CAM**	130	—
130	230	64	3	565	815	57 500	83 000	**22226L11CAM**	144	—
160	220	45	2	360	675	37 000	69 000	**23932L11CAM**	170	—

Remark Bearing designations other than those listed above may be available for production.



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

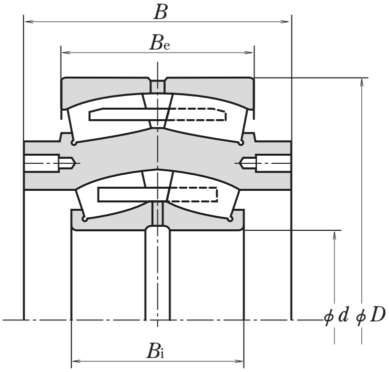
Static Equivalent Load

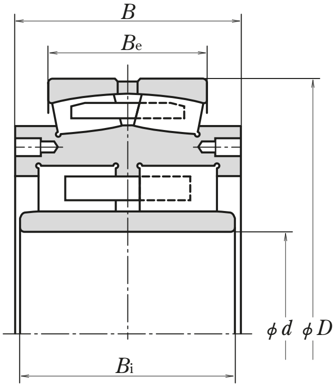
$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

Fillet Dimensions (mm) D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
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



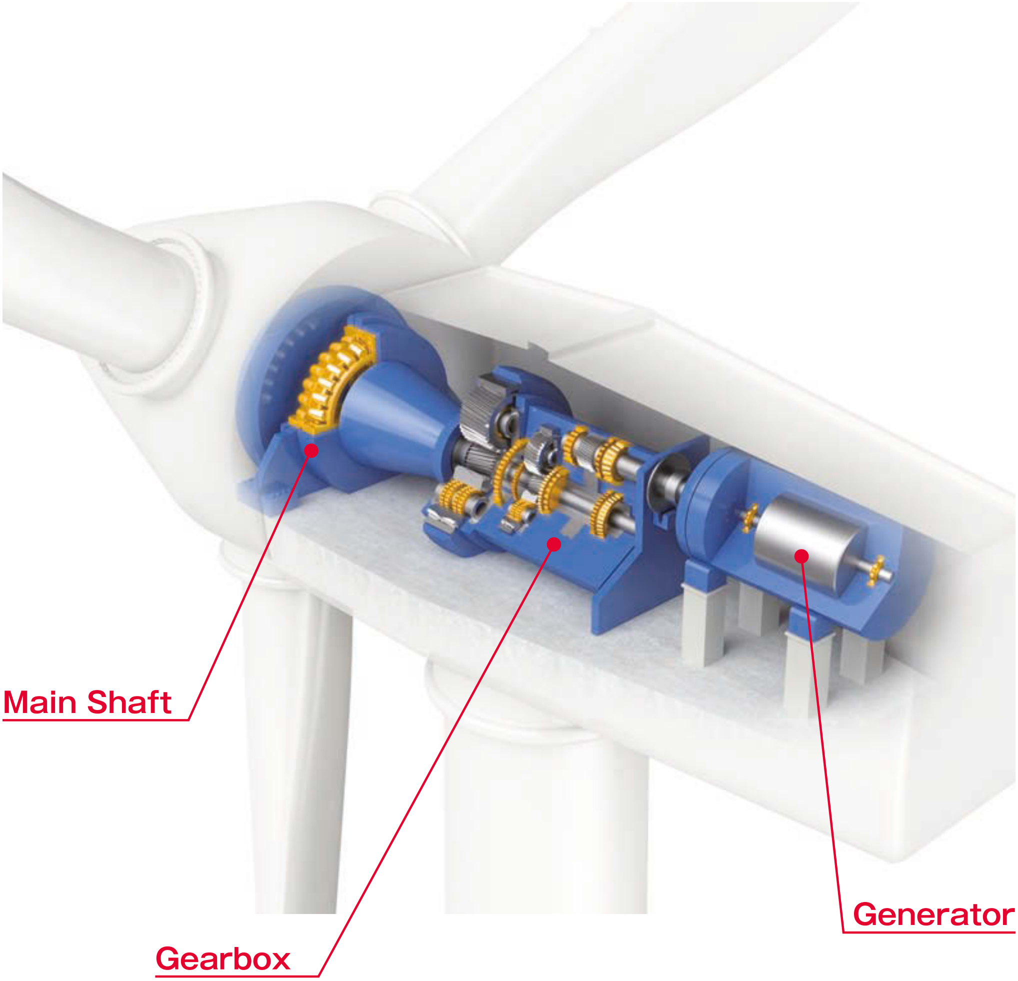


Bearing Designation	Boundary Dimensions (mm)					Mass
	d	D	B_i	B_e	B	(kg)
2SL180-2 UPA	180	480	140	160	215.9	175
2SL200-2 UPA	200	520	160	180	241.3	230
2SL220-2 UPA	220	600	180	200	279.4	330
2SL240-2 UPA	240	620	200	200	279.4	410
2SL260-2 UPA	260	680	218	218	317.5	490
2SL280-2 UPA	280	720	218	218	317.5	525
2SL300-2 UPA	300	780	243	250	342.9	735
2SL320-2 UPA	320	820	258	258	368.3	840
2SL340-2 UPA	340	870	280	272	393.7	1 050
2SL380-3 UPA	380	980	240	308	431.8	1 370
2PSL180-1 UPA	180	460	153	118	160	127
2PSL240-1 UPA	240	600	205	160	225	285

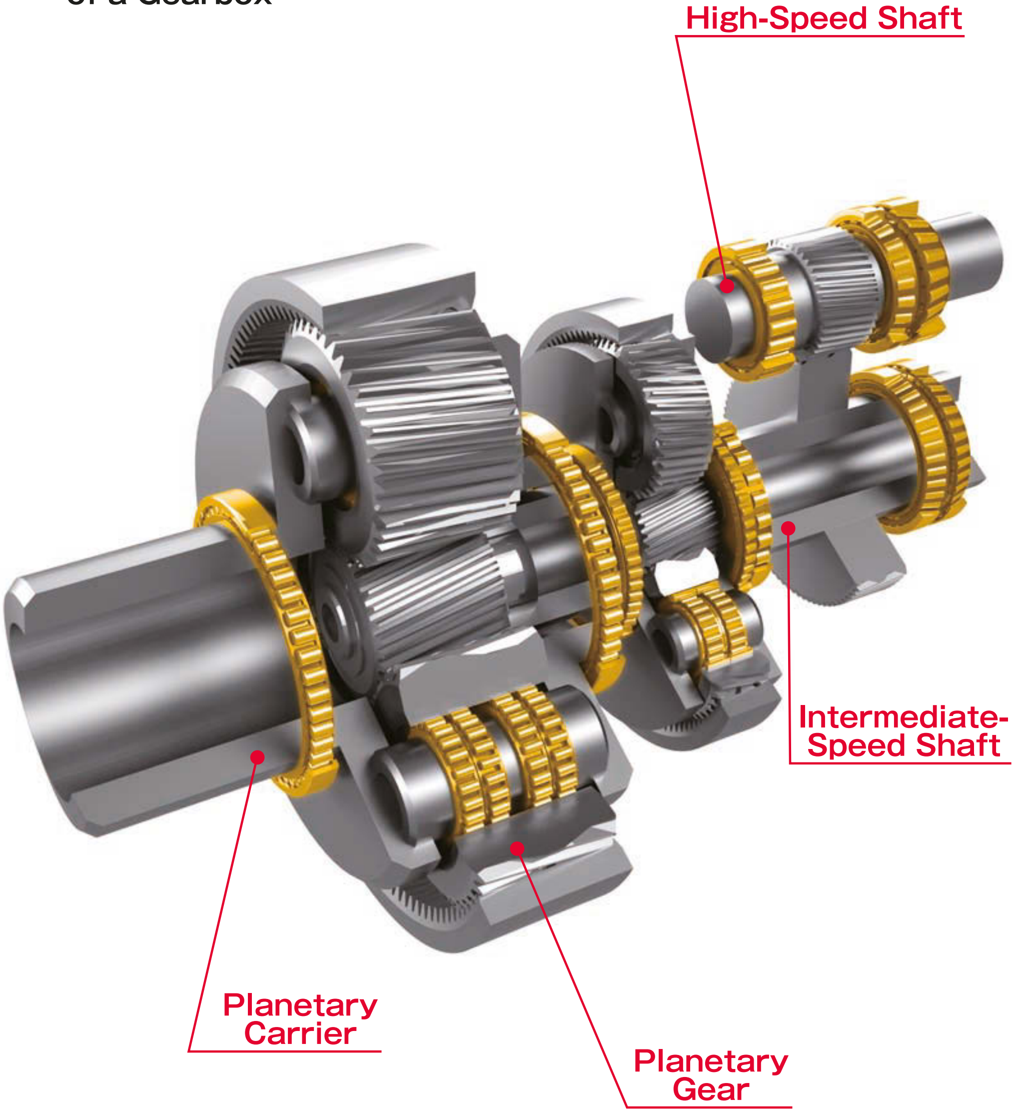
Bearings for the Wind Power Industry

High-performance, high-quality bearings offer long life for stable, low-maintenance operation.

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

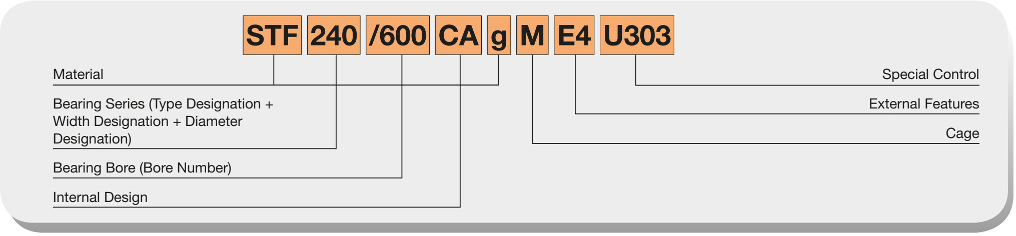
Super-TF™ Bearings

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.

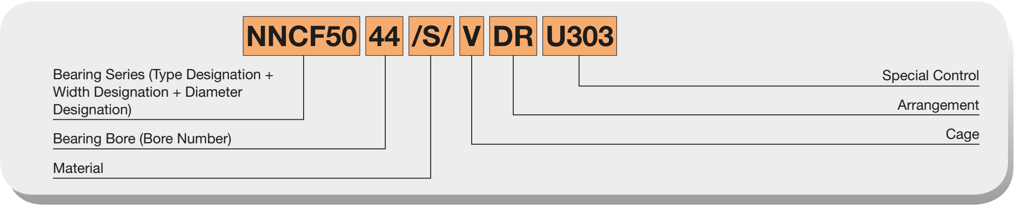
AWS-TF™ Bearings

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.

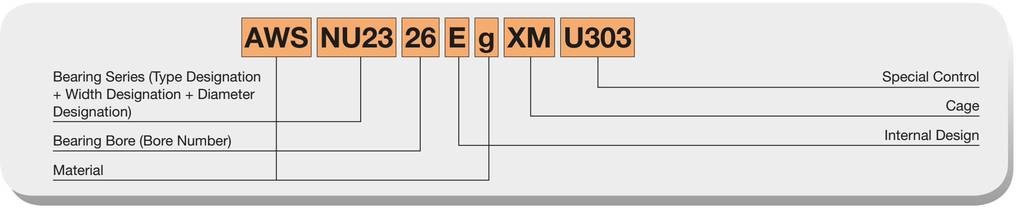
Example Bearing Designations



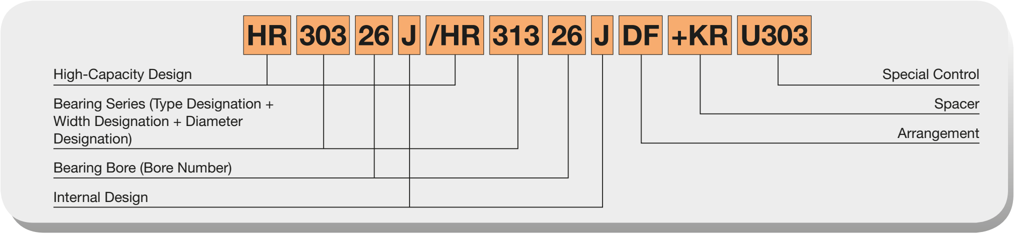
240	: Spherical Roller Bearing Width Series 4 Diameter Series 0
/600	: Bearing Bore 600 mm
CA	: High-Capacity Design
STF~g	: Long-Life Steel
M	: Machined-Brass Cage
E4	: Lubricating Groove in Outside Surface and Holes in Outer Ring
U303	: Special Process Control for Wind Turbine Bearings



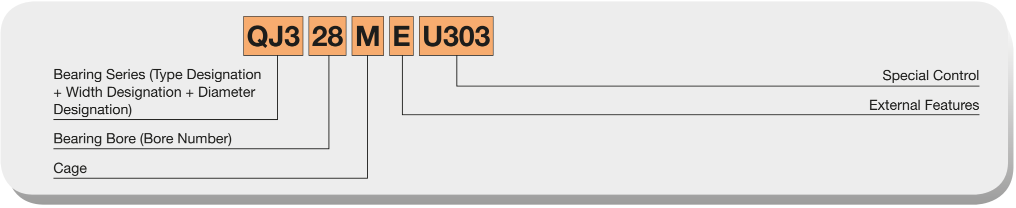
NNCF50	: NNCF Full Complement Cylindrical Roller Bearing Width Series 5 Diameter Series 0
44	: Bearing Bore 220 mm
/S/	: Black Oxide Coating
V	: Without Cage
DR	: Controlled Size Variation Arrangement
U303	: Special Process Control for Wind Turbine Bearings



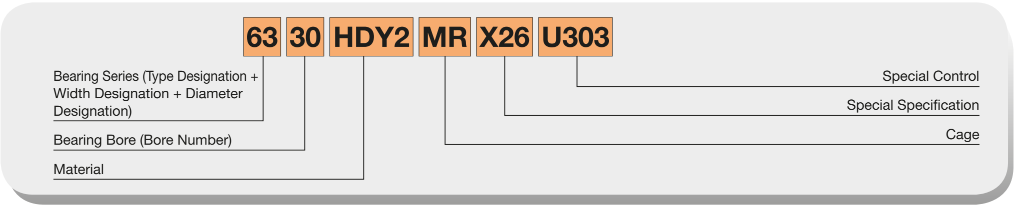
NU23	: NU-Type Cylindrical Roller Bearing Width Series 2 Diameter Series 3
26	: Bearing Bore 130 mm
E	: High Capacity Design
AWS~g	: Long-Life Steel, Specialized to Prevent White-Structure Flaking
XM	: High-Capacity Machined-Brass Cage
U303	: Special Process Control for Wind Turbine Bearings



HR/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 : 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



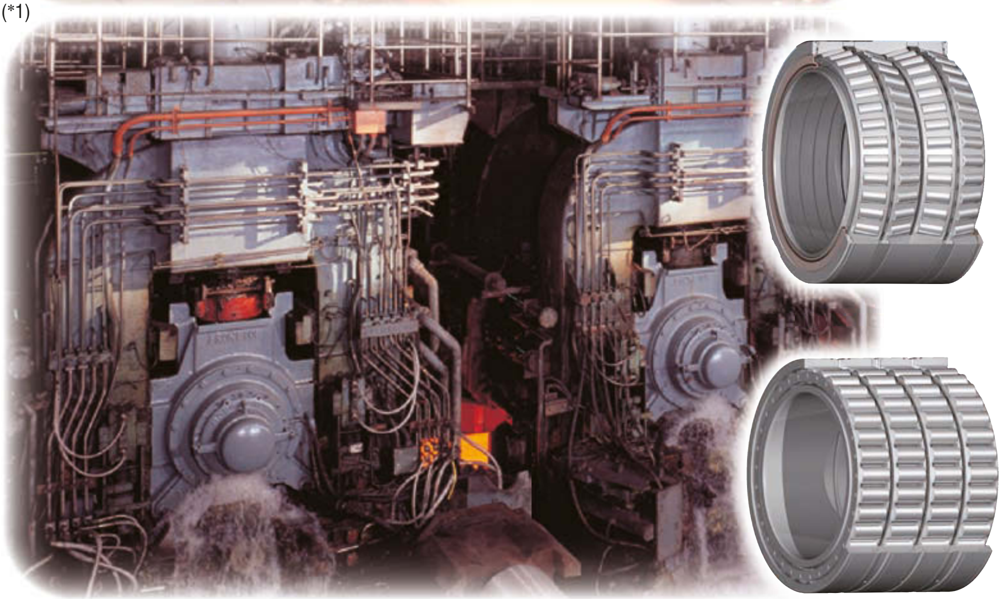
63 : Single-Row Deep Groove Ball Bearing Diameter Series 3
30 : Bearing Bore 150 mm
HDY2 : Ceramic-Insulated Coating on Outer Ring
MR : Ball-Guided Machined-Brass Cage
X26 : Dimensional Stabilizing Treatment
U303 : Special Process Control for Wind Turbine Bearings

Bearings for the Steel Industry

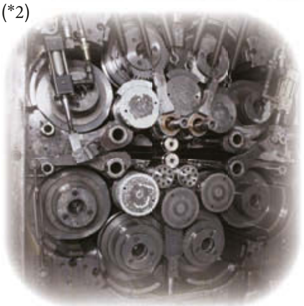
High-performance bearings help maximize uptime and reduce maintenance costs.

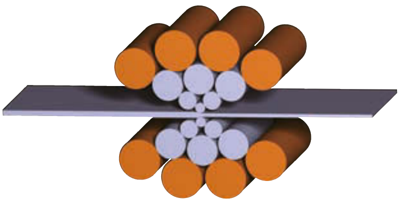
(*1)

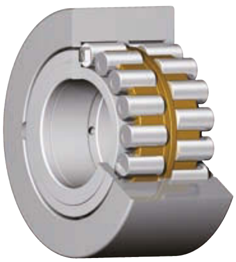
(*1)



(*2)

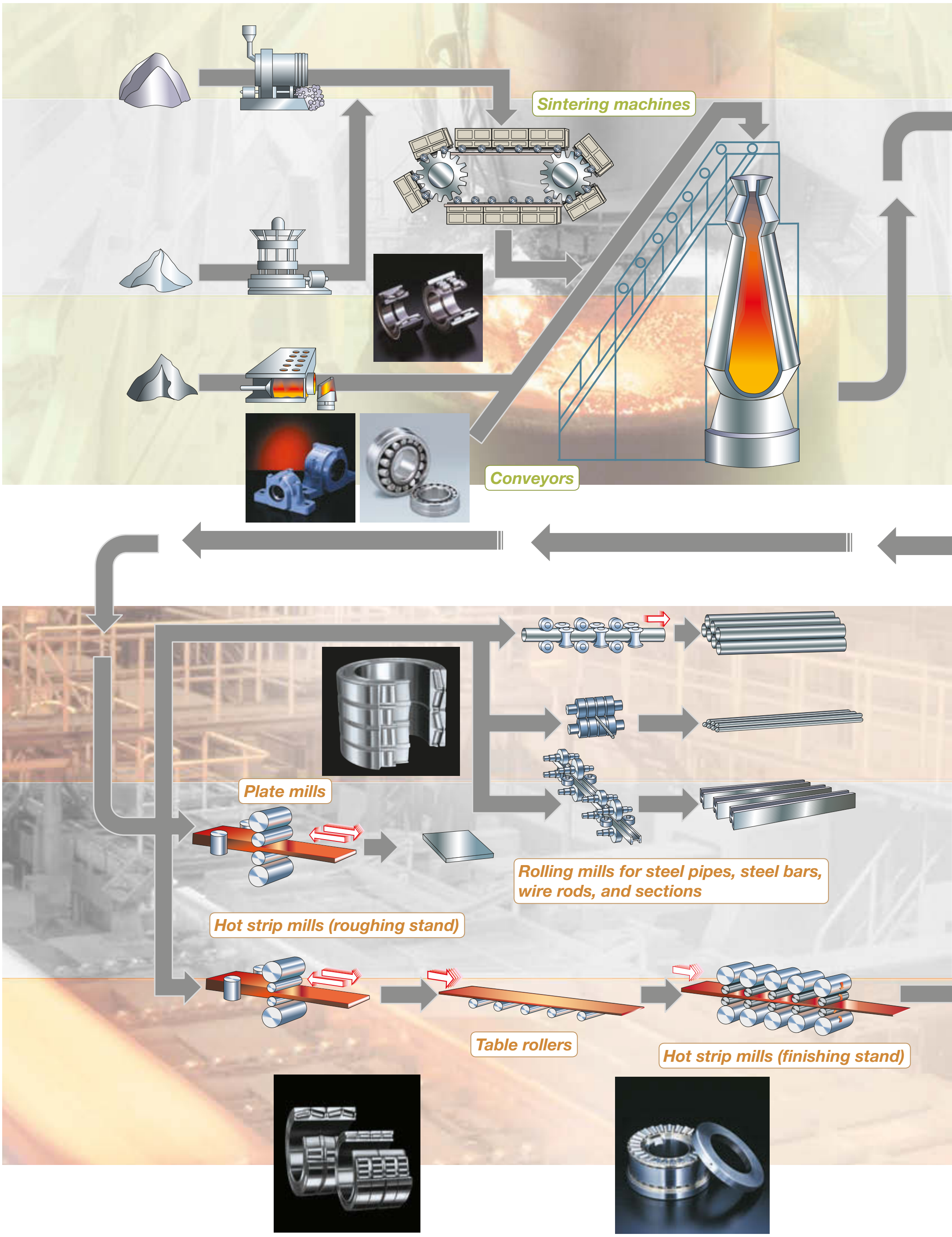


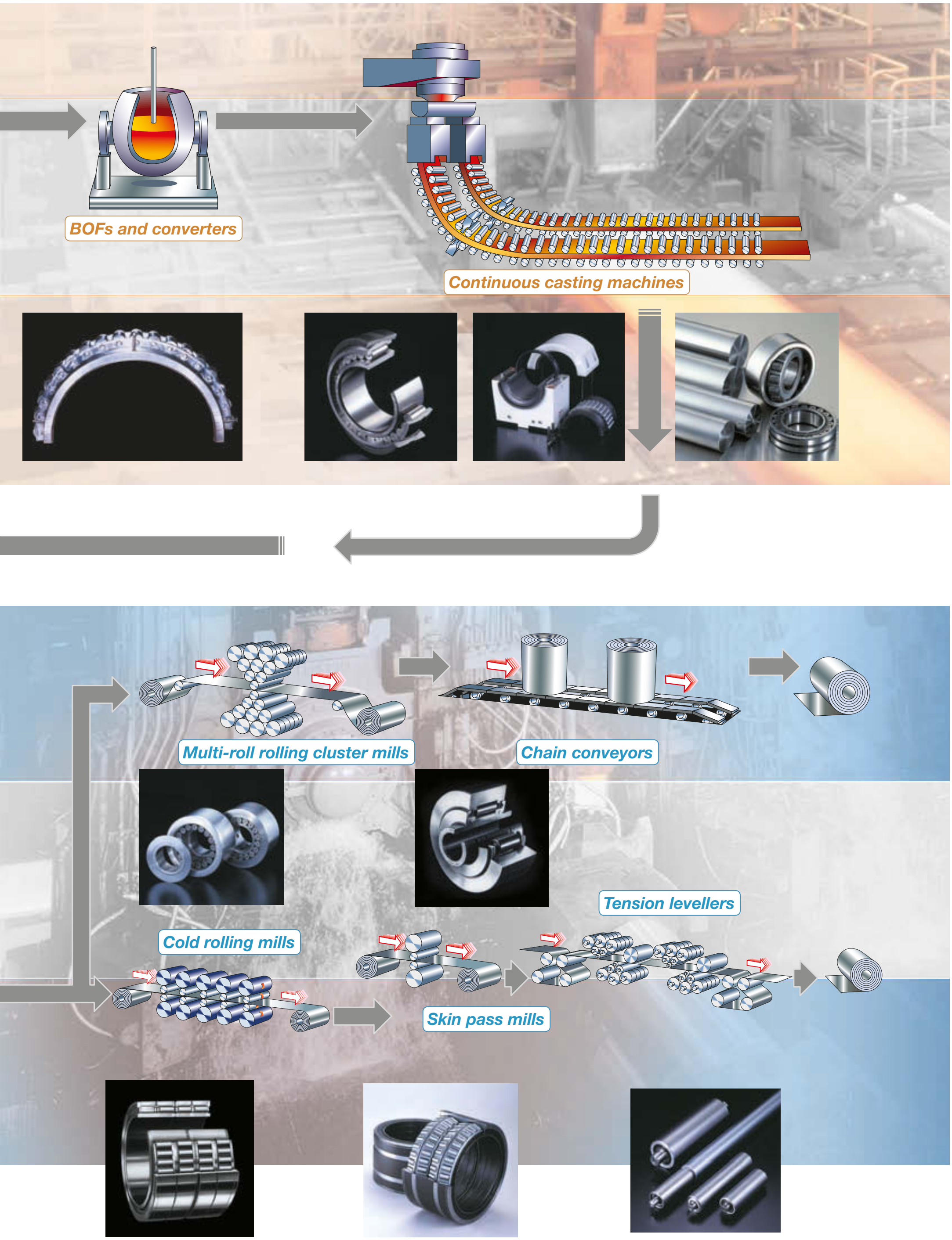




Notes (*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.
(*2): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

A complete product line for all steel mill processes delivers improved productivity and lower maintenance costs thanks to highly reliable long-life bearings.




BOFs and converters
Continuous casting machines
Multi-roll rolling cluster mills
Chain conveyors
Tension levellers
Cold rolling mills
Skin pass mills

Bearings for Sintering Equipment

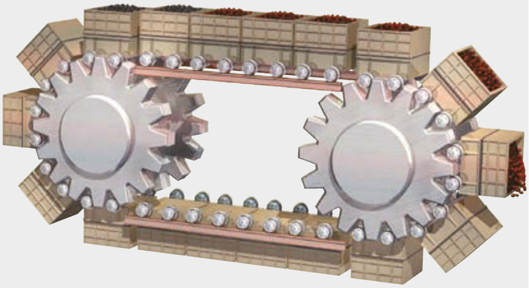
Sealed-Clean Bearings for Pallet Wheels / Sealed-Clean Bearings for Inboard Rollers

Benefits

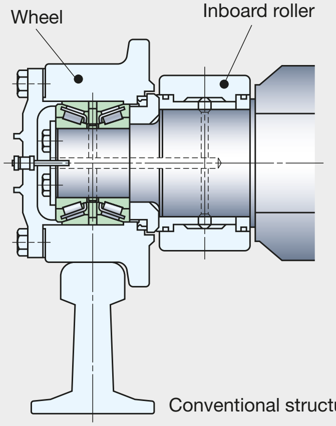
❶ Stable machinery operation through higher reliability and longer operating life
❷ Cleaner areas adjacent to equipment
❸ Lower maintenance costs

1. Operating conditions

High temperature — Heavy loads — Low speed — Scale (sintered particles)



Sintering equipment



Conventional structure

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)

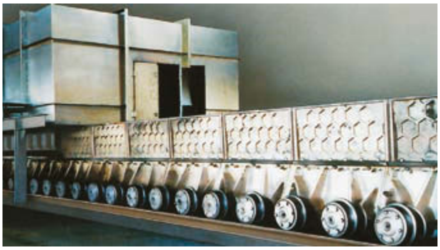
Problem 2

Contamination around equipment, high maintenance costs

Frequent greasing → Leakage of grease into surroundings

Frequent greasing → High operational cost for grease

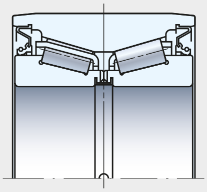
Leakage of grease into surroundings → Contamination around equipment, high usage cost



3. Countermeasures

Features AR-Series Sealed-Clean Bearings for Pallet Wheels

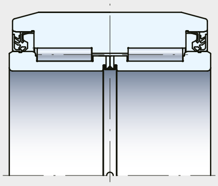
- Optimum crowning of the roller raceway surface enables resistance to unbalanced wheel load
- High sealing performance (featuring a special contact seal)
- Packed with grease featuring excellent heat and pressure resistance
- Easier handling (one-piece design with fastening ring inner ring)



Designations Page D100

Features Sealed-Clean Bearings for Inboard Rollers–2J, 2M Series

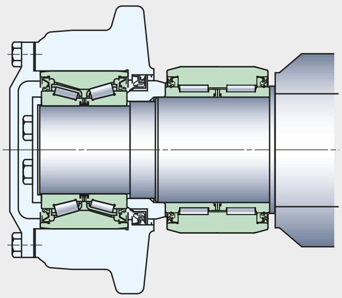
- Higher load capacity (by outer ring thickness design with high strength and full-complement roller type)
- Improvement of axial load capacity
- High sealing performance (featuring a special contact seal)
- Packing of grease with excellent heat and pressure resistance
- Easier handling (one-piece design with fastening ring adopted for the inner ring)



Designations Page D101

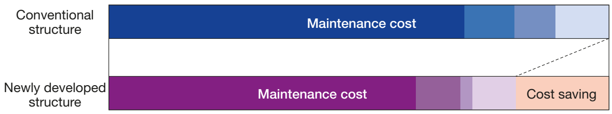
Durability Performance of Bearings in Field Test

	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

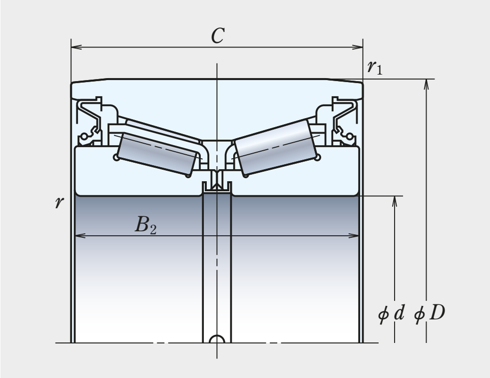


Maintenance costs include replacement costs for bearings, seals, and grease and operational costs associated with bearing replacement and greasing.

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}
AR80-24	80	150	67	67	2.5	1	269	390
AR90-25	90	160	74	74	2.5	0.5	240	435
AR90-26	90	160	80	80	2.5	0.5	240	435
AR90-27	90	160	78	78	2.5	0.5	240	435
AR90-32A	90	160	100	100	2.5	—	440	850
AR100-29	100	180	98	100	2.5	1	350	675
AR100-30	100	180	100	100	2.5	1	350	675
AR100-38	100	180	100	100	3	0.5	525	835
AR100-39	100	180	98	100	3	0.5	525	835
AR100-40	100	180	98	100	3	0.5	525	835
AR100-44	100	180	91	91	3	0.5	435	665
AR110-28	110	180	86	86	3	0.5	330	660
AR110-29	110	200	92	100	2.5	1	415	805
AR110-39	110	200	100	100	3	1	570	950
AR110-50A	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

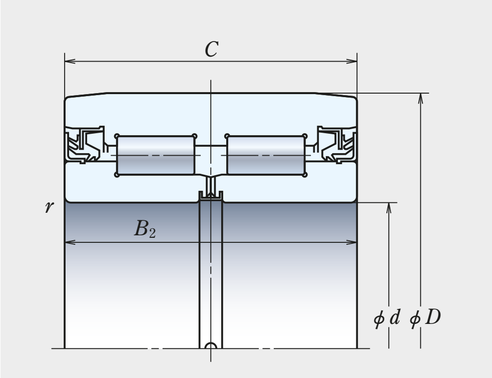


Fig. 1

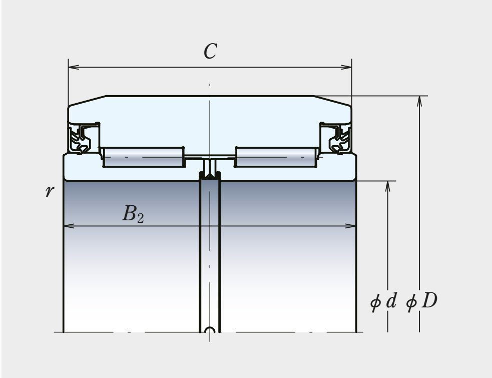


Fig. 2

Bearing Designation	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Fig.
	d	D	B_2	C	r(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

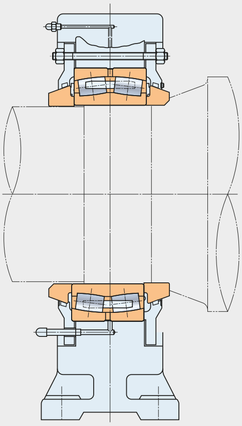
1. Operating conditions

High temperature

Heavy loads

Ultra-low speed and rocking

BOFs and converters

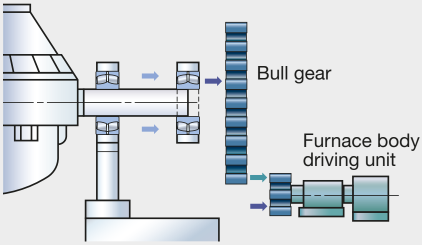


Conventional structure

2. Problems

Typical problems with bearings for BOFs and converters

Inboard bearings cannot be replaced without removing the bull gear

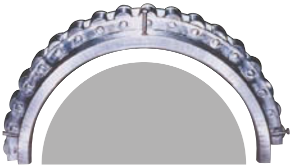


↓

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

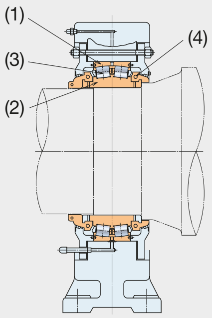


(*1)

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

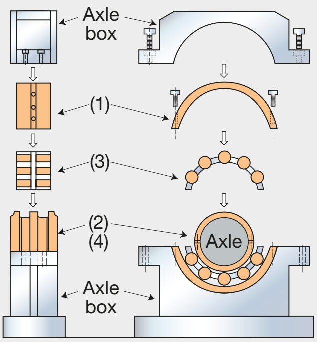
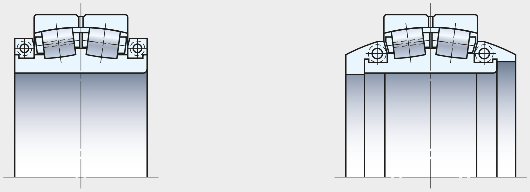


Image of bearing mounting

- 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.

■Bearings for BOFs and Converters

Extra-Large Split Bearings for BOFs and Converter Trunnions

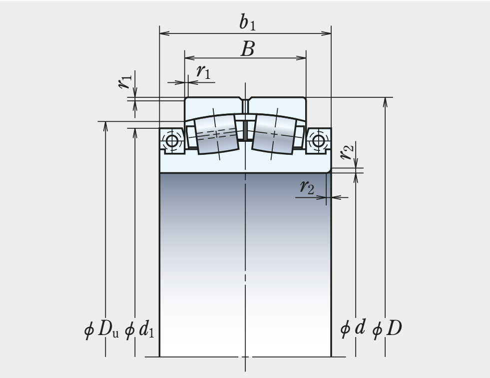


Fig. 1

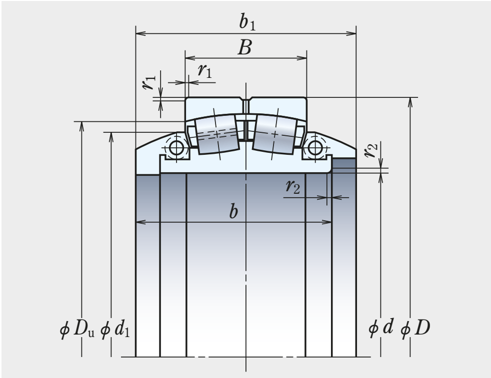


Fig. 2 Clamp Ring With Tangential Seal Surface

Bearing Designation	Boundary Dimensions (mm)								
	d	D	B	b	b_1	d_1	D_u	r_1(min)	r_2(min)
750SLPT1051	750	1 000	250	355	—	905	914.4	6	7.5
SL850-7	850	1 120	272	385	—	1 015	1 025	6	6
900SLPT1251	900	1 250	285	410	—	1 100	1 142	7.5	19
950SLPT1451	950	1 400	300	520	600	1 182	1 265	7.5	28
SL1120-3	1 120	1 580	320	632.5	697.5	1 400	1 445	9.5	30
∗1200SLPT1751	1 200	1 700	410	780	780	1 470	1 536	9.5	31
1200SLPT1752	1 200	1 700	410	660	730	1 470	1 536	9.5	19
1320SLPT1851	1 320	1 850	530	815	814	1 600	1 670	12	31
∗1400SLPT1951	1 400	1 900	530	880	880	1 680	1 710	12	31
∗1400SLPT1953	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.

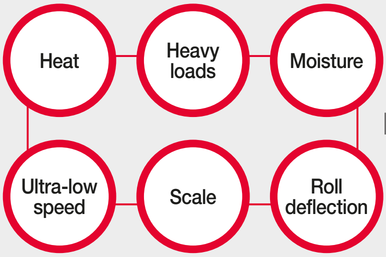
	Basic Load Ratings (kN)		Fig.
	C_r	C_{0r}	
	6 800	18 300	1
	8 000	21 600	1
	9 850	24 200	1
	12 300	27 900	2
	13 200	32 000	2
	17 300	43 500	2*
	17 300	43 500	2
	22 500	63 500	2
	22 800	65 000	2*
	22 800	65 000	2*

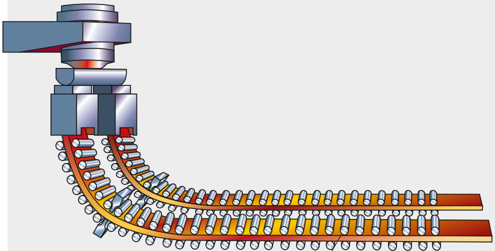
Bearings for Continuous Casting Machines

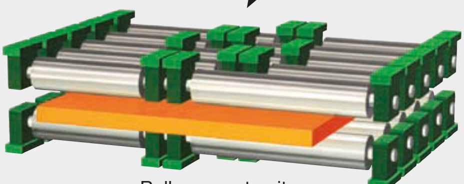
Bearings for Guide Rolls

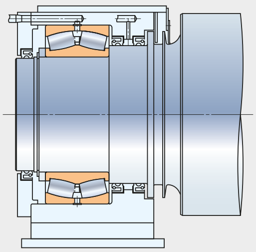
Benefits
❶ Improved bearing durability reduces unplanned downtime
❷ Less frequent roll segment replacement reduces maintenance costs

1. Operating conditions




Continuous casting machine


Roll segment unit


Axle box structure

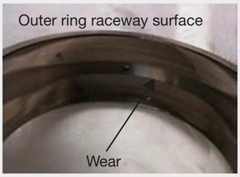
2. Problems

Typical problems with bearings for continuous casting machines

Differential sliding specific to spherical roller bearings

↓

Uneven wear



↓

Flaking

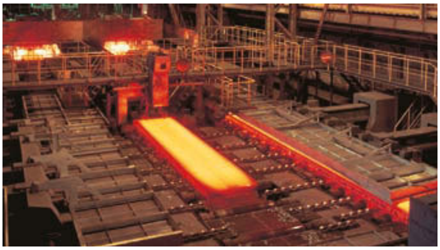
Flaking and cracking

↓

Crack

↓

- Expansion of roll gaps (failure of rolls)
- Decline in product quality
- Unexpected downtime
- High bearing usage cost



(*1)

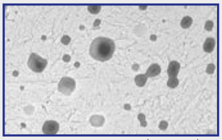
3. Countermeasures

Features SWR™ Bearings (Spherical Roller Bearings)

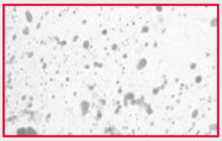
- Improved wear resistance → Three times higher than AISI 52100 bearing steel
- Improved flaking life → Five times higher than AISI 52100 bearing steel
- Improved toughness of material core
  (prevention of cracks) → Five times stronger than AISI 52100 bearing steel

Designations	Pages D108 to D115
SWR Bearing	CAT.No.E1242

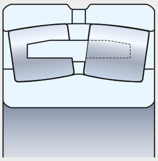
Microstructure (TEM)



SUJ2 1μm



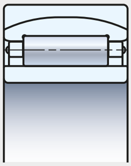
SWR 1μm



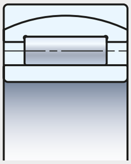
SWR

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)



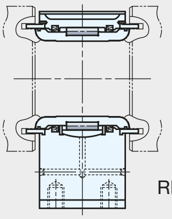
RUB (full complement)

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 plummer block unit

Designations	Pages D124 to D127

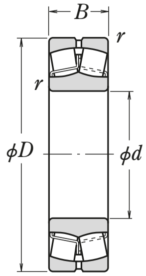


RNPH/PCR

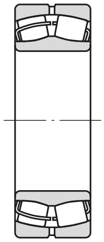
Note (*1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS.

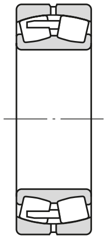
Bearings for Continuous Casting Machines

SWR™ Bearings (Spherical Roller Bearings)
Bore Diameter 40 – 100 mm

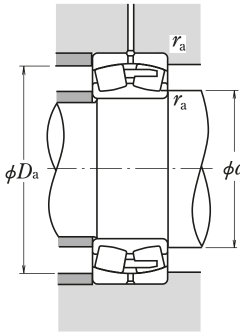


EA


C,CD


CA

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Designation	Abutment	
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}		d_a min.	max.
40	80	23	1.1	90.5	99.5	9 200	10 100	**22208SWREAE4**	47	49
	90	33	1.5	136	153	13 900	15 600	**22308SWRCAME4**	49	—
50	90	23	1.1	99	119	10 100	12 100	**22210SWREAE4**	57	60
55	100	25	1.5	119	144	12 100	14 600	**22211SWREAE4**	64	65
	120	29	2	142	174	14 500	17 800	**21311SWREAE4**	65	72
60	95	26	1.1	98.5	141	10 000	14 400	**23012SWRCE4**	67	68
	110	28	1.5	142	174	14 500	17 800	**22212SWREAE4**	69	72
	110	28	1.5	178	154	18 100	15 700	**22212SWRCAME4**	69	—
	130	31	2.1	190	244	19 400	24 900	**21312SWREAE4**	72	87
	130	46	2.1	246	288	25 100	29 400	**22312SWRCAME4**	72	—
65	120	31	1.5	152	190	15 500	19 300	**22213SWRCAME4**	74	—
	140	48	2.1	265	315	27 000	32 500	**22313SWRCAME4**	77	—
70	125	31	1.5	225	232	22 900	23 600	**22214SWREAE4**	79	84
	125	31	1.5	163	205	16 600	20 900	**22214SWRCAME4**	79	—
75	130	31	1.5	238	244	24 200	24 900	**22215SWREAE4**	84	87
80	140	33	2	264	275	27 000	28 000	**22216SWREAE4**	90	94
	170	39	2.1	355	375	36 000	38 000	**21316SWREAE4**	92	109
	170	58	2.1	390	480	39 500	48 500	**22316SWRCAME4**	92	—
85	150	36	2	310	325	320	33 500	**22217SWREAE4**	95	101
90	160	40	2	360	395	37 000	40 000	**22218SWREAE4**	100	108
	160	52.4	2	340	490	34 500	50 000	**23218SWRCE4**	100	105
	190	64	3	665	705	68 000	72 000	**22318SWREAE4**	104	115
95	170	43	2.1	296	395	30 000	40 000	**22219SWRCAME4**	107	—
100	150	37	1.5	212	335	21 600	34 500	**23020SWRCDE4**	109	112
	150	50	1.5	276	470	28 100	48 000	**24020SWRCE4**	109	110
	165	65	2	345	535	35 500	54 000	**24120SWRCAME4**	110	113
	180	46	2.1	455	490	46 500	50 000	**22220SWREAE4**	112	119



Dynamic Equivalent Load

$P=XF_r+YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0=F_r+Y_0F_a$

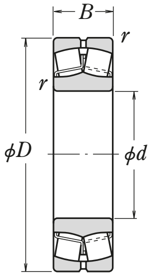
The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

and Fillet Dimensions (mm) D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
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

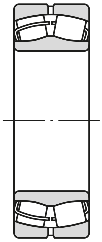
Bearings for Continuous Casting Machines

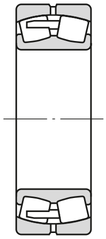
SWR™ Bearings (Spherical Roller Bearings)

Bore Diameter 110 – 140 mm

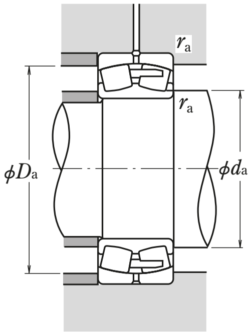


EA


C,CD


CA

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Designation	Abutment	
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}		d_a min.	max.
110	170	45	2	293	465	29 900	47 500	**23022SWRCDE4**	120	124
	170	45	2	293	465	30 900	47 500	**23022SWRCAME4**	120	—
	170	60	2	380	645	38 500	66 000	**24022SWRCE4**	120	121
	180	56	2	480	630	49 000	64 000	**23122SWRCAME4**	120	—
	180	69	2	460	750	47 000	76 500	**24122SWRCE4**	120	123
	200	53	2.1	605	645	61 500	66 000	**22222SWREAE4**	122	129
	200	53	2.1	425	585	43 500	59 500	**22222SWRCAME4**	122	—
	200	69.8	2.1	645	760	65 000	77 500	**23222SWRCAME4**	122	—
	240	80	3	1030	1120	10 500	115 000	**22322SWREAE4**	124	145
120	180	46	2	315	525	32 000	53 500	**23024SWRCDE4**	130	134
	180	46	2	395	525	40 000	53 500	**23024SWRCAME4**	130	—
	180	60	2	395	705	40 500	72 000	**24024SWRCE4**	130	131
	180	60	2	480	680	49 000	69 000	**24024SWRCAME4**	130	131
	200	80	2	575	950	58 500	96 500	**24124SWRCE4**	130	136
	200	80	2	695	905	70 500	92 000	**24124SWRCAME4**	130	—
	215	58	2.1	490	690	50 000	70 000	**22224SWRCAME4**	132	—
	215	76	2.1	790	970	80 500	99 000	**23224SWRCAME4**	132	—
	260	86	3	845	1 120	80 600	115 000	**22324SWRCAME4**	134	—
130	200	52	2	400	655	40 500	67 000	**23026SWRCDE4**	140	147
	200	69	2	495	865	50 500	88 000	**24026SWRCE4**	140	143
	200	69	2	620	865	60 300	88 000	**24026SWRCAME4**	140	—
	210	80	2	590	1 010	60 000	103 000	**24126SWRCE4**	140	146
	210	80	2	590	1 010	60 000	103 000	**24126SWRCAME4**	140	—
	230	64	3	820	940	83 500	96 000	**22226SWREAE4**	144	152
	230	64	3	565	815	57 500	83 000	**22226SWRCAME4**	144	—
	230	80	3	875	1 080	89 500	110 000	**23226SWRCAME4**	144	—
140	210	53	2	420	715	43 000	73 000	**23028SWRCDE4**	150	157
	210	69	2	525	945	53 500	96 500	**24028SWRCE4**	150	154
	210	69	2	635	905	64 500	92 500	**24028SWRCAME4**	150	—



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

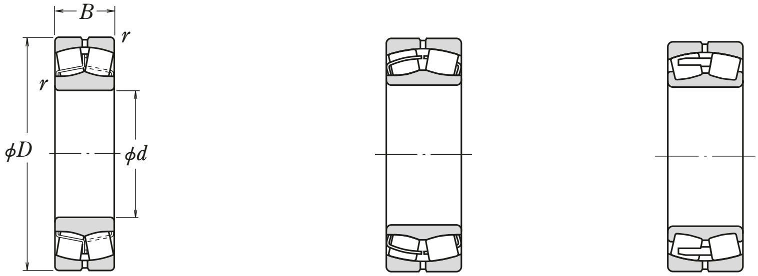
The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
D_a		r_a					
max.	min.	max.	e	Y_2	Y_3	Y_0	approx.
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

Bearings for Continuous Casting Machines

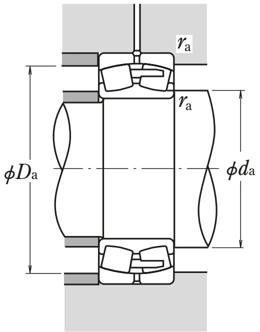
SWR™ Bearings (Spherical Roller Bearings)

Bore Diameter 140 – 180 mm



EA C,CD CA

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Designation	Abutment	
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}		d_a min.	d_a 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	—
150	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	—
	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
160	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
	290	80	3	1 140	1 320	116 000	135 000	**22232SWRCAME4**	174	—
170	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
180	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
	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

$P=XF_r+YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0=F_r+Y_0F_a$

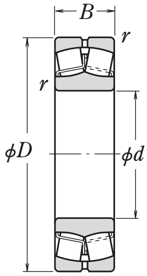
The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
D_a		r_a					
max.	min.	max.	e	Y_2	Y_3	Y_0	approx.
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

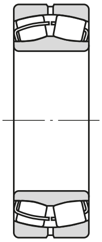
Bearings for Continuous Casting Machines

SWR™ Bearings (Spherical Roller Bearings)

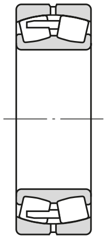
Bore Diameter 190 – 240 mm



EA

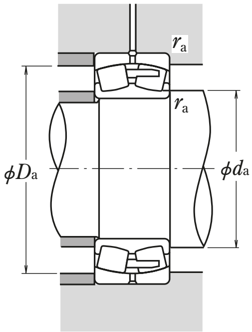


C,CD



CA

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Designation	Abutment	
d	D	B	r min.	C_r	C_{0r}	C_r	C_{0r}		d_a min.	max.
190	290	75	2.1	970	1 350	99 000	138 000	**23038SWRCAME4**	202	—
	290	100	2.1	975	1 840	99 500	188 000	**24038SWRCE4**	202	210
	290	100	2.1	1 220	1 840	124 000	188 000	**24038SWRCAME4**	202	—
	320	128	3	1 370	2 330	140 000	238 000	**24138SWRCE4**	204	211
	320	128	3	1 710	2 330	175 000	238 000	**24138SWRCAME4**	204	—
	340	92	4	1 140	1 730	116 000	176 000	**22238SWRCAME4**	208	—
	340	120	4	1 440	2 350	147 000	240 000	**23238SWRCE4**	208	222
200	310	82	2.1	1 180	1 700	120 000	174 000	**23040SWRCAME4**	212	—
	310	109	2.1	1 140	2 120	116 000	216 000	**24040SWRCE4**	212	223
	310	109	2.1	1 420	2 120	145 000	216 000	**24040SWRCAME4**	212	—
	340	140	3	1 570	2 670	160 000	272 000	**24140SWRCE4**	214	226
	340	140	3	1 960	2 660	199 000	271 000	**24140SWRCAME4**	214	—
	360	98	4	1 300	2 010	133 000	204 000	**22240SWRCAME4**	218	—
220	340	90	3	1 360	1 980	139 000	202 000	**23044SWRCAME4**	234	—
	340	118	3	1 640	2 490	168 000	265 000	**24044SWRCE4**	234	244
	340	118	3	1 310	2 490	134 000	254 000	**24044SWRCAME4**	234	—
	370	150	4	1 800	3 200	183 000	325 000	**24144SWRCE4**	238	248
	370	150	4	1 800	3 200	183 000	325 000	**24144SWRCAME4**	238	—
	400	108	4	1 570	2 430	160 000	247 000	**22244SWRCAME4**	238	—
	400	144	4	2 010	3 400	206 000	350 000	**23244SWRCE4**	238	260
240	360	118	3	1 730	2 730	176 000	278 000	**24048SWRCAME4**	254	—
	400	160	4	2 660	3 800	272 000	385 000	**24148SWRCAME4**	258	—



Dynamic Equivalent Load

$P=XF_r+YF_a$

$F_a/F_r\leqq e$		$F_a/F_r>e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0=F_r+Y_0F_a$

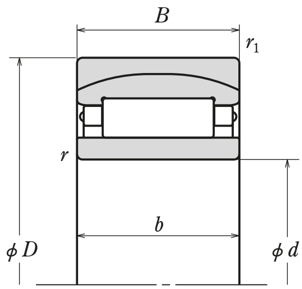
The values of e, Y_2, Y_3 , and Y_0 are given in the table below.

and Fillet Dimensions (mm) D_a max.	D_a min.	r_a max.	Constant e	Axial Load Factors Y_2	Y_3	Y_0	Mass (kg) approx.
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

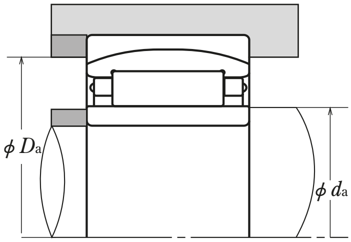
Bearings for Continuous Casting Machines

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)	
d	D	B	b	r min.	r_1 min.	C_r	C_{0r}
90	160	56	50	1.1	2	220	335
	170	68	52.4	2	2	270	375
	190	64	64	3	3	340	490
100	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
110	170	75	45	1.1	1.1	191	325
120	180	46	46	2.5	2.5	215	415
	180	76	46	2	2	215	415
	200	80	80	2	2	370	680
124.96	255	133	66	2.1	5	430	590
130	200	79	52	2	2	261	440
	230	90	90	3	3	540	930
140	250	68	68	3	3	480	740
150	250	100	100	2.1	2.1	540	1 040
	270	130	96	3	3	690	1 210
180	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
200	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
220	380	120	120	4	4	1 090	1 950
	400	108	108	4	4	1 040	1 770
240	400	150	128	4	4	1 260	2 500



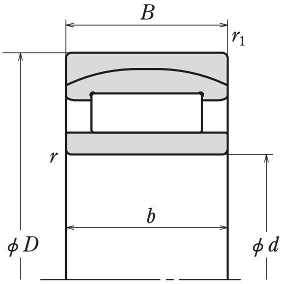
Bearing Designation	Abutment and Fillet Dimensions (mm)		
	d_a min.	d_a max.	D_a min.
90RUB1601P	99	105	143
90RUB1702P	99	106	153
90RUB1908P	103	109	166
100RUB31AP	106.5	113	147
100RUB1602P	106.5	113	147
100RUB22P	111	117	163
100RUB23P	108	125	190
110RUB1701P	116.5	121	155
120RUB30P	132	133	165
120RUB1801P	129	133	166
120RUB41P	129	136	174
125RUB2502P	144.96	154	229
130RUB2001P	139	144	184
130RUB2301P	143	149	200
140RUB22P	153	161	227
150RUB41P	161	169	219
150RUB2702P	163	172	236
180RUB40P	191	200	250
180RUB3002P	193	203	260
180RUB3001P	193	203	260
180RUB3201P	196	207	279
200RUB30P	213	222	286
200RUB40P	211	222	280
200RUB41P	213	229	295
220RUB3801P	236	251	341
220RUB22E1P	236	255	358
240RUB4001P	256	269	362

Bearings for Continuous Casting Machines

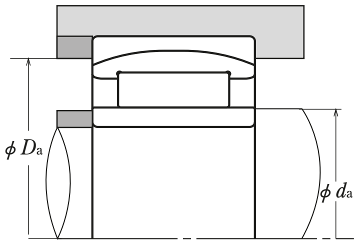
RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 50 – 110 mm

Full Complement



Boundary Dimensions (mm)						Basic Load Ratings (kN)	
d	D	B	b	r min.	r_1 min.	C_r	C_{0r}
50	90	23	23	1.5	1.5	69.5	104
	110	40	40	2	2	140	295
55	90	32	32	1.1	1.1	82	195
	100	25	25	1.5	1.5	88	121
65	120	31	31	1.5	1.5	131	200
	140	48	48	2.1	2.1	221	440
70	125	31	31	1.5	1.5	127	213
75	130	31	31	1.5	1.5	151	248
85	150	65	65	2.5	2.5	286	595
90	150	72	60	1.5	1	262	575
	190	64	64	3	1.5	415	780
100	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
103	180	60	60	2	2	330	790
110	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

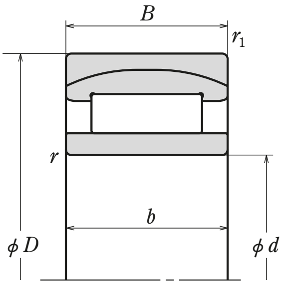


Bearing Designation	Abutment and Fillet Dimensions (mm)		
	d_a min.	d_a max.	D_a min.
50RUB22PV	57	58	80
50RUB23PV	59	70	94
55RUB9001PV	61.5	62.5	80
55RUB22APV	62	63	90
65RUB22PV	73	75	107
65RUB23PV	76	85	121
70RUB22APV	78	85	113
75RUB22APV	83	85	118
85RUB1501P	97	98	130
90RUB1501PV	95	101	131
90RUB23APV	98	116	168
100RUB40PV	108	109	134
100RUB1501PV	108	109	134
100RUB31PV	109	113	147
100RUB22APV	111	123	164
100RUB32PV	111	116	160
103RUB1801PV	112	132	163
110RUB30A1PV	119	123	155
110RUB40PV	119	123	151
110RUB31A1PV	123	124	161
110RUB41A2PV	119	123	157
110RUB22APV	121	130	180

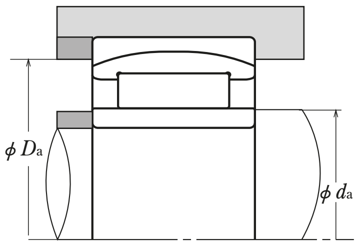
Bearings for Continuous Casting Machines

RUB Series Cylindrical Roller Bearings With Aligning Rings (for Free End)

Bore Diameter 120 – 160 mm
Full Complement



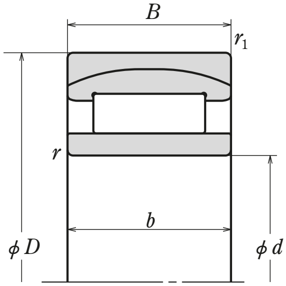
Boundary Dimensions (mm)						Basic Load Ratings (kN)	
d	D	B	b	r min.	r_1 min.	C_r	C_{0r}
120	180	46	46	2	2	275	625
	180	60	60	2	2	330	790
	180	80	60	2	2	330	790
	200	80	80	2.5	2.5	470	1 040
	225	58	58	2.5	2.5	460	690
130	200	69	69	2	2	410	955
	210	64	64	2	2	415	865
	210	80	80	2	2	510	1 130
	230	64	64	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
	250	88	88	3	3	670	1 500
150	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
	250	100	100	2.1	2.1	710	1 620
	270	96	96	3	3	815	1 640
160	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



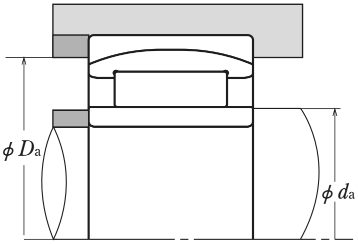
Bearing Designation	Abutment and Fillet Dimensions (mm)		
	d_a min.	d_a max.	D_a min.
120RUB30B2PV	129	132	165
120RUB40A2PV	129	132	163
120RUB1803PV	129	132	163
20RUB41A1PV	133	137	174
120RUB2201APV	133	138	204
130RUB40A1PV	139	143	180
130RUB31APV	139	144	189
130RUB41A2PV	139	144	184
130RUB22APV	143	151	208
130RUB32APV	143	146	204
140RUB30A2PV	149	155	194
140RUB40APV	149	152	190
140RUB31APV	151	156	203
140RUB41A1PV	151	156	200
140RUB22APV	153	172	227
140RUB32PV	153	170	221
150RUB30APV	163	166	208
150RUB40A1PV	161	165	203
150RUB2201PV	161	164	203
150RUB31APV	161	170	221
150RUB41APV	161	170	219
150RUB32APV	163	174	236
160RUB40A1PV	171	176	217
160RUB2402PV	171	176	217
160RUB41AE2PV	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)	
d	D	B	b	r min.	r_1 min.	C_r	C_{0r}
170	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
180	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
190	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
200	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
220	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
240	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.
170RUB30APV	181	188	239
170RUB40A1PV	181	188	233
170RUB32APV	186	195	273
180RUB40APV	193	198	250
180RUB41APV	193	202	260
180RUB32APV	196	204	279
190RUB40A1PV	201	210	260
190RUB31APV	203	214	286
190RUB32APV	206	218	297
200RUB40A1PV	211	219	280
200RUB31APV	213	230	305
200RUB41APV	213	230	295
220RUB30PV	233	243	313
220RUB40APV	233	243	308
220RUB3401PV	233	247	308
220RUB41APV	236	248	322
240RUB31APV	256	271	362

Bearings for Continuous Casting Machines

RNPH Series Split Cylindrical Roller Bearings (for Segmented Rolls)

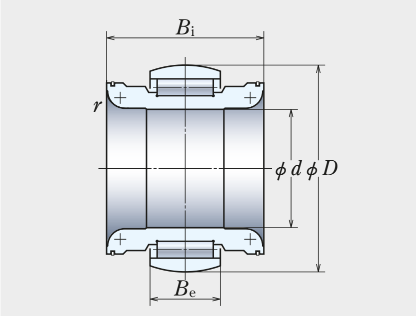


Fig. 1

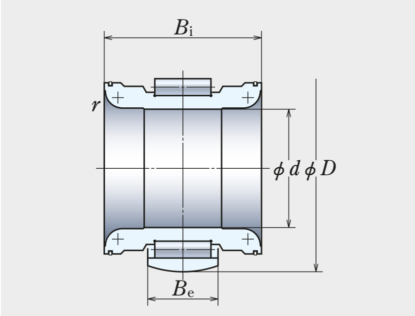


Fig. 2

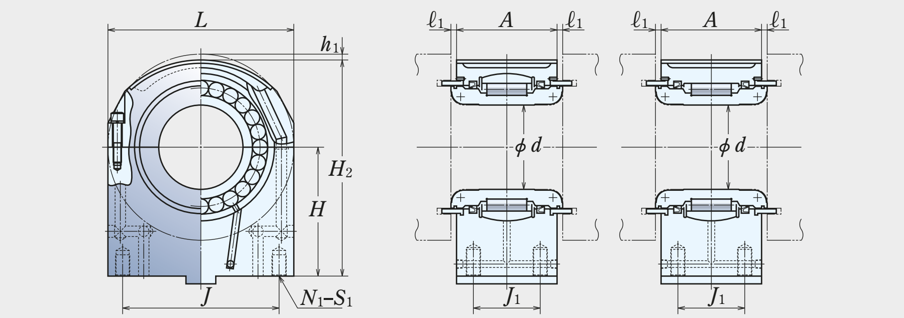
Bearing Designation	Boundary Dimensions (mm)			
	d	D	B_i	B_e
100RNPH1801	100	185	169	74
110RNPH1801	110	180	137	49
110RNPH1803	110	185	154	76
110RNPH2001	110	200	179	80
115RNPH2001	115	205	202	98
120RNPH1901	120	195	157	66
120RNPH2001	120	205	179	80
130RNP2001	130	205	139	60
130RNP2101	130	215	174	75
130RNPH2105	130	215	143	60
130RNPH2107	130	215	174	75
130RNPH2201	130	225	189	90
130RNPH2202	130	220	186	79
135RNPH2101	135	215	183	84
135RNPH2102	135	210	183	84
140RNPH2102	140	215	162	60
140RNPH2103	140	215	189	74
140RNPH2302	140	235	194	84
140RNP2401	140	245	184	85
145RNPH2201	145	225	179	76
145RNPH2303	145	232	196	84
145RNPH2401	145	240	208	89
150RNPH2303	150	230	199	78
150RNPH2401	150	245	159	80
150RNPH2403	150	240	195	84
150RNPH2503	150	250	169	70
150RNPH2505	150	250	208	89
150RNPH2601	150	265	187	98
150RNPH2702	150	275	199	100
155RNPH2401	155	245	199	88
160RNPH2502	160	255	199	90
160RNPH2504	160	255	189	86
160RNPH2601	160	265	200	82
160RNPH2703	160	275	214	100
170RNPH2601	170	265	214	100
180RNPH2901	180	290	214	85

Remark Other bearings are available. Please contact NSK for additional information.

r	Basic Load Ratings (kN) C_r	C_{0r}	Roll Diameter (mm)	Fig.
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) d	L	A	H
100PCR2201	100	235	152	132
110PCR2301	110	230	120	160
110PCR2303	110	230	135	180
110PCR2502	110	250	156	150
115PCR2401	115	245	183	190
120PCR2501	120	250	142	165
120PCR2502	120	255	162	230
130PCR2701	130	265	118	190
130PCR2801	130	280	156	160
130PCR2705	130	270	132	197
130PCR2604	130	265	175	145
130PCR2802	130	280	172	180
130PCR2603	130	265	171	175
135PCR2701	135	270	160	160
135PCR2502	135	250	160	160
140PCR2701	140	270	145	180
140PCR2601	140	265	174	175
140PCR2804	140	285	179	175
140PCR3101	140	310	166	175
145PCR2801	145	280	162	250
145PCR2804	145	280	183	260
145PCR2901	145	295	195	270
150PCR2801	150	280	184	175
150PCR280	150	330	144	310
150PCR3004	150	305	180	205.5
150PCR3003	150	300	150	180
150PCR2901	150	295	193	310
150PCR3203	150	320	168	220
150PCR3301	150	330	182	220
155PCR3001	155	300	182	260
160PCR3101	160	310	178	185
160PCR3002	160	305	174	217
160PCR3302	160	330	185	225
160PCR3401	160	340	199	200
170PCR3301	170	320	194	290.5
180PCR3301	180	335	150	217.5

Remark Other bearings are available. Please contact NSK for additional information.

Boundary Dimensions (mm)

h_1	H_2	ℓ_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

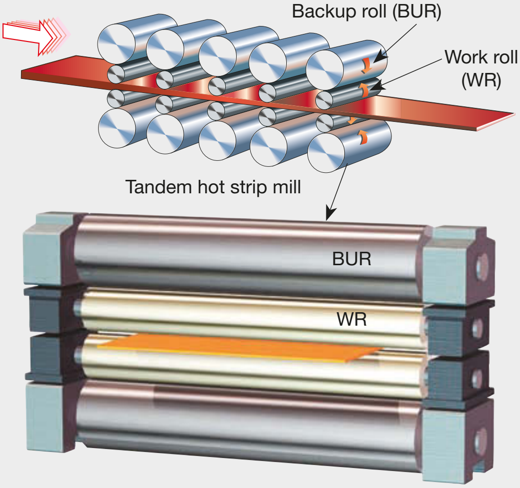
❶ Higher reliability and longer operating life prevent unexpected accidents
❷ Bearing seal requires less cleaning of work environment and reduces grease consumption
❸ Lower maintenance costs

1. Operating conditions

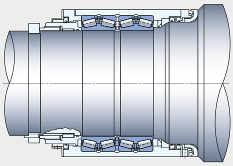
- High and low speeds
- Heavy loads
- Vibration and Impact
- High temperature
- Scale
- Water infiltration

Major target mills:

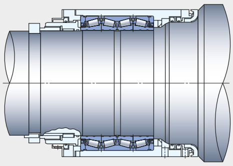
- Hot strip mills
- Skin pass mills
- Cold rolling mills
- Temper rolling mills



Tandem hot strip mill



(1) Open four-row tapered roller bearing



(2) Sealed four-row tapered roller bearing

2. Problems

Typical problems for work roll bearings

(1) Open four-row tapered roller bearings
→ (a) Large grease consumption and high maintenance costs
→ (b) Premature failure due to poor lubrication

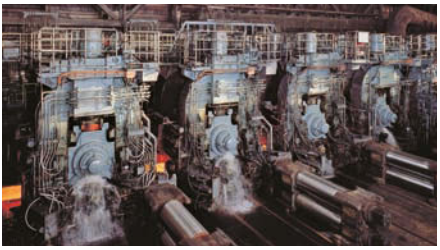
(2) Sealed four-row tapered roller bearings
→ Severe operating conditions, including high load, debris, and water entry

Flaking

Seizure

High bearing usage cost

Unexpected downtime



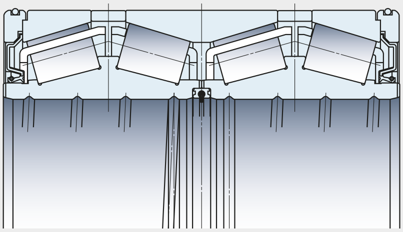
(*1)

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 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)

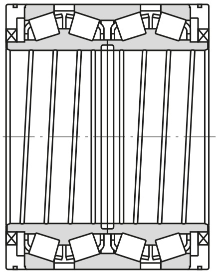


Fig. 1 Basic Design of Two-Seal Type (KVE)

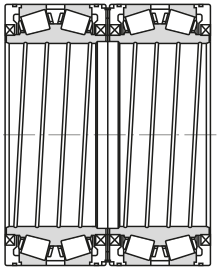


Fig. 2 Basic Design of Four-Seal Type (KVE)

	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)

	Variations
2-1	Oil holes in outer ring spacers
2-2	Clearance between inner ring faces

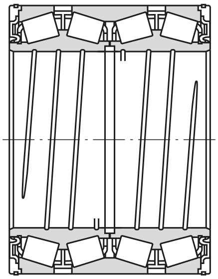
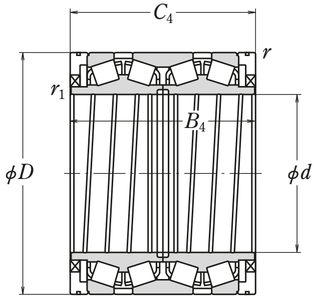


Fig. 3 Basic Design of Two-Seal Type (KVS)

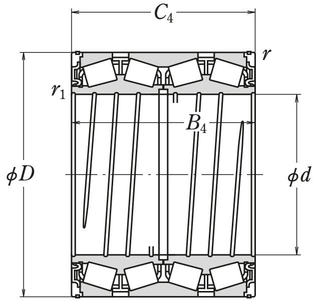
	Variations
3-1	Oil holes in outer ring spacers

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 (kN)		{kgf}	
d	D	B_4	C_4	r_1 min.	r min.	C_r	C_{0r}	C_r	C_{0r}
101.600	200.025	320.000	320.000	1.0	3.0	1 450	2 420	148 000	247 000
4.000	7.8750	12.5984	12.5984						
150	210	240	240	1	2.5	990	2 270	101 000	231 000
170	240	175	175	2.5	2.5	1 020	2 000	103 000	204 000
187.325	269.875	230.000	230.000	2.0	3.3	1 460	3 200	149 000	325 000
7.3750	10.6250	9.0551	9.0551						
215.900	288.925	177.800	177.800	0.8	3.3	1 070	2 350	109 000	239 000
8.5000	11.3750	7.0000	7.0000						
216.103	330.2	263.525	269.875	1.5	3.3	2 290	4 550	233 000	465 000
8.5080	13.0000	10.3750	10.6250						
220	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
225	320	230	230	1	2	1 510	3 300	154 000	335 000
228.600	400.050	296.875	296.875	3.3	3.3	2 410	4 250	246 000	435 000
9.0000	15.7500	11.6880	11.6880						
234.950	327.025	196.850	196.850	1.5	3.3	1 550	3 200	158 000	325 000
9.2500	12.8750	7.7500	7.7500						
240	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
244.475	327.025	193.680	193.680	1.5	3	1 370	3 300	148 000	325 000
9.6250	12.8750	7.6250	7.6250						
245	345	310	310	2	3	2 700	6 650	275 000	680 000
250	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

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

Where $Y_0 \fallingdotseq Y_3$

The values of e, Y_2, and Y_3 are given in the table below.

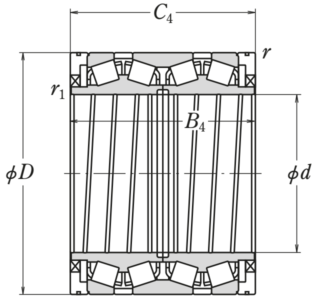
Bearing Designations Super-TF Series	Bearing Designations Water-TF Series	Figure(1)	Constant e	Axial Load Factors Y_2	Axial Load Factors Y_3	Mass (kg) approx.
∗STF101KVE2051Eg		1-2	0.36	2.8	1.9	47.8
STF150KVE2101Eg		1-1	0.32	3.2	2.1	26.1
STF170KVS2401Eg		3	0.32	3.2	2.1	23
∗STF187KVE2651Eg		1-1	0.29	3.4	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 (∗).

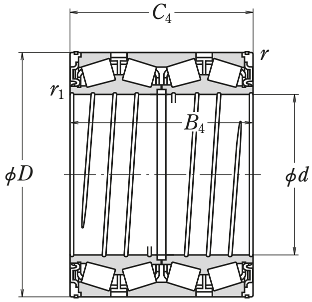
Note (1) Refer to Pages D130 and D131.

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 (kN)		{kgf}	
d	D	B_4	C_4	r_1 min.	r min.	C_r	C_{0r}	C_r	C_{0r}
254.000	358.775	269.875	269.875	1.5	3.3	2 420	5 500	247 000	560 000
10.0000	14.1250	10.6250	10.6250						
260	365	340	340	2.7	4	2 960	7 350	300 000	750 000
	365	340	340	2.5	4	2 960	7 350	300 000	750 000
260.350	422.275	314.325	317.500	6.4	3.3	3 600	7 050	370 000	720 000
10.2500	16.6250	12.3750	12.5000						
266.700	355.600	230.188	228.600	1.5	3.3	1 960	4 600	200 000	470 000
10.5000	14.0000	9.0625	9.0000						
276.225	393.700	269.875	269.875	1.5	3.3	2 720	6 100	277 000	620 000
10.8750	15.5000	10.6251	10.6251						
279.400	393.700	269.875	269.875	1.5	6.4	2 720	6 100	277 000	620 000
11.0000	15.5000	10.6250	10.6250						
	393.700	270.630	269.875	1.5	6.4	2 290	5 150	233 000	525 000
	15.5000	10.6547	10.6250						
279.4	393.7	320	320	1.5	6.4	3 100	7 350	315 000	745 000
	410	420	420	1	6.4	3 300	7 400	335 000	755 000
280	380	290	290	1.5	3	2 230	5 350	227 000	545 000
	395	340	340	1.5	2.5	2 950	7 050	300 000	720 000
	395	340	340	1.5	2.5	2 950	7 050	300 000	720 000
	410	268	268	1.5	6.4	2 330	4 600	237 000	470 000
	412	340	340	3	3	3 300	7 400	335 000	755 000
290	400	346	346	3	4	3 250	8 400	330 000	855 000
304.648	438.048	280.990	279.400	3.3	3.3	3 100	6 750	315 000	690 000
11.9940	17.2460	11.6260	11.0000						
	438.048	281.740	279.400	3.3	3.3	2 630	5 600	268 000	570 000
	17.2460	11.0921	11.0000						
304.8	419.100	269.875	269.875	1.5	6.4	2 850	6 550	291 000	665 000
12.0000	16.5000	10.6250	10.6250						
304.902	412.648	266.700	266.700	1.5	3.3	2 760	6 500	281 000	665 000
12.0040	16.2460	10.5000	10.5000						

Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

Where $Y_0 \fallingdotseq Y_3$

The values of e, Y_2, and Y_3 are given in the table below.

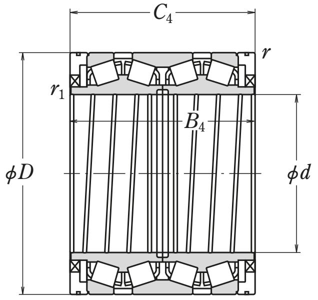
Bearing Designations Super-TF Series	Bearing Designations Water-TF Series	Figure(1)	Constant e	Axial Load Factors Y_2	Axial Load Factors Y_3	Mass (kg) approx.
∗**STF254KVS3552Eg**	∗**WTF254KVS3552Eg**	3	0.40	2.5	1.7	86
STF260KVS3601Eg	**WTF260KVS3601Eg**	3	0.40	2.5	1.7	110
STF260KVS3651Eg	**WTF260KVS3651Eg**	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 (∗).

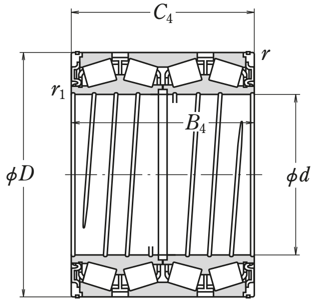
Note (1) Refer to Pages D130 and D131.

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 (kN)		{kgf}	
d	D	B_4	C_4	r_1 min.	r min.	C_r	C_{0r}	C_r	C_{0r}
310	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
317.500 **12.5000**	422.275 16.6250	269.875 10.6250	269.875 10.6250	1.5	3.3	2 740	6 750	279 000	690 000
	447.675 17.6250	367.000 14.4488	367.000 14.4488	2.5	3.0	3 450	8 100	350 000	825 000
343.052 **13.5060**	457.098 17.9960	254.000 10.0000	254.000 10.0000	1.5	3.3	2 430	6 700	289 000	685 000
	457.098 17.9960	299.000 11.7717	299.000 11.7717	1.5	3.3	2 830	6 950	289 000	705 000
355.600 **14.0000**	457.200 18.0000	252.412 9.9375	252.412 9.9375	1.5	3.3	2 650	6 750	270 000	685 000
395	545	360	360	2.5	5	3 600	9 050	365 000	920 000
406.400 **16.0000**	546.100 21.5000	288.925 11.3750	288.925 11.3750	1.5	6.4	3 950	9 450	400 000	965 000
	546.100 21.5000	346.000 13.6221	346.000 13.6221	0.5	6.4	2 560	5 800	261 000	590 000
420	590	395	375	2.5	5	3 550	8 200	365 000	835 000
440	590	510	510	4	4	5 450	14 300	555 000	1 460 000
	620	454	454	4	6	6 500	15 700	665 000	1 600 000
450	595	368	368	4	5	5 550	15 000	565 000	1 520 000
457.200 **18.0000**	596.900 23.5000	276.225 10.8750	279.400 11.0000	1.5	3.3	4 000	9 850	405 000	1 010 000
460	590	470	470	2.5	5	4 900	14 100	500 000	1 440 000
480	615	435	435	3	5	4 650	12 800	470 000	1 310 000
	678	574	574	3	5	8 400	21 500	860 000	2 190 000
482.600 **19.0000**	615.950 24.2500	330.200 13.0000	330.200 13.0000	4.3	6.4	4 900	13 500	500 000	1 370 000

Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

Where $Y_0 \doteqdot Y_3$

The values of e, Y_2, and Y_3 are given in the table below.

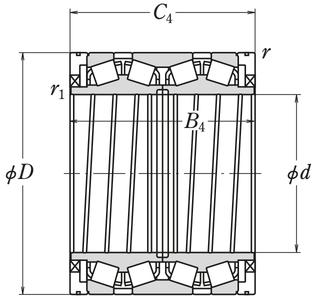
Bearing Designations Super-TF Series	Bearing Designations Water-TF Series	Figure(1)	Constant e	Axial Load Factors Y_2	Axial Load Factors Y_3	Mass (kg) approx.
STF310KVS4301Eg	**WTF310KVS4301Eg**	3	0.46	2.2	1.5	140
STF310KVS4302Eg	**WTF310KVS4302Eg**	3	0.46	2.2	1.5	155
∗STF317KVS4251Eg	**∗WTF317KVS4251Eg**	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 (∗).

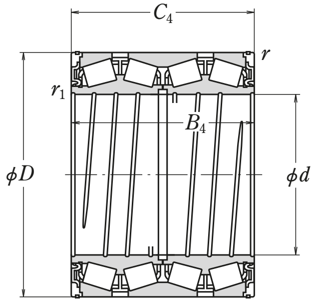
Note (1) Refer to Pages D130 and D131.

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 (kN)		Basic Load Ratings {kgf}	
d	D	B_4	C_4	r_1 min.	r min.	C_r	C_{0r}	C_r	C_{0r}
	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
488.950 **19.2500**	622.300 24.5000	365.125 14.3750	365.125 14.3750	3.8	6.4	3 450	8 950	350 000	915 000
490	625	435	435	3	5	4 550	12 500	465 000	1 280 000
509.948 **20.0767**	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
520	735	535	535	5	6	8 800	22 700	900 000	2 310 000
558.800 **22.0000**	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
595.312 **23.4375**	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
609.600 **24.0000**	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
711.200 **28.0000**	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
785	1 015	700	700	4	6	13 500	41 000	1 380 000	4 150 000
825.5	1 160	565	565	5	6	13 900	33 500	1 420 000	3 400 000

Dynamic Equivalent Load

$P=XF_r+YF_a$

$F_a/F_r \leqq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0=F_r+Y_0F_a$

Where $Y_0 \fallingdotseq Y_3$

The values of e, Y_2, and Y_3 are given in the table below.

Bearing Designations Super-TF Series	Bearing Designations Water-TF Series	Figure([1])	Constant e	Axial Load Factors Y_2	Axial Load Factors Y_3	Mass (kg) approx.
∗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 ([1]) Refer to Pages D130 and D131.

Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings for Roll Necks

Benefits

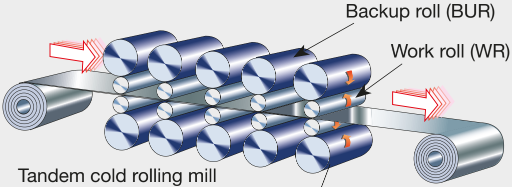
❶ Higher reliability and longer operating life prevent unexpected downtime
❷ Lower maintenance costs
❸ Smoother rolling improves plate making precision

1. Operating conditions

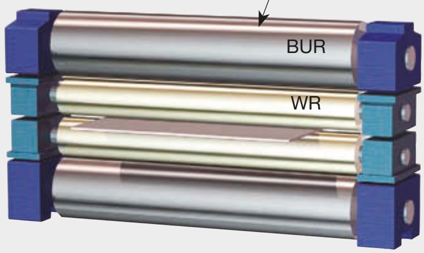
- Vibration and shocks
- Heavy loads
- High temperature
- High and low speeds

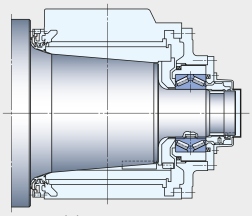
Major target mills:

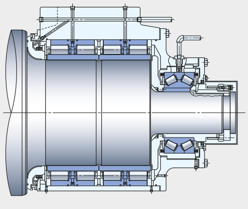
- Plate mills
- Hot strip mills
- Cold rolling mills
- Skin pass mills
- Temper rolling mills
- Bar mills
- Rod mills
- Section mills



Tandem cold rolling mill




(1) Plain bearing


(2) Rolling bearing

2. Problems

Typical problems for backup roll bearings

(1) Plain bearings

Oil film change → Problems with plate-making precision

(2) Rolling bearings (four-row cylindrical roller bearings)

Harsher lubrication conditions and rolling load

Insufficient EHL oil film formation

Flaking

Super-heavy loads

Cracks on rollers

Seizure

High bearing usage cost

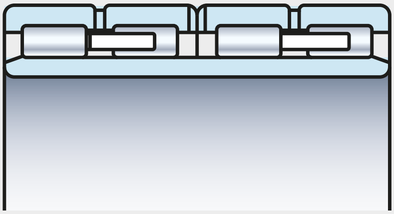
Unexpected production downtime

(*1)

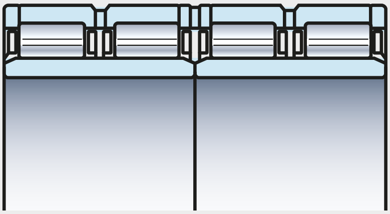
3. Countermeasures

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)



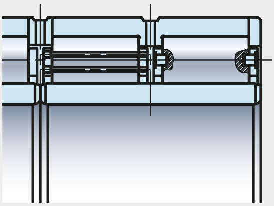
RV (Pin cage)

	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.

Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Figures of Typical Four-Row Cylindrical Roller Bearings

Cylindrical Bores

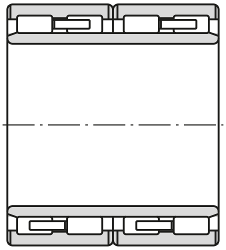


Figure 1

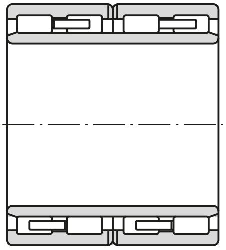


Figure 2

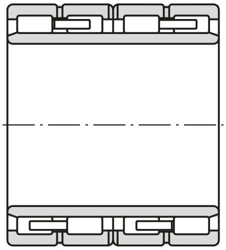


Figure 3

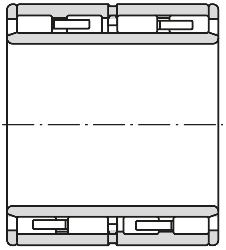


Figure 4

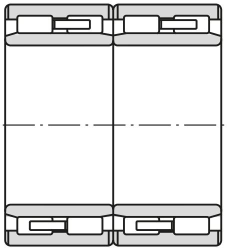


Figure 5

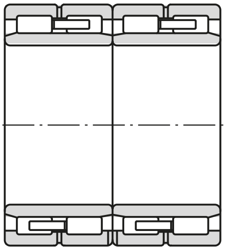


Figure 6

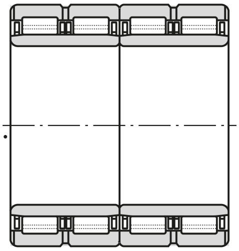


Figure 7

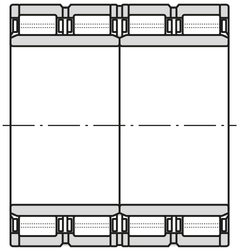


Figure 8

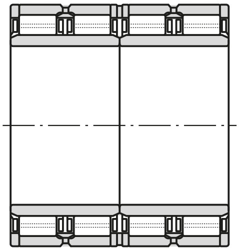


Figure 9

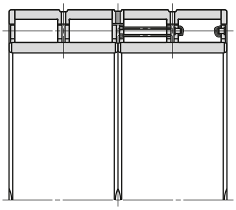


Figure 8SP

Tapered Bores

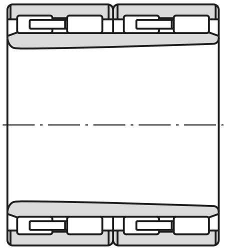


Figure 10

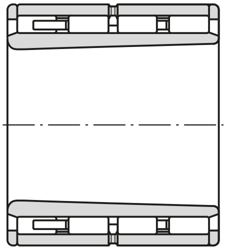


Figure 11

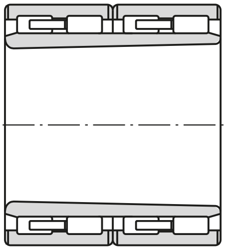


Figure 12

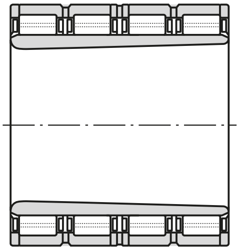
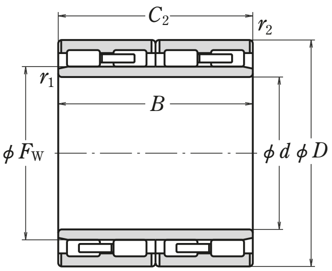


Figure 13

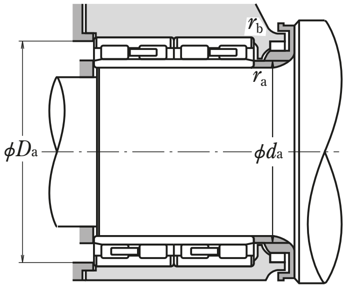
■Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 100 – 160 mm



Boundary Dimensions (mm)							Basic Load Ratings (kN)	
d	D	B	C_2	F_w	r_1 min.	r_2 min.	C_r	C_{0r}
100	140	104	104	111	1.5	1.1	400	820
110	160	120	120	124	1.1	1.1	560	1 080
	170	120	120	127	2	2	615	1 100
120	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
127	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
130	200	125	125	149	2	2	700	1 190
	200	104	104	149	2	2	570	950
140	210	116	116	160	2	2	640	1 130
145	210	155	155	166	1.5	1.5	925	1 920
	225	156	156	169	2	2	975	1 820
150	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
159.99	220	180	180	176	2	2	1 050	2 410
160	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

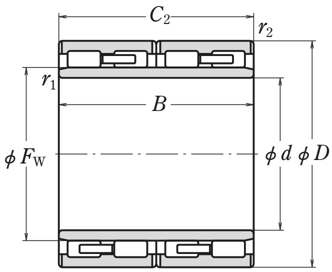
Note ([1]) Refer to Pages D142 and D143.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm)				Mass (kg)
		d_a	D_a	r_a max.	r_b max.	approx.
HTF100RV1401g	3	110	130	1.5	1	4.8
HTF110RV1601g	3	119	150	1	1	7.9
HTF110RV1701g	1	122	157	2	2	9.9
HTF120RV1601g	1	130	155	1	1	5.4
HTF120RV1801g	1	132	167	2	2	8.9
HTF120RV2101g	1	134	199	2	2	26.6
HTF127RV1722g	1	138	163	1.5	1.5	10.5
HTF127RV2001g	1	139	190	2	2	15.4
STF130RV2001g	1	142	187	2	2	14
STF130RV2003g	1	142	187	2	2	11.7
STF140RV2101g	1	152	196	2	2	13.9
STF145RV2101g	1	157	197	1.5	1.5	17.8
STF145RV2201g	1	158	211	2	2	23
STF150RV2201g	1	163	206	2	2	20
STF150RV2203g	1	162	209	1.5	2	20.8
STF150RV2204g	1	165	209	2	2	18.6
STF150RV2301g	1	165	214	2	2	19.6
STF150RV2302g	1	163	216	2	2	23.6
STF159RV2201g	2	173	206	2	2	20.6
STF160RV2301g	1	173	216	2	2	16.4
STF160RV2307g	1	173	216	2	2	23.0
STF160RV2302g	1	173	216	2	2	22.7
STF160RV2303g	2	173	216	2	2	24.2
STF160RV2401g	1	175	224	2	2	18.8
STF160RV2402g	1	173	226	2	2	26.6
STF160RV2403g	1	175	224	2	2	22.3

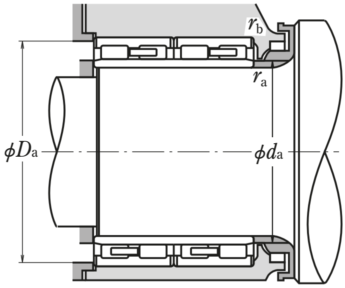
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 165.1 – 200 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}
165.1	225.45	168.3	168.3	180.975	1.5	2.5	1 010	2 220
170	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
	260	150	150	195	2.1	2.1	1 030	1 840
180	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
	280	180	180	205.085	2.1	2.1	1 410	2 490
190	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
	280	200	200	214	2.1	2.1	1 480	2 920
200	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
	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
	310	230	230	229	2.1	2.1	1 840	3 500
	320	216	216	231	3	3	2 120	3 900

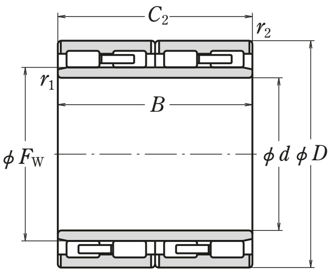
Notes ([1]) Refer to Pages D142 and D143.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Fig-ure(1)	Abutment and Fillet Dimensions (mm)				Mass (kg)
		d_a	D_a	r_a max.	r_b max.	approx.
STF165RV2221g	5	177	209	1.5	2	19.4
STF170RV2301g	1	183	216	2	2	14
STF170RV2402g	1	183	226	2	2	22.8
STF170RV2501g	1	185	234	2	2	27.4
STF170RV2502g	1	185	234	2	2	27.7
STF170RV2503g	1	185	239	2	2	31.5
STF170RV2602g	1	185	244	2	2	28.2
STF180RV2501g	1	193	236	2	2	23.4
STF180RV2601g	1	195	244	2	2	29.2
STF180RV2602g	1	195	248	2	2	33.7
STF180RV2603g	1	195	248	2	2	33.4
STF180RV2802g	3	195	263	2	2	40.9
STF190RV2601g	1	203	245	2	2	26.6
STF190RV2701g	1	206	253	2	2	36
STF190RV2702g	1	206	253	2	2	30.4
STF190RV2703g	1	203	255	2	2	30.6
STF190RV2801g	1	206	263	2	2	41.3
STF200RV2521g	SP	210	240	1	1	22.3
STF200RV2702g	1	216	253	2	2	27.9
STF200RV2703g	SP	216	253	2	2	34.4
STF200RV2801g	1	216	263	2	2	38.3
STF200RV2802g	1	216	263	2	2	38.6
STF200RV2803g	1	216	263	2	2	36.4
STF200RV2804g	1	216	263	2	2	32.3
STF200RV2808g	1	216	263	2	2	37.8
STF200RV2901g	1	216	273	2	2	42.3
STF200RV3102g	1	216	293	2	2	63.7
STF200RV3231g	4	218	300	4	4	69.9

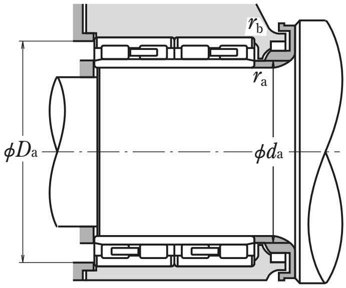
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 210 – 260 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}
210	290	192	192	236	2.1	2.1	1 400	3 350
	300	210	210	234	2	2	1 750	3 600
219.954	310	183	183	244.5	1.5	1	1 480	3 150
220	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
222.25	320.675	241.3	241.3	251	2.1	2.1	1 990	4 350
230	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
240	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
250	340	230	230	276	4	4	2 030	4 750
	350	220	220	278	3	3	1 930	4 200
259.948	368	218	218	290	2.1	1.1	2 010	4 350
260	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

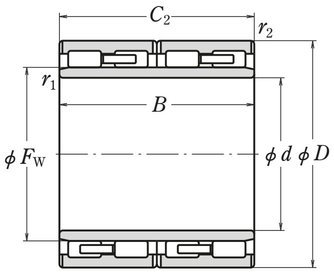
Notes ([1]) Refer to Pages D142 and D143.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
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

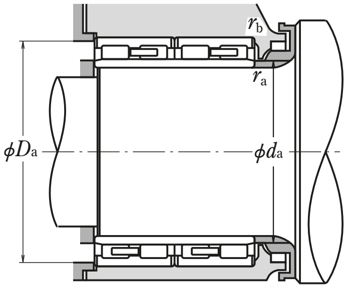
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 270 – 330 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}
270	380	230	230	298	2.1	2.1	2 330	5 050
280	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
290	390	234	234	320	3	3	2 270	5 600
	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
300	400	300	300	328	2	2	2 720	6 900
	420	240	240	332	3	3	2 670	5 750
	420	300	300	332	3	3	3 200	7 200
	420	300	300	332	Spec.	1.5	3 550	8 350
	420	300	300	332	2	2	3 200	7 200
310	420	300	300	338	3	3	3 300	8 050
	430	240	240	344.5	3	3	2 610	5 950
320	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
	460	240	240	364	3	3	2 820	6 100
	480	350	350	364	4	1.5	4 850	10 500
330	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

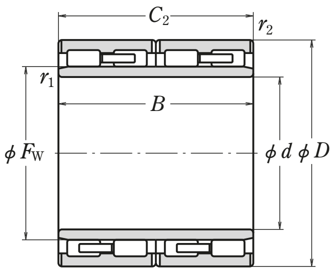
Notes ([1]) Refer to Pages D142 and D143.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure[1]	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF270RV3801g	1	287	361	2	2	83
STF280RV3901g	1	299	369	2.5	2.5	80.9
STF280RV3902g	1	299	369	2.5	2.5	88.5
STF280RV3903g	1	299	375	2.5	1	100
STF280RV3907Ag	1	299	369	2.5	2.5	81.6
STF280RV3911Ag	SP	298	375	2	1	99.5
STF280RV3921Ag	6	298	369	2	2.5	99.2
STF280RV4021g	5	299	379	2.5	2.5	117
STF290RV3901g	1	310	369	2.5	2.5	79.7
STF290RV4101g	1	310	389	2.5	2.5	99
STF290RV4102g	1	310	389	2.5	2.5	97.1
STF290RV4201g	1	310	398	2.5	2.5	138
STF300RV4021g	5	316	383	2	2	103
STF300RV4201g	1	320	398	2.5	2.5	101
STF300RV4204Ag	3	320	398	2.5	2.5	127
STF300RV4216g	SP	319	403	2	1.5	132
STF300RV4221g	5	316	402	2	2	128
STF310RV4201g	1	330	398	2.5	2.5	119
STF310RV4301g	1	330	408	2.5	2.5	107
STF320RV4401g	1	343	415	3	3	104
STF320RV4501g	1	340	428	2.5	2.5	120
STF320RV4502g	1	340	428	2.5	2.5	117
STF320RV4601g	3	340	438	2.5	2.5	184
STF320RV4621g	5	340	438	2.5	2.5	131
STF320RV4811g	8	343	462	3	1.5	232
STF330RV4301g	1	350	408	2.5	2.5	86.3
STF330RV4401g	3	350	418	2.5	2.5	83.8
STF330RV4601g	1	353	435	3	3	174
STF330RV4611g	SP	353	439	3	2	172

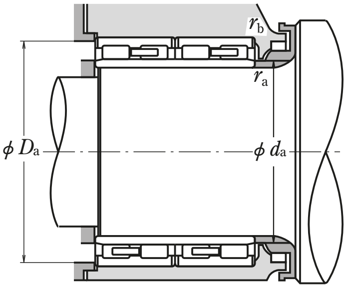
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 340 – 400 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}
340	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
345	480	350	350	376	3	3	4 400	10 300
350	500	380	380	389	5	5	4 850	11 100
360	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
370	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
380	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
390	510	290	290	424	3	3	3 400	9 000
	550	400	400	434	5	5	5 150	12 400
400	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

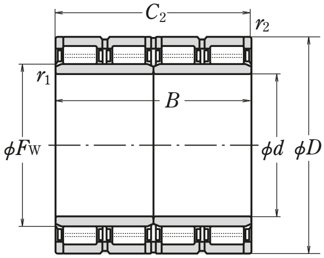
Notes (1) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure(1)	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF340RV4501g	1	361	428	2.5	2.5	108
STF340RV4502g	3	361	428	2.5	2.5	108
STF340RV4801g	1	364	454	3	3	198
STF340RV4812Eg	1	355	462	2.9	1.5	208
STF340RV4901g	1	368	460	4	4	186
STF345RV4821g	6	366	457	2.5	2.5	190
STF350RV5021g	6	378	470	4	4	237
STF360RV4801g	1	381	457	2.5	2.5	146
STF360RV5022g	5	381	477	2.5	2.5	146
STF360RV5101g	1	384	484	3	3	234
STF370RV4801g	1	391	457	2.5	2.5	116
STF370RV5211g	SP	394	500	3	2	263
STF370RV5212g	SP	393	501	3	1.5	252
STF370RV5401g	1	394	513	3	3	311
STF380RV5001g	1	401	477	2.5	2.5	153
STF380RV5201g	1	404	493	3	3	181
STF380RV5202g	1	404	493	3	3	174
STF380RV5431g	4	408	509	4	4	259
STF380RV5401g	3	408	509	4	4	280
STF380RV5411g	8	408	520	4	2	305
STF380RV5412g	SP	408	520	4	2	294
STF390RV5101g	1	412	487	2.5	2.5	156
STF390RV5521g	6	419	519	4	4	303
STF400RV5202g	3	425	493	3	3	136
STF400RV5501g	1	425	523	3	3	212
STF400RV5612g	8	429	529	4	4	308
STF400RV5613g	8M	429	539	4	2	315
STF400RV5621g	6	429	529	4	4	304
STF400RV5611g	8	429	539	4	2	315

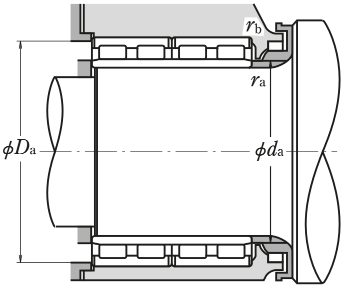
■Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 406.4 – 500 mm



Boundary Dimensions (mm)							Basic Load Ratings (kN)	
d	D	B	C_2	F_w	r_1 min.	r_2 min.	C_r	C_{0r}
406.4	609.6	304.8	304.8	460	5	5	4 650	9 150
410	600	440	440	460	5	5	7 350	16 600
420	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
430	591	420	420	476	4	4	6 350	16 100
	591	420	420	476	4	4	5 200	13 400
440	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
450	630	450	450	500	4	4	6 950	17 500
460	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
470	660	470	470	519	4	4	8 450	20 800
480	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
500	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

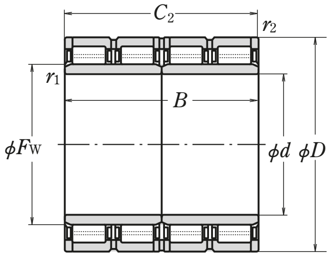
Notes (1) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF406RV6001g	1	435	577	4	4	307
STF410RV6011g	8	439	568	4	4	438
STF420RV5601g	1	445	533	3	3	190
STF420RV5602g	6	445	533	3	3	270
STF420RV6011g	8	449	579	4	4	419
STF420RV6012g	8	449	568	4	4	402
STF430RV5911g	8	455	563	3	3	347
STF430RV5921g	5	455	563	3	3	347
STF440RV6213g	8	470	588	4	4	430
STF440RV6215g	8	466	594	3	2.5	433
STF440RV6221g	5	466	591	3	3	430
STF450RV6321g	5	476	601	3	3	440
STF460RV6201g	1	486	591	3	3	347
STF460RV6211g	8	486	591	3	3	358
STF460RV6212g	8M	486	591	3	3	412
STF460RV6511g	8	496	624	5	2.5	514
STF460RV6513g	8	486	624	3	2.5	501
STF460RV6721g	7	496	631	5	5	596
STF470RV6611g	8	496	631	3	3	505
STF480RV6814g	8	508	653	3.5	2.5	490
STF480RV6815g	8	506	653	3	2.5	586
STF480RV6801g	7	510	646	4	4	610
STF480RV6811g	8	510	646	4	4	610
STF480RV7031g	9	517	660	5	5	538
STF500RV6713g	8	529	640	3.5	3	446
STF500RV6712Eg	SP	531	637	4	4	464
STF500RV6812g	8	531	646	4	4	451

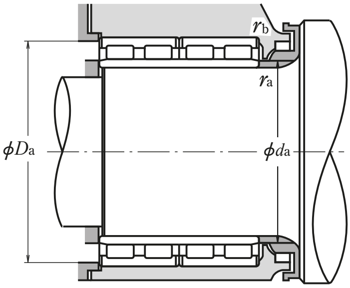
■Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 500 – 610 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}
500	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
510	670	320	320	554	5	5	4 950	12 700
	680	500	500	560	5	5	8 950	25 700
520	735	535	535	574.5	5	5	10 400	26 300
	735	535	535	574.5	5	5	10 800	27 500
530	780	570	570	601	6	6	11 800	29 200
	780	570	570	595	6	6	11 800	29 200
536.176	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
550	740	510	510	602	5	5	9 150	25 700
	740	510	510	600	Spec.	2	10 100	27 600
560	800	600	600	620	6	6	12 400	31 500
	820	600	600	625	Spec.	6	14 100	34 000
570	815	594	594	628	6	6	13 200	32 000
	815	594	594	628	6	6	13 700	33 500
571.1	812.97	594	594	636	6	5	13 200	34 500
600	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
610	850	570	570	670	6	5	12 600	33 000
	870	660	660	680	6	6	15 400	41 500

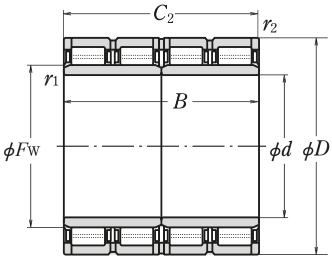
Notes ([1]) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF500RV6913g	8M	531	656	4	4	480
STF500RV6921g	7	531	656	4	4	580
STF500RV7021g	7	531	666	4	4	622
STF500RV7111g	8	531	676	4	4	632
STF500RV7211g	8	537	680	5	5	782
STF500RV7214g	8M	537	680	5	5	722
STF510RV6701g	1	541	637	4	4	298
STF510RV6811g	8	541	646	4	4	514
STF520RV7331g	9	551	700	4	4	750
STF520RV7311g	8M	551	700	4	4	733
STF530RV7811g	8M	568	738	5	5	960
STF530RV7813g	8	568	738	5	5	960
STF536RV7631g	9	568	727	4	4	849
STF536RV7612Eg	SP	568	731	5.8	3	849
STF550RV7411Ag	8M	582	705	4	4	648
STF550RV7413g	8	580	716	3.5	2	632
STF560RV8011g	8	598	758	5	5	1 020
STF560RV8211g	8	595	778	4.5	5	1 100
STF570RV8113g	8	608	773	5	5	1 010
STF570RV8111g	8	608	773	5	5	960
STF571RV8111g	8	610	777	5	4	947
STF600RV8212Eg	SP	629	790	5.5	2.5	931
STF600RV8511g	8M	633	813	4	4	1 110
STF600RV8711g	8M	645	836	6	3	1 320
STF600RV8713g	8	645	836	6	3	1 320
STF600RV8714g	8M	633	833	4	4	1 310
STF610RV8511g	8	649	813	5	4	1 040
STF610RV8711g	8	649	827	5	5	1 330

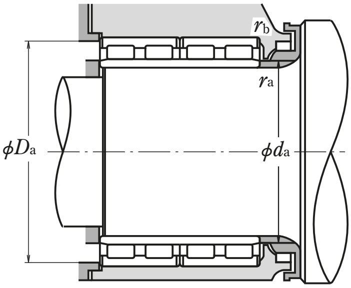
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 628 – 750 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}
628	922	600	600	702	6	5	15 600	37 000
634.5	901.87	674	674	705	7.5	4	16 200	43 500
	901.87	674	674	705	5	4	17 000	44 500
640	870	610	610	697	6	3	14 200	40 000
	880	600	600	700	6	6	14 200	38 000
650	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
660	930	660	660	728	6	6	17 000	44 000
680	980	640	640	760	Spec.	4	17 500	43 500
690	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
700	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
710	1000	715	715	787.5	7.5	7.5	18 700	50 500
725	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
730	960	620	620	790	6	3	15 000	44 500
	1030	750	750	809	6	6	20 700	56 500
750	1000	670	670	813	6	6	16 800	49 500
	1000	670	670	813	Spec.	3	17 500	50 000

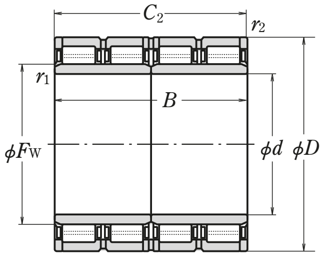
Notes ([1]) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF628RV9211g	8	668	883	5	4	1 390
STF634RV9031g	9	680	868	6	3	1 440
STF634RV9011g	8M	668	868	4	3	1 410
STF640RV8711g	8M	680	839	5	2.5	1 100
STF640RV8812g	8	680	836	5	5	1 110
STF650RV9011g	8	688	862	4.5	4	1 280
STF650RV9212g	8	696	870	6	6	1 470
STF650RV9211g	8	696	870	6	6	1 520
STF660RV9311g	8	700	885	5	5	1 440
STF680RV9811g	8	727	944	6	3	1 630
STF690RV9611g	8	737	909	6	6	1 520
STF690RV9831g	9	737	929	6	6	1 790
STF690RV9832g	9M	737	929	6	6	1 880
STF690RV9812g	8	737	929	6	6	1 880
STF690RV9813g	8M	737	929	6	6	1 860
STF700RV9311g	8	741	885	5	5	1 200
STF700RV9313g	8	741	885	5	5	1 180
STF700RV9813g	8	741	934	5	5	1 680
STF700RV9821g	7	741	934	5	5	1 720
STF710RV1011g	8	757	948	6	6	1 840
STF725RV1011g	8	767	954	5	5	1 670
STF725RV1012g	8	763	964	4.5	3	1 700
STF725RV1021g	7	767	954	5	5	1 670
STF730RV9611g	8	772	928	5	2.5	1 250
STF730RV1011g	8	772	983	5	5	2 050
STF750RV1011g	8	792	954	5	5	1 520
STF750RV1013g	8	798	967	6	2.5	1 490

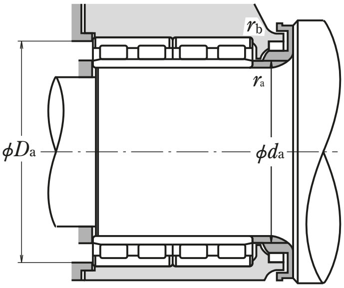
Bearings for Rolling Mills

Four-Row Cylindrical Roller Bearings
Bore Diameter 755 – 850 mm



Boundary Dimensions (mm)							Basic Load Ratings (kN)	
d	D	B	C_2	F_w	r_1 min.	r_2 min.	C_r	C_{0r}
755	1 070	750	750	837	7.5	7.5	21 700	58 500
760	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
761.425	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
770	1 075	770	770	847	7.5	7.5	23 100	63 500
780	1 070	780	780	853	6	6	22 800	64 500
800	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
820	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
840	1 160	840	840	920	2	7.5	24 900	71 000
850	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

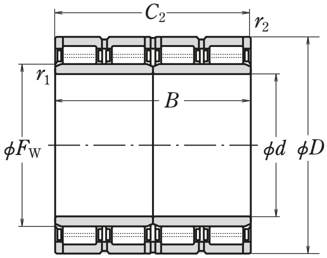
Notes ([1]) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure[1]	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF755RV1011g	8	803	1 017	6	6	2 230
STF760RV1031g	9	808	978	6	6	1 880
STF760RV1012g	8M	808	978	6	6	1 850
STF760RV1032Ag	9M	802	1 032	5	5	2 430
STF761RV1012g	8	807	1 026	5.5	6	2 390
STF761RV1032g	9	810	1 026	6	6	2 390
STF770RV1011g	8M	819	1 022	6	6	2 220
STF780RV1013g	8	823	1 023	5	5	2 140
STF800RV1013g	8	843	1 045	5	2.5	1 920
STF800RV1011g	8	843	1 045	5	2.5	1 910
STF800RV1012g	8	843	1 032	5	5	2 050
STF800RV1032g	9	843	1 032	5	5	2 050
STF820RV1132g	SP	863	1 065	5	2.5	2 000
STF820RV1119g	8M	863	1 052	5	5	1 990
STF820RV11112g	8	867	1 081	5.5	5	2 000
STF820RV1117g	8M	870	1 076	6	6	2 510
STF820RV1134g	SP	870	1 076	6	6	2 530
STF820RV1111Ag	8	870	1 105	6	6	2 900
STF840RV1111g	8M	866	1 105	2	6	2 790
STF850RV1114g	8	900	1 111	6	3	2 610
STF850RV1115g	8	900	1 093	6	6.5	2 600
STF850RV1133g	9	900	1 125	6	6	2 260
STF850RV1111g	8M	900	1 125	6	6	2 850
STF850RV1112Ag	8M	900	1 125	6	6	2 880

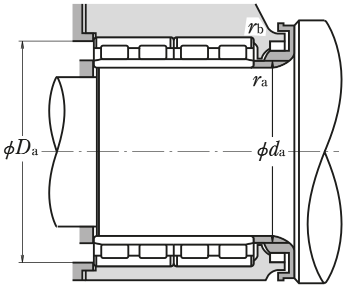
Bearings for Rolling Mills

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}
860	1 130	670	670	934	6	6	18 400	56 500
	1 160	735	710	940	7.5	4	20 400	60 000
865	1 180	750	750	945.3	Spec.	7.5	23 800	67 000
870	1 145	705	685	940	9.5	6	20 500	61 000
880	1 230	850	850	970	7.5	7.5	29 100	81 000
900	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
920	1 280	865	865	1 015	7.5	7.5	28 000	80 000
950	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
1 120	1 580	1 150	1 150	1 255	9.5	9.5	43 500	134 500
1 270	1 602	850	850	1 350	7.5	7.5	32 000	103 000
1 300	1 655	890	880	1 391	7.5	7.5	34 000	110 500
1 348.95	1 745	1 010	1 000	1 466	11.4	7.5	42 500	134 000

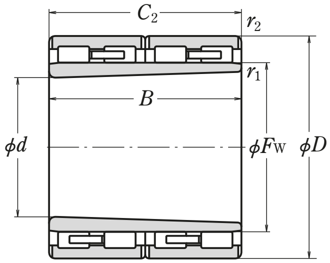
Notes ([1]) Refer to Pages D142 and D143.
"M" indicates a bearing designed for oil mist lubrication.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure[1]	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	r_b max.	Mass (kg) approx.
STF860RV1132g	9	904	1 081	5	5	1 780
STF860RV1133g	9	910	1 121	6	3	2 200
STF865RV1111g	8	915	1 125	6	6	2 480
STF870RV1111g	8	929	1 096	8	5	1 970
STF880RV1211g	8	931	1 174	6	6	3 240
STF900RV1216g	8	951	1 170	6	5	2 790
STF900RV1212g	8	951	1 179	6	3	2 950
STF900RV1211g	8M	951	1 174	6	6	3 200
STF900RV1213g	8	951	1 223	6	6	3 990
STF900RV1217g	8	951	1 223	6	6	4 010
STF920RV1211Ag	8M	972	1 223	6	6	3 510
STF950RV1314g	8	1 008	1 266	7.5	7.5	4 240
STF950RV1311g	8	1 010	1 313	8	4	4 910
STF1120RV1511g	8	1 184	1 509	8	8	7 400
STF1270RV1612g	SP	1 329	1 538	6	6	4 130
STF1300RV1612g	SP	1 359	1 590	6	6	4 710
STF1348RV1711g	SP	1 423	1 678	9.5	6	6 240

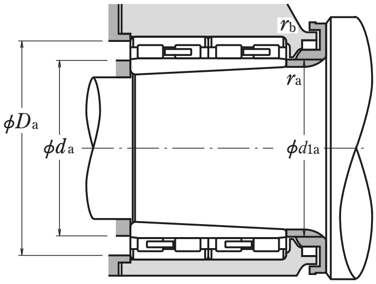
■Bearings for Rolling Mills

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}
110.417	180	115	115	136	1	1	490	840
151.5	230	168	168	180	1	1	1 040	2 170
179.75	260	175	168	212	1.1	2	1 140	2 600
180	260	175	168	212	1.1	2	1 140	2 600
181.5	260	168	168	209	1	2	1 140	2 600
235.367	360	268	268	278	1.5	1.5	2 770	6 000
266.25	400	285	285	312	2	2	3 200	7 500
356.667	550	400	400	434	5	5	5 450	13 300
	550	400	400	431.9	3	2.5	5 450	13 300
412.335	650	488	488	494.5	3	4	8 900	21 100
485	740	540	540	580	5	5	10 100	26 800
633.333	960	680	680	745.8	7.5	7.5	18 100	47 000

Notes ([1]) Refer to Pages D142 and D143.
"SP" indicates a special design.
Please consult with NSK for detailed specifications.



Bearing Designation	Figure([1])	Abutment and Fillet Dimensions (mm)					Mass (kg)
		d_a	d_{1a}	D_a	r_a max.	r_b max.	approx.
STF120RVK1801g	10	118	128	171	1	1	10
STF165RVK2331g	11	160	174	220	1	1	23.5
STF193RVK2602g	10	190	205	245	1	2	25.1
STF194RVK2602g	10	191	206	245	1	2	25
STF195RVK2602g	10	191	205	245	1	2	24.2
STF257RVK3631g	11	249	272	344	1.5	1.5	92.9
STF290RVK4031g	11	281	305	383	2	2	118
STF390RVK5531g	12	385	419	519	4	4	328
STF390RVK5532g	12	378	412	527	2.5	2	328
STF453RVK6521g	SP	434	476	621	2.5	3	603
STF530RVK7431g	13	516	561	705	4	4	823
STF690RVK9632g	13	679	737	909	6	6	1 720

Backing Bearings for Multi-Roll Rolling Cluster Mills

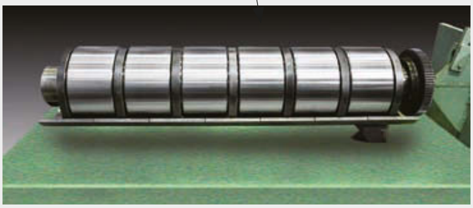
Benefits

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

Impact load
Heavy load
Low viscosity oil lubrication

E.g. Sendzimir Mill



Backing bearings of a roll assemble unit

Backing bearings

2. Problems

Typical problems with backing bearings

Harsh lubrication conditions

Harsher load

Insuffcient EHL Oil film formation

Raceway fatigue

Fatigue of outer ring outside surface

Regrinding (Outer ring)

Flaking

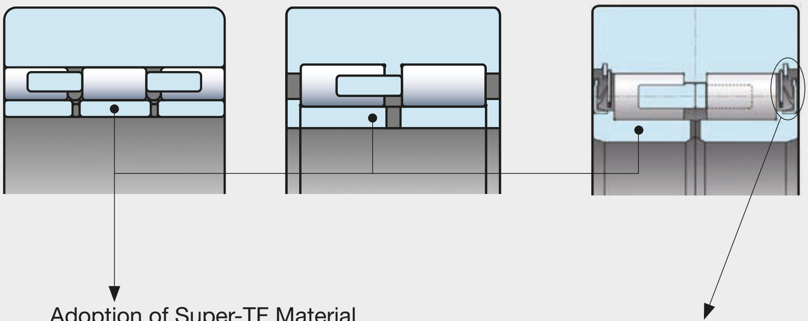
High bearing usage cost

(*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

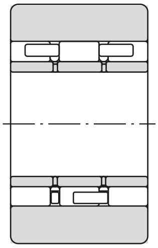
Distribution of carbides and carbonitrides in a Super-TF bearing.
(x 4000 magnification).

Designations	Pages D170 to D173
Super-TF Material	Pages A258 to A261

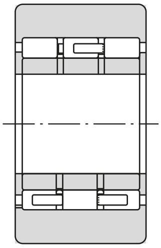
Note (*1): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

Backing Bearings for Multi-Roll Rolling Cluster Mills

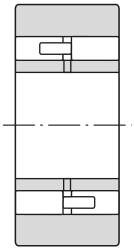
Typical Backing Bearings for Multi-Roll Rolling Mills



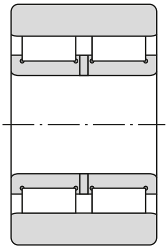
3PL
Figure 1



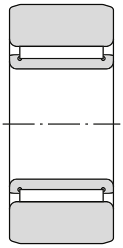
3U
Figure 2



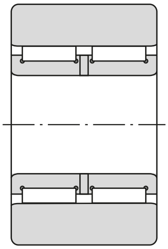
2PL
Figure 3



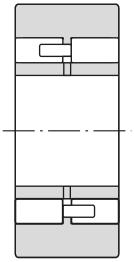
2L
Figure 4



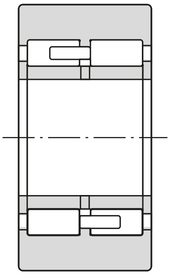
S
Figure 5



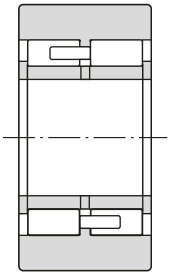
2S
Figure 6



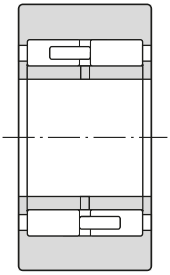
2U
Figure 7



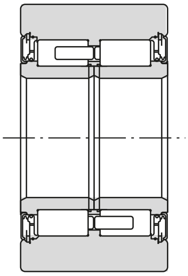
2U
Figure 8



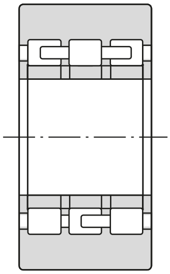
2U
Figure 9



2U
Figure 10

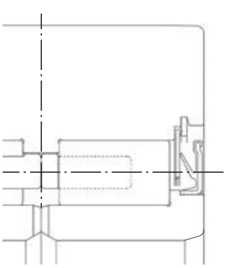


2U (Sealed Types)
Figure 11

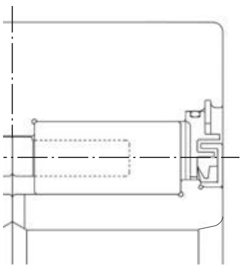


3U
Figure 12

Sealed 2U bearing structure examples



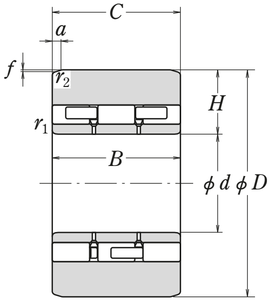
2U180-7



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
d	D	B	C	r_1 min.	r_2	C_r	C_{0r}(1)		
31.75	76.2	46.23	45.85	1	0.8	94.5	174	91.8	**2S31Z-5**
50	120	80	80	1.5	1.5	257	385	147	**2U50-4**
									***2U50-4g3**
	120	85	85	1	1.5	305	435	113	**2U50-6**
									***2U50-6g3**
55	120	26	26	1.6	1.6	74.5	142	90.2	**S55-2**
									***S55-2g5**
	120	52.2	52	1.6	1.6	159	375	185	**S55-1**
									S55-1g5
	120	52.2	52	1	1	186	298	115	**2L55-1**
60	160	95	95	1.1	1.5	400	590	290	**2U60-4**
62	155	90	90	1.5	1	355	530	247	**2U62-1**
	155	110	110	1.5	1	405	620	297	**3U62-1**
70	160	90	90	1.1	1	410	745	303	**3PL70-1**
90	220	95	95	1.1	2	590	880	347	**2U90-18**
									***STF2U90-18g4**
	220.02	96	94	1.5	1.5	520	730	333	**2U90-13**
	220	120	119	1	3	685	1 020	411	**2U90-11**
	220	122	119	1	3	685	1 020	410	**2U90-17**
	220	120	120	1	2	675	1 260	494	**3U90-1**
	220	130	130	1	2	680	1 090	499	**3U90-4**
	230	100	100	2.5	2	645	990	322	**2U90-9**
100	225	80	80	2	1.5	535	925	366	**2PL100-3**
	225	120	119	2	3	550	1 000	586	**2U100-14**
									***2U100-14g3**
	225	120	120	2	2	715	1 350	542	**3PL100-1A**
100	260	130	130	2	2	950	1 580	617	**2U100-15**
110	280	165	165	2.5	2	1 120	1 880	818	**3U110-4**
115	260	140	140	1.1	2	940	1 660	613	**3U115-3**
120	280	165	165	2.5	2	1 190	2 060	802	**2U120-15**
	300	160	160	2	2	1 180	1 960	847	**3U120-4**
	350	165	165	2.5	2	1 370	2 220	1 140	**2U120-14**

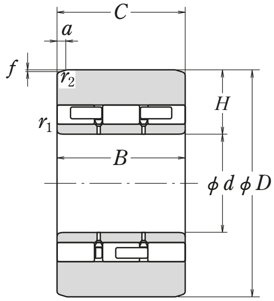
Notes (1) These basic load ratings are not the limiting load. C_{0r} is for reference.
(2) Refer to Pages D168 and D169.
"SP" indicates a special design.

Figure(2)	Outer Ring Edge Bevel (mm) *a*	*f*	Radial Thickness When Delivered (mm) *H*		Mass (kg) 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)	Bearing Designation
d	D	B	C	r_1 min.	r_2	C_r	C_{0r}(1)	approx.	
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**
	300	172.64	172.64	2	4	1 580	2 930	862	**3PL130-1F**
									∗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 (1) These basic load ratings are not the limiting load. C_{0r} is for reference.
(2) Refer to Pages D168 and D169.
"SP" indicates a special design.

Figure([2])	Outer Ring Edge Bevel (mm) *a*	*f*	Radial Thickness When Delivered (mm) *H*		Mass (kg) approx.
8SP	28.2	0.082	85	-0.015 to 0	52.3
9SP	25	0.145	85.01	-0.015 to 0	60.9
1	9	0.209	84.95	0 to +0.010	66.6
1	10	0.131	84.95	0 to +0.010	71.8
1SP	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

Appendix Table 1 SI (International Units) System Conversion Table

Comparison of SI, CGS, and Engineering Units

Unit System \ Units	Length	Mass	Time	Temp.	Acceleration	Force	Stress	Pressure	Energy	Power
SI	m	kg	s	K, °C	m/s^2	N	Pa	Pa	J	W
CGS System	cm	g	s	°C	Gal	dyn	dyn/cm^2	dyn/cm^2	erg	erg/s
Engineering Unit System	m	$kgf \cdot s^2/m$	s	°C	m/s^2	kgf	kgf/m^2	kgf/m^2	kgf · m	kgf · m/s

Conversion Factors From SI Units

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	10^6 10^{10}
Area	Square meter	m^2	Are Hectare	a ha	10^{-2} 10^{-4}
Volume	Cubic meter	m^3	Liter Deciliter	l, L dl, dL	10^3 10^4
Time	Second	s	Minute Hour Day	min h d	1/60 1/3 600 1/86 400
Frequency	Hertz	Hz	Cycle	s^{-1}	1
Speed of Rotation	Revolution per second	s^{-1}	Revolution per miunte	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^2	Gal g	Gal G	10^2 1/9.806 65
Mass	Kilogram	kg	Ton	t	10^{-3}
Force	Newton	N	Kilogram-force Ton-force Dyne	kgf tf dyn	1/9.806 65 $1/(9.806\ 65 \times 10^3)$ 10^5
Torque or Moment	Newton · meter	N · m	Kilogram-force meter	kgf · m	1/9.806 65
Stress	Pascal	Pa (N/m^2)	Kilogram-force per square centimeter Kilogram-force per square millimeter	kgf/cm^2 kgf/mm^2	$1/(9.806\ 65 \times 10^4)$ $1/(9.806\ 65 \times 10^6)$

Prefixes Used in SI

Multiples	Prefix	Symbols	Multiples	Prefix	Symbols
10^{18}	Exa	E	10^{-1}	Deci	d
10^{15}	Peta	P	10^{-2}	Centi	c
10^{12}	Tera	T	10^{-3}	Milli	m
10^{9}	Giga	G	10^{-6}	Micro	μ
10^{6}	Mega	M	10^{-9}	Nano	n
10^{3}	Kilo	k	10^{-12}	Pico	p
10^{2}	Hecto	h	10^{-15}	Femto	f
10	Deca	da	10^{-18}	Ato	a

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^2)	Kilogram-force per square meter Water Column Mercury Column Torr Bar Atmosphere	kgf/m^2 mH_2O mmHg Torr bar atm	1/9.806 65 $1/(9.806\ 65\times10^3)$ $760/(1.013\ 25\times10^5)$ $760/(1.013\ 25\times10^5)$ 10^{-5} $1/(1.013\ 25\times10^5)$
Energy	Joule (Newton · meter)	J (N · m)	Erg Calorie (International) Kilogram-force meter Kilowatt hour French horsepower hour	erg cal_{IT} kgf · m kW · h PS · h	10^7 1/4.186 8 1/9.806 65 $1/(3.6\times10^6)$ $\approx 3.776\ 72\times10^{-7}$
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^2/s	Stokes Centistokes	St cSt	10^4 10^6
Temperature	Kelvin, Degree celsius	K, °C	Degree	°C	(See note (1))
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	$4\pi/10^3$
Magnetic Flux Density	Tesla	T	Gauss Gamma	Gs γ	10^4 10^9
Electrical Resistance	Ohm	Ω	(Volts per ampere)	(V/A)	1

Note (1) The conversion from TK into θ °C is $\theta = T - 273.15$ but $\Delta T = \Delta\theta$ for temperature differences. Note that, ΔT 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	**1**	0.1020	333.43	**34**	3.4670	657.05	**67**	6.8321
19.613	**2**	0.2039	343.23	**35**	3.5690	666.85	**68**	6.9341
29.420	**3**	0.3059	353.04	**36**	3.6710	676.66	**69**	7.0360
39.227	**4**	0.4079	362.85	**37**	3.7729	686.47	**70**	7.1380
49.033	**5**	0.5099	372.65	**38**	3.8749	696.27	**71**	7.2400
58.840	**6**	0.6118	382.46	**39**	3.9769	706.08	**72**	7.3420
68.647	**7**	0.7138	392.27	**40**	4.0789	715.89	**73**	7.4439
78.453	**8**	0.8158	402.07	**41**	4.1808	725.69	**74**	7.5459
88.260	**9**	0.9177	411.88	**42**	4.2828	735.50	**75**	7.6479
98.066	**10**	1.0197	421.69	**43**	4.3848	745.31	**76**	7.7498
107.87	**11**	1.1217	431.49	**44**	4.4868	755.11	**77**	7.8518
117.68	**12**	1.2237	441.30	**45**	4.5887	764.92	**78**	7.9538
127.49	**13**	1.3256	451.11	**46**	4.6907	774.73	**79**	8.0558
137.29	**14**	1.4276	460.91	**47**	4.7927	784.53	**80**	8.1577
147.10	**15**	1.5296	470.72	**48**	4.8946	794.34	**81**	8.2597
156.91	**16**	1.6315	480.53	**49**	4.9966	804.15	**82**	8.3617
166.71	**17**	1.7335	490.33	**50**	5.0986	813.95	**83**	8.4636
176.52	**18**	1.8355	500.14	**51**	5.2006	823.76	**84**	8.5656
186.33	**19**	1.9375	509.95	**52**	5.3025	833.57	**85**	8.6676
196.13	**20**	2.0394	519.75	**53**	5.4045	843.37	**86**	8.7696
205.94	**21**	2.1414	529.56	**54**	5.5065	853.18	**87**	8.8715
215.75	**22**	2.2434	539.37	**55**	5.6084	862.99	**88**	8.9735
225.55	**23**	2.3453	549.17	**56**	5.7104	872.79	**89**	9.0755
235.36	**24**	2.4473	558.98	**57**	5.8124	882.60	**90**	9.1774
245.17	**25**	2.5493	568.79	**58**	5.9144	892.41	**91**	9.2794
254.97	**26**	2.6513	578.59	**59**	6.0163	902.21	**92**	9.3814
264.78	**27**	2.7532	588.40	**60**	6.1183	912.02	**93**	9.4834
274.59	**28**	2.8552	598.21	**61**	6.2203	921.83	**94**	9.5853
284.39	**29**	2.9572	608.01	**62**	6.3222	931.63	**95**	9.6873
294.20	**30**	3.0591	617.82	**63**	6.4242	941.44	**96**	9.7893
304.01	**31**	3.1611	627.63	**64**	6.5262	951.25	**97**	9.8912
313.81	**32**	3.2631	637.43	**65**	6.6282	961.05	**98**	9.9932
323.62	**33**	3.3651	647.24	**66**	6.7301	970.86	**99**	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	**1**	2.205	15.422	**34**	74.957	30.391	**67**	147.71
0.907	**2**	4.409	15.876	**35**	77.162	30.844	**68**	149.91
1.361	**3**	6.614	16.329	**36**	79.366	31.298	**69**	152.12
1.814	**4**	8.818	16.783	**37**	81.571	31.751	**70**	154.32
2.268	**5**	11.023	17.237	**38**	83.776	32.205	**71**	156.53
2.722	**6**	13.228	17.690	**39**	85.980	32.659	**72**	158.73
3.175	**7**	15.432	18.144	**40**	88.185	33.112	**73**	160.94
3.629	**8**	17.637	18.597	**41**	90.390	33.566	**74**	163.14
4.082	**9**	19.842	19.051	**42**	92.594	34.019	**75**	165.35
4.536	**10**	22.046	19.504	**43**	94.799	34.473	**76**	167.55
4.990	**11**	24.251	19.958	**44**	97.003	34.927	**77**	169.76
5.443	**12**	26.455	20.412	**45**	99.208	35.380	**78**	171.96
5.897	**13**	28.660	20.865	**46**	101.41	35.834	**79**	174.17
6.350	**14**	30.865	21.319	**47**	103.62	36.287	**80**	176.37
6.804	**15**	33.069	21.772	**48**	105.82	36.741	**81**	178.57
7.257	**16**	35.274	22.226	**49**	108.03	37.195	**82**	180.78
7.711	**17**	37.479	22.680	**50**	110.23	37.648	**83**	182.98
8.165	**18**	39.683	23.133	**51**	112.44	38.102	**84**	185.19
8.618	**19**	41.888	23.587	**52**	114.64	38.555	**85**	187.39
9.072	**20**	44.092	24.040	**53**	116.84	39.009	**86**	189.60
9.525	**21**	46.297	24.494	**54**	119.05	39.463	**87**	191.80
9.979	**22**	48.502	24.948	**55**	121.25	39.916	**88**	194.01
10.433	**23**	50.706	25.401	**56**	123.46	40.370	**89**	196.21
10.886	**24**	52.911	25.855	**57**	125.66	40.823	**90**	198.42
11.340	**25**	55.116	26.308	**58**	127.87	41.277	**91**	200.62
11.793	**26**	57.320	26.762	**59**	130.07	41.730	**92**	202.83
12.247	**27**	59.525	27.216	**60**	132.28	42.184	**93**	205.03
12.701	**28**	61.729	27.669	**61**	134.48	42.638	**94**	207.23
13.154	**29**	63.934	28.123	**62**	136.69	43.091	**95**	209.44
13.608	**30**	66.139	28.576	**63**	138.89	43.545	**96**	211.64
14.061	**31**	68.343	29.030	**64**	141.10	43.998	**97**	213.85
14.515	**32**	70.548	29.484	**65**	143.30	44.452	**98**	216.05
14.969	**33**	72.753	29.937	**66**	145.51	44.906	**99**	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	**−100**	−148.0	0.0	**32**	89.6	21.7	**71**	159.8	43.3	**110**	230
−62.2	**− 80**	−112.0	0.6	**33**	91.4	22.2	**72**	161.6	46.1	**115**	239
−51.1	**− 60**	− 76.0	1.1	**34**	93.2	22.8	**73**	163.4	48.9	**120**	248
−40.0	**− 40**	− 40.0	1.7	**35**	95.0	23.3	**74**	165.2	51.7	**125**	257
−34.4	**− 30**	− 22.0	2.2	**36**	96.8	23.9	**75**	167.0	54.4	**130**	266
−28.9	**− 20**	− 4.0	2.8	**37**	98.6	24.4	**76**	168.8	57.2	**135**	275
−23.3	**− 10**	14.0	3.3	**38**	100.4	25.0	**77**	170.6	60.0	**140**	284
−17.8	**0**	32.0	3.9	**39**	102.2	25.6	**78**	172.4	65.6	**150**	302
−17.2	**1**	33.8	4.4	**40**	104.0	26.1	**79**	174.2	71.1	**160**	320
−16.7	**2**	35.6	5.0	**41**	105.8	26.7	**80**	176.0	76.7	**170**	338
−16.1	**3**	37.4	5.6	**42**	107.6	27.2	**81**	177.8	82.2	**180**	356
−15.6	**4**	39.2	6.1	**43**	109.4	27.8	**82**	179.6	87.8	**190**	374
−15.0	**5**	41.0	6.7	**44**	111.2	28.3	**83**	181.4	93.3	**200**	392
−14.4	**6**	42.8	7.2	**45**	113.0	28.9	**84**	183.2	98.9	**210**	410
−13.9	**7**	44.6	7.8	**46**	114.8	29.4	**85**	185.0	104.4	**220**	428
−13.3	**8**	46.4	8.3	**47**	116.6	30.0	**86**	186.8	110.0	**230**	446
−12.8	**9**	48.2	8.9	**48**	118.4	30.6	**87**	188.6	115.6	**240**	464
−12.2	**10**	50.0	9.4	**49**	120.2	31.1	**88**	190.4	121.1	**250**	482
−11.7	**11**	51.8	10.0	**50**	122.0	31.7	**89**	192.2	148.9	**300**	572
−11.1	**12**	53.6	10.6	**51**	123.8	32.2	**90**	194.0	176.7	**350**	662
−10.6	**13**	55.4	11.1	**52**	125.6	32.8	**91**	195.8	204	**400**	752
−10.0	**14**	57.2	11.7	**53**	127.4	33.3	**92**	197.6	232	**450**	842
− 9.4	**15**	59.0	12.2	**54**	129.2	33.9	**93**	199.4	260	**500**	932
− 8.9	**16**	60.8	12.8	**55**	131.0	34.4	**94**	201.2	288	**550**	1022
− 8.3	**17**	62.6	13.3	**56**	132.8	35.0	**95**	203.0	316	**600**	1112
− 7.8	**18**	64.4	13.9	**57**	134.6	35.6	**96**	204.8	343	**650**	1202
− 7.2	**19**	66.2	14.4	**58**	136.4	36.1	**97**	206.6	371	**700**	1292
− 6.7	**20**	68.0	15.0	**59**	138.2	36.7	**98**	208.4	399	**750**	1382
− 6.1	**21**	69.8	15.6	**60**	140.0	37.2	**99**	210.2	427	**800**	1472
− 5.6	**22**	71.6	16.1	**61**	141.8	37.8	**100**	212.0	454	**850**	1562
− 5.0	**23**	73.4	16.7	**62**	143.6	38.3	**101**	213.8	482	**900**	1652
− 4.4	**24**	75.2	17.2	**63**	145.4	38.9	**102**	215.6	510	**950**	1742
− 3.9	**25**	77.0	17.8	**64**	147.2	39.4	**103**	217.4	538	**1000**	1832
− 3.3	**26**	78.8	18.3	**65**	149.0	40.0	**104**	219.2	593	**1100**	2012
− 2.8	**27**	80.6	18.9	**66**	150.8	40.6	**105**	221.0	649	**1200**	2192
− 2.2	**28**	82.4	19.4	**67**	152.6	41.1	**106**	222.8	704	**1300**	2372
− 1.7	**29**	84.2	20.0	**68**	154.4	41.7	**107**	224.6	760	**1400**	2552
− 1.1	**30**	86.0	20.6	**69**	156.2	42.2	**108**	226.4	816	**1500**	2732
− 0.6	**31**	87.8	21.1	**70**	158.0	42.8	**109**	228.2	871	**1600**	2912

Appendix Table 5 Viscosity Conversion Table

Kinematic Viscosity mm²/s	Saybolt Universal SUS (sec) 100°F	Saybolt Universal SUS (sec) 210°F	No.1 Type Redwood R (sec) 50°C	No.1 Type Redwood R (sec) 100°C	Engler E (degree)
2	32.6	32.8	30.8	31.2	1.14
3	36.0	36.3	33.3	33.7	1.22
4	39.1	39.4	35.9	36.5	1.31
5	42.3	42.6	38.5	39.1	1.40
6	45.5	45.8	41.1	41.7	1.48
7	48.7	49.0	43.7	44.3	1.56
8	52.0	52.4	46.3	47.0	1.65
9	55.4	55.8	49.1	50.0	1.75
10	58.8	59.2	52.1	52.9	1.84
11	62.3	62.7	55.1	56.0	1.93
12	65.9	66.4	58.2	59.1	2.02
13	69.6	70.1	61.4	62.3	2.12
14	73.4	73.9	64.7	65.6	2.22
15	77.2	77.7	68.0	69.1	2.32
16	81.1	81.7	71.5	72.6	2.43
17	85.1	85.7	75.0	76.1	2.54
18	89.2	89.8	78.6	79.7	2.64
19	93.3	94.0	82.1	83.6	2.76
20	97.5	98.2	85.8	87.4	2.87
21	102	102	89.5	91.3	2.98
22	106	107	93.3	95.1	3.10
23	110	111	97.1	98.9	3.22
24	115	115	101	103	3.34
25	119	120	105	107	3.46
26	123	124	109	111	3.58
27	128	129	112	115	3.70
28	132	133	116	119	3.82
29	137	138	120	123	3.95
30	141	142	124	127	4.07
31	145	146	128	131	4.20
32	150	150	132	135	4.32
33	154	155	136	139	4.45
34	159	160	140	143	4.57

Kinematic Viscosity mm²/s	Saybolt Universal SUS (sec) 100°F	Saybolt Universal SUS (sec) 210°F	No.1 Type Redwood R (sec) 50°C	No.1 Type Redwood R (sec) 100°C	Engler E (degree)
35	163	164	144	147	4.70
36	168	170	148	151	4.83
37	172	173	153	155	4.96
38	177	178	156	159	5.08
39	181	183	160	164	5.21
40	186	187	164	168	5.34
41	190	192	168	172	5.47
42	195	196	172	176	5.59
43	199	201	176	180	5.72
44	204	205	180	185	5.85
45	208	210	184	189	5.98
46	213	215	188	193	6.11
47	218	219	193	197	6.24
48	222	224	197	202	6.37
49	227	228	201	206	6.50
50	231	233	205	210	6.63
55	254	256	225	231	7.24
60	277	279	245	252	7.90
65	300	302	266	273	8.55
70	323	326	286	294	9.21
75	346	349	306	315	9.89
80	371	373	326	336	10.5
85	394	397	347	357	11.2
90	417	420	367	378	11.8
95	440	443	387	399	12.5
100	464	467	408	420	13.2
120	556	560	490	504	15.8
140	649	653	571	588	18.4
160	742	747	653	672	21.1
180	834	840	734	757	23.7
200	927	933	816	841	26.3
250	1 159	1 167	1 020	1 051	32.9
300	1 391	1 400	1 224	1 241	39.5

Remark 1mm²/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										
0	**0.000000**	**0.000**	**25.400**	**50.800**	**76.200**	**101.600**	**127.000**	**152.400**	**177.800**	**203.200**	**228.600**	**254.000**
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
1/16	**0.062500**	**1.588**	**26.988**	**52.388**	**77.788**	**103.188**	**128.588**	**153.988**	**179.388**	**204.788**	**230.188**	**255.588**
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
1/8	**0.125000**	**3.175**	**28.575**	**53.975**	**79.375**	**104.775**	**130.175**	**155.575**	**180.975**	**206.375**	**231.775**	**257.175**
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
3/16	**0.187500**	**4.762**	**30.162**	**55.562**	**80.962**	**106.362**	**131.762**	**157.162**	**182.562**	**207.962**	**233.362**	**258.762**
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
1/4	**0.250000**	**6.350**	**31.750**	**57.150**	**82.550**	**107.950**	**133.350**	**158.750**	**184.150**	**209.550**	**234.950**	**260.350**
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
5/16	**0.312500**	**7.938**	**33.338**	**58.738**	**84.138**	**109.538**	**134.938**	**160.338**	**185.738**	**211.138**	**236.538**	**261.938**
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
3/8	**0.375000**	**9.525**	**34.925**	**60.325**	**85.725**	**111.125**	**136.525**	**161.925**	**187.325**	**212.725**	**238.125**	**263.525**
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
7/16	**0.437500**	**11.112**	**36.512**	**61.912**	**87.312**	**112.712**	**138.112**	**163.512**	**188.912**	**214.312**	**239.712**	**265.112**
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
1/2	**0.500000**	**12.700**	**38.100**	**63.500**	**88.900**	**114.300**	**139.700**	**165.100**	**190.500**	**215.900**	**241.300**	**266.700**
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
9/16	**0.562500**	**14.288**	**39.688**	**65.088**	**90.488**	**115.888**	**141.288**	**166.688**	**192.088**	**217.488**	**242.888**	**268.288**
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
5/8	**0.625000**	**15.875**	**41.275**	**66.675**	**92.075**	**117.475**	**142.875**	**168.275**	**193.675**	**219.075**	**244.475**	**269.875**
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
11/16	**0.687500**	**17.462**	**42.862**	**68.262**	**93.662**	**119.062**	**144.462**	**169.862**	**195.262**	**220.662**	**246.062**	**271.462**
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
3/4	**0.750000**	**19.050**	**44.450**	**69.850**	**95.250**	**120.650**	**146.050**	**171.450**	**196.850**	**222.250**	**247.650**	**273.050**
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
13/16	**0.812500**	**20.638**	**46.038**	**71.438**	**96.838**	**122.238**	**147.638**	**173.038**	**198.438**	**223.838**	**249.238**	**274.638**
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
7/8	**0.875000**	**22.225**	**47.625**	**73.025**	**98.425**	**123.825**	**149.225**	**174.625**	**200.025**	**225.425**	**250.825**	**276.225**
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
15/16	**0.937500**	**23.812**	**49.212**	**74.612**	**100.012**	**125.412**	**150.812**	**176.212**	**201.612**	**227.012**	**252.412**	**277.812**
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									
0	0.0000	279.400	304.800	330.200	355.600	381.000	406.400	431.800	457.200	482.600	508.000
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
1/4	0.2500	285.750	311.150	336.550	361.950	387.350	412.750	438.150	463.550	488.950	514.350
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
1/2	0.5000	292.100	317.500	342.900	368.300	393.700	419.100	444.500	469.900	495.300	520.700
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
3/4	0.7500	298.450	323.850	349.250	374.650	400.050	425.450	450.850	476.250	501.650	527.050
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									
0	0.0000	533.400	558.800	584.200	609.600	635.000	660.400	685.800	711.200	736.600	762.000
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
1/4	0.2500	539.750	565.150	590.550	615.950	641.350	666.750	692.150	717.550	742.950	768.350
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
1/2	0.5000	546.100	571.500	596.900	622.300	647.700	673.100	698.500	723.900	749.300	774.700
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
3/4	0.7500	552.450	577.850	603.250	628.650	654.050	679.450	704.850	730.250	755.650	781.050
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									
0	0.0000	787.400	812.800	838.200	863.600	889.000	914.400	939.800	965.200	990.600	1016.000
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
1/4	0.2500	793.750	819.150	844.550	869.950	895.350	920.750	946.150	971.550	996.950	1022.350
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
1/2	0.5000	800.100	825.500	850.900	876.300	901.700	927.100	952.500	977.900	1003.300	1028.700
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
3/4	0.7500	806.450	831.850	857.250	882.650	908.050	933.450	958.850	984.250	1009.650	1035.050
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 Load 588.4N {60kgf} Brale Indenter	B Scale Load 980.7N {100kgf} 1.588 mm (1/16in) Ball	
68	940	—	—	85.6	—	97
67	900	—	—	85.0	—	95
66	865	—	—	84.5	—	92
65	832	—	739	83.9	—	91
64	800	—	722	83.4	—	88
63	772	—	705	82.8	—	87
62	746	—	688	82.3	—	85
61	720	—	670	81.8	—	83
60	697	—	654	81.2	—	81
59	674	—	634	80.7	—	80
58	653	—	615	80.1	—	78
57	633	—	595	79.6	—	76
56	613	—	577	79.0	—	75
55	595	—	560	78.5	—	74
54	577	—	543	78.0	—	72
53	560	—	525	77.4	—	71
52	544	500	512	76.8	—	69
51	528	487	496	76.3	—	68
50	513	475	481	75.9	—	67
49	498	464	469	75.2	—	66
48	484	451	455	74.7	—	64
47	471	442	443	74.1	—	63
46	458	432	432	73.6	—	62
45	446	421	421	73.1	—	60
44	434	409	409	72.5	—	58
43	423	400	400	72.0	—	57
42	412	390	390	71.5	—	56
41	402	381	381	70.9	—	55
40	392	371	371	70.4	—	54
39	382	362	362	69.9	—	52
38	372	353	353	69.4	—	51
37	363	344	344	68.9	—	50
36	354	336	336	68.4	(109.0)	49
35	345	327	327	67.9	(108.5)	48
34	336	319	319	67.4	(108.0)	47
33	327	311	311	66.8	(107.5)	46
32	318	301	301	66.3	(107.0)	44
31	310	294	294	65.8	(106.0)	43
30	302	286	286	65.3	(105.5)	42
29	294	279	279	64.7	(104.5)	41
28	286	271	271	64.3	(104.0)	41
27	279	264	264	63.8	(103.0)	40
26	272	258	258	63.3	(102.5)	38
25	266	253	253	62.8	(101.5)	38
24	260	247	247	62.4	(101.0)	37
23	254	243	243	62.0	100.0	36
22	248	237	237	61.5	99.0	35
21	243	231	231	61.0	98.5	35
20	238	226	226	60.5	97.8	34
(18)	230	219	219	—	96.7	33
(16)	222	212	212	—	95.5	32
(14)	213	203	203	—	93.9	31
(12)	204	194	194	—	92.3	29
(10)	196	187	187	—	90.7	28
(8)	188	179	179	—	89.5	27
(6)	180	171	171	—	87.1	26
(4)	173	165	165	—	85.5	25
(2)	166	158	158	—	83.5	24
(0)	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^{-1})	Hardness (Brinell)	Young's modulus (MPa) {kgf/mm²}	Tensile Strength (MPa) {kgf/mm²}	Yield Point (MPa) {kgf/mm²}	Elongation (%)
Bearing Steel (hardened)		7.83	12.5×10^{-6}	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^{-6}	580	200 000 {20 400}	1 960 {200}	1 860 {190}	—
Mild Steel (C=0.12 to 0.20%)		7.86	11.6×10^{-6}	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^{-6}	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^{-6}	150	193 000 {19 700}	588 {60}	245 {25}	60
Cast Iron	Gray Iron FC200	7.3	10.4×10^{-6}	223	98 100 {10 000}	More than 200 {20}	—	—
Cast Iron	Spheroidal graphite Iron FCD400	7.0	11.7×10^{-6}	Less than 201	169 000 {17 200}	More than 400 {41}	—	More than 12
Aluminum		2.69	23.7×10^{-6}	15 to 26	70 600 {7 200}	78 {8}	34 {3.5}	35
Zinc		7.14	31×10^{-6}	30 to 60	92 200 {9 400}	147 {15}	—	30 to 40
Copper		8.93	16.2×10^{-6}	50	123 000 {12 500}	196 {20}	69 {7}	15 to 20
Brass	(Annealed)	8.5	19.1×10^{-6}	45	103 000 {10 500}	294 to 343 {30 to 35}	—	65 to 75
Brass	(Machined)			85 to 130		363 to 539 {37 to 55}		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.

Diameter Classification (mm) over	incl.	Single Plane Mean B.D. Deviation (Normal) Δ_{dmp}	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6
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 : μm

j5	j6	j7	k5	k6	k7	m5	m6	n6	p6	r6	r7	Diameter Classification (mm) over	incl.
+3 / −2	+6 / −2	+8 / −4	+6 / +1	+9 / +1	+13 / +1	+9 / +4	+12 / +4	+16 / +8	+20 / +12	+23 / +15	+27 / +15	3	6
+4 / −2	+7 / −2	+10 / −5	+7 / +1	+10 / +1	+16 / +1	+12 / +6	+15 / +6	+19 / +10	+24 / +15	+28 / +19	+34 / +19	6	10
+5 / −3	+8 / −3	+12 / −6	+9 / +1	+12 / +1	+19 / +1	+15 / +7	+18 / +7	+23 / +12	+29 / +18	+34 / +23	+41 / +23	10	18
+5 / −4	+9 / −4	+13 / −8	+11 / +2	+15 / +2	+23 / +2	+17 / +8	+21 / +8	+28 / +15	+35 / +22	+41 / +28	+49 / +28	18	30
+6 / −5	+11 / −5	+15 / −10	+13 / +2	+18 / +2	+27 / +2	+20 / +9	+25 / +9	+33 / +17	+42 / +26	+50 / +34	+59 / +34	30	50
+6 / −7	+12 / −7	+18 / −12	+15 / +2	+21 / +2	+32 / +2	+24 / +11	+30 / +11	+39 / +20	+51 / +32	+60 / +41	+71 / +41	50	65
										+62 / +43	+73 / +43	65	80
+6 / −9	+13 / −9	+20 / −15	+18 / +3	+25 / +3	+38 / +3	+28 / +13	+35 / +13	+45 / +23	+59 / +37	+73 / +51	+86 / +51	80	100
										+76 / +54	+89 / +54	100	120
+7 / −11	+14 / −11	+22 / −18	+21 / +3	+28 / +3	+43 / +3	+33 / +15	+40 / +15	+52 / +27	+68 / +43	+88 / +63	+103 / +63	120	140
										+90 / +65	+105 / +65	140	160
										+93 / +68	+108 / +68	160	180
+7 / −13	+16 / −13	+25 / −21	+24 / +4	+33 / +4	+50 / +4	+37 / +17	+46 / +17	+60 / +31	+79 / +50	+106 / +77	+123 / +77	180	200
										+109 / +80	+126 / +80	200	225
										+113 / +84	+130 / +84	225	250
+7 / −16	±16	±26	+27 / +4	+36 / +4	+56 / +4	+43 / +20	+52 / +20	+66 / +34	+88 / +56	+126 / +94	+146 / +94	250	280
										+130 / +98	+150 / +98	280	315
+7 / −18	±18	+29 / −28	+29 / +4	+40 / +4	+61 / +4	+46 / +21	+57 / +21	+73 / +37	+98 / +62	+144 / +108	+165 / +108	315	355
										+150 / +114	+171 / +114	355	400
+7 / −20	±20	+31 / −32	+32 / +5	+45 / +5	+68 / +5	+50 / +23	+63 / +23	+80 / +40	+108 / +68	+166 / +126	+189 / +126	400	450
										+172 / +132	+195 / +132	450	500
—	—	—	—	+44 / 0	+70 / 0	—	+70 / +26	+88 / +44	+122 / +78	+194 / +150	+220 / +150	500	560
										+199 / +155	+225 / +155	560	630
—	—	—	—	+50 / 0	+80 / 0	—	+80 / +30	+100 / +50	+138 / +88	+225 / +175	+255 / +175	630	710
										+235 / +185	+265 / +185	710	800
—	—	—	—	+56 / 0	+90 / 0	—	+90 / +34	+112 / +56	+156 / +100	+266 / +210	+300 / +210	800	900
										+276 / +220	+310 / +220	900	1 000
—	—	—	—	+66 / 0	+105 / 0	—	+106 / +40	+132 / +66	+186 / +120	+316 / +250	+355 / +250	1 000	1 120
										+326 / +260	+365 / +260	1 120	1 250
—	—	—	—	+78 / 0	+125 / 0	—	+126 / +48	+156 / +78	+218 / +140	+378 / +300	+425 / +300	1 250	1 400
										+408 / +330	+455 / +330	1 400	1 600
—	—	—	—	+92 / 0	+150 / 0	—	+150 / +58	+184 / +92	+262 / +170	+462 / +370	+520 / +370	1 600	1 800
										+492 / +400	+550 / +400	1 800	2 000

Appendix Table 10

Diameter Classification (mm) over	Diameter Classification (mm) incl.	Single Plane Mean O.D. Deviation (Normal) Δ_{Dmp}	E6	F6	F7	G6	G7	H6	H7	H8	J6	J7	JS6	JS7
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 : μm

K5	K6	K7	M5	M6	M7	N5	N6	N7	P6	P7	Diameter Classification (mm)	
											over	incl.
+ 2 − 6	+ 2 − 9	+ 6 − 12	− 4 − 12	− 4 − 15	0 − 18	− 9 − 17	− 9 − 20	− 5 − 23	− 15 − 26	− 11 − 29	10	18
+ 1 − 8	+ 2 − 11	+ 6 − 15	− 5 − 14	− 4 − 17	0 − 21	− 12 − 21	− 11 − 24	− 7 − 28	− 18 − 31	− 14 − 35	18	30
+ 2 − 9	+ 3 − 13	+ 7 − 18	− 5 − 16	− 4 − 20	0 − 25	− 13 − 24	− 12 − 28	− 8 − 33	− 21 − 37	− 17 − 42	30	50
+ 3 − 10	+ 4 − 15	+ 9 − 21	− 6 − 19	− 5 − 24	0 − 30	− 15 − 28	− 14 − 33	− 9 − 39	− 26 − 45	− 21 − 51	50	80
+ 2 − 13	+ 4 − 18	+ 10 − 25	− 8 − 23	− 6 − 28	0 − 35	− 18 − 33	− 16 − 38	− 10 − 45	− 30 − 52	− 24 − 59	80	120
+ 3 − 15	+ 4 − 21	+ 12 − 28	− 9 − 27	− 8 − 33	0 − 40	− 21 − 39	− 20 − 45	− 12 − 52	− 36 − 61	− 28 − 68	120	180
+ 2 − 18	+ 5 − 24	+ 13 − 33	− 11 − 31	− 8 − 37	0 − 46	− 25 − 45	− 22 − 51	− 14 − 60	− 41 − 70	− 33 − 79	180	250
+ 3 − 20	+ 5 − 27	+ 16 − 36	− 13 − 36	− 9 − 41	0 − 52	− 27 − 50	− 25 − 57	− 14 − 66	− 47 − 79	− 36 − 88	250	315
+ 3 − 22	+ 7 − 29	+ 17 − 40	− 14 − 39	− 10 − 46	0 − 57	− 30 − 55	− 26 − 62	− 16 − 73	− 51 − 87	− 41 − 98	315	400
+ 2 − 25	+ 8 − 32	+ 18 − 45	− 16 − 43	− 10 − 50	0 − 63	− 33 − 60	− 27 − 67	− 17 − 80	− 55 − 95	− 45 − 108	400	500
—	0 − 44	0 − 70	—	− 26 − 70	− 26 − 96	—	− 44 − 88	− 44 − 114	− 78 − 122	− 78 − 148	500	630
—	0 − 50	0 − 80	—	− 30 − 80	− 30 − 110	—	− 50 − 100	− 50 − 130	− 88 − 138	− 88 − 168	630	800
—	0 − 56	0 − 90	—	− 34 − 90	− 34 − 124	—	− 56 − 112	− 56 − 146	− 100 − 156	− 100 − 190	800	1 000
—	0 − 66	0 − 105	—	− 40 − 106	− 40 − 145	—	− 66 − 132	− 66 − 171	− 120 − 186	− 120 − 225	1 000	1 250
—	0 − 78	0 − 125	—	− 48 − 126	− 48 − 173	—	− 78 − 156	− 78 − 203	− 140 − 218	− 140 − 265	1 250	1 600
—	0 − 92	0 − 150	—	− 58 − 150	− 58 − 208	—	− 92 − 184	− 92 − 242	− 170 − 262	− 170 − 320	1 600	2 000
—	0 − 110	0 − 175	—	− 68 − 178	− 68 − 243	—	− 110 − 220	− 110 − 285	− 195 − 305	− 195 − 370	2 000	2 500

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 1. Standard tolerance grades IT14 to IT18 must not be used for basic sizes less than or equal to 1 mm.
2. 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

Appedix 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^{-1})	Speed Factor f_n Ball Bearings	Speed Factor f_n 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
33.3	**1.00**	**1.00**
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^{-1})	Speed Factor f_n Ball Bearings	Speed Factor f_n 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^{-1})	Speed Factor f_n Ball Bearings	Speed Factor f_n 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 L (10^6 rev)	Ball Bearing Life L_h (h)	Roller Bearing Life L (10^6 rev)	Roller Bearing Life 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
1.00	**1.00**	**500**	**1.00**	**500**
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 L (10^6 rev)	Ball Bearing Life L_h (h)	Roller Bearing Life L (10^6 rev)	Roller Bearing Life 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) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
657	*d*	73.025	C232
658	*d*	74.612	C232
659	*d*	76.200	C232
661	*d*	79.375	C234
663	*d*	82.550	C234
664	*d*	84.138	C236
665	*d*	85.725	C236
665 A	*d*	85.725	C236
672	*D*	168.275	C236,C238,C240
677	*d*	85.725	C236
681	*d*	92.075	C238
683	*d*	95.250	C238
685	*d*	98.425	C238
687	*d*	101.600	C240
742	*D*	150.089	C230,C234,C236
743	*D*	150.000	C234
745 A	*d*	69.850	C230
749	*d*	85.026	C236
749 A	*d*	82.550	C234
749 S	*d*	85.026	C236
750	*d*	79.375	C234
752	*D*	161.925	C234,C236
753	*D*	168.275	C234,C236
757	*d*	82.550	C234
758	*d*	85.725	C236
759	*d*	88.900	C236
760	*d*	90.488	C236
766	*d*	88.900	C236
772	*D*	180.975	C238,C240
776	*d*	95.250	C238
779	*d*	98.425	C238
780	*d*	101.600	C240
782	*d*	104.775	C240
787	*d*	104.775	C240
792	*D*	206.375	C242
795	*d*	120.650	C242
797	*d*	130.000	C242
799	*d*	128.588	C242
799 A	*d*	130.175	C242
832	*D*	168.275	C234,C236
837	*d*	76.200	C234
842	*d*	82.550	C234
843	*d*	76.200	C234
850	*d*	88.900	C236
854	*D*	190.500	C236,C238,C240
855	*d*	88.900	C236
857	*d*	92.075	C238
861	*d*	101.600	C240
864	*d*	95.250	C238
866	*d*	98.425	C238
932	*D*	212.725	C240
938	*d*	114.300	C240
1220	*D*	57.150	C210
1280	*d*	22.225	C210

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
1328	*D*	52.388	C210
1329	*D*	53.975	C210
1380	*d*	22.225	C210
1620	*D*	66.675	C216
1680	*d*	33.338	C216
1729	*D*	56.896	C210,C212
1755	*d*	22.225	C210
1779	*d*	23.812	C212
1922	*D*	57.150	C212
1988	*d*	28.575	C212
1997 X	*d*	26.988	C212
A2047	*d*	12.000	C210
A2126	*D*	31.991	C210
2523	*D*	69.850	C214,C216
2558	*d*	30.162	C214
2559	*d*	30.162	C214
2580	*d*	31.750	C214
2582	*d*	31.750	C214
2585	*d*	33.338	C216
2631	*D*	66.421	C214
2690	*d*	29.367	C214
2720	*D*	76.200	C218
2729	*D*	76.200	C218
2735 X	*D*	73.025	C218
2788	*d*	38.100	C218
2789	*d*	39.688	C218
2820	*D*	73.025	C216
2877	*d*	34.925	C216
2924	*D*	85.000	C222
2984	*d*	46.038	C222
3120	*D*	72.626	C214,C216
3188	*d*	31.750	C214
3197	*d*	33.338	C216
3320	*D*	80.167	C218
3386	*d*	39.688	C218
3420	*D*	79.375	C216,C218
3478	*d*	34.925	C216
3479	*d*	36.512	C218
3490	*d*	38.100	C218
3525	*D*	87.312	C220
3576	*d*	41.275	C220
3578	*d*	44.450	C220
3720	*D*	93.264	C220
3730	*D*	93.264	C224
3775	*d*	50.800	C224
3780	*d*	50.800	C224
3782	*d*	44.450	C220
3820	*D*	85.725	C220
3877	*d*	41.275	C220
3920	*D*	112.712	C228,C230
3926	*D*	112.712	C226,C228
3981	*d*	58.738	C226
3982	*d*	63.500	C228
3984	*d*	66.675	C230

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
3994	*d*	66.675	C230
A4050	*d*	12.700	C210
A4059	*d*	15.000	C210
A4138	*D*	34.988	C210
4335	*D*	90.488	C220
4388	*d*	41.275	C220
4535	*D*	104.775	C226
4595	*d*	53.975	C226
A5069	*d*	17.455	C210
A5144	*D*	36.525	C210
5335	*D*	103.188	C222
5356	*d*	44.450	C222
5535	*D*	122.238	C226,C228
5566	*d*	55.562	C226
5582	*d*	60.325	C228
5584	*d*	63.500	C228
5735	*D*	135.733	C232,C234
5760	*d*	76.200	C232
5795	*d*	77.788	C234
A6062	*d*	15.875	C210
A6067	*d*	16.993	C210
A6075	*d*	19.050	C210
A6157	*D*	39.992	C210
6220	*D*	127.000	C224,C226
6279	*d*	50.800	C224
6280	*d*	53.975	C226
6320	*D*	135.755	C228,C230
6376	*d*	60.325	C228
6379	*d*	65.088	C230
6420	*D*	149.225	C226,C230,C232
6454	*d*	69.850	C230
6455	*d*	57.150	C226
6460	*d*	73.025	C232
6461	*d*	76.200	C232
6535	*D*	161.925	C232,C234,C236
6536	*D*	161.925	C232
6559	*d*	82.550	C234
6575	*d*	76.200	C232
6576	*d*	76.200	C232
6580	*d*	88.900	C236
9121	*D*	152.400	C228,C230
9180	*d*	61.912	C228
9185	*d*	68.262	C230
9220	*D*	161.925	C232
9285	*d*	76.200	C232
9320	*D*	177.800	C234
9321	*D*	171.450	C234,C236
9378	*d*	76.200	C234
9380	*d*	76.200	C234
9385	*d*	84.138	C236
02420	*D*	68.262	C212,C214
02473	*d*	25.400	C212
02474	*d*	28.575	C212
02475	*d*	31.750	C214
02820	*D*	73.025	C212,C216
02872	*d*	28.575	C212
02878	*d*	34.925	C216
03062	*d*	15.875	C210
03162	*D*	41.275	C210
05062	*d*	15.875	C210
05068	*d*	17.462	C210
05075	*d*	19.050	C210
05079	*d*	19.990	C210
05175	*D*	44.450	C210
05185	*D*	47.000	C210
07079	*d*	20.000	C210
07087	*d*	22.225	C210
07097	*d*	25.000	C212
07098	*d*	24.981	C212
07100	*d*	25.400	C212
07100SA	*d*	25.400	C212
07196	*D*	50.005	C210,C212
07204	*D*	51.994	C210,C212
07205	*D*	52.001	C212
08118	*d*	30.162	C214
08125	*d*	31.750	C214
08231	*D*	58.738	C214
09062	*d*	15.875	C210
09067	*d*	19.050	C210
09074	*d*	19.050	C210
09078	*d*	19.050	C210
09081	*d*	20.625	C210
09194	*D*	49.225	C210
09195	*D*	49.225	C210
09196	*D*	49.225	C210
11162	*d*	41.275	C220
11300	*D*	76.200	C220
11520	*D*	42.862	C210
11590	*d*	15.875	C210
LM11710	*D*	39.878	C210
LM11749	*d*	17.462	C210
LM11910	*D*	45.237	C210
LM11949	*d*	19.050	C210
12168	*d*	42.862	C220
12303	*D*	76.992	C220
12520	*D*	49.225	C210
12580	*d*	20.638	C210
M12610	*D*	50.005	C210
M12648	*d*	22.225	C210
M12649	*d*	21.430	C210
LM12710	*D*	45.237	C210
LM12711	*D*	45.975	C210
LM12749	*d*	22.000	C210
13175	*d*	44.450	C220
13181	*d*	46.038	C222
13318	*D*	80.962	C220,C222
13620	*D*	69.012	C218
13621	*D*	69.012	C218

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
13685	*d*	38.100	C218
13687	*d*	38.100	C218
13830	*D*	63.500	C218
13889	*d*	38.100	C218
14123 A	*d*	31.750	C214
14125 A	*d*	31.750	C214
14130	*d*	33.338	C216
14131	*d*	33.338	C216
14137 A	*d*	34.925	C216
14138 A	*d*	34.925	C216
14139	*d*	34.976	C216
14274	*D*	69.012	C214,C216
14276	*D*	69.012	C214,C216
14283	*D*	72.085	C216
15100	*d*	25.400	C212
15101	*d*	25.400	C212
15106	*d*	26.988	C212
15112	*d*	28.575	C212
15113	*d*	28.575	C212
15116	*d*	30.112	C214
15117	*d*	30.000	C214
15118	*d*	30.213	C214
15119	*d*	30.213	C214
15120	*d*	30.213	C214
15123	*d*	31.750	C214
15125	*d*	31.750	C214
15126	*d*	31.750	C214
15245	*D*	62.000	C212,C214
15250	*D*	63.500	C214
15250 X	*D*	63.500	C212
15520	*D*	57.150	C212
15523	*D*	60.325	C212
15578	*d*	25.400	C212
15580	*d*	26.988	C212
16150	*d*	38.100	C218
16284	*D*	72.238	C218
16929	*D*	74.988	C220
16986	*d*	43.000	C220
17098	*d*	24.981	C212
17118	*d*	30.000	C214
17244	*D*	62.000	C212,C214
17520	*D*	42.862	C210
17580	*d*	15.875	C210
17831	*D*	79.985	C222
17887	*d*	45.230	C222
18200	*d*	50.800	C224
18337	*D*	85.725	C224
18520	*D*	73.025	C218
18590	*d*	41.275	C218
18620	*D*	79.375	C222
18690	*d*	46.038	C222
18720	*D*	85.000	C224
18790	*d*	50.800	C224
19138	*d*	34.976	C216

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
19150	*d*	38.100	C218
19268	*D*	68.262	C216,C218
21075	*d*	19.050	C210
21212	*D*	53.975	C210
L21511	*D*	34.988	C210
L21549	*d*	15.875	C210
22168	*d*	42.862	C220
22325	*D*	82.550	C220
23100	*d*	25.400	C212
23256	*D*	65.088	C212
23621	*D*	73.025	C216
23691	*d*	35.000	C216
24720	*D*	76.200	C220
24721	*D*	76.200	C220
24780	*d*	41.275	C220
25520	*D*	82.931	C220,C222
25521	*D*	83.058	C220
25523	*D*	82.931	C220,C222
25577	*d*	42.875	C220
25578	*d*	42.862	C220
25580	*d*	44.450	C220
25584	*d*	44.983	C222
25590	*d*	45.618	C222
25820	*D*	73.025	C216
25821	*D*	73.025	C216,C218
25877	*d*	34.925	C216
25878	*d*	34.925	C216
25880	*d*	36.487	C218
26118	*d*	30.000	C214
26131	*d*	33.338	C216
26283	*D*	72.000	C214,C216
26820	*D*	80.167	C220
26822	*D*	79.375	C220
26823	*D*	76.200	C220
26882	*d*	41.275	C220
26884	*d*	42.875	C220
27620	*D*	125.412	C234
27687	*d*	82.550	C234
27689	*d*	83.345	C234
27690	*d*	83.345	C234
27820	*D*	80.035	C218
27880	*d*	38.100	C218
28138	*d*	34.976	C216
28315	*D*	80.000	C216
28521	*D*	92.075	C224
28580	*d*	50.800	C224
28584	*d*	52.388	C224
28622	*D*	97.630	C226
28680	*d*	55.562	C226
28920	*D*	101.600	C228
28921	*D*	100.000	C228
28985	*d*	60.325	C228
29520	*D*	107.950	C228
29586	*d*	63.500	C228

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
29620	*D*	112.712	C230,C232
29630	*D*	120.650	C230
29675	*d*	69.850	C230
29685	*d*	73.025	C232
LM29710	*D*	65.088	C218
LM29711	*D*	65.088	C218
LM29748	*d*	38.100	C218
LM29749	*d*	38.100	C218
31520	*D*	76.200	C216
31594	*d*	34.925	C216
33262	*d*	66.675	C230
33275	*d*	69.850	C230
33281	*d*	71.438	C232
33287	*d*	73.025	C232
JHM33410	*D*	55.000	C212
JHM33449	*d*	24.000	C212
33462	*D*	117.475	C230,C232
33821	*D*	95.250	C224
33889	*d*	50.800	C224
34300	*d*	76.200	C232
34306	*d*	77.788	C234
34478	*D*	121.442	C232,C234
36620	*D*	193.675	C242
36690	*d*	146.050	C242
36920	*D*	227.012	C244
36990	*d*	177.800	C244
37425	*d*	107.950	C240
37625	*D*	158.750	C240
M38510	*D*	66.675	C216
M38511	*D*	65.987	C216
M38547	*d*	35.000	C216
M38549	*d*	34.925	C216
39236	*d*	60.000	C228
39250	*d*	63.500	C228
39412	*D*	104.775	C228
39520	*D*	112.712	C228,C230
39521	*D*	112.712	C230
39585	*d*	63.500	C228
39590	*d*	66.675	C230
41100	*d*	25.400	C212
41125	*d*	28.575	C212
41126	*d*	28.575	C212
41286	*D*	72.626	C212
42350	*d*	88.900	C236
42362	*d*	92.075	C238
42368	*d*	93.662	C238
42375	*d*	95.250	C238
42376	*d*	95.250	C238
42381	*d*	96.838	C238
42584	*D*	148.430	C238
42587	*D*	149.225	C236,C238
42620	*D*	127.000	C232,C234
42687	*d*	76.200	C232
42688	*d*	76.200	C232

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
42690	*d*	77.788	C234
43118	*d*	30.162	C214
43131	*d*	33.338	C216
43300	*D*	76.200	C214
43312	*D*	79.375	C216
44143	*d*	36.512	C218
44150	*d*	38.100	C218
44157	*d*	40.000	C218
44162	*d*	41.275	C220
44348	*D*	88.501	C218,C220
L44610	*D*	50.292	C212
L44640	*d*	23.812	C212
L44643	*d*	25.400	C212
L44649	*d*	26.988	C212
45220	*D*	104.775	C226
45221	*D*	104.775	C226
45289	*d*	57.150	C226
L45410	*D*	50.292	C214
L45449	*d*	29.000	C214
46143	*d*	36.512	C218
46162	*d*	41.275	C220
46176	*d*	44.450	C220
46368	*D*	93.662	C218,C220
46720	*D*	225.425	C242
46780	*d*	158.750	C242
47420	*D*	120.000	C230,C232
47487	*d*	69.850	C230
47490	*d*	71.438	C232
47620	*D*	133.350	C232,C234
47680	*d*	76.200	C232
47685	*d*	82.550	C234
47686	*d*	82.550	C234
47687	*d*	82.550	C234
47820	*D*	146.050	C238
47890	*d*	92.075	C238
47896	*d*	95.250	C238
48120	*D*	161.925	C240
48190	*d*	107.950	C240
48220	*D*	182.562	C242
48282	*d*	120.650	C242
48286	*d*	123.825	C242
48290	*d*	127.000	C242
48320	*D*	190.500	C242
48385	*d*	133.350	C242
48393	*d*	136.525	C242
LM48510	*D*	65.088	C216
LM48511	*D*	65.088	C216
LM48548	*d*	34.925	C216
48620	*D*	200.025	C242
48685	*d*	142.875	C242
49175	*d*	44.450	C220
49176	*d*	44.450	C220
49368	*D*	93.662	C220
49520	*D*	101.600	C224

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
49585	*d*	50.800	C224
52387	*d*	98.425	C238
52393	*d*	100.012	C238
52400	*d*	101.600	C240
52618	*D*	157.162	C238,C240
52637	*D*	161.925	C238,C240
53150	*d*	38.100	C218
53162	*d*	41.275	C220
53176	*d*	44.450	C222
53177	*d*	44.450	C222
53178	*d*	44.450	C222
53375	*D*	95.250	C218,C222
53387	*D*	98.425	C220,C222
55175	*d*	44.450	C222
55187	*d*	47.625	C222
55200	*d*	50.800	C224
55200C	*d*	50.800	C224
55206	*d*	52.388	C224
55437	*D*	111.125	C222,C224
55443	*D*	112.712	C222
56418	*d*	106.362	C240
56425	*d*	107.950	C240
56650	*D*	165.100	C240
59200	*d*	50.800	C224
59429	*D*	108.966	C224
64433	*d*	109.992	C240
64450	*d*	114.300	C240
64700	*D*	177.800	C240
65200	*d*	50.800	C224
65212	*d*	53.975	C226
65237	*d*	60.325	C228
65320	*D*	114.300	C222
65385	*d*	44.450	C222
65500	*D*	127.000	C224,C226,C228
66187	*d*	47.625	C222
66462	*D*	117.475	C222
66520	*D*	122.238	C226,C228
66584	*d*	53.975	C226
66585	*d*	60.000	C228
66587	*d*	57.150	C226
LM67010	*D*	59.131	C212,C214
LM67043	*d*	28.575	C212
LM67048	*d*	31.750	C214
67320	*D*	203.200	C242
67322	*D*	196.850	C242
67388	*d*	127.000	C242
67389	*d*	130.175	C242
67390	*d*	133.350	C242
67720	*D*	247.650	C242,C244
67780	*d*	165.100	C242
67787	*d*	174.625	C244
67790	*d*	177.800	C244
67820	*D*	266.700	C244
67885	*d*	190.500	C244

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
67920	*D*	282.575	C244
67983	*d*	203.200	C244
67985	*d*	206.375	C244
L68110	*D*	59.131	C216
L68111	*D*	59.975	C216
L68149	*d*	35.000	C216
68450	*d*	114.300	C240
68462	*d*	117.475	C240
68709	*D*	180.000	C240
68712	*D*	180.975	C240
JL69310	*D*	63.000	C218
JL69349	*d*	38.000	C218
71412	*d*	104.775	C240
71425	*d*	107.950	C240
71437	*d*	111.125	C240
71450	*d*	114.300	C240
71453	*d*	115.087	C240
71750	*D*	190.500	C240
72187	*d*	47.625	C222
72200	*d*	50.800	C224
72200C	*d*	50.800	C224
72212	*d*	53.975	C226
72212C	*d*	53.975	C226
72218	*d*	55.562	C226
72218C	*d*	55.562	C226
72225C	*d*	57.150	C226
72487	*D*	123.825	C222,C224,C226
LM72810	*D*	47.000	C212
LM72849	*d*	22.606	C212
74500	*d*	127.000	C242
74525	*d*	133.350	C242
74537	*d*	136.525	C242
74550	*d*	139.700	C242
74850	*D*	215.900	C242
74856	*D*	217.488	C242
77375	*d*	95.250	C238
77675	*D*	171.450	C238
78225	*d*	57.150	C226
78250	*d*	63.500	C228
LM78310	*D*	62.000	C216
LM78310A	*D*	62.000	C216
LM78349	*d*	35.000	C216
78537	*D*	136.525	C228
78551	*D*	140.030	C226,C228
78571	*D*	144.983	C226
HM81610	*D*	47.000	C210
HM81649	*d*	16.000	C210
M84210	*D*	59.530	C212
M84249	*d*	25.400	C212
M84510	*D*	57.150	C212
M84548	*d*	25.400	C212
M86610	*D*	64.292	C212,C214
M86643	*d*	25.400	C212
M86647	*d*	28.575	C212

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
M86648A	*d*	30.955	C214
M86649	*d*	30.162	C214
M88010	*D*	68.262	C214,C216
M88043	*d*	30.162	C214
M88046	*d*	31.750	C214
M88048	*d*	33.338	C216
HM88510	*D*	73.025	C214,C216
HM88542	*d*	31.750	C214
HM88547	*d*	33.338	C216
HM88610	*D*	72.233	C212,C214,C216,C218
HM88630	*d*	25.400	C212
HM88638	*d*	32.000	C214
HM88648	*d*	35.717	C218
HM88649	*d*	34.925	C216
HM89410	*D*	76.200	C216,C218
HM89411	*D*	76.200	C216
HM89443	*d*	33.338	C216
HM89444	*d*	33.338	C216
HM89446	*d*	34.925	C216
HM89446A	*d*	34.925	C216
HM89449	*d*	36.512	C218
99100	*D*	254.000	C242
99550	*d*	139.700	C242
99575	*d*	146.050	C242
99587	*d*	149.225	C242
99600	*d*	152.400	C242
LM102910	*D*	73.431	C222
LM102949	*d*	45.242	C222
JLM104910	*D*	82.000	C224
LM104911	*D*	82.550	C224
LM104911A	*D*	82.550	C224
LM104912	*D*	82.931	C224
LM104947A	*d*	50.000	C224
JLM104948	*d*	50.000	C224
LM104949	*d*	50.800	C224
M201011	*D*	73.025	C218
M201047	*d*	39.688	C218
JM205110	*D*	90.000	C224
JM205149	*d*	50.000	C224
JM207010	*D*	95.000	C226
JM207049	*d*	55.000	C226
JH211710	*D*	120.000	C230
JH211749	*d*	65.000	C230
HM212010	*D*	122.238	C228,C230
HM212011	*D*	122.238	C228,C230
HM212044	*d*	60.325	C228
HM212046	*d*	63.500	C228
HM212047	*d*	63.500	C228
HM212049	*d*	66.675	C230
JH217210	*D*	150.000	C236
JH217249	*d*	85.000	C236
HM218210	*D*	147.000	C236
HM218248	*d*	90.000	C236
HH221410	*D*	190.500	C236,C238,C240

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
HH221432	*d*	87.312	C236
HH221434	*d*	88.900	C236
HH221440	*d*	95.250	C238
HH221442	*d*	98.425	C238
HH221447	*d*	99.982	C238
HH221449	*d*	101.600	C240
HH224310	*D*	212.725	C240
HH224335	*d*	101.600	C240
HH224340	*d*	107.950	C240
HH224346	*d*	114.300	C240
M224710	*D*	174.625	C242
M224748	*d*	120.000	C242
LL225710	*D*	165.895	C242
LL225749	*d*	127.000	C242
HM231110	*D*	236.538	C242
HM231140	*d*	146.050	C242
M236810	*D*	260.350	C244
M236849	*d*	177.800	C244
LM300811	*D*	68.000	C218
LM300849	*d*	41.000	C218
L305610	*D*	80.962	C224
L305649	*d*	50.800	C224
JH307710	*D*	110.000	C226
JH307749	*d*	55.000	C226
JHM318410	*D*	155.000	C236
JHM318448	*d*	90.000	C236
L327210	*D*	177.008	C242
L327249	*d*	133.350	C242
LM328410	*D*	187.325	C242
LM328448	*d*	139.700	C242
H414210	*D*	136.525	C230,C232
H414245	*d*	68.262	C230
H414249	*d*	71.438	C232
JH415610	*D*	145.000	C232
JH415647	*d*	75.000	C232
LM501310	*D*	73.431	C218
LM501314	*D*	73.431	C218
LM501349	*d*	41.275	C218
LM503310	*D*	75.000	C222
LM503349	*d*	46.000	C222
HH506310	*D*	114.300	C224
HH506348	*d*	49.212	C224
JLM506810	*D*	90.000	C226
JLM506849	*d*	55.000	C226
JLM508710	*D*	95.000	C228
JLM508748	*d*	60.000	C228
JM511910	*D*	110.000	C230
JM511946	*d*	65.000	C230
JM515610	*D*	130.000	C234
JM515649	*d*	80.000	C234
HM516410	*D*	133.350	C234
HM516448	*d*	82.550	C234
JHM516810	*D*	140.000	C236
JHM516849	*d*	85.000	C236

Designation INNER RING, OUTER RING	Nominal Dimension (mm) *d*:I.R. (Bore Dia.) *D*:O.R. (Outside Dia.)		Pages
HM518410	*D*	152.400	C236
HM518445	*d*	88.900	C236
LM522510	*D*	159.987	C240
LM522546	*d*	107.950	C240
LM522548	*d*	109.987	C240
LM522549	*d*	109.987	C240
JHM522610	*D*	180.000	C240
JHM522649	*d*	110.000	C240
JHM534110	*D*	230.000	C244
JHM534149	*d*	170.000	C244
LM603011	*D*	77.788	C222
LM603012	*D*	77.788	C222
LM603049	*d*	45.242	C222
L610510	*D*	94.458	C228
L610549	*d*	63.500	C228
JM612910	*D*	115.000	C232
JM612949	*d*	70.000	C232
LM613410	*D*	112.712	C230
LM613449	*d*	69.850	C230
HM617010	*D*	142.138	C236
HM617049	*d*	85.725	C236
L623110	*D*	152.400	C240
L623149	*d*	114.300	C240
JLM710910	*D*	105.000	C230
JLM710949	*d*	65.000	C230
JLM714110	*D*	115.000	C232
JLM714149	*d*	75.000	C232
JM714210	*D*	120.000	C232
JM714249	*d*	75.000	C232
H715311	*D*	136.525	C228,C230,C232
H715334	*d*	61.912	C228
H715340	*d*	65.088	C230
H715341	*d*	66.675	C230
H715343	*d*	68.262	C230
H715345	*d*	71.438	C232
JM716610	*D*	130.000	C236
JM716648	*d*	85.000	C236
JM716649	*d*	85.000	C236
JM718110	*D*	145.000	C236
JM718149	*d*	90.000	C236
JM719113	*D*	150.000	C238
JM719149	*d*	95.000	C238
JM720210	*D*	155.000	C238
JHM720210	*D*	160.000	C238
JM720249	*d*	100.000	C238
JHM720249	*d*	100.000	C238
JL724314	*D*	170.000	C242
JL724348	*d*	120.000	C242
JL725316	*D*	175.000	C242
JL725346	*d*	125.000	C242
JM734410	*D*	240.000	C244
JM734449	*d*	170.000	C244
JM738210	*D*	260.000	C244
JM738249	*d*	190.000	C244

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HM801310	*D*	82.550	C218
HM801346	*d*	38.100	C218
M802011	*D*	82.550	C220
M802048	*d*	41.275	C220
HM803110	*D*	88.900	C220
HM803145	*d*	41.275	C220
HM803146	*d*	41.275	C220
HM803149	*d*	44.450	C220
M804010	*D*	88.900	C222
M804049	*d*	47.625	C222
HM804810	*D*	95.250	C220,C222,C224
HM804840	*d*	41.275	C220
HM804843	*d*	44.450	C222
HM804846	*d*	47.625	C222
HM804848	*d*	48.412	C224
HM804849	*d*	48.412	C224
HM807010	*D*	104.775	C222,C224
HM807011	*D*	104.775	C224
JHM807012	*D*	105.000	C224
HM807040	*d*	44.450	C222
HM807044	*d*	49.212	C224
JHM807045	*d*	50.000	C224
HM807046	*d*	50.800	C224
JLM813010	*D*	110.000	C232
JLM813049	*d*	70.000	C232
JLM820012	*D*	150.000	C238
JLM820048	*d*	100.000	C238
JM822010	*D*	165.000	C240
JM822049	*d*	110.000	C240
JHM840410	*D*	300.000	C244
JHM840449	*d*	200.000	C244
HM903210	*D*	95.250	C222
HM903247	*d*	44.450	C222
HM903249	*d*	44.450	C222
HM911210	*D*	130.175	C226
HM911242	*d*	53.975	C226
H913810	*D*	146.050	C228,C230
H913842	*d*	61.912	C228
H913849	*d*	69.850	C230

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<As of December 2019>
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CAT. No. E1103b 2020 B-9 Printed in Japan First edition published in JAN. 2016